INTERCITY ORIGIN DESTINATION ESTIMATION WITH MULTI ROUTE TRIP ASSIGNMENT

by

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1.0 Introduction

Disaggregate studies of individual intercity trip makers are expensive and difficult to conduct. Consequently, not many such studies have been conducted, and intercity travel behaviour remains not nearly as well understood as urban travel behaviour. As a result, most of the behavioural postulates used in constructing predictive models are conjectural in nature and are validated empirically only in aggregate fashion.

As in urban transportation, the potential intercity traveler faces a series of choices concerning the various attributes of the trip (destination, route, time, etc.). In the demand analysis, it is implicity assumed that this choice process is simultaneous and consequently most intercity models are simultaneous demand models.

An Origin-destination matrix is the result of a large number of individual decisions of the travelling population. When we consider one set of such decisions, we obtain an O-D matrix. However, several such sets may also result in the same O-D matrix. In entropy maximisation method a trip matrix is obtained so that it is compatible with the available information (link volume counts and partial O-D results) which can be formed in the greatest number of ways.

Ratnayake (1988) showed that the solution to the above formulation can be expressed as;

$$Tij = tij \quad _{L} \quad nija/Kij \; ; \; ij \; w \qquad (1)$$

$$\text{where } nija = e^{-} \frac{1}{nijaL} \times e^{a} \qquad (2)$$

$$Kij = \quad _{a\,L} \quad nija \qquad (3)$$

Tij = Actual traffic between origin i and destination i
tij = the available a priori information
a = link volume number
L = number of link volume counts taken
$_{a}$ = the Lagrangian multipliers

2.0 Multi Route Trip Assignment

In most cases it is not sufficient to know the choice probabilities; one needs to estimate the volume of users on any transportation system. For this, the relationship between choice models end demand models must be explored. In general if it is known that N people are making a trip and that certain proportions of them are choosing certain routes, then it is possible to estimate the specific traffic volumes involved.

Ratnayake and Wirasinghe (1989) give an approximate method to determine intercity travel volumes in a multi route trip assignment. For intercity travel in Sri Lanka. Ratnayake and Wirasinghe (1989) gave the following multi route assignment model;

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$$N_{ijr} = \frac{e^{-0.9t_{ijr}}}{\underset{k.\ R_{ij}}{e^{-0.9t_{ijk}}}} \qquad (4)$$

where,

N_{ijr} = the proportion of traffic in route r for the O-D pair i-j

t_{ijr} = the travel time between the O-D pair i-j for the route r

t_{ijk} = the travel time between the O-D pair i-j for the route k

R_{ij} = the route taken by all i-j pairs in the system.

3.0 The Solution to the Maximum Entropy Multiproportional Model

If $X_a = e^{a}$ (5)

the equation (1) can be written in the form

$$T_{ij} = t_{ij} \quad a\ L \quad X_a^{n_{ija}} \qquad (6)$$

The volume V_a on link a is given by

$$V = \underset{(i,j)\ W}{T_{ij}} \ .\ n_{ija} \quad a\ L \qquad (7)$$

Marchland (1977) suggested the following iterative procedure to solve equations (6) and (7).

Step I

Determine the (n_{ija}) using a suitable route choice model (since the intercity roads in Sri Lanka are not congested), the all or nothing proportional assignment method can be adopted to determine the values for n_{ija} (1 or 0).

Step II

Adopt an initial value of t_{ij} using the following gravity of model.

$$t_{ij} = \frac{P_i^{\alpha_1} \quad P_j^{\alpha_2}}{(\text{time})_{ij}^{\alpha_3}} \qquad (8)$$

Where,

P_i = Urban Population of city i

$(\text{time})_{ij}$ = Minimum travel time from city i to city j

Since, in Sri Lanka almost all higher income groups are in the urban population, urban population or the number of cars in a city is more appropriate for the value of P in equation (8).

Suitable values of $\alpha 1$, $\alpha 2$, and $\alpha 3$ are then assumed, from available literature.

Step III

Take one link from an observed link in set L and calculate its synthesised flow;

$\hat{V}_a^m$ in iteration m

Hence,

$$\hat{V}_a^m = \sum T_{ij}^m \ .\ n_{ij} \qquad (9)$$

Step IV

Set

$$Y_a = \frac{V_a}{\hat{V}_a^m} \qquad (10)$$

and

$$X_a^{m+1} \quad X_a^m \ .\ Y_a$$

Step V

Modify all T_{ij} values using the selected link by the following equation, and assuming

$X_a^m = 1$ and $T_{ij}^m = t_{ij}$ for $m = 0$

$$T_{ij}^{m+1} = T_{ij}^m . \quad a\ L \quad X_a^{n_{ija}}$$

Step VI

Set

$$m = m + 1 \qquad (12)$$

If the observed link list has not been exhausted, or at least one Y_a does not meet the following convergence criterion,

$$Y_a = 1 \pm \delta \qquad (13)$$

(δ can be 0.01 to 0.05)

Repeat Steps III to V

If the list is exhausted and all Y_a meet the convergence criteria (13), the calculations are stopped.

A computer algorithm was written for the above solution and the details of the programme are available in the User's Manual by Ratnayake et al (1986).

Once, the convergence has taken place, it is possible to determine all the Tij values. A matrix showing the names of cities and the intercity estimated trips are finally produced using the above computer algorithm.

4.0 Origin-Destination Results

The Origin-destination matrix for intercity auto travel for Sri Lanka with initial values of tij (equation (8)) with typical values of $\alpha 1 = \alpha 2 = 1$ and $\alpha 3 = 2$ and using the maximum entropy model (1) subjected to (2) and (3) is given in Table 1 for all or nothing route choice model.

Nguyen (1984) reported that the accuracy of the resulting trip estimates is depended and in many occasions highly sensitive to the priori information contained in the reference input trip matrix $(tij)_w$. Therefore the initial values $(tij)_w$ are now varied and a new origin-destination matrix is obtained.

The following demand model was developed by Ratnayake (1988) to estimate intercity auto travel in Sri Lanka, for all or nothing assignment model.

$$Tij = 2.43 \times 10^{-3} \frac{Pi\ Pj}{tij^{2.35}} + 7.64 \qquad (14)$$

The origin-destination matrix obtained using the demand model (14) is given in Table 2.

The minimum number of auto trips between any two cities using the demand model (14) is 7. However, when the maximum entropy formation is used even low values like zero for some intercity travel is possible. Since the car ownership in Sri Lanka is very low (about 1 car per 100 persons) and auto travel cost are very high relative to income, the very low trip numbers like one (1) or zero (0) intercity auto travel is not impossible. Apart from this main difference at very low values, the trip values obtained using the two methods are compatible.

The establishment of origin-destination proportions (Nija) in various links using a logit type route choice model is more appropriate for Sri Lanka. The maximum entropy model was then run for logit route choice model. The intercity trip matrix for this model is given in Table 3.

Ratnayake (1988) showed that the district car ownership in Sri Lanka is directly proportional to the urban population in a district. Hence, the maximum entropy model was run with a typical gravity model with district car ownerships instead of the urban population for all or nothing and logit route choice models separately. The results are given in Table 4 and Table 5 respectively. The O-D data from Colombo to Kandy, Galle, Jaffna etc. is given in Figure 1.

5.0 Maximum Entropy Model with Partial Data

The maximum entropy based models have the advantage of using any partial information about the origin-destination surveys. Also, it can make use of an available origin-destination matrix and produce the new O-D matrix if there had not been changes in travel pattern between the two time, periods, and if the link volumes are known.

A feasibility study on the Colombo-Katunayake (Airport) Expressway was done in 1983 by the (JICA) Japan International Cooperation Agency (1984). For this purpose

Table .1 - Origin Destintantion Matrix with initial $t_{ij} = \dfrac{P_i P_j}{(\text{time})_{ij}^2}$

	Ampa	Anur	Badu	Batt	Colo	Gall	Hamb	Jaff	Kalu	Kand	Kega	Kuru	Mann	Mtle	Mata	Mona	Mull	Nuwa	Para	Poll	Putt	Ratn	Trin	Vavu	Jael
Amp	0	0	24	454	0	0	16	0	0	229	0	0	0	0	0	NE	0	0	0	0	0	7	1	0	0
Anu	0	0	0	4	200	0	0	9	9	93	11	49	NE	82	0	0	43	0	61	213	60	0	81	NE	39
Bad	24	0	0	241	158	0	174	0	0	181	0	23	0	0	4	134	0	186	0	16	0	17	121	0	0
Bat	454	4	241	0	0	0	1	0	0	1	0	1	0	2	0	58	0	0	0	78	0	0	297	1	0
Col	0	200	158	0	0	1,385	238	0	NE	29	1,359	853	14	0	0	118	0	634	0	0	NE	NE	2	54	NE
Bal	0	0	0	0	1,385	0	1	0	275	0	0	0	0	0	941	0	0	0	0	0	11	0	0	0	173
Ham	16	0	174	1	238	1	0	0	0	0	0	0	0	0	829	46	0	67	0	0	4	32	0	0	34
Jaf	0	9	0	0	0	0	0	0	0	0	0	0	147	0	0	0	163	0	573	0	0	0	0	7	0
Kal	0	9	0	0	NE	275	0	0	0	1	37	28	1	0	0	0	0	29	0	0	NE	590	0	3	NE
Kan	229	93	181	1	29	0	0	0	1	0	1,332	NE	5	1,154	0	0	0	431	0	87	191	1	425	22	5
Keg	0	11	0	0	1,359	0	0	0	37	1,332	0	NE	1	0	0	0	0	0	0	10	23	42	49	2	257
Kur	0	49	23	1	853	0	0	0	28	NE	NE	0	2	82	0	0	0	41	0	46	101	53	188	9	156
Man	0	NE	0	0	14	0	0	147	1	5	1	2	0	3	0	0	NE	0	NE	7	1	0	5	NE	3
Mtl	0	82	0	2	0	0	0	0	0	1,154	0	82	3	0	0	0	0	0	0	77	0	0	337	16	0
Mat	0	0	4	0	0	941	829	0	0	0	0	0	0	0	0	1	0	2	0	0	0	NE	0	0	0
Mon	NE	0	134	58	118	0	46	0	0	0	0	0	0	0	1	0	0	0	0	0	0	12	0	0	17
Mul	0	43	0	0	0	0	0	163	0	0	0	0	NE	0	0	0	0	0	NE	0	0	0	0	51	0
Nuw	0	0	186	0	634	0	67	0	29	431	0	41	0	0	2	0	0	0	0	0	0	9	0	0	0
Par	0	61	0	0	0	0	0	573	0	0	0	0	NE	0	0	0	NE	0	0	0	0	0	0	78	0
Pol	0	213	16	78	0	0	0	0	0	87	10	46	7	77	0	0	0	0	0	0	0	0	NE	39	0
Put	0	60	0	0	NE	11	4	0	NE	191	23	101	1	0	0	0	0	0	0	0	0	NE	0	8	NE
Rat	7	0	17	0	NE	0	32	0	590	1	42	53	0	0	NE	12	0	9	0	0	NE	0	0	0	NE
Tri	1	81	121	297	2	0	0	0	0	425	49	188	5	337	0	0	0	0	0	NE	0	0	0	59	0
Vau	0	NE	0	1	54	0	0	7	3	22	2	9	NE	16	0	0	51	0	78	39	8	0	59	0	10
Jael	0	39	0	0	NE	173	34	0	NE	5	257	156	3	0	0	17	0	0	0	0	NE	NE	0	10	0

Table 2 - Origin Destintantion Matrix with initial $t_{ij} = 2.43\times10^{-3}\,\dfrac{P_iP_j + 7.64}{10^{-2.35}}$

	Ampa	Anur	Badd	Batt	Colo	Gall	Hamb	Jaff	Kalu	Kand	Kega	Kuru	Mann	Mtle	Mata	Mona	Mull	Nuwa	Para	Poll	Putt	Ratn	Trin	Vavu	Jael
Amp	0	0	18	462	0	0	13	0	0	230	0	0	0	0	2	NE	0	0	0	0	0	6	4	0	0
Anu	0	0	0	14	189	0	0	32	8	90	11	55	NE	85	0	0	30	0	43	207	82	0	78	NE	39
Bad	18	0	0	234	154	0	162	0	0	179	0	20	0	0	15	140	0	185	0	9	0	20	106	0	0
Bat	462	14	234	0	0	0	3	0	0	6	1	4	1	6	0	44	0	1	0	62	0	0	308	3	0
Col	0	189	154	0	0	1351	233	1	NE	101	1285	844	11	0	2	117	1	617	1	2	NE	NE	10	47	NE
Gal	0	0	0	0	1351	0	2	0	323	0	0	0	0	0	938	0	0	0	0	0	8	1	0	0	160
Ham	13	0	162	3	233	2	0	0	0	2	0	0	0	0	807	47	0	56	0	0	3	38	0	0	32
Jaf	0	32	0	0	1	0	0	0	0	0	0	0	113	0	0	0	139	0	585	0	0	0	0	28	0
Kal	0	8	0	0	NE	323	0	0	0	3	30	25	1	0	0	0	0	26	0	0	NE	588	0	2	NE
Kan	230	90	179	6	101	0	2	0	3	0	1238	NE	4	1168	0	0	0	433	0	87	181	5	395	19	18
Keg	0	11	0	1	1285	0	0	0	30	1238	0	NE	0	0	0	0	0	1	0	11	23	52	47	2	249
Kur	0	55	20	4	844	0	0	0	25	NE	NE	0	1	68	0	0	0	36	0	54	111	58	196	9	157
Man	0	NE	0	1	11	0	0	113	1	4	0	1	0	3	0	0	NE	0	NE	5	1	0	4	NE	2
Mtl	0	85	0	6	0	0	0	0	0	1168	0	68	3	0	0	0	0	0	0	82	0	0	327	15	0
Mat	2	0	15	0	2	938	807	0	0	0	0	0	0	0	0	3	0	7	0	0	0	NE	0	0	0
Mon	NE	0	140	44	117	0	47	0	0	0	0	0	0	0	3	0	0	0	0	0	0	14	0	0	17
Mul	0	30	0	0	1	0	0	139	0	0	0	0	NE	0	0	0	0	0	NE	0	0	0	0	42	0
Nuw	0	0	185	1	617	0	56	0	26	433	1	36	0	0	7	0	0	0	0	0	0	10	1	0	0
Par	0	43	0	0	1	0	0	585	0	0	0	0	NE	0	0	0	NE	0	0	0	0	0	0	67	0
Pol	0	207	9	62	2	0	0	0	0	87	11	54	5	82	0	0	0	0	0	0	0	0	NE	32	0
Put	0	82	0	0	NE	8	3	0	NE	181	23	111	1	0	0	0	0	0	0	0	0	NE	0	9	NE
Rat	6	0	20	0	NE	1	38	0	588	5	52	58	0	0	NE	14	0	10	0	0	NE	0	1	0	NE
Tri	4	78	106	308	10	0	0	0	0	395	47	1196	4	327	0	0	0	1	0	NE	0	1	0	62	2
Vau	0	NE	0	3	47	0	0	28	2	19	2	9	NE	15	0	0	42	0	67	32	9	0	62	0	9
Jael	0	39	0	0	NE	160	32	0	NE	18	249	157	2	0	0	17	0	0	0	0	NE	NE	2	9	0

Table 3 - The O-D Trip Matrix For Maximum Entropy Model and Logit Route Choice Model

	Ampa	Anur	Badu	Batt	Colo	Gall	Hamb	Jaff	Kalu	Kand	Kega	Kuru	Mann	Mtle	Mata	Mona	Mull	Nuwa	Para	Poll	Putt	Ratn	Trin	Vavu	Jael
Amp	0	0	399	NE	0	0	NE	0	0	2	0	0	0	0	211	NE	0	0	0	5	0	84	125	0	0
Anu	0	0	0	0	7	0	0	0	0	26	11	1204	NE	54	0	0	383	0	NE	NE	NE	0	290	NE	0
Bad	399	0	0	NE	0	0	NE	0	0	0	0	0	0	.0	3	NE	0	NE	0	0	2	704	747	0	0
Bat	NE	0	NE	0	0	0	308	0	0	27	0	57	0	43	1	101	0	22	0	NE	0	13	NE	0	0
Col	0	7	0	0	0	1038	283	0	NE	0	3137	1837	0	0	231	94	0	0	0	0	NE	1995	0	0	NE
Bal	0	0	0	0	1038	0	493	0	NE	0	17	11	0	0	NE	0	0	0	0	0	13	28	0	0	247
Ham	NE	0	NE	308	283	493	0	0	224	0	26	0	0	0	NE	84	0	0	0	0	14	89	0	0	173
Jaf	0	0	0	0	0	0	0	0	0	0	0	0	252	0	0	0	226	0	NE	0	0	0	1	421	0
Kal	0	0	0	0	NE	NE	224	0	0	0	NE	NE	23	0	69	0	12	0	10	0	NE	NE	0	49	NE
Kan	2	26	0	27	0	0	0	0	0	0	NE	NE	0	NE	0	264	0	NE	0	21	NE	309	60	0	0
Keg	0	11	0	0	3137	17	26	0	NE	NE	0	NE	0	676	0	0	0	329	0	0	240	NE	0	0	0
Kur	0	1204	0	57	1837	11	0	0	NE	NE	NE	0	61	NE	0	0	1	29	0	72	NE	NE	171	22	0
Man	0	NE	0	0	0	0	0	252	23	0	0	61	0	NE	0	0	NE	0	NE	NE	.NE	0	NE	NE	0
Mtl	0	54	0	43	0	0	0	0	0	NE	676	NE	NE	0	0	0	0	1124	0	119	97	3	302	2	0
Mat	211	0	3	1	231	NE	NE	0	69	0	0	0	0	0	0	0	0	0	0	0	3	NE	0	0	43
Mon	NE	0	NE	101	94	0	84	0	0	264	0	0	0	0	0	0	0	232	0	1	6	54	17	0	0
Mul	0	383	0	0	0	0	0	226	12	0	0	1	NE	0	0	0	0	0	NE	0	10	0	20	NE	0
Nuw	0	0	NE	22	0	0	0	0	0	NE	329	29	0	1124	0	232	0	0	0	0	458	1210	0	0	0
Par	0	NE	0	0	0	0	0	0	10	0	0	0	NE	0	0	0	NE	0	0	1	8	0	17	NE	0
Pol	5	NE	0	NE	0	0	0	0	0	21	0	72	NE	119	0	1	0	0	1	0	3	20	NE	10	0
Put	0	NE	2	0	NE	13	14	0	NE	NE	240	NE	NE	97	3	6	10	458	8	3	0	NE	192	82	NE
Rat	84	0	704	13	1995	28	89	0	NE	309	NE	NE	0	3	NE	54	0	1210	0	20	NE	0	0	0	1
Tri	125	290	747	NE	0	0	0	1	0	60	0	171	NE	302	0	17	20	0	17	NE	192	0	0	NE	0
Vau	0	NE	0	0	0	0	0	421	49	0	0	22	NE	2	0	0	NE	0	NE	10	82	0	NE	0	0
Jael	0	0	0	0	NE	247	173	0	NE	0	0	0.	0	0	43	0	0	0	0	0	NE	1	0	0	0

Table .4 - Origin Destintantion Matrix with initial $t_{ij} = \frac{C_iC_j}{(time)^2_{ij}}$ for all or nothing assignment model

	Ampa	Anur	Badd	Batt	Colo	Gall	Hamb	Jaff	Kalu	Kand	Kega	Kuru	Mann	Mtle	Mata	Mona	Mull	Nuwa	Para	Poll	Putt	Ratn	Trin	Vavu	Jael
Amp	0	0	24	454	0	0	16	0	0	229	0	0	0	0	0	NE	0	0	0	0	0	7	1	0	0
Anu	0	0	0	4	200	0	0	9	9	93	11	49	NE	82	0	0	43	0	61	213	60	0	81	NE	39
Bad	24	0	0	241	158	0	174	0	0	181	0	23	0	0	4	134	0	186	0	16	0	17	121	0	0
Bat	454	4	241	0	0	0	1	0	0	1	0	1	0	2	0	58	0	0	0	78	0	0	297	1	0
Col	0	200	158	0	0	1358	238	0	NE	29	1359	330	14	0	0	118	0	634	0	0	210	NE	2	54	NE
Bal	0	0	0	0	1358	0	1	0	275	0	0	0	0	0	941	0	0	0	0	0	11	0	0	0	173
Ham	16	0	174	1	238	1	0	0	0	0	0	0	0	0	829	46	0	67	0	0	4	32	0	0	34
Jaf	0	9	0	0	0	0	0	0	0	0	0	0	147	0	0	0	163	0	573	0	0	0	0	7	0
Kal	0	9	0	0	NE	275	0	0	0	1	37	28	1	0	0	0	0	29	0	0	NE	590	0	3	NE
Kan	229	93	181	1	29	0	0	0	1	0	1332	NE	5	1154	0	0	0	431	0	87	191	1	425	22	5
Keg	0	11	0	0	1359	0	0	0	37	1332	0	NE	1	0	0	0	0	0	0	10	23	42	49	2	257
Kur	0	49	23	1	330	0	0	0	28	NE	NE	0	2	82	0	0	0	41	0	46	101	53	188	9	156
Man	0	NE	0	0	14	0	0	147	1	5	1	2	0	3	0	0	NE	0	NE	7	1	0	5	NE	3
Mtl	0	82	0	2	0	0	0	0	0	1154	0	82	3	0	0	0	0	0	0	77	0	0	337	16	0
Mat	0	0	4	0	0	941	829	0	0	0	0	0	0	0	0	1	0	2	0	0	0	NE	0	0	0
Mon	NE	0	134	58	118	0	46	0	0	0	0	0	0	0	1	0	0	0	0	0	0	12	0	0	17
Mul	0	43	0	0	0	0	0	163	0	0	0	0	NE	0	0	0	0	0	NE	0	0	0	0	51	0
Nuw	0	0	186	0	634	0	67	0	29	431	0	41	0	0	2	0	0	0	0	0	0	9	0	0	0
Par	0	61	0	0	0	0	0	573	9	0	0	0	NE	0	0	0	NE	0	0	0	0	0	0	78	0
Pol	0	213	16	78	0	0	0	0	9	87	10	46	7	77	0	0	0	0	0	0	0	0	NE	39	0
Put	0	60	0	0	210	11	4	0	NE	191	23	101	1	0	0	0	0	0	0	0	0	NE	0	8	NE
Rat	7	0	17	0	NE	0	32	0	590	1	42	53	0	0	NE	12	0	9	0	0	NE	0	0	0	NE
Tri	1	81	121	297	2	0	0	0	0	425	49	188	5	337	0	0	0	0	0	NE	0	0	0	59	0
Vau	0	NE	0	1	54	0	0	7	3	22	2	9	NE	16	0	0	51	0	78	39	8	0	59	0	10
Jael	0	39	0	0	NE	173	34	0	NE	5	257	156	3	0	0	17	0	0	0	0	NE	NE	0	10	0

$$\frac{C_i C_j}{(time)^2_{ij}}$$

Table 5 - Origin Destintantion Matrix with initial tij = (time)2 with Logit Route Choice Model

	Ampa	Anur	Badu	Batt	Colo	Gall	Hamb	Jaff	Kalu	Kand	Kega	Kuru	Mann	Mtle	Mata	Mona	Mull	Nuwa	Para	Poll	Putt	Ratn	Trin	Vavu	Jael
Amp	0	8	9	17	13	8	8	8	8	10	8	8	8	8	8	8	8	8	8	8	8	8	8	8	9
Anu	8	0	9	11	89	10	8	18	11	30	10	22	9	17	9	8	8	9	9	10	43	10	22	34	24
Bad	9	9	0	14	63	14	12	9	12	35	9	11	8	11	13	21	8	46	8	8	9	15	9	8	16
Bat	17	11	14	0	41	9	8	10	9	18	8	11	8	10	9	8	8	10	8	11	9	9	12	8	13
Col	13	89	63	41	0	816	37	66	4,871	937	297	337	12	124	249	15	10	76	11	20	240	471	73	28	120,622
Bal	8	10	14	9	816	0	22	11	201	27	11	13	8	11	526	9	8	10	8	8	13	23	10	8	103
Ham	8	8	12	8	37	22	0	8	11	10	8	8	8	8	33	9	8	9	8	8	8	13	8	8	12
Jaf	8	18	9	10	66	11	8	0	11	19	9	11	11	11	9	8	12	9	24	8	13	10	17	17	18
Kal	8	11	12	9	4,871	201	11	11	0	39	14	17	8	12	47	8	8	11	8	8	15	51	11	9	391
Kan	10	30	35	18	937	27	10	19	39	0	130	249	9	537	16	10	8	62	8	11	30	31	24	12	177
Keg	8	10	9	8	297	11	8	9	14	130	0	58	8	15	9	8	8	10	8	8	10	13	10	8	64
Kur	8	22	11	11	337	13	8	11	17	249	58	0	8	38	10	8	8	12	8	10	21	14	16	10	69
Man	8	9	8	8	12	8	8	11	8	9	8	8	0	8	8	8	8	8	8	8	8	8	8	9	8
Mtl	8	17	11	10	124	11	8	11	12	537	15	38	8	0	9	8	8	13	8	9	12	11	14	9	28
Mat	8	9	13	9	249	526	33	9	47	16	9	10	8	9	0	9	8	10	8	8	10	17	9	8	39
Mon	8	8	21	8	15	9	9	8	8	10	8	8	8	8	9	0	8	9	8	8	8	9	8	8	9
Mul	8	8	8	8	10	8	8	12	8	8	8	8	8	8	8	8	0	8	9	8	8	8	8	9	8
Nuw	8	9	46	10	76	10	9	9	11	62	10	12	8	13	10	9	8	0	8	8	9	11	9	8	19
Par	8	9	8	8	11	8	8	24	8	8	8	8	8	8	8	8	9	8	0	8	8	8	9	9	8
Pol	8	10	8	11	20	8	8	8	8	11	8	10	8	9	8	8	8	8	8	0	8	8	10	8	10
Put	8	43	9	9	240	13	8	13	15	30	10	21	8	12	10	8	8	9	8	8	0	10	12	12	61
Rat	8	10	15	9	471	23	13	10	51	31	13	14	8	11	17	9	8	11	8	8	10	0	9	8	60
Tri	8	22	9	12	73	10	8	17	11	24	10	16	8	14	9	8	8	9	9	10	12	9	0	19	19
Vau	8	34	8	8	28	8	8	17	9	12	8	10	9	9	8	8	9	8	9	8	12	8	19	0	12
Jael	9	24	16	13	120,622	103	12	18	391	177	64	69	8	28	39	9	8	19	8	10	61	60	19	12	0

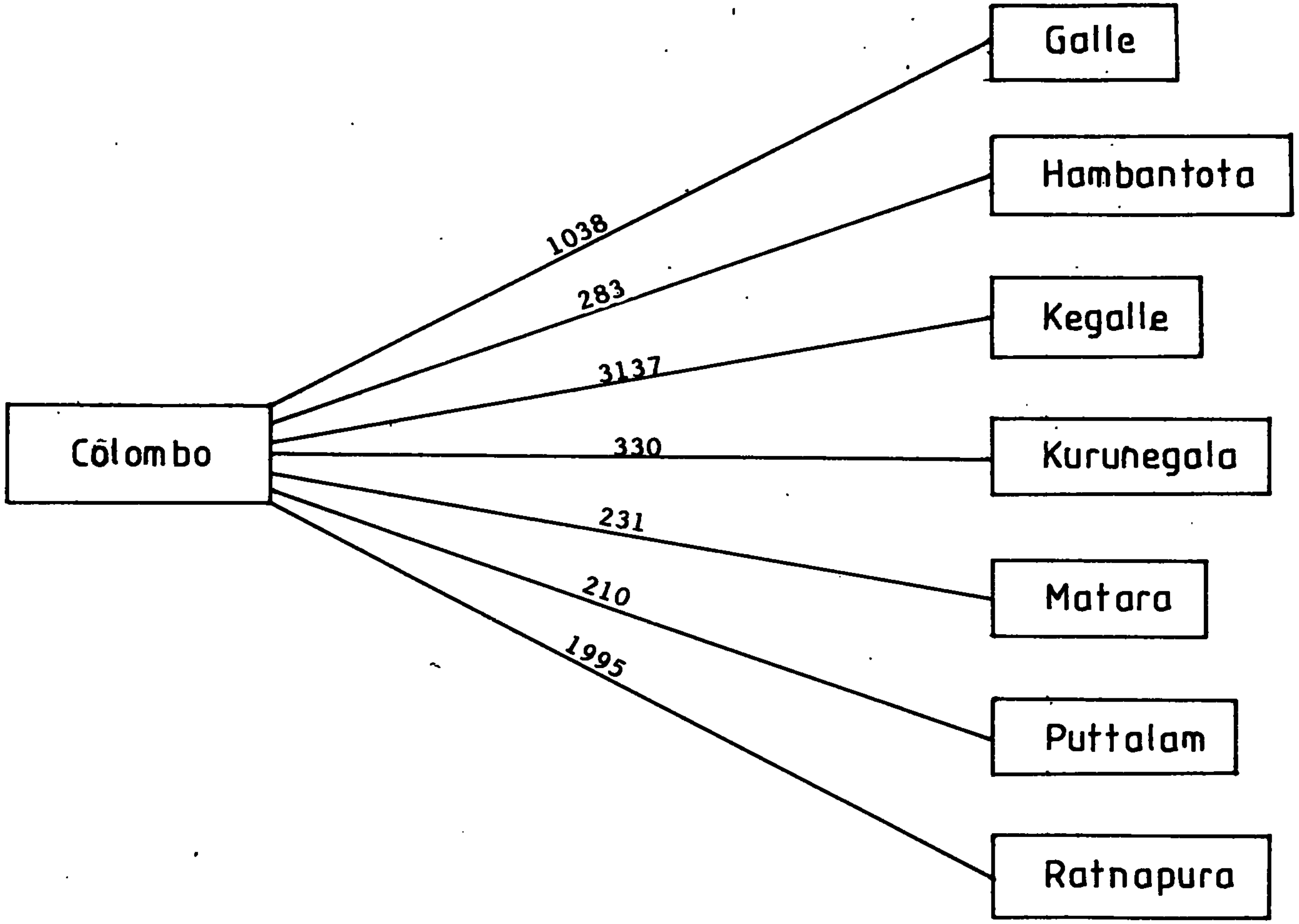

Fig. 1 - Some Origin - Destination Results (Bothways) for Maximum Entropy Model with Logit Route Choice Model

an origin-destination survey was carried out in Colombo during one day. Consequently, limited information about some origin-destination pairs are available for 1983. Using the traffic growth model suggested by JICA (1984), the estimated origin-destination values for base year 1984 are given in Table 6.

The origin-destination matrix using the information available in Table 6, and using the maximum entropy model (1) is given in Table 7.

6.0 Comparison of Results

The comparison of origin-destination results obtained using initial trip values from equations (8) (with $\alpha_1 = \alpha_2 = 1$, $\alpha_3 = 2$) and the demand model (14) (with $\alpha_1 = \alpha_2$ $\alpha_3 = 2.35$ etc.) show some difference. The comparison of values obtained from these two methods with the actual data from JICA (1984) survey is given below in the Table 8.

The demand model values give better O-D estimates as the priori O-D information is very limited.

7.0 Conclusions

a) Intercity Origin-Destination trip estimation using link volume data with all or nothing trip assignment gives only approximate results. When the above estimation is carried out with multi route trip assignment model (logit type) it gives better results.

b) Intercity Origin-Destination trip estimation for Sri Lanka with a simple demand model give better results than the entropy maximisation model. This may be due to the non availability of origin destination information for Sri Lanka.

c) The Origin-Destination results can be used to plan new highway networks, feasibility studies in the establishment of new highways, planning of by-pass roads to take away intercity traffic from all purpose roads etc.

For example the above models can be used to estimate traffic intercity traffic in all the 'A' Class roads. The intercity traffic volume in a link or links can be determined from the matrices in Tables 1 to 5 or Table 7. When this volume is removed from the total volume, the local traffic volume can be determined. Thus the feasibility of constructing a by pass road to take away the intercity traffic can be established.

8.0 References

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d) Ratnayake, L.L., Roose R., and Mc leod S., (1986), "User Manual for the Computer Algorithm on Route Choice Analysis and Trip Estimation", Research Publication # CE 86-8, The Department of Civil Engineering, The University of Calgary, Canada, 110p. May, 1986.

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TABLE 6

O-D DATA

City Pairs Origin-Destination Values

		Actual Survey Values (1983)	Estimated Values (1984)
(a)	Colombo - Puttalam	192	200
(b)	Colombo - Kurunegala	312	330

Table 7 - The O-D Trip Matrix For Maximum Entropy Model and Logit Route Choice Fixing Colombo-Puttalam and Colombo-Kurunegala Trip Values

	Ampa	Anur	Badu	Batt	Colo	Gall	Hamb	Jaff	Kalu	Kand	Kega	Kuru	Mann	Mtle	Mata	Mona	Mull	Nuwa	Para	Poll	Putt	Ratn	Trin	Vavu	Jael
Amp	0	0	399	NE	0	0	NE	0	0	2	0	0	0	0	211	NE	0	0	0	5	0	84	125	0	0
Anu	0	0	0	0	7	0	0	0	0	26	11	1204	NE	54	0	0	383	0	NE	NE	NE	0	290	NE	0
Bad	399	0	0	NE	0	0	NE	0	0	0	0	0	0	0	3	NE	0	NE	0	0	2	704	747	0	0
Bat	NE	0	NE	0	0	0	308	0	0	27	0	57	0	43	1	101	0	22	0	NE	0	13	NE	0	0
Col	0	7	0	0	0	1038	283	0	NE	0	3137	330	0	0	231	94	0	0	0	0	210	1995	0	0	NE
Bal	0	0	0	0	1038	0	493	0	NE	0	17	11	0	0	NE	0	0	0	0	0	13	28	0	0	247
Ham	NE	0	NE	308	283	493	0	0	224	0	26	0	0	0	NE	84	0	0	0	0	14	89	0	0	173
Jaf	0	0	0	0	0	0	0	0	0	0	0	0	252	0	0	0	226	0	NE	0	0	0	1	421	0
Kal	0	0	0	0	NE	NE	224	0	0	0	NE	NE	23	0	69	0	12	0	10	0	NE	NE	0	49	NE
Kan	2	26	0	27	0	0	0	0	0	0	NE	NE	0	NE	0	264	0	NE	0	21	NE	309	60	0	0
Keg	0	11	0	0	3137	17	26	0	NE	NE	0	NE	0	676	0	0	0	329	0	0	240	NE	0	0	0
Kur	0	1204	0	57	330	11	0	0	NE	NE	NE	0	61	NE	0	0	1	29	0	72	NE	NE	171	22	0
Man	0	NE	0	0	0	0	0	252	23	0	0	61	0	NE	0	0	NE	0	NE	NE	NE	0	NE	NE	0
Mtl	0	54	0	43	0	0	0	0	0	NE	676	NE	NE	0	0	0	0	1124	0	119	97	3	302	2	0
Mat	211	0	3	1	231	NE	NE	0	69	0	0	0	0	0	0	0	0	0	0	0	3	NE	0	0	43
Mon	NE	0	NE	101	94	0	84	0	0	264	0	0	0	0	0	0	0	232	0	1	6	54	17	0	0
Mul	0	383	0	0	0	0	0	226	12	0	0	1	NE	0	0	0	0	0	NE	0	10	0	20	NE	0
Nuw	0	0	NE	22	0	0	0	0	0	NE	329	29	0	1124	0	232	0	0	0	0	458	1210	0	0	0
Par	0	NE	0	NE	0	0	0	NE	10	0	0	0	NE	0	0	0	NE	0	0	1	8	0	17	NE	0
Pol	5	NE	0	0	0	0	0	0	0	21	0	72	NE	119	0	1	0	0	1	0	3	20	NE	10	0
Put	0	NE	2	13	210	13	14	0	NE	NE	240	NE	NE	97	3	6	10	458	8	3	0	NE	192	82	NE
Rat	84	0	704	NE	1995	28	89	0	NE	309	NE	NE	0	3	NE	54	0	1210	0	20	NE	0	0	0	1
Tri	125	290	747	0	0	0	0	1	0	60	0	171	NE	302	0	17	20	0	17	NE	192	0	0	NE	0
Vau	0	NE	0	0	0	0	0	421	49	0	0	22	NE	2	0	0	NE	0	NE	10	82	0	NE	0	0
Jael	0	0	0		NE	247	173	0	NE	0	0	0	0	0	43	0	0	0	0	0	NE	1	0	0	0

TABLE 8

Comparison O-D Values for 1984

City Pair(s)	Actual One Day Values (Both Ways (Table 2)	Values from the Demand Model	Values from the Entropy Model (Table 3)
(a) Colombo - Puttalam	220	240	Not estimated
(b) Colombo - Kurunegala	330	337	500
(c) Colombo- Anuradhapura, Jaffna, Mannar, Mullaitivu, Vavuniya, Killinochchi	285	216	323

f) Ratnayake, L.L. and Wirasinghe S.C. (1989), "Demand Estimation for Auto Travel from Link Volume Counts - Intercity Passenger Travel in Sri Lanka", Vol. III, Research Report # CE 89-1, 120p. May 1989.

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