ECONOMICAL EVALUATION OF CONSTRUCTING Urban TRANSPORTATION INFRASTRUCTURES IN CONGESTED CORRIDORS (CASE STUDY: SADR HIGHWAY)

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Abstract:
Investment and construction of transportation infrastructures are some of the most complex issues that confront government authorities. Uncertainty in the benefits of such infrastructures and, difficulty in scaling costs to financial profits, create doubts in the decision making process. Congestion, pollution, noise and other issues have significant costs and, therefore, the initial cost of the infrastructure cannot be a proper comparison factor for its economical assessment. Therefore, it seems necessary to analyze the demand in the horizon year, considering the current situation and using the outcome of planning studies and in the next step, evaluating construction and operation costs next to the project profits which can lead to more feasible decisions.

One of the main challenges in analyzing the effects of construction a new road transportation or improving an existing infrastructure is the limitations related to the effect of these projects on future traffic pattern. So, the main question is the method of evaluation of these changes for defining their benefits which makes the main subject of this research.

The method considered in this research is applying planning software (Emme2) for estimating the demand caused by these changes in the network. The cost groups (in addition to the capital cost) are congestion and emission which caused by vehicles. The methodology for estimating these costs are based on recent researches by Ozbay et al & Brenchman et al which defined congestion and pollution costs as follows[1,2,3]:

$$C_{cong} = Q\frac{d_{a,b}}{V_o}\left(1+0.15\left(\frac{Q}{C}\right)^4\right)VOT \qquad if Q \le C \qquad (1)$$

$$C_{cong} = Q\frac{d_{a,b}}{V_o}\left(1+0.15\left(\frac{Q}{C}\right)^4\right)VOT + Q\left(\frac{Q}{C}-1\right)\frac{VOT}{2} \qquad if Q \ge C \qquad (2)$$

Where:
Q: Flow (veh/h)
da,b: Distance (mile)
C: Capacity (veh/h)
VOT: Value of Time (($/h)
V_O: Free Flow Speed (mph)

The first model is applied when the network is under saturated. The second model which was applied for estimating pollution cost is as follows:

$$TC_{air} = Q(0.01094 + 0.2155F) \quad (3)$$

Which TC_{air} showed the cost of pollution and F can be calculated as follows:

$$F = 0.0723 - 0.00312V + 5.403\times10^{-5}V^2 \quad (4)$$

Where:
a: Age of Vehicles (years)
F: Fuel Consumption (G/Mile)
V: Average Speed (mph)

Three alternatives, i.e. maintaining current conditions, a grade separated route (tunnel, in this case) and developing a metro line are considered as main alternatives for the decision maker to improve the network. In this regard, the research aims to study the solution in a particular route case; Sadr expressway in Tehran, which is the only highway to connect the north and north-east of Tehran City to its CBD.

The city of Tehran with 9 million populations is the largest city in Iran and most crowded one in the Middle East. Daily, more than 15 million trips and 2.5 million vehicles are moving in this city. In the current condition, the share of freeways and highways in this city is 13.7 percent, arterials make 28.2 percents and local accesses and collectors make 51.5 percents of all roads in this city and the rest is ramps and loops. The average speed in highways and freeways is 35.5 and for arterials 17 kilometers per hour which proves that the most share of arterial roads in this city are over saturated.
In our particular case, studies in the horizon year show that there will be a 104 percent increase of total delay on this expressway in a do nothing scenario which implies that further attention of authorities is needed in upcoming years.

For improving mobility and reducing delay, it was assumed that 3 alternatives can be considered such as:

1. Increasing the capacity with applying highway developing methods in the same altitude level (for example constructing a highway that works in the same direction of current facility)
2. Applying alternatives not in the same level as current facility (for example constructing a tunnel or bridge in the same direction as current facility)
3. Constructing a metro line in the same direction of current facility for reducing the demand for personal cars and increasing the efficiency of the facility.

Three above mentioned alternatives were considered in two situations (constructing and not constructing the infrastructure) and results gained from this comparison helped us to access the changes caused by applied strategies in the network. After defining these distinctions and considering user` s value of time, it was possible to estimate the total costs of each alternative which consist of the primary and out of pocket costs.

Figure 1 shows the comparison of congestion and pollution costs of each alternative in 2026 (horizon year of Tehran city). Results suggest that there is a considerable difference between the congestion and pollution costs in current condition with other alternatives. The costs at do nothing alternative is more than 1.6 times the cost for tunneling alternative and 3 times more than metro scenario.

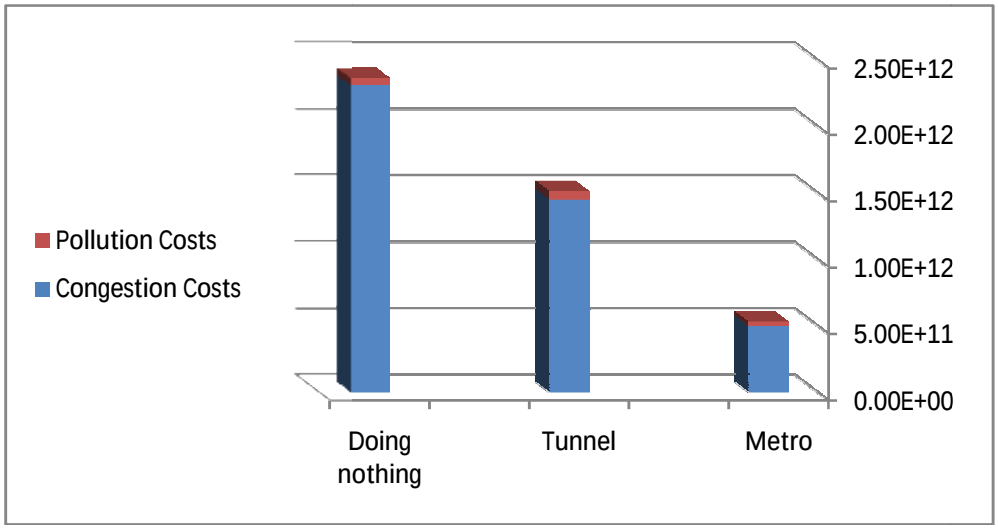

Figure 1- Comparing external costs between alternatives

The results suggest that indirect costs are so significant that the profits of the metro line in the horizon year made 17% of the total cost. However, considering discount rates, profits for the tunnel alternative is only 9% of the whole cost. In addition, it is concluded that decisions made on just capital costs (without counting for profits) may not be evaluated properly. The metro alternative, though having higher capital cost in comparison to the tunnel alternative, looks more economical in the long term, due to its faster investment return time.

Also, in many conditions, traffic only studies cannot be enough for decision making for developing a road infrastructure. For example, in this research it has been shown that constructing a tunnel can have many traffic benefits like lowering delay and congestion but cannot present an economical measure for authorities.

Moreover, it was shown that, in some cases, choosing the no action alternative can be even better than constructing an infrastructure. The pollution cost in the tunnel alternative was estimated as being more than the no action alternative, due to the induced traffic when constructing a new infrastructure.

Keywords: Cost Benefit Analysis, Out of Pocket Costs, Pollution Costs, Value of Time**.**

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