A Study for Determining the Economical Route Configuration for a High Speed Railway Line between Ankara and Izmir

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Abstract: Before starting to construction of high speed railway projects, railway engineers should figure out determine the economic route configuration in terms of having sustainable competitive advantage against to other transportation systems. This paper shows to specify the route of Ankara and Izmir high speed railway line project which is added to investment agenda by Turkish State Railways for 2013. Especially, the best effective and economic journey time of high speed railway project between Ankara and Izmir is investigated in order to compete with airway transportation.

1. INTRODUCTION

Fundamental changes have been made in transportation policies that were pursued by Turkish Government after the end of 1990s and the importance given to railway transportation again came into prominence. Efforts to increase competition ability among the other forms of transportation systems have been accelerated to improve railway transportation with changes of this policy. In this context, Turkish government has decided to make new railway projects and Ankara and Izmir high speed railway line project is one of these projects has been added to the investment agenda by Turkish State Railways for 2013 (Apaydın, 2012).

The aim of this document is to investigate Ankara and Izmir high speed railway line project in terms of economic perfective and to give approximate comparable results in order to help Turkish State Railways while determining the route configuration which should have the best operational solution. Therefore, different transportation systems that perform services in between the cities of Ankara and Izmir were investigated with the generalized cost function analysis method. The aim of analysing the different transportation systems was to find out the optimum journey time of Ankara and Izmir high speed railway line which should have a sustainable competitive advantage among the other transportation systems (Milan, 1993).

2. GENERALISED COST FUNCTION METHOD

The selection of transportation systems for travelling from one point to another point is an important decision that creates sometimes a problem for those who are living in large cities because the process of choosing suitable transportation system has a structure that contains multi-dimensional parameters and uncertain situations (Murat and Kulak, 2005). Passengers generally want to arrive their destination points within the shortest time and they especially tend to choose the most safely transportation system; thus this behaviour requires a multi-purpose decision making. In such case, decision makers want to obtain detailed analysis in relation to the transportation alternatives which should meet the highest level of their expectations.

Basic approach to the selection of the type of journey between two points is to choose the lowest cost option that is called as the value of time (Rus, 2012). The concept of the lowest cost travel can be defined with journey time, access time, waiting time, average delay and the number of changes. For example, develop of the generalized cost function that takes into account all these parameters is extremely difficult. For this purpose, some approaches have been developed for creating a good modelling that includes time and money parameters. Economists have created the formula of Generalised Cost Function that can be accepted as an "index of hassle" with using these two parameters (Harris, 2011).

Generalised cost formula can be given as an algebraically form;

$$GC = Fare/a_0 + a_{1i}\, t_{ji} + a_2\, t_a + a_{3i}\, t_{wi} + a_4\, t_d + a_5\, n_c \qquad (1)$$

where,

$Fare$: Direct cost or fare payable for the journey [TL];

a_0 : Value of time of traveller [TL/min];

$a_{1i}\, t_{ji}$: Weighting factor (usually 1) × journey time [min];

$a_2\, t_a$: Weighting factor (depends on journey type) × access time [min];

$a_{3i}\, t_{wi}$: Weighting factor (usually 1.5 or 2) × waiting time [min];

$a_4\, t_d$: Weighting factor (usually 3 or more) × average delay [min];

$a_5\, n_c$: Inconvenience allowance [min] × number of changes.

This formula consists of some parameters which are journey time, access time, waiting time, average delay and number of changes and the value of time of traveller. There are also weighting factors to express the effect on the behaviours of

people's likes or dislikes for a particular aspect of a journey or transportation mode. Generalised cost function consists of time and monetary elements and therefore different transportation systems can be compared against to each other (Adler, Pels and Nash, 2010). The value of time of journey will reflect the effects of these two elements and it will be generally defined as TL / hour or Kurus / minute.

Different type of transportation systems such as intercity bus transportation, airway transportation and high speed railway transportation between Ankara and Izmir will be examined and the optimum journey time of high speed railway line will be found out in terms of having sustainable competitive advantage among the other transportation systems.

3. ANALYSIS OF DIFFERENT TRANSPORTATION SYSTEMS BETWEEN ANKARA AND IZMIR

3.1 Intercity Bus Transportation System

Intercity bus transportation between Ankara and Izmir (Figure 1) was investigated with generalised cost function analysis method in order to find out the value of intercity bus journey time.

Figure 1. Locations of Ankara and Izmir on the Turkey map.

The total journey fare of intercity bus transportation between Ankara Kecioren district and Izmir Independence Square is 55 TL and the total of time element is 632.5 minutes. According to the report of Trade Union of Confederation of Turkish Employer (2011), one employee's per minute fee is 0.155 TL / minute. If this information is put in generalised cost function formula, the total generalised cost of intercity bus transportation journey can be found out as following;

$$GC = Fare/a_0 + 632.5 = 55 / 0.155 + 632.5 = 987.3 \text{ minutes} \tag{2}$$

This result shows that the journey of intercity bus transportation between Ankara and Izmir is extremely exhausting and passengers spend lots of time. However, this journey is quite inexpensive; hence many passengers prefer to travel by bus today.

3.2 Air Transportation System

According to same assumptions and approaches which were used calculations of intercity bus transportation system, the total journey fare of airway transportation is 82 TL and the total of time element is 202.5 minute.

As mentioned previously, one employee's per minute fee is 0.155 TL / minute. If this information is put on generalised cost formula with total fare of journey and total of time element, generalised cost of airway transportation journey can be calculated as following;

$$GC = fare/a_0 + 253.5 = 82 / 0.155 + 202.5 = 731 \text{ minutes} \tag{3}$$

This result shows that airway transportation between Ankara and Izmir is better than intercity bus transportation which is 987.3 minutes. However, airway transportation should be better than this result because airway journey between Ankara Esenboga Airport and Izmir Adnan Menderes Airport takes just 75 minutes. This problem originates, there are no railway connection in between the city centres and airports. Hence, passengers spend lots of time especially in the city centres as seen in the intercity bus transportation journey. In addition, security control points and check-in processes in airports take many times so that people suffer from waiting. Consequently, the quality of journey decreases and airway journey becomes more exhausting than expected.

For these reasons, Turkish State Railways should focus on the quality of high speed railway journey because railway stations were established at the heart of the cities thus; railway passengers can easily access to stations from their homes.

3.3 High Speed Railway Transportation System

Especially in airway transportation, passengers have to do check-in process, demonstrate their tickets consistently at airports and airway companies usually shall request that passengers must be at airports before the time of travel. It means that passengers spend a lot of time unnecessarily. This situation is much worse for Ankara and Izmir due to positions of airports which were established far away from the city centres. Therefore, the new high speed railway line will have a competitive advantage against to airway transportation because of positions of train stations which were built at the heart of the city centres.

In the light of all these information, the total journey fare of railway transportation will be 54 TL and the total of time element is 114 minute without journey time of railway transportation. As calculated in previous parts, the total generalised cost of high speed railway transportation journey can be found out as following;

$$GC = Fare/a_0 + 114 = 54 / 0.155 + 114 = 462 \text{ minutes}$$
$$\text{(without journey time)} \tag{4}$$

The total generalised cost of airway transportation journey has been calculated and as a result was found 731 minutes. If this value is used as a reference in generalised cost formula, the maximum journey time of railway transportation can be calculated as following;

$$GC = 731 \text{ minutes - } 462 \text{ minutes} = 269 \text{ minutes}$$
$$\text{(could be increased up to this value)} \tag{5}$$

However, Turkish State Railways should take into account passengers comfort because general aim of passengers is to reach desirable destination as soon as possible. For this reason, the optimum journey time of high speed railway should be approximately 200 minutes due to having sustainable competitive advantage against to airway transportation. As a result, the total generalised cost of high speed railway journey can be calculated as following;

$$GC = Fare/a_0 + 114 = 54 / 0.155 + 200 + 114 = 662 \text{ minutes} \tag{6}$$

As shown in the calculation, the total generalised cost of high speed railway transportation is 662 minutes with journey time of high speed railway transportation. Consequently, this value will compete with the generalised cost of airway transportation journey which is 731 minutes.

At the present time, Turkish State Railways serve rail transportation with conventional line which is 824 km in between Ankara and Izmir and journey time is 14 hours (Gul, Pekin and Cetin, 2009). The same authors continue that thanks to the new high speed railway line, new alignment that is estimated nearly 215 km shorter than existing line will be constructed; hence duration of journey will be planned by reducing more than 10 hours.

4. CONCLUSIONS

The results of comparing different transportation systems in between Ankara and Izmir can be shown in Table 1.

Table1. Summary of Comparing Different Transportation Systems

Transportation Type	Total of Time Elements (min)	Total Journey Fare (TL)	Total Generalised Cost (min)
Bus Transport	632.5	55	987.3
Air Transport	202.5	82	731
Rail Transport	314	54	662

According to the Table 1, bus transportation has remained far from competitive in terms of the value of time, however many people in Turkey still prefer it due to the lowest-cost travel. On the other hand, air transportation is now the best option between Ankara and Izmir in terms of journey time and total generalised cost but journey fare is still above the expectations. For these reasons, the optimum journey time of Ankara and Izmir high speed railway line should be approximately 200 minutes due to having sustainable competitive advantage against to airway transportation.

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