



Effects of Connector Pattern on Traffic Assignment Results; Case Study: Qazvin

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ABSTRACT: In transportation literature, in order to relate supply (street network) and demand (traffic zone) sides, definition of centroids and connectors is essential. Centroids and their connector(s), despite their importance, are usually selected based on the engineering judgment and experience of experts. The main purpose of this paper is to investigate the effect of centroid connection pattern on static traffic assignment. Applying user equilibrium approach, different scenarios of connector patterns (from centroids to all possible connector nodes) are implemented and evaluated for the real-size city of Qazvin with a population of about 0.4 million and 113 traffic zones. Results of 6 different scenarios show that different patterns and number of connectors can result in about 10 percent change in average link volumes and about 20 percent change in total vehicle-kilometer. Results also indicate that due to the high number of connection patterns, it is difficult to specify the optimum pattern; this difficulty indicates the effects of connector pattern on traffic assignment results.

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1- Introduction

Each Transportation system has two major sides: demand and supply, whose equilibrium results in equilibrium traffic flow. Any type of traffic assignment requires a suitable relationship between the demand (TAZ¹) and supply (Network) sides revealing their interaction. The link between the zones represented by their centroids and the network is represented by virtual links called connectors. This approach can cause much error. The main purpose of this paper is to investigate quantitatively the effect of different centroid connector pattern scenarios on static traffic assignment results. This paper addresses these two main questions for a real-size city:

- Are assignment results for different connector patterns the same and reliable?
- How does number of connectors affect traffic assignment results?

2- Methodology

The assignment model employed in this paper is user equilibrium derived from Wardrop's first principle which is compliant with self-utility maximization axiom of economics. For a real situation, three different types of delay functions are assumed for the network elements, as follows:

$$D_1 = t_0 \left[1 + \alpha \left(\frac{V}{Q} \right)^\beta \right] \quad (1)$$

$$D_2 = \frac{(c-g)^2}{2c \left(1 - \frac{V}{S} \right)} + 43 \left(\frac{V}{S \left(\frac{g}{c} \right)} \right)^4 + 5 \quad (2)$$

$$D_3 = t \cdot m \left[2.5 + 2 \left(\frac{V}{Q} \right)^2 \right] \quad (3)$$

in which:

- D_1 to D_3 =delay functions for link, signalized intersection and un-signalized intersection, respectively,
- c =cycle length in signalized intersection (s),
- g =green time for specific approach (s),
- V =link volume (pc),
- S =saturation link capacity (pc),
- t =un-signalized intersection parameter,
- m =number of allowable movements in intersection,
- Q =nominal link capacity.

In order to implement the procedures quantitatively, Qazvin city with a population of about 0.4 million and 113 traffic zones is discussed as the case study. Six different scenarios of connectors are developed (Table 1) and assignment results are compared with the base scenario (master plan pattern scenario). In order to develop a suitable scenario spectrum, different scenarios from one connector to all the possible connectors are assumed and implemented. Comparison indexes are proportional frequency distribution of link and connector volumes and speeds, average link volume and speed, total network vehicle-kilometer, total network vehicle-hour, total emitted pollution, total consumed fuel.

¹ Traffic Analysis Zone

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Table 1. Characteristics of connector pattern scenarios

Scenario number	Scenario description (Connector pattern)	Number of connectors	Length of connectors (km)
0	Base scenario	181	27
1	Delete 1 connector from base condition	128	19
2	Add 1 connector to base condition	288	65
3	Only 1 connector to nearest node	113	14
4	Only 1 connector to farthest node	113	17
5	2 Connectors to nearest and farthest nodes	167	25
6	Connection to all possible nodes	513	155

3- Results and conclusion

Results of equilibrium traffic assignment for the city of Qazvin are summarized in Table 2 for the base and the six connector pattern scenarios.

The results of six different scenarios and their comparison with base scenario are as follow:

- With increasing connector number, average link volume decreases indicating a more uniform distribution of volume between the surrounding links.

- The second scenario (connecting to the farthest and nearest nodes) has the least effect (0.2 percent) and the sixth scenario (all possible connectors) has the most effect (8.7 percent) on average link volume.

- With increasing number of connectors, total VKT¹, total VHT² and consequently, the emitted pollution and consumed fuel decrease.

- Changes in the pattern and number of connectors can result in about 10 percent change in average link volumes and about 20 percent change in total VKT of the network. However network improvement scenarios can result, at most, in 10 percent change in these indexes.

- Increasing the number of connectors will not necessarily result in a more realistic model, because it would decrease total VKT, using different available routes.

- Low number of connectors can result in unrealistic congestion in the upstream links, whereas large number of connectors can result in unrealistic decrease in traffic congestion of local links.

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Table 2. Traffic assignment results summary for base scenario

Measure number	Measure description	Unit	Amount
1	Total travel length	Vehicle-Kilometer	417800
2	Total travel time	Vehicle-Hour	17300
3	Total fuel consumption	Liter	62300
4	Total pollution	Kilogram	30900
5	Average street flow rate	Hourly passenger car	1810
6	Street flow rate Stdv.	Hourly passenger car	1260
7	Average street speed	Kilometer/Hour	25
8	Street speed Stdv.	Kilometer/Hour	11
9	Average connectors flow rate	Hourly passenger car	460
10	Connectors flow rate Stdv.	Hourly passenger car	450

¹ Vehicle- Kilometer Traveled

² Vehicle- Hour Traveled

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