EFFECTIVENESS OF EN-ROUTE TRAFFIC INFORMATION SERVICE FOR VARIOUS NETWORK STRUCTURE AND CONGESTION LEVEL

Joong Rae CHO
Professor
Department of Transportation Engineering
Myongji University
San 38-2 NamDong Yongin Kyunggido, Korea
Fax: +82-31-336-2885
E-mail: jrcho@wh.myongji.ac.kr

Young Tae SON
Professor
Department of Transportation Engineering
Myongji University
San 38-2 NamDong Yongin Kyunggido, Korea
Fax: +82-31-336-2885
E-mail: son@wh.myongji.ac.kr

Young Suk HONG
Ph.D Candidate
Department of Transportation Engineering
Myongji University
San 38-2 NamDong Yongin Kyunggido, Korea
Fax:+82-31-336-2885
E-mail: yshong@wh.myongji.ac.kr

Abstract : Recently several transportation engineers and planners argue against ATIS, especially against "en-route traffic information service". The main content of the arguments is that social benefit from en-route traffic information service is not clear, since there are so many factors affecting on the outcome of en-route traffic information service; degree of information, type of information, spatial structure of road network, level of congestion, patterns of spatial distribution of travel demand, behavioral response to such information, etc. This paper discusses outcomes of en-route traffic information service for answering what-if questions associated the above factors.

Key Words: En-route traffic information, ATIS, Time Dependent Traffic Assignment

1. INTRODUCTION

Recently, in the US, Europe, Japan and Korea, there are increasing interests on policy and support on ITS. Already, a number of developments is completed in several advanced countries that the on-site experiment and test operation are undertaken. However, Korea has not been able to make full scale policy and technology development of the ITS fields, but it is expected to have full-blown investment before long. However, before such a large-scale investment is made, there are a number of problems that must be reviewed.

Especially, many opinions for effectiveness have been presented in connection with the traffic information service among ITS. Accordingly, there is a necessity to evaluate the magnitude and durability for effectiveness of traffic information service through the practical field test or simulation under a variety of transportation environment. In accordance with the realistic need, there have developed many researches and various models to analyze the effectiveness of traffic information service until now. But most of those efforts are not suitable to apply to actual network, because those are models of experimental property test suited for small-scale network.

On this point, this research is to develop a model to simulate a variety of phenomenon and to analyze effectiveness as en-route traffic information service in large-scale network After the model computerization, effectiveness of traffic information service

will be analyzed in various cases through simulation and case study. For that purpose, pseudo-dynamic traffic assignment based on incremental traffic assignment had developed, and this model was named "Time-Dependent Assignment: TDA"
To simulate effectiveness of traffic information service with TDA, there are scenarios composed based on network type, network size, trip distribution, level of congestion, degree of information service, and simulation for each scenario. Also, to study the possibility of effect-analysis of traffic information service for real network, the case studies for en-route traffic information service are performed with Suwon City network.

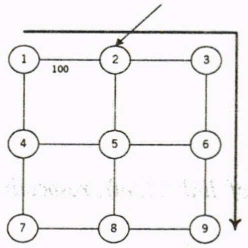
2. TIME DEPENDENT TRAFFIC ASSIGNMENT(TDA)

2.1 Concept of TDA

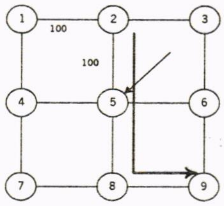
The TDA model is a time-dependent traffic assignment model that has the concept that the driver changes the travel route by given information in response to change of traffic condition with time.
The TDA model is not a complete dynamic model, nor is the static model, but it is an intermediate model. As described previously, because of consideration for dynamic characteristics of all drivers, it is difficult to apply complete dynamic model in real network. On the other hand, the TDA model is less constraint than dynamic model in terms of network size, on the other hand, that is less sufficient than the illustration of dynamic traffic behavior, because all drivers are included in one increment that is not dealt with individually but on the whole in the TDA model. Therefore, this model has an advantage in affording simulation on various cases including the actual network.
The TDA model has the following procedures. Traffic volume is assigned to a link directly connected to the origin on the minimum path for an O-D pairs. After the implementation of such assignment process, calculate the new link traffic time and generate new OD. The new O-D is made with the initial origin node that is directly connected with the intermediary node that becomes the new OD. With the basis of new link traffic time as the basis, the minimum path is found to assign the new OD traffic demand on a link in accordance with the above method. Such a procedure is terminated for its repetition once all the origin is identical with destination and the traffic assignment is completed. <Figure 1> is an example that describes the above procedure.

2.2 TDA Algorithm

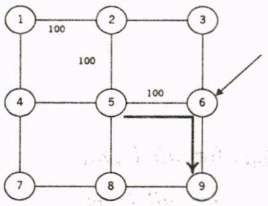
Traffic assignment algorithm based on the above concept of TDA was developed, and it is named TDA3. This model is a method that assigns the one-hour traffic demand divided into 5-minute traffic demands. After the assignment of traffic demand on one link, generate new O/D by summing up the rest O/D and the next increment O/D. To calculate the link traffic time based on traffic volume assigned to this time, continue this until all O/D is assigned while assigning the next increment O/D.
Also, the TDA3 model is marked with TDA3j, and 'j' is a script that represents the frequency of information services. If j = 1, it means that the users are serviced with information in every node, and if j = n, it means that the information is received in every nth node. Model was tested until j is 3, but the value of j can be set up to the entire number of node. TDA3 algorithm is shown as follows when arranged.



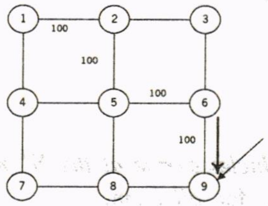
< Process 1 >
- Initial OD(1→9) Volume : 100
- If minimum path is ①→②→③→⑥→⑨, then
  1) Assign OD(1→9) 100 to link 1-2
  2) Modify origin : 1 → 2
  3) Generate new OD : OD(2→9)



< Process 2 >
- Update link travel time
- Update OD(2→9) Volume : 100
- If minimum path is ②→⑤→⑧→⑨, then
  1) Assign OD(2→9) Volume 100 to link 2-5
  2) Modify origin : 2 → 5
  3) Generate new OD : OD(5→9)

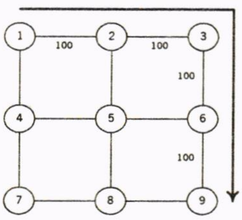


< Process 3 >
- Update link travel time
- Update OD(5→9) Volume : 100
- If minimum path is ⑤→⑥→⑨, then
  1) Assign OD(5→9) Volume 100 to link 5-6
  2) Modify origin : 5 → 6
  3) Generate new OD : OD(6→9)



< Process 4 >
- Update link travel time
- Update OD(6→9) Volume : 100
- If minimum path is ⑥→⑨, then
  1) Assign OD(6→9) Volume 100 to link 6-9
  2) Modify origin : 6 → 9
  3) Generate new OD : O is equal D
     → terminated

▶ Result of All-or-Nothing



▶ Result of TDA

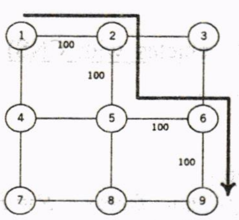


Figure 1. Concept of TDA

STEP-0 : (Initialization)

$V_{lm}=0$, for $all\ l, m$,
$T_{lm}=T^{o}_{lm}$, for $all\ l, m$,
$k=0$,
$I^{o}_{ij}=0$, for $all\ i, j$,
$R=0$,
where, V_{lm} = *traffic volume of link* (l, m)
T_{lm}, T^{o}_{lm} = *travel time* and *free flow travel time of link* (l, m), *respectively*
I^{o}_{ij} = *initial vehicle OD*(i, j) *of informed users.*

STEP-1 : (OD Update)

$k=k+1$,
$U^{k}_{ij}=O_{ij}\cdot(1-\pi)\cdot F_{k}$, for $all\ i, j$,
$I^{k}_{ij}=I^{k-1}_{ij}+O_{ij}\cdot\pi\cdot F_{k}$, for $all\ i, j$.
where, O_{ij} = *total demand of* (i, j) *pair*,
U^{k}_{ij} = *demand of uninformed users between* (i, j) *pair to be assigned in the* k^{th} *iteration*,
I^{k}_{ij} = *demand of informed users between* (i, j) *pair to be assigned in the* k^{th} *iteration*,
π = *ratio of vehicles with CNS*
F_{k} = *assignment friction factor of* k^{th} *iteration.*

STEP-2 : (Assignment of Uninformed Users)

(1) *Find the minimum path based on* T_{lm}.
(2) *Assign* U_{ij} *to the minimum path* : $V_{lm}=V_{lm}+U_{ij}\cdot\omega^{ij}_{lm}$, for $all\ l, m$,
(3) *Update travel time* : $T_{lm}=T^{o}_{lm}[1+\alpha(\frac{V_{lm}}{C_{lm}})^{\beta}]$ for $all\ l, m$.

where, ω^{ij}_{lm} = 1, if *link* (l, m) *is in the minimum path between* (i, j)
0, *otherwise*.
C_{lm} = *Capacity of link* (l, m).

STEP-3 : (Assignment of Informed Users)

(1) *Find minimum path based on updated* T_{lm}.
(2) *Assign* I^{k}_{ij} *to the minimum path between* (i, j) *until vehicles arrive at the* N^{th} *node from the starting node* i : $V_{lm}=V_{lm}+I^{k}_{ij}\cdot\omega^{ij}_{lm}\cdot\delta_{im}$, for $all\ l, m$.
(*where*, δ_{im} = 1, if *node* m *is within the* N^{th} *node from the starting node* i,
0, *otherwise.*)
(3) *Update travel time.*

STEP-4 : (Update OD of vehicles with CNS)

If $p\neq j$, $I^{k}_{pj}=I^{k}_{ij}$,
otherwise, $I^{k}_{ij}=0$.

STEP-5 : (Iteration Update)

(1) *Update cumulative friction factor* : $R=R+F_{k}$.
(2) *If* R = 1.0, *GOTO STEP*−6.
otherwise, *GOTO STEP*−1.

STEP-6 : (Stopping Rule)

(1) *If* $I^{k}_{ij}=0$, for *all* (i, j), *STOP*.
(2) *Otherwise*, *GOTO STEP*−3.

3. SIMULATION

3.1 Simulation Design

In this section, there is a designed simulation plan to analyze the en-route traffic information service affecting on the network. Each scenario is set up as network type, network size, spatial distribution of traffic demand, and level of congestion. Effectiveness of en-route traffic information service was analyzed through simulation for each scenario, and case study was made with 348 nodes and 1179 links as the ratio of informed user and degree of information service. Concrete content of scenario is as follows.

1) Scenario composition factor
(1) Network structure
For a simulation, the network structure is to set up with grid-type and circle-type network, and for the purpose of objective comparison, contents is made with as identical condition as possible.
Grid-type network is comprised with 25 nodes and 80 links, and the capacity of each link is uniformly comprised with 2000 pcu. Also, the length of the link is for 200m and the total length of link is comprised with 16km.
Circle-type network is comprised with 25 nodes and 72 links, and the capacity is the same as the grid-type network. The length of horizontal and vertical length is 203.5m and the length of diagonal link is 287.8m. In order to be the same condition as the grid-type network, the total length of link is set for 16km. Each node of networks is regarded as zone centroid.

(2) Level of traffic congestion
In order of setting up the size of OD traffic, two scenarios are established. When the OD traffic is assigned to network, "non-congestion" is defined as OD volume that averages the V/C of link for about 0.75 and the "congestion" is defined as OD volume that averages the V/C of link for about 1.5. As a result, the total volume of "non-congestion" OD is 36,000 vehicles/hour and that of "congestion" OD is 72,000 vehicles/hour.

(3) Trip distribution
In order to set up the scenario on the land use, two types of scenario for traffic distribution is established. First, it is assumed that the traffic demand is distributed evenly in all regions. Second, it is assumed that the traffic demand is distributed in the CBD area exclusively that central node (node 13) and neighboring nodes (node 8, 12, 14, 18) are directly connected with the nodes regarded as such. In case of "uniform-distribution with non-congestion", all regional OD traffic is 60 vehicles/hour, and in case of "uniform-distribution and congestion", the OD traffic is assumed 120 vehicles/hour. In case of the CBD concentration distribution, demand of node 13 is five times as much as the outside node and demand nodes of 8, 12, 14, and 18 that are four times as much as the outside node.

(4) Ratio of informed user
The ratio of users receiving the information from the entire travelers is increased by 5% from 0% to 100% and progress with the simulation test. The drivers of the vehicle receiving the information are assumed to rely on the provided information completely and use the shortest path based on the information provided.

(5) Network scale
Depending on the size of the network, the simulation is made to see how effective it is for providing the en-route information service. The case study is performed and analyzed on the actual network of Suwon City for 9 by 9 grid network in addition to 5 by 5 basic grid-type network.

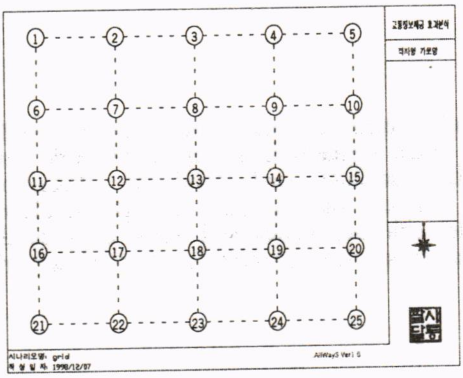


Figure 2. GRID Type Network

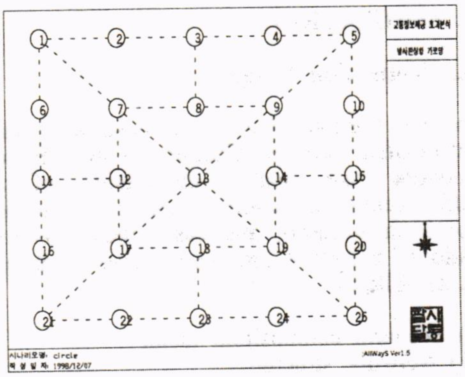


Figure 3. CIRCLE Type Network

2) Composition of scenario
Each factor for composition is defined with the following 8 scenarios of the combined contents.

Table 1. Scenario for simulation

	Network type	Trip distribution	Level of congestion	Notes
Scenario 1	GRD	UD	NC	GRD : Grid network
Scenario 2	DIA	UD	NC	DIA : Circle network
Scenario 3	GRD	CD	NC	UD : Uniform distribution
Scenario 4	DIA	CD	NC	CD : CBD concentration distribution
Scenario 5	GRD	UD	VC	NC : non-congestion
Scenario 6	DIA	UD	VC	VC : congestion
Scenario 7	GRD	CD	VC	
Scenario 8	DIA	CD	VC	

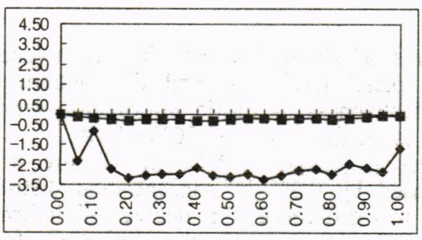
3) Measure of Effectiveness
Measure of Effectiveness for simulation result on analyzing the effectiveness on en-route traffic information service uses the rate of change in the total system cost. The meaning of "ratio of change" is a showing how the total system cost is reduced in case of information service is provided in proportion with the case of such service is not provided under the situation that is defined by each scenario.

$$\Delta C_r^s = \frac{C_r^s - C_0^s}{C_0^s} \times 100 \qquad (1)$$

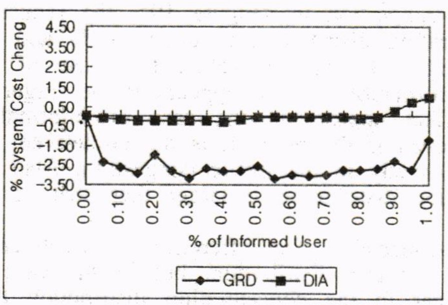
where, C_r^s is total system cost of scenario s with r % informed user.

3.2 Result of Simulation

1) Total system cost by network type
<Figure 4> represents the result of network type under the uniform distribution and non-congestion (*, UD, NC). In case of the grid-type network, it is more effective for 3% better than the circle-type network where the ratio of informed user is for 30%~70%. In the grid-type network, there is a little difference for the degree of information service. But there is a little difference in the circle-type network.
<Figure 5> represents the result under the concentration distribution and non-congestion (*, CD, NC). In case of the grid-type network, it is more effective for 2% than the circle-type network where the ratio of informed user is for 30%~70%. In the grid-type network, the difference for degree of information service is a little. But with the more degree of information service increase, the more the total system cost increased in the circle-type network.
<Figure 6> represents the result of the uniform distribution and congestion (*, UD, VC). In case of the grid-type network, it is more effective for 3% than the circle-type network where the ratio of informed user is for 30%~80%. Also, the information service in every 3rd link is more effective than that for the every link.
<Figure 7> represents the result of the concentration distribution and congestion (*, CD, VC). In case of the grid-type network, it is more effective for 4% than the circle-type network where the ratio of informed user is for 30%~80%. The difference in the degree of information service is appeared for 2% in two type networks and according to the degree of information service increased with the decrease of effectiveness.
In the above result of comparison analysis, it is determined that the effectiveness is stable and shows its greatest when the ratio of informed user is in the range of 30%~70%. Also, the effectiveness of traffic information is 3~4% larger in the grid-type network than that of the circle-type network without the regard to the level of congestion. This is determined as the grid-type network that has much more alternative route than the circle-type network and the difference of traffic cost between the alternative routes is even smaller.

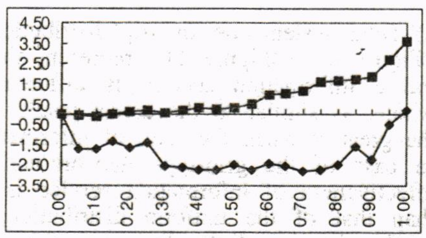


(a) TDA31

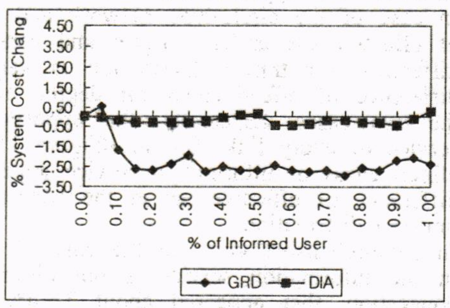


(b) TDA33

Figure 4. Comparison for Network Type (*,UD,NC)

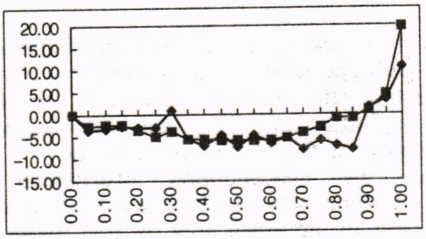


(a) TDA31

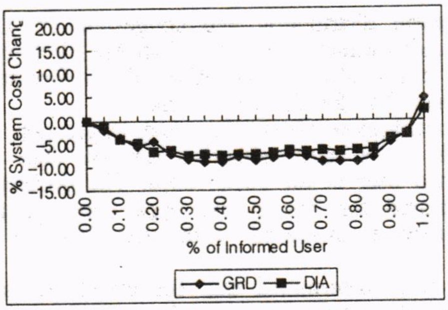


(b) TDA33

Figure 5. Comparison for Network Type (*,CD,NC)

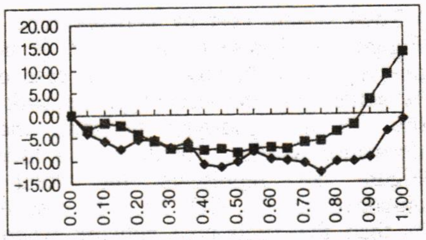


(a) TDA31

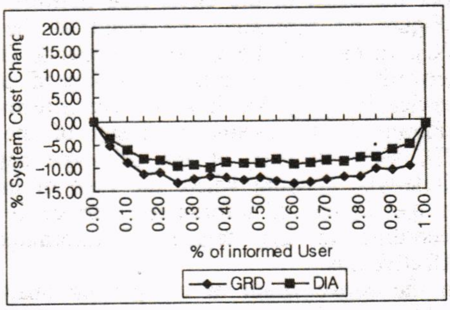


(b) TDA33

Figure 6. Comparison for Network Type (*,UD,VC)



(a) TDA31



(b) TDA33

Figure 7. Comparison for Network Type (*,CD,VC)

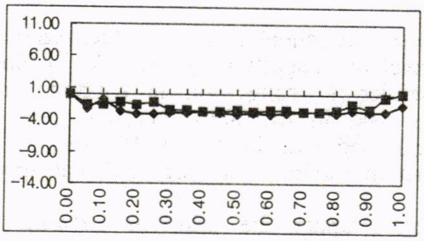
2) Total system cost by trip distribution

<Figure 8>～<Figure 11> represent the results of simulation that the effectiveness of traffic information service is different for spatial traffic demand distribution. As a whole, as similar to the above result, the effectiveness of traffic information service is the greatest when the ratio of informed user is in the range of 30%～80%.

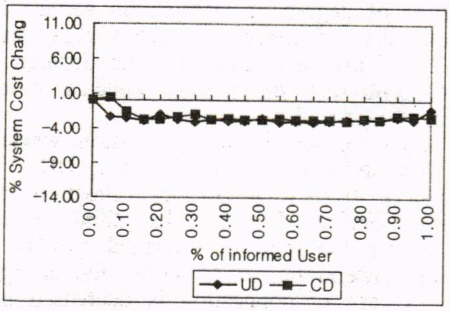
In case of the grid-type network/non-congestion (GRD, *, NC) in <Figure 8>, the effectiveness of information service is increased by 0.5% in concentration distribution than that of the uniform distribution, and the difference for degree of information service is very little. In case of congestion in <Figure 9>, the difference for trip distribution is appeared clearer than that of the case of non-congestion.

In case of the circle-type network and non-congestion in <Figure 10>, the reduction of effectiveness under uniform and concentration distribution is under 0.5% and the difference for traffic distribution is very little. To be noticeable, this case of the difference of effectiveness for degree of information service appears to be larger in the two cases. Especially, the opposite effect appears in the case of information service of every link. But in <Figure 11>, even if the network is the circle-type, the effectiveness of information service appears exactly in the traffic congestion. Also the difference of effectiveness in the concentration distribution is larger than that of the uniform distribution.

In comprehensive view, in the case of non-congestion, the difference of effectiveness in the information service is not observed for trip distribution, but in the case of congestion, that appeared about 3～4% larger in the concentration distribution than that of the uniform distribution.

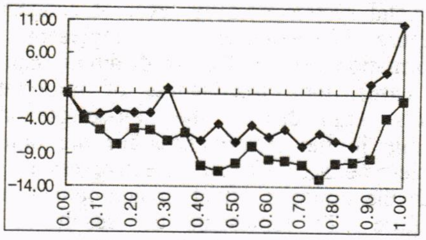


(a) TDA31

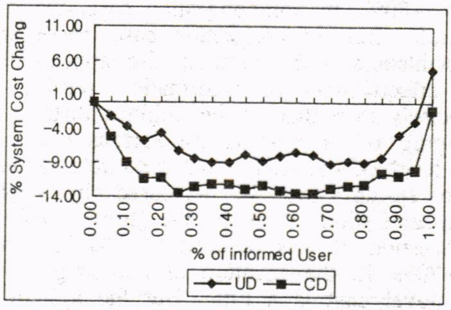


(b) TDA33

Figure 8. Comparison for Trip Distribution (GRD,*,NC)

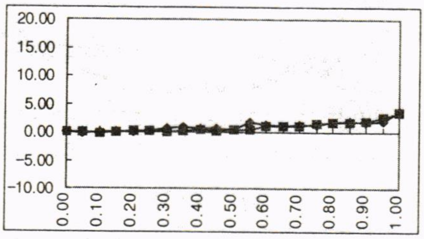


(a) TDA31

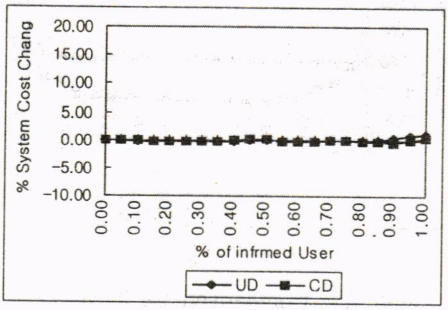


(b) TDA33

Figure 9. Comparison for Trip Distribution (GRD,*,VC)

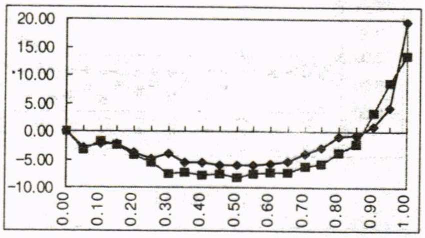


(a) TDA31

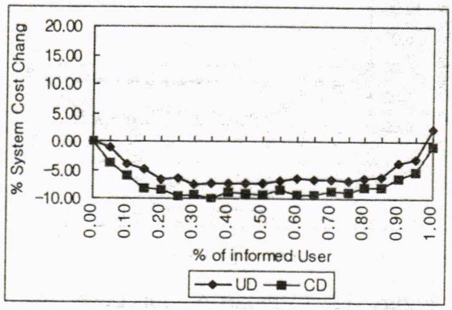


(b) TDA33

Figure 10. Comparison for Trip Distribution (DIA,*,NC)



(a) TDA31



(b) TDA33

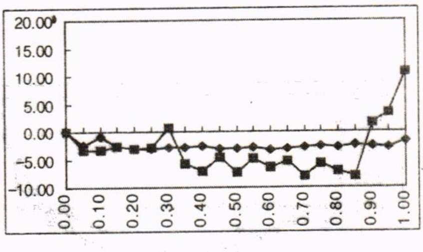
Figure 11. Comparison for Trip Distribution (DIA,*,VC)

3) Total system cost by level of congestion

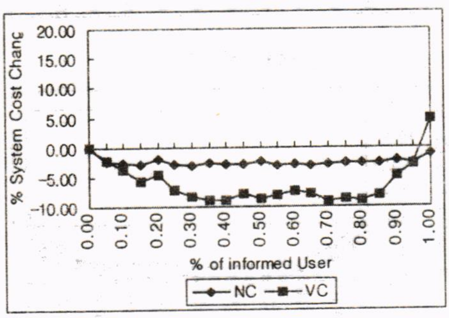
<Figure 12>～<Figure 15> represent the result of simulation of effectiveness in information service that is different than the level of congestion in network. In almost all cases, the effectiveness of information service in congestion is appeared more precise than that of the non-congestion cases, and in the non-congestion case, the change in the effectiveness for the ratio of informed user is very little. Also, in the circle-type network, the effectiveness of information service is a little, and that appears with the opposite effect in non-congestion.

<Figure 12> represents the result of simulation under the grid-type network and uniform distribution. The effectiveness of information service in congestion case is 7% more effective than that of the non-congestion when the ratio of informed user is 30%～80%. In non-congestion case, the difference of degree of information service is a little. But, in congestion case, there is about 3% difference of effectiveness, and unstableness with vibration also appears. In case of the same network, the difference of effectiveness of information service in concentration distribution appears more precisely than that of the uniform distribution in <Figure 13>.

<Figure 14> represents the various results for the effect of traffic information service by level of congestion on the circle network with uniform distribution (DIA, UD, *). The system cost is decreased by approximately 0.5～1.0% in the situation of non-congestion through the traffic information service. But in the situation of congestion, it was reduced by 7% in network which the ratio of informed user is 30～70%. In the situation of non-congestion with concentration distribution, the change of travel cost is a little. But the system cost in case of congestion is decreased by 10% in network where the ratio of informed user is 30 - 70% in <Figure 15>.

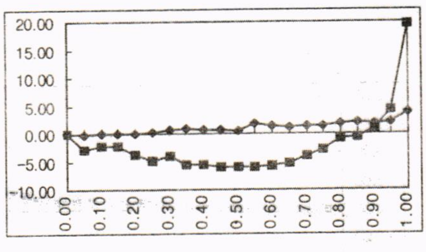


(a) TDA31

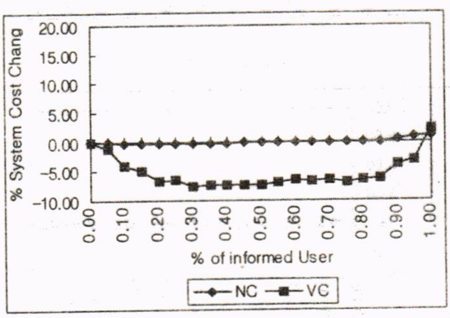


(b) TDA33

Figure 12. Comparison for Level of Congestion (GRD,UD,*)

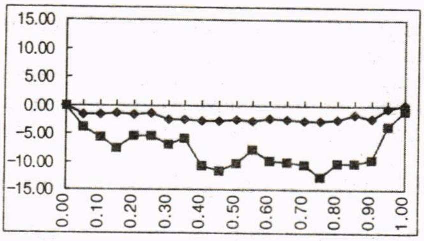


(a) TDA31

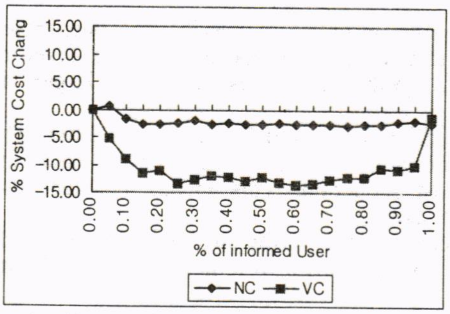


(b) TDA33

Figure 13. Comparison for Level of Congestion (GRD,CD,*)

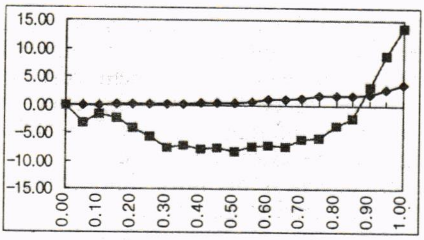


(a) TDA31

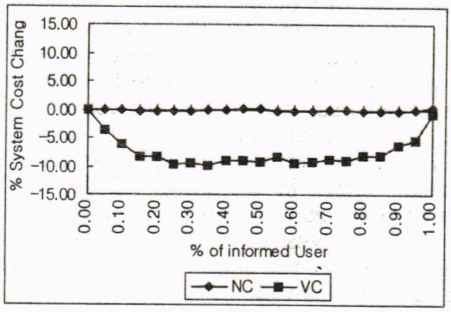


(b) TDA33

Figure 14. Comparison for Level of Congestion (DIA,UD,*)



(a) TDA31



(b) TDA33

Figure 15. Comparison for Level of Congestion (DIA,CD,*)

4) Total system cost by scale of network

To compare the effectiveness of traffic information service for scale of network is established with 9 by 9 grid-type network with 81 nodes and 288 links. This is established similarly with the scenario 5, assuming the uniform distribution and congestion case.

The system cost is decreased by 20% on the 9 by 9 network where the ratio of informed user is 30～70% compared with the uninformed user. The effect of reduction for system cost is about twice larges than that of the 5 by 5 grid-type network in <Figure 16>. This result shows that the effectiveness of information service is enlarged in proportion to the scale of network and this phenomenon appears more clearly in the case study of the next chapter.

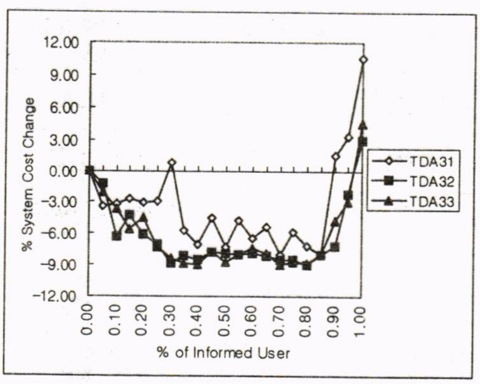


Figure 16. Result of Simulation of 5×5 GRID Network

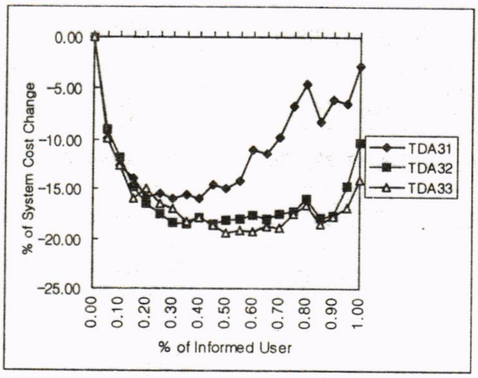


Figure 17. Result of Simulation of 9×9 GRID Network

5) Summary for result of analysis and comparison with the existing research results

Summary of results analyzed in simulation is as follows.

In almost all cases, the system cost is constantly reduced until the ratio of informed user comes to be 30% and the effect of reduction for travel cost is the largest when the ratio of informed user is 30~80%. But from 80% or more, there is a tendency of having the effect decreased.

The effectiveness of traffic information service is larger in the grid-type network than that of the circle-type network.

The difference of effectiveness for trip distribution is a little in the case of small volume (non-congestion). But in situation of congestion, the effect of reduction is larger than that of the uniform distribution.

The analysis made for the effectiveness of traffic information service is insignificant in the situation of non-congestion, but it is increasing in proportion to the level of congestion. Under the defined scenario, the effectiveness is 7~10% larger in congestion than that of the non-congestion.

The difference of effectiveness for degree of traffic information service is a little. The frequent route change through the traffic information service would be to have the opposite effect in the effect of the traffic cost reduction. This means the fact that optimal frequency of traffic information service exists.

The effectiveness of traffic information service increases with the scale of network. This is determined since the dispersion effect of the traffic volume is increased with the scale of network.

The system cost is rapidly increased or deceased in irregular situations where the ratio of informed user is under 20% or above 80%.

<Table 2> represents the results to compare this research with other research in the aspect of scale.

Table 2. Comparison of Effectiveness with exist research

Reference research	Result of Measure of Effectiveness	Remarks
Kobayashi(1979)	- Travel Time Reduction : 6% - Fuel Consumption reduction : 5%	CACS, Japan
Jeffery(1981)	- Driver Journey Cost Recovery : 2%	Autoguide, U.K.
Tsuji, Takayama(1987)	- Probability that guided veh. arrive earlier than unguided veh. : .85 - Travel Time Reduction : 9-14%	CACS, Japan
Jeffery(1987)	- Resource Saving : 10%	Autoguide, U.K.
Al-Deek et al.(1989)	- Maximum Realized Saving: 10 min for a 30 min trip	PATHFINDER, USA
Jones, Mahamassani(1993)	- Travel Time Reduction (by Route Change) : 6% (by Departure Time Switching) : 10-22%	Tx. USA
Y. Gardes, et al(1993)	- Travel Time Reduction : 6-18%	PATH, USA (12, 12)*
Ha, Dongik(1994)	- Travel Time Reduction : 7-13%	VISROG, Korea (16, 17)
Chon,K.S., J.R., Cho (1993)	- Total System Cost Reduction (Real Time Information service) : 11-17% (Predicted Information) : 15-23%	Korea (25, 80)
This paper(2001)	- Total System Cost Reduction (Simulation 1) : 10-14% (Simulation 2) : 20% (Case Study) : 50%	Korea (25, 80) (80, 288) (348, 1179)

notes * : (number of node, number of link)

4. CASE STUDY

Suwon City is chosen to have this case study. The attributing data that are used in the case research, such as network, O-D and link attributes are the status information actually surveyed in 1996. The network for Suwon City is consisted of 47 zones including the outside zone, 348 nodes including zone centroid, and 1179 links. The O-D data obtained from the survey with 5% sampling are divided into passenger vehicle, bus and taxi O-D data at the peak hour. <Figure 19> shows the network used in this study.

<Figure 18> represents the results of this case study. The effectiveness of traffic information service is a little with the ratio of informed user for 10%. Also, the system cost reduces constantly when the ratio of informed user is in the 20~30% range. In the situation of 30~60% (% of informed user), the reduction ratio of the system cost is approximately 50% and have the maximum value. The difference of effectiveness is not clear in the ratio of informed user or degree of information service. But in the case of above 60% (% of informed user), the difference for degree of information service is appeared excessively, and become unstable with the irregular and sharp change. The results indicate that the traffic information service could bring the unexpected opposite effect when the traffic information service is applied in the actual network.

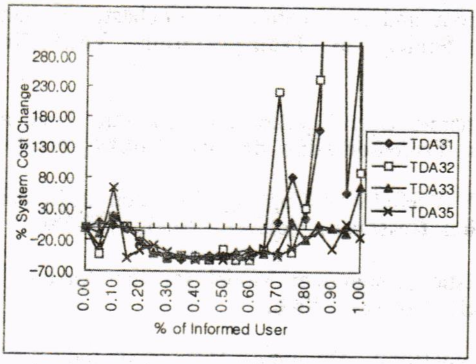


Figure 18. Result of Case Study

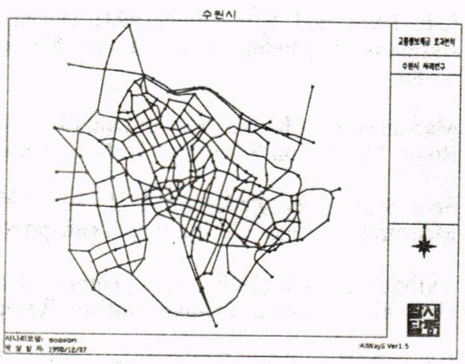


Figure 19. Network of Su-won City

5. CONCLUSION

Results of simulation are analyzed and shown that the effectiveness of traffic information service is larger on the grid-type network than that of the circle-type network. Also, in case of congestion and concentration distribution, it is shown that it is more effective than the case of non-congestion and uniform distribution.

In general, the total system cost is continuously decreasing in proportion to the ratio of informed user for up to 30%. And it has the lowest value when the informed user is comprised from 30% to 60%, and the change of system cost is very little. But for above 70%, the system cost is increased with the situation that is appeared to show the unstable and irregular phenomenon. And the difference of effectiveness for the information service is a little, but the frequent route change during travel with the traffic information service can bring the opposite effect in the increase of the system cost. The effectiveness of information service increases in proportion with the scale of network. And in case of the research for Suwon City, it is analyzed that the system cost may be reduced up to 50% through en-route traffic information service.

In this report, the case study is performed for the Suwon City networks. But to overcome the limit of former research targeted for toy network up to now, and to estimate practical effectiveness of traffic information service, the comprehensive and systematic case study has been performed. Also, this study has analyzed the effectiveness of traffic information service from the viewpoint of total system cost. But also, it is important to have the effectiveness of traffic information service from the viewpoint of user. For that purpose, the simulation model for path analysis would have to be developed.

REFERENCES

a) Journal papers

Aerde, M.V. and S. Yagar(1998) Dynamic Integrated Freeway/Traffic Signal Networks : Problems and Proposed Solutions, **Transportation Research, Vol.22A, NO.6.**

Alfa, A.S.,(1989) Departure Rate and Route Assignment of Commuter Traffic During Peak Period, **Transportation Research, Vol.23B, No.5.**

Ben-Akiva, M., A. de Palma and I. Kaysi(1991) Dynamic Network Models and Driver Information Systems, **Transportation Research, Vol.25A, No.5.**

Lee, I.W., and N.H. Jung(1993) Development and Application of Stochastic Dynamic Assignment Model, **Journal of Korean Society of Transportation, Vol.11,No.1,** 67-86.

Mahamassani H. and R. Herman(1984) Dynamic User Equilibrium Departure Time and Route Choice on Idealized Traffic Arterials, **Transportation Science, Vol.18., No.4.**

Seo, S.D., C.H. Park and C.H. Kim(1990) A Highway Capacity Function in Korea : Measurement and Calibration, **Transportation Research, Vol.24A, No.3., 177-186.**

Vythoulkas, P.C.(1990) A Dynamic Stochastic Assignment Model for the Analysis of General Networks, **Transportation Research, Vol.24B, No.6.**

Wie B.W., T.L. Friesz and R.L. Tobin(1990) Dynamic User Optimal Traffic Assignment on Congested Multi-Destination Networks, **Transportation Research, Vol.24B, No.6.**

b) Papers presented to conferences

Aere, M.V., H. Rakha(1989) Development and Potential of System Optimized Route Guidance Strategies, **Proceeding of the IEEE.**

Chon, K.S., J.R. Cho(1994) A Simulation Model for Impact Analysis of ATIS, Korea-U.S.A. **Symposium on IVHS & GIS-T, 215-228.**

Gardes, Y., M.E. Lunsford, A.D. May and M.V. Aerde(1993) Application of Integrated Model to demonstrate the Simulation of Advanced Traveler Information System, **T.R.B, 72nd Annual Meeting,** 115-149.

Rakha, H., M.V. Aerde, E.R. Caes, and A. Ugge(1989) Evaluating the Benefits and Interactions of Route Guidance and Traffic Control Strategies Using Simulation, **proceedings of the IEEE.**

c) Other documents

Ha, D.I., J.H. Baek and S.H. Lee(1993) A Study on How to Develop IVHS in Korea, **The Korea Transport Institute.**