High Speed Rail Passenger Satisfaction According to Socio-Demographic Variables in Turkey

Türkiye'de Sosyodemografik Değişkenlere Göre Yüksek Hızlı Tren Yolcu Memnuniyeti

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ABSTRACT

This study evaluates the high speed rail (HSR) satisfaction from the perspective of passengers of different socio-demographic structures. The population of the study consisted of 427 individuals who are older than 18 years old and the main scope of the study was on Ankara-Konya HSR route, which constitutes 28% of the total HSR trips, at the economy class. In the present study, in line with the data obtained from the literature, 23 sub-criteria sets under 6 main headings that are expected to affect passenger satisfaction are provided to the users in a questionnaire form. To weight the determined criteria according to the degree of importance, the analytic hierarchy process (AHP) method was used and expert opinion was referred. When AHP analysis results were examined, trip and train comfort were determined to have more impact on passenger satisfaction in the main criteria, while fare, ticket services, and train service times had more impact in the sub-criteria. Considering the gender variable, it is found that female participants differ from male participants in terms of trip comfort and security and risk satisfaction. HSR overall satisfaction level was identified to decrease as the level of age and education increases. The early-aged and aged group (55 and over age) delivered a negative opinion for train comfort in particular. Station comfort satisfaction score was found to be inversely proportionated to income, while fare and ticket services total satifaction score was direclty proportionated to income. Considering the general satisfaction scores according to the trip purposes; it was determined that participants traveling with the aim of visiting their friends and participating in socio-cultural activities were found to be more satisfied with HSR, while the participants traveling for care services, on the other hand, were found to have the lowest satisfaction score.

Keywords: Analytic hierarchy process; customer satisfaction; high speed rail; passenger satisfaction; service quality.

ÖZ

Bu çalışmada, yüksek hızlı tren memnuniyeti farklı sosyodemografik yapıdaki yolcuların bakış açısıyla değerlendirilmektedir. Çalışmanın örneklemini Ankara-Konya yüksek hızlı tren güzergahında seyahat eden, 18 yaşından büyük, ekonomi sınıfını kullanan 427 kişi oluşturmaktadır. Çalışmada literatürden elde edilen bilgiler doğrultusunda yolcuların memnuniyetine etki edeceği öngörülen altı ana başlıkta 23 alt kriter seti anket formu şeklinde kullanıcılara sunulmuş, anketlerde likert tipi ölçek kullanılmıştır. Belirlenen kriterlerin önem derecesine göre ağırlıklandırılması amacıyla analitik hiyerarşi süreci yönteminden yararlanılarak uzman görüşüne başvurulmuştur. Analitik hiyerarşi süreci analiz sonuçları incelendiğinde ana kriterlerde yolculuk ve tren konforu; alt kriterlerde ise sefer sıklığı, bilet ücreti ve sefer saatlerinin yolcu memnuniyetine daha fazla etki ettiği saptanmıştır. Cinsiyet değişkeni ele alındığında kadın katılımcıların erkek katılımcılardan tren konforu ile güvenlik ve risk memnuniyetinde farklılaştıkları görülmüştür. Yüksek hızlı tren genel memnuniyet düzeyinin, yaş ve eğitim düzeyi arttıkça azaldığı saptanmıştır. Erken yaşlı-yaşlı grubu (55 yaş ve üzeri) özellikle tren konforuna ilişkin olumsuz görüş bildirmiştir. İstasyon konforu memnuniyet puanının gelirle ters orantılı, ücret ve bilet hizmetleri toplam memnuniyet puanının gelirle doğru orantılı olduğu tespit edilmiştir. Yolculuk amaçlarına göre genel memnuniyet puanlarına bakıldığında arkadaş ziyareti ve sosyokültürel etkinliklere katılım amacıyla yolculuk yapan katılımcıların yüksek hızlı trenden daha memnun olduğu; bakım hizmeti amacıyla yolculuk yapan katılımcıların ise en düşük memnuniyet puanına sahip olduğu saptanmıştır.

Anahtar sözcükler: *Analitik hiyerarşi süreci; müşteri memnuniyeti; yüksek hızlı tren; yolcu memnuniyeti; hizmet kalitesi.*

Introduction

High speed rails, considered one of the most significant technological developments in passenger transportation, were developed in the second half of the 20th century. In a historical perspective, railways were reaching 100 km/h until 1850's, 130 km/h in 1854 and 200 km/h in the beginning of the 20th century. After some noteworthy speed records in Europe (see Germany, Italy, UK and France), in 1964, Japanese national railways launched an entirely new high-speed line, and this date was considered to be the milestone of HSR. The following countries followed suit, offering HSR trip in Europe, respectively: Italy and Germany in 1988, Spain in 1992, Belgium in 1997, England in 2003 and the Netherlands in 2009. This development was followed by other countries and regions, China was included in the HSR system in 2003, South Korea in 2004, and Taiwan in 2007 (UIC, 2019).

High speed railway has become one of the main transportation means for long-distance passenger transportation in the world (Liu et al., 2012). Hence, HSR differs from other transportation systems with its features such as security, strong carrying capacity, low energy consumption, speed, time advantage and being environmentally friendly (Cao & Chen, 2011). It is predicted, therefore, by 2030-2035, that the established HSR network will be more than 80,000 kilometers across the world (UIC, 2019).

Railway transportation in Turkey, in parallel with the developments in the world, gained acceleration with the introduction of HSR in 2009. Turkish State Railways (TCDD) tries to spread the HSR services out across the country. In this context, the following lines were implemented respectively: Ankara-Eskisehir in 2009, Ankara-Konya in 2011 and Ankara-Istanbul and Konya-Istanbul lines in 2014. The lines between Ankara-Izmir, Ankara-Sivas, Bursa-Bilecik and Konya-Karaman are other planned HSR lines to be implemented (Figure 1). Every year, there is an increase in the number of passengers using HSR, for example, in 2018, the total number of passengers increased by 13% compared to the previous year (TCDD, 2018).

As in the world, HSR attracts a significant number of passengers in Turkey, especially in the transportation market for long-distance trip. To maintain this trend, the quality of passenger services is one of the main concerns of railway operators (Nathanail, 2008); in addition to providing passenger satisfaction and loyalty, service quality ensures keeping the operator in a competitive position in the field of passenger transportation (Kotler, 1997). In the competitive market conditions, organizations increasingly feel the importance of establishing good relationships with their customers, and therefore, make efforts to meet customer expectations (Wang, et al., 2007). Measuring perceptions of the services provided and determining the expectations and demands regarding these services help improve the quality of passenger transportation companies (Alpu, 2015). Increasing the share of public transportation in transportation systems takes its place in urban policies for a sustainable environment. Service quality and therefore customer satisfaction are two important factors for orientation to public transportation. Customer satisfaction and perceived service quality are related to each other and passengers who perceive quality public transport continue to use this service (Chen, 2008; Jen & Hu, 2003; Kilibarda et al., 2016; Lai & Chen, 2011).

While the main requirement of passengers in the past was to get from one place to another, today, the trip frequency increasing with the improvement of the economy and living standards has brought with it an increasing demand for comfort. Thus, the quality and satisfaction have become more and more important in creating corporate image and competitiveness (Chin et
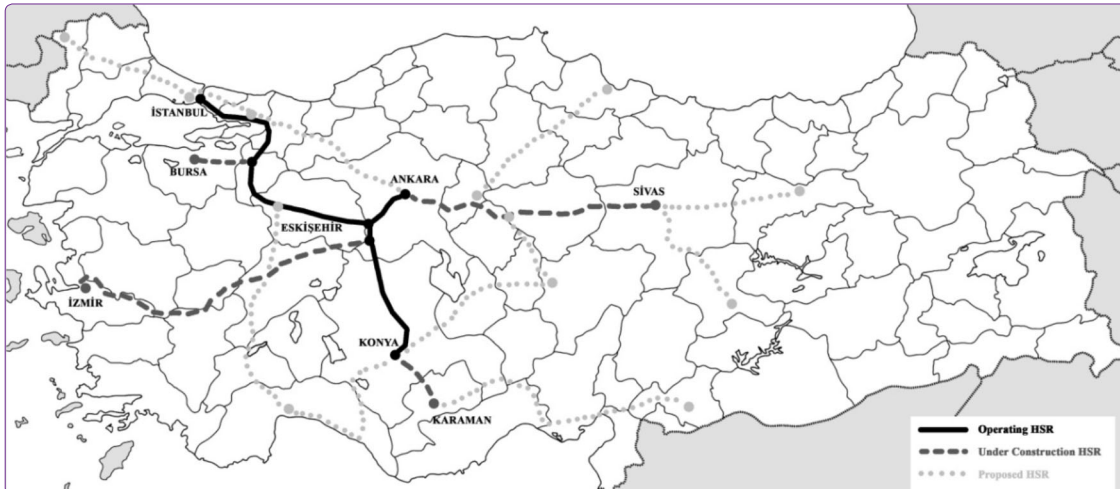

Figure 1. Turkey high-speed rail network (TCDD, 2018; Ray Haber, 2020).

al., 2019). This increased interest in customer satisfaction, on the other hand, made it compulsory for transport companies to define and measure the parameters that cause the satisfaction or dissatisfaction of their passengers (Agarwal, 2008).

While current studies recognize the importance of improving the quality of service and its component passenger satisfaction to some extent, there are still some gaps in reaching an HSR service with high passenger satisfaction (Chin et al., 2019). The first of these gaps is the absence of sufficient research on how to improve passenger satisfaction (from passenger perspective). The second point is the determination of satisfaction levels regardless of the socio-demographic structure of the user group; whereas, many variables such as age, gender, education, profession, etc. affect satisfaction differently. The present study, therefore, focuses on examining the satisfaction levels of TCDD high-speed rail passengers by considering their socio-demographic characteristics, improving the HSRs in the light of this information and increasing the number of HSR passengers and their satisfaction with these trips. In this regard, weight calculation was made through analytic hierarchy process (AHP) method for both main criteria and sub criteria and later, questionnaire technique was implied to collect data in this study. The questionnaires comprise of 6 basic and 23 sub-criteria, besides, these criteria are weighted using the AHP method, where expert opinion is obtained. Thus, the needs and expectations of the passengers are classified according to priorities, and the overall accuracy and reliability of the obtained results were increased.

Literature Review

Customer satisfaction depends on the quality of the product (or service) provided (Anderson & Sullivan, 1993), therefore, service quality and satisfaction are highly related (Liu et al., 2005; Olsen, 2002). However, due to the reasons such as multi-dimensional structure of service quality, and the presence of few scales specific to service quality particularly in the transport industry (measurement problems) (Wu & Lin, 2011), determining customer (passenger) satisfaction instead of service quality gives more tangible results. As a matter of fact, various studies measuring customer satisfaction, service quality and degree of commitment to HSR revealed that satisfaction directly affects trip behaviors, while service quality and corporate image play an indirect role (Cao & Chen, 2011; Chou & Kim, 2009; Kuo & Tang, 2011; Nathanail, 2008). This study, therefore, examines customer satisfaction rather than service quality.

Hu et al. (2009) describe customer satisfaction as a cognitive or affective response that corresponds to a single or long-term service provider; while Eroğlu (2005), on the other hand, defines this as the difference arising from the expectations of the customer and the consumption or usage. Customer satisfaction is discussed with different criteria for each service area; a literature review on public transport and HSR was carried out within the study.

Joewono and Kubota (2007) have defined the criteria for availability, accessibility, reliability, information, customer service, comfort, safety, price and environmental impact of Indonesian paratransit systems; while Silcock (1981) has characterized criteria for accessibility, reliability, comfort, convenience and security measures in public transport. Cheng (2011) has evaluated website service quality in public transportation; while Parasuraman et al. (1988) addressed five criteria: reliability, responsiveness, tangibility, assurance, and empathic. Pullen (1993) considered the accessibility, reliability, comfort, convenience and safety criteria in local public transport; de Oña et al. (2018) on the other hand, discussed customer service, tangible service equipment, availability of the service, individual space, accessibility, information, security, environmental pollution (noise, vibration) criteria. As is seen, criteria such as frequency, reliability, comfort, security, information, personnel behavior, cleaning, ticketing and price are among the most used criteria in public transportation studies (Lao & Liu, 2009). Among these criteria determined in public transportation, on the other hand, Dell'Olio et al. (2011) state that hygiene, comfort and time of waiting; while Redman et al. (2013) service security and frequency; and Mouwen and Rietveld (2013), on the other hand, state that the factors such as service frequency, trip speed, and precision have more impact on passenger satisfaction.

In terms of railway transportation, Rothbauer and Sieg (2011) lists the quality and satisfaction criteria as safety, hygiene, passenger comfort, service frequency, and speed; while Harvey et al. (2014) states them as reliability, safety, convenience, comfort, flexibility, cost, trip time, and amenities. In his study on Turkish State Railways, Zeybek (2018) examined transit time, availability of wagons, accessibility, loss and damage, secure transport, reliability, flexibility, distance, technical equipment, price-quality ratio; while Aydin et al. (2015) investigated the criteria of train comfort, ticketing, information systems, safety, accessibility, station comfort, welcoming, fare, and time. Chou et al.(2011); Xiaoqiang et al. (2017) suggested a passenger satisfaction index and evaluated the overall satisfaction, proper price tolerance and the effects of the ticket service system. The common criteria for railway passenger satisfaction can be summarized as reliability, safety and security, convenience, and comfort (Allen & DiCesare, 1976; Miller, 1995; Pullen, 1993).

Studies addressing railway passenger satisfaction more specifically can be listed as suitability of train stations for the elderly (Zhao et al., 2018), thermal comfort of stations (Y. Liu & Yang, 2018) and customer satisfaction in the cabin (Chin et al., 2019). The sub-criteria used in HSR passenger satisfaction are quite diverse, these are stable internet connections, sufficient sockets and noiseless trip environment (Tang et al., 2018); well-transmitted information, proper luggage storage, sensory comfort, civilized riding environment, well-prepared facilities (Chin et al., 2019); train performance (delays per passenger train), overcrowding, safety or accident risk (Pollitt & Smith, 2002); comfortable seat, cleanliness of sitting area (Drea & Hanna, 2000; Hanna & Drea, 1998).

Vanniarajan and Stephen (2008) evaluated passenger satisfaction using the data collected from the passengers of the Southern Railways and identified the factors of reliability, assurance and empathy for passengers. In his study on Indian Railways, Agarwal (2008) analyzed 47 different qualities such as ticket, platform, trip and employee behavior, and stated that employee behavior among these various factors considered has greatly affected customer satisfaction. Alpu (2015) has determined 4 factors: physical conditions, food services, information and personnel behavior. But she found that the most important contribution to customer satisfaction was provided by the attitude and behavior of the staff. In her study on Helenic railways, Nathanail (2008) examined 6 criteria such as cleanliness, itinerary accuracy, system safety, passenger comfort, servicing, and passenger information and determined that itinerary accuracy and system safety criteria were more effective in satisfaction. Nandan (2010) took 16 variables to measure service quality in Indian railways and stated that safety and security, basic facilities, information system, behavioral factors and refreshments factors were effective in order of priorities. Zhen et al. (2018) reported that the highest correlation regarding passenger satisfaction was staff attitude, ease of booking and accessibility.

As can be seen, passenger satisfaction differs in every society and even in every sample group (customer satisfaction criterias are presented in Table A.1). For this reason, companies need to understand the different needs of customers in using distribution channels in order to provide suitable and quality service to the passengers (Cheng & Huang, 2014).

In this context, the objectives of the present study can be listed as follows:

- To determine the factors and importance levels affecting the satisfaction of HSR passengers,
- To analyze the general satisfaction perceptions of the passengers on HSR,
- To compare the satisfaction levels of the passengers with different trip purposes and different socio-demographic structures.

Empirical Study and Results

Ankara-Konya HSR

HSR trips between Ankara, the capital city of Turkey, and Konya, which is the 1st in terms of the surface area of the country and the 7th largest city in terms of population, constitute the scope of this study. Today, the Ankara-Konya line, which constitutes 28% of the total HSR trips, has a transportation share of 66% after its opening. As of 2018, a total of 2,242,870 passengers were transported on the Ankara-Konya route and 6,606 train runs were performed. During these runs, an average of 4,800 people on weekdays and 5,500 people on weekends are transported. On the 1 hour 45 minutes-line, there are 20 daily trips in summer, and 14 trips in the winter season. On the Ankara-Konya route, trains stop at Eryaman and Polatlı stations. There are no stations on the Konya-Ankara route yet.

On the Ankara-Konya line, Siemens Velaro branded trains are used, consisting of 8 carriages, 1 of which is a cafeteria. These trains have portable catering, air conditioning, and music systems, special seating areas for the disabled and vacuum toilets. The train capacity is 483 people, including 424 economy class, 57 business class and 2 disabled (wheelchair-bound) passengers.

Methodology and Data Collection

To measure HSR passenger satisfaction, a questionnaire was applied during the trips at different times of the day to 427 people (confidence interval is 95%) aged over 18 years old between the dates of 14-20 May 2018 (education continues on these dates) with the approval of TCDD. 234 (54.8%) people on the Ankara-Konya line and 193 (45.2%) people on the Konya-Ankara line completed the questionnaire, while 128 questionnaires were excluded since they were not completed and 194 questionnaires were excluded since they were left blank.

The questionnaires were prepared including three main sections: the socio-demographic information of the participants, their trip information and their evaluation of HSR satisfaction. The majority of the participants were young, highly-educated and non-employed individuals (Table 1). Those who were not working were comprising of: 70.4% students, 6.7% sick/disabled, 5.6% housewives, and 10.6% retired.

When the trip information of the participants is examined, it is seen that the trips are made for the following purposes: visiting relatives (29.3%), business and business follow-up (28.1%), education (17.2%), friend visit (11.5%), participation in social and cultural events (8.1%), health services (3.7%), child, elderly and patient

care (2.0%). Besides, 31.8% of the respondents use HSR at least once a week (Table 2).

In light of the information obtained from the literature, 23 sub-criteria under 6 main headings (Table 3) were

Table 1. Demographic profile of questionnaire respondents of HSR passengers

Variable	Variable level	Frequency	Valid Percent
Age	18-24 years	149	35.6
	25-34 years	129	30.8
	35-44 years	77	18.4
	45-54 years	35	8.4
	55-64 years	25	5.9
	65 and over	4	0.9
Gender	Female	177	41.5
	Male	250	58.5
Marital status	Married	185	43.6
	Single	231	55.5
	Divorced / widowed	8	1.9
Education	Primary school	14	3.3
	Secondary school	20	4.7
	High school	82	19.3
	University	221	52.2
	Graduate	87	20.5
Occupation	Unemployed	163	39.4
	Private sector workers	145	35.0
	Public sector workers	77	18.6
	Self-employment	29	7.0
Income (1 YTL= 0,17 $)	0-500 YTL	67	17.2
	501-1500 YTL	34	12.6
	1501-2000 YTL	42	8.7
	2001-3000 YTL	49	15.9
	3001-4000 YTL	62	10.8
	4001 and over	135	34.8

determined to affect the satisfaction of the passengers. In this section of the survey, a 5-point Likert-type assessment scale was used (1:"strongly disagree", 5:"strongly agree"). Based on the assumption that these criteria will not have the same importance for passengers and will have different effects on satisfaction, the analytic hierarchy process method was used and criteria weights were determined based on expert opinion.

Analytic Hierarchy Process

Analytic hierarchy process (AHP), which was developed by Thomas L. Saaty in the 1970s, is a method frequently used in decision-making mechanisms (Saaty, 2008). AHP is simple in logical explanation, but based on mathematical hypotheses and assumptions in its own process and provides multi-criteria decision-making opportunity among the alternatives (Lee et al., 2009). Unlike other multi-criteria decision-making methods, AHP compares the criteria in pairs and measures whether the comparisons are consistent.

The first five steps to achieve criteria weights through AHP are: identification of the problem, determining and defining the main and sub-criteria of decision, determining the alternatives, creating the hierarchical structure, and determining the importance scale (Table 4) (Uludağ & Doğan, 2016).

In the sixth step, pairwise comparison matrix is created. The created comparison matrix is normalized. For this operation, column totals are taken and each value is divided by its own column total. The next step is to create the weight matrix and calculate the Consistency Ratio (CR). CR is obtained by the ratio of Consistency Index (CI) to Random Index (RI) (Table 5). In AHP applications, the fact that CR is less than 0,10 indicates that the application is consistent (Saaty, 1980).

Empirical Results

In the study, firstly, weight calculation was made through AHP method for both main criteria and sub criteria (Table 6-13).

Table 2. HSR trip purposes and trip frequency

		Trip Purposes (%)						
	Frequency (%)	Health Services	Friend visit	Social and cultural activity	Education	Child and patient care	Visiting of relatives	Business and business follow-up
Trip Frequency								
Several times a year	19.4	20.0	29.0	38.6	10.8	0.0	17.7	18.4
Once a month	26.3	45.0	27.4	20.5	20.4	45.5	34.2	19.1
2-3 times a month	23.1	15.0	25.8	27.3	30.1	18.2	25.9	15.1
1-2 times a week	5.4	0.0	6.5	4.5	8.6	0.0	5.7	3.9
3-4 times a week	20.4	20.0	11.3	9.1	30.1	36.4	16.5	24.3
5 and above a week	5.4	0.0	0.0	0.0	0.0	0.0	0.0	19.1

Table 3. Satisfaction criteria

Main Criteria	Code	Sub Criteria
Security and risk (S)	S1	Security measures for emergencies and disasters
	S2	Security measures for theft, harassment, etc.
	S3	Security measures in the station and its vicinity
	S4	Insurance against accident risk
Fare and ticket services (F)	F1	Fare
	F2	Special discounts (TCDD charges a low fee for groups such as disabled, teacher, retired, student, 65 years old, etc.)
	F3	Accessibility for ticket services and information
Station comfort (SC)	SC1	Comfort of passenger lounge
	SC2	Platform compatibility
	SC3	Compatibility of stations to climatic conditions
Trip comfort (T)	T1	Passenger density
	T2	Trip frequency
	T3	Trip hours
	T4	Sex discrimination in seats (TCDD does not allow female and male passengers to sit side by side out of their own will for security reasons)
Personnel behavior (PB)	PB1	Attitude of service personnel
	PB2	Attitude of ticket controllers
	PB3	Attitude of booking office personnel
	PB4	Returning to complaints
Train comfort (TC)	TC1	Cleaning (seat, floor, window, wc, etc.)
	TC2	Width of seating areas
	TC3	Ventilation and heating system
	TC4	Sound-noise level
	TC5	Suitability for disadvantaged people (disabled, elderly, child, etc.)

Table 4. Cross-criteria significance scale (Saaty, 1990)

Significance Level (aij)	Description
1	i and j are equally important
3	i criterion slightly more important than j criterion
5	i criterion obviously more important than j criterion
7	i criterion highly more important j criterion
9	i criterion extremely more important j criterion
2,4,6,8	Intermediate values

Table 5. Index values of average random consistency (Saaty, 2008)

Degree	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

When the main criteria matrix is examined, it is seen that the consistency is high (CR = 0.0297) and weights are ranked as T> TC> F> S> SC> PB (Table 6).

The consistency of the security and risk sub-criteria matrix is high and the weight order is S1> S3> S2> S4 (Table 7). Being located of Turkey in a geography with high disaster risk and the terrorist attack on Ankara train station in 2015 increased the weight of the S1 and S3 criteria.

The consistency of the fare and ticket services sub-criteria matrix is very high (Table 8). Ticket prices appear to be highly effective in satisfaction (weight ranking F1> F2> F3).

The consistency of the station comfort sub-criteria matrix is high. When the results were evaluated, the compliance of the stations to the climatic conditions was found to be more effective in satisfaction as a result of the expert opinion (Table 9; weight ranking SC3> SC2> SC1). To avoid confusion since there are two stations on the Ankara route and the main station is located within the shopping center; only Konya station was included in the evaluation. Ankara and Konya are the cities where severe climate (cold-dry) conditions are often experienced.

The consistency of the trip comfort sub-criteria matrix is high (Table 10). Among these criteria, the trip frequency has the highest weight. In reservations or bookings, seats are selected according to gender and it is not allowed to

Table 6. Pairwise comparison matrix and weights of the main criteria

	S	F	SC	T	PB	TC	Weights
Security and risk (S)	1	1/3	2	1/5	3	1/2	0.089
Fare and ticket services (F)	3	1	5	1/3	7	2	0.233
Station comfort (SC)	1/2	1/5	1	1/7	2	1/3	0.054
Trip comfort (T)	5	3	7	1	9	4	0.452
Personnel behavior (PB)	1/3	1/7	1/2	1/9	1	1/4	0.034
Train comfort (TC)	2	1/2	3	1/4	4	1	0.138

λmax=6.1844 CR=0.0297<0.10

Table 7. Pairwise comparison matrix and weights of security and risk sub-criteria

	S1	S2	S3	S4	Weights
Security measures for emergencies and disasters (S1)	1	4	2	7	0.508
Security measures for theft, harassment, etc. (S2)	1/4	1	1/2	4	0.160
Security measures in the station and its vicinity (S3)	1/2	2	1	5	0.276
Insurance against accident risk (S4)	1/7	1/4	1/5	1	0.056

λmax=4.0911 CR=0.0337<0.10

Table 8. Pairwise comparison matrix and weights of fare and ticket services sub-criteria

	F1	F2	F3	Weights
Fare (F1)	1	4	6	0.701
Special discounts (F2)	1/4	1	2	0.193
Accessibility for ticket services and information (F3)	1/6	1/2	1	0.106

λmax=3.0148 CR=0.0128<0.10

Table 9. Pairwise comparison matrix and weights of station comfort sub-criteria

	SC1	SC2	SC3	Weights
Comfort of passenger lounge (SC1)	1	1/3	1/6	0.096
Platform compatibility (SC2)	3	1	1/3	0.251
Compatibility of stations to climatic conditions (SC3)	6	3	1	0.653

λmax=3.0272 CR=0.0234<0.10

Table 10. Pairwise comparison matrix and weights of trip comfort sub criteria

	T1	T2	T3	T4	Weights
Passenger density (T1)	1	1/9	1/6	1/4	0.047
Trip frequency (T2)	9	1	2	4	0.510
Trip hours (T3)	6	1/2	1	3	0.305
Sex discrimination in seats (T4)	4	1/4	1/3	1	0.138

λmax=4.0906 CR=0.0336<0.10

Table 11. Pairwise comparison matrix and weights of personnel behavior sub-criteria

	PB1	PB2	PB3	PB4	Weights
Attitude of service personnel (PB1)	1	5	2	3	0.467
Attitude of ticket controllers (PB2)	1/5	1	1/4	1/2	0.079
Attitude of booking office personnel (PB3)	1/2	4	1	3	0.315
Returning to complaints (PB4)	1/3	2	1/3	1	0.139

λmax=4.0748 CR=0.0276<0.10

Table 12. Pairwise comparison matrix and weights of train comfort sub-criteria

	TC1	TC2	TC3	TC4	TC5	Weights
Cleanliness (TC1)	1	1/3	3	2	3	0.221
Width of seating areas (TC2)	3	1	6	3	6	0.486
Ventilation and heating system (TC3)	1/3	1/6	1	1/2	1	0.075
Sound-noise level (TC4)	1/2	1/3	2	1	2	0.143
Suitability for disadvantaged people (TC5)	1/3	1/6	1	1/2	1	0.075

λmax=5.0571 CR=0.0127<0.10

book a seat next to the opposite sex (see T4). This situation was found to be of third-degree significance among the criteria (weight ranking T2> T3> T4> T1).

The consistency of the personnel behavior sub-criteria matrix is high. It is seen that the behaviors of the service and booking personnel were scored are more weighted (Table 11; weight ranking PB1> PB3> PB4> PB2).

The consistency of the train comfort sub-criteria matrix is quite high (Table 12). It is possible to say that the most important criterion in train comfort is the width of the seating areas (weight ranking TC2> TC1> TC4> TC3 = TC5). To accurately measure the satisfaction with the seating areas on trains, only economy class users were surveyed,

the business-class with a larger and more comfortable seat is not included in the study.

When the AHP results are examined; the criteria with the highest total weight scores, trip frequency (T2), ticket price (F1) and trip times (T3) seem to have more impact on passenger satisfaction (Table 13).

At this stage of the study, according to the variables of gender, age, education, income and trip purposes, the mean scores of the participants regarding HSR satisfaction were analyzed by multiplying the total weights of the criteria (Table A.2-3). When the gender variable is examined (Table A.2), female participants ($\bar{x}$ = 3.2116) seem to have a very close satisfaction score with male

Table 13. Results of AHP analysis

Main criteria	MW	SCC	SW	TW	Main criteria	MW	SCC	SW	TW
Security and risk (S)	0.089	S1	0.508	0.04521	Trip comfort (T)	0.452	T1	0.047	0.02124
	0.089	S2	0.160	0.01424		0.452	T2	0.510	0.23052
	0.089	S3	0.276	0.02456		0.452	T3	0.305	0.13786
	0.089	S4	0.056	0.00498		0.452	T4	0.138	0.06238
Fare and ticket services (F)	0.233	F1	0.701	0.16333	Station comfort (SC)	0.054	SC1	0.096	0.00518
	0.233	F2	0.193	0.04497		0.054	SC2	0.251	0.01355
	0.233	F3	0.106	0.02470		0.054	SC3	0.653	0.03526
Train comfort (TC)	0.138	TC1	0.221	0.03050	Personnel behavior (PB)	0.034	PB1	0.467	0.01588
	0.138	TC2	0.486	0.06707		0.034	PB2	0.079	0.00269
	0.138	TC3	0.075	0.01035		0.034	PB3	0.315	0.01071
	0.138	TC4	0.143	0.01973		0.034	PB4	0.139	0.00473
	0.138	TC5	0.075	0.01035					

MW: Main criteria weights; SCC: Sub criteria codes; SW: Sub criteria weights; TW: total weights.

participants (x̄ = 3.2016), however, it is observed that they differ in trip comfort and security and risk criteria. Female participants were less satisfied with the security measures (S3) taken in the station and its vicinity and theft and harassment measures (S2) inside the train. Male participants, on the other hand, find the trip frequencies (T2) to be insufficient. This result may be associated with the fact that male passengers use trains more frequently (Female passengers use HSR an average of 48 days a year, while male passengers use 67 days).

While examining satisfaction levels by age variable, the data were rearranged according to the 3-age group. Since the age at first employment is mostly (32.1%) 25 years in Turkey (TUIK, 2019), the 18-24 age group constitutes the youth group that is considered to be not included in the working life, while the 25-54 age group forms the second group of youth-middle age, and 55 and over group was the third group of early aged-aged group. HSR general satisfaction level decreases with increasing age (Table A.2). Participants aged 55 and over find HSR safer. The same age group scored lower on train comfort (especially to ventilation and heating systems) than other participants (18-24 years x̄ = 0.5395; 25-54 years x̄ = 0.5373; 55 and over x̄ = 0.4961). Another problem for the 55 and over age group is the fact that stations are not suitable for climate conditions (SC3). While the 25-54 age group does not find the trip frequency (T2) sufficient, they are also not satisfied with the sex discrimination in the seats (T4). Compared to other participants, participants in the 18-24 age group stated that accessibility to ticket services are satisfactory. This result may be associated with the new generation's relative ease in use of technology (buying tickets using the website or a smartphone, etc.).

In terms of ease of comparison in the training variable, the classification was done as follows: literate, primary and secondary school graduates in the first group; high school and college graduates in the second group; bachelor and postgraduate graduates in the third group. When general satisfaction scores are examined (Table A.2); it is found that as the education level increases, satisfaction with HSR decreases (elementary and below x̄=3.4054; high school and equivalent x̄=3.2118; bachelor and above x̄=3.1092). Similarly, the total satisfaction scores of security and risk, station comfort and trip comfort are inversely proportional to the level of education. Participants with bachelor and higher education find the security measures (S3) in the station and its vicinity insufficient.

When analyzing income data, evaluations were made in three categories: subminimum rate, minimum wage (1,603 YTL), and above minimum wage. Total satisfaction scores of fare and ticket services seem to be directly proportional to income, while station comfort total satisfaction scores

are inversely proportional to income (Table A.3). It is an expected result that satisfaction with ticket prices (F1) will decrease in the low income group. The conformity of the stations to climatic conditions (SC3) is scored lower by individuals with minimum wage or higher income. In addition, these two income groups have low satisfaction with trip comfort.

HSR travel purposes are divided into seven categories: participation in socio-cultural events, visiting of relatives, friend visits, business and business follow-up, health services, education services, and elderly, patient, child care services. Looking at the overall satisfaction scores, participants traveling with the purpose of visiting friends (x̄=3.4316) and participating in socio-cultural activities (x̄=3.3728) are more satisfied with HSR. Participants traveling for elderly, patient or childcare services have the lowest overall satisfaction score (x̄=3.0336). Trip comfort scores were lower in business and business follow-up purpose trips, while security and risk and train and station comfort scores were lower in the trips for health care purposes, and fare and ticket services total scores were lower in care-purposed trips. Participants who stated that they traveled for access to health services do not find the station platform (SC2), the suitability of the stations for climatic conditions (SC3) and the width of the seats (TC2) inside the train sufficient. Ticket prices (F1) in the trips for education and care services and gender discrimination in seats (T4) in the trips for business and business follow-up and education purposes are other criticized issues.

Limitations of the Study and Future Research

The most important limitation of the study is the the data set comprising of only HSR passengers between Ankara-Konya route. It was not possible to apply the questionnaires simultaneously on other HSR routes; therefore, it is not possible to generalize the satisfaction level for all HSR services. However, it is thought that the study will contribute to the further studies in terms of determining the method and satisfaction criteria.

The second limitation is the fact that satisfaction with security and risk cannot be measured with the absolute perceptions. Security and risk are related to social memory as well as one's own experiences. As a matter of fact, no accident, terrorist attack or similar incident occurred in TCDD's Ankara-Konya trips until the date of the questionnaire. Due to this social memory, passengers' confidence in HSR is already (in a prejudiced way) high. However, approximately seven months after the questionnaires were conducted (on December 13, 2018), the train on the Ankara-Konya route crashed in Ankara, 9 people died and 47 were injured. Officials explained that the accident was caused by signaling problems, all

trip services departing from Ankara continued for a long time in a delayed manner. The question of how this fact, which will directly affect the safety and risk satisfaction of the passengers and indirectly the satisfaction of trip comfort, would affect further studies is uncertain. Similar uncertainty is true of satisfaction with the ticket prices, as a matter of fact, as of October 7, 2019, TCDD started to offer ticket prices with a 20% increase. In this context, comparing the safety level, ticket prices and trip satisfaction measurements within this study in additional studies will be useful for monitoring the changes over time.

Conclusion and Further Discussions

High speed railways are considered as one of the most important technological developments in passenger transportation today. In recent years, supply and demand for HSR transportation has increased in intercity trips. In this context, this study provides a different approach to the assessment of HSR passenger satisfaction. The study aims to measure satisfaction, thus both main and sub-criteria are weighted using AHP method and then, satisfaction of different socio-demographic passenger groups is measured by considering these weighted scores. Based on the AHP results, the trip comfort and train comfort criteria had high, while fare and ticket services and security and risk criteria had medium, and station comfort and personnel behavior criteria had lower weighted scores. In this regard, the results reveal that trip and train comfort is important factors for increasing HSR passenger satisfaction and this result was found to be similar to the studies of Chin et al. (2019), de Oña et al.(2018), Harvey et al. (2014). While security and risk affects the satisfaction at medium level (Aydin et al., 2015; Nandan, 2010; Harvey et al., 2014; Nathanail, 2008; Vanniarajan & Stephen, 2008), the least impact is related to the personnel behavior. However, it is possible to claim that the low effect of personnel behavior on satisfaction is contradictory with some studies in the literature (Agarwal, 2008; Alpu, 2015; Chin et al., 2019; Ghosh & Ojha, 2017; Zhen et al., 2018).

According to AHP results, among the 6 main criteria, the sub criteria of ticket prices, the conformity of stations to the climate conditions, trip frequency, security measures for emergencies and disasters, width of seats, behavior of service personnel are the sub-criteria with the highest score (see Table 13, sub criteria weights). When it is evaluated with the main criterion weights, on the other hand, it is found that the frequency of voyages, ticket prices and trip times sub-criteria have more impact on satisfaction. In the context of these criteria (in total scores), young passengers (18-24 years old) with primary and lower education traveling for the purpose of visiting relatives and friends seem to be more satisfied with HSR, while as the level of education, income and age increase, it is

seen that expectations from HSR increase, and satisfaction decreases.

Hence, to increase passenger satisfaction by providing a higher quality HSR service in the future, TCDD needs to analyze the different socio-demographic variables well and develop new strategies for some groups. For example, satisfaction with ticket prices, which is an important criterion, is very low for the low income group. After TCDD raises the ticket prices, the gap between the train and bus ticket prices has closed. Passengers prefer HSR because they save their time, however, if, in the future, the new price raises would carry the fares over the bus ticket prices, this may cause low-income passengers to prefer the bus. This could negatively affect the HSR operations in the long-term.

In addition to pricing policies, age is a significant factor in passenger satisfaction. For instance, since the group of 55 and over age group are more affected from heat and cold, those in this group state that the stations are not suitable for climatic conditions. Similarly, these people scored the ventilation and heating systems in the train with lower scores. Another problem stated by this age group is the inability to access booking services as easily as young people since they are not able to use technology like them. In this context, TCDD should review HSR services with an age-sensitive approach and take different measures (increasing the closed areas at the stations, controlling the carrier air conditioners, preparation of brochures describing online ticket purchase, etc.).

Another significant result of the study is that, female and highly-educated passengers think that safety measures before and during the trip are not sufficient. This result may be associated with the fact that Turkey is a country with high risk of disaster and terrorism and defects in the protective legal system. For this reason, firstly, enforcements and inspections regarding security breach should be increased. Individuals traveling for the purpose of care services or health services such as elderly, sick, children have lower HSR satisfaction than other passengers. The station platform, the conformity of the stations for the climatic conditions and the width of the seats in the train are not deemed to be sufficient by these people. The design of the stations and platforms should be revised for these vulnerable groups. However, increasing the areas reserved for disabled people in the train and allocation of larger and more comfortable seats for passengers who are sick or accompany any person in need of care would have a positive impact on HSR satisfaction.

All in all, as being the most efficient and highly preferred public transport mode in terms of intercity transportation HSR promises a lot for the future. On the other hand, HSR operators need to pay attention to user satisfaction in order to both provide better services and increase their

monetary gains. In this context, this study provides an overview for the case of user satisfaction by focusing on the Ankara-Konya route while similar studies should be conducted at other locations to derive more general results and enhance passenger satisfaction during HSR trips.

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Table A.1. Some customer satisfaction criteria using in the literature

	Criteria	Researchers
Public transport	Website service quality	Cheng (2011)
	Customer service, tangible service equipment, availability of the service, individual space, accessibility, information, security, environmental pollution (noise, vibration)	de Oña et al., (2018)
	Cleanliness, comfort, time of waiting	Dell'Olio et al., (2011)
	Availability, accessibility, reliability, information, customer service, comfort, safety, price and environmental impact	Joewono & Kubota (2007)
	Reliability, comfort, security, information, personnel behavior, cleanliness, ticketing and price	Lao & Liu (2009)
	Service frequency, trip speed, precision	Mouwen & Rietveld (2013)
	Reliability, responsiveness, tangibility, assurance, empathic	Parasuraman et al., (1988)
	Accessibility, reliability, comfort, convenience and safety	Pullen (1993)
	Service security, frequency	Redman et al., (2013)
	Accessibility, reliability, comfort, convenience and security	Silcock (1981)
Railway	Service quality, fare	Allen & DiCesare (1976)
	Physical conditions, food services, information ve personnel behavior	Alpu (2015)
	Train comfort, ticketing, information systems, safety, accessibility, station comfort, welcoming, fare, time	Aydin et al., (2015)
	Well-transmitted information, proper luggage storage, sensory comfort, civilized riding environment, well-prepared facilities	Chin et al., (2019)
	Security, station, shuttle service, information and communication technologies, information availability, attitude of the official, cleanliness, personal space in the train, air-condition, comfort, the design of the waiting area, route, frequency, arrival times, ticket service system, frequency of complaints, price tolerance	Chou et al., (2011)
	Comfortable seat, cleanliness of sitting area	Drea & Hanna (2000)
	Safety and security, basic facilities, information system, behavioral factors ve refreshments	Nandan (2010)
	Reliability, safety, convenience, comfort, flexibility, cost, travel time, amenities	Harvey et al., (2014)
	Reliability, safety and security, convenience, comfort	Miller (1995)
	Cleanliness, itinerary accuracy, system safety, passenger comfort, servicing, and passenger information	Nathanail (2008)
	Train performance, overcrowding, safety or accident risk	Pollitt & Smith (2002)
	Passengers' waiting time, lost mileage, characteristics of each travel mode	Pullen (1993)
	Safety, cleanliness, passenger comfort, service frequency, speed	Rothbauer & Sieg (2011)
	Stable internet connections, sufficient sockets and noiseless trip environment	Tang et al., (2018)
	Reliability, assurance, empathy for passengers	Vanniarajan & Stephen (2008)
	Transit time, availability of wagons, accessibility, loss and damage, secure transport, reliability, flexibility, distance, technical equipment, price-quality ratio	Zeybek (2018)
	Staff attitude, ease of booking, accessibility	Zhen et al., (2018)

Table A.2. Satisfaction score averages by variables of gender, age and educational background

Main Criteria	Code	Weight	Gender		Age			Education		
			Female	Male	18-24 age	25-54 age	55 and over	Primary & below	High s. & equivalent	Bachelor and over
Security and	S1	0.04521	0.1537	0.1533	0.1542	0.1505	0.1619	0.1727	0.1524	0.1474
risk (S)	S2	0.01424	0.0386	0.0488	0.0440	0.0443	0.0477	0.0493	0.0441	0.0434
	S3	0.02456	0.0567	0.0813	0.0651	0.0717	0.0793	0.0725	0.0742	0.0690
	S4	0.00498	0.0179	0.0200	0.0184	0.0196	0.0181	0.0190	0.0192	0.0192
	Total		0.2669	0.3034	0.2817	0.2862	0.3070	0.3134	0.2899	0.2791
Fare and ticket	F1	0.16333	0.4606	0.4639	0.4410	0.4786	0.4328	0.4688	0.4590	0.4704
services (F)	F2	0.04497	0.1664	0.1664	0.1713	0.1623	0.1745	0.1704	0.1664	0.1628
	F3	0.02470	0.0882	0.0892	0.0931	0.0860	0.0855	0.0879	0.0897	0.0860
	Total		0.7152	0.7194	0.7054	0.7269	0.6928	0.7271	0.7150	0.7191
Station comfort	SC1	0.00518	0.0152	0.0135	0.0149	0.0137	0.0146	0.0157	0.0141	0.0133
(SC)	SC2	0.01355	0.0416	0.0371	0.0398	0.0385	0.0386	0.0432	0.0385	0.0355
	SC3	0.03526	0.0927	0.0987	0.1005	0.0973	0.0931	0.1097	0.0948	0.0903
	Total		0.1496	0.1494	0.1552	0.1495	0.1463	0.1686	0.1474	0.1391
Trip comfort (T)	T1	0.02124	0.0797	0.0794	0.0767	0.0811	0.0816	0.0837	0.0777	0.0850
	T2	0.23052	0.7192	0.6916	0.7423	0.6731	0.7284	0.7999	0.7031	0.6501
	T3	0.13786	0.4425	0.4191	0.4384	0.4232	0.4301	0.4715	0.4274	0.4108
	T4	0.06238	0.1797	0.1772	0.1940	0.1753	0.2021	0.1597	0.1903	0.1709
	Total		1.4211	1.3673	1.4513	1.3528	1.4422	1.5148	1.3984	1.3168
Personnel	PB1	0.01588	0.0624	0.0594	0.0594	0.0615	0.0602	0.0626	0.0603	0.0616
behavior (PB)	PB2	0.00269	0.0105	0.0098	0.0099	0.0102	0.0105	0.0105	0.0101	0.0102
	PB3	0.01071	0.0412	0.0391	0.0394	0.0402	0.0401	0.0406	0.0399	0.0403
	PB4	0.00473	0.0144	0.0144	0.0146	0.0140	0.0162	0.0156	0.0143	0.0142
	Total		0.1286	0.1227	0.1233	0.1258	0.1269	0.1293	0.1246	0.1262
Train comfort	TC1	0.0305	0.1171	0.1229	0.1226	0.1199	0.1125	0.1202	0.1226	0.1193
(TC)	TC2	0.06707	0.2723	0.2703	0.2743	0.2703	0.2602	0.2763	0.2696	0.2703
	TC3	0.01035	0.0377	0.0387	0.0397	0.0393	0.0203	0.0392	0.0384	0.0369
	TC4	0.01973	0.0649	0.0681	0.0637	0.0689	0.0653	0.0742	0.0673	0.0649
	TC5	0.01035	0.0383	0.0394	0.0391	0.0389	0.0378	0.0423	0.0385	0.0375
	Total		0.5303	0.5394	0.5395	0.5373	0.4961	0.5522	0.5364	0.5289
Overall satisfaction score * ortalama			3.2116	3.2016	3.3943	3.3726	3.3383	3.4054	3.2118	3.1092

*The overall satisfaction score was evaluated over 5 points.

Table A.3. Satisfaction score averages according to income and travel purpose variables

Main Criteria	Code	Weight	Income			Trip purpose						
			Sub-minimum rate	Minimium wage	Over minimum wage	Visiting of relative	Business and follow-up	Health services	Friend visit	Participation in social and cultural events	Education	Care services
Security and risk (S)	S1	0.0452	0.1542	0.1569	0.1501	0.1542	0.1564	0.1388	0.1524	0.1442	0.1496	0.1695
	S2	0.0142	0.0436	0.0457	0.0451	0.0453	0.0466	0.0409	0.0440	0.0443	0.0417	0.0392
	S3	0.0246	0.0648	0.0732	0.0734	0.0928	0.0756	0.0656	0.0771	0.0673	0.0661	0.0553
	S4	0.0050	0.0191	0.0199	0.0192	0.0192	0.0203	0.0173	0.0204	0.0194	0.0181	0.0174
	Total		0.2817	0.2956	0.2879	0.3115	0.2989	0.2625	0.2938	0.2752	0.2755	0.2814
Fare and ticket services (F)	F1	0.1633	0.3724	0.4508	0.5063	0.4639	0.4606	0.5227	0.4949	0.4900	0.4198	0.3267
	F2	0.0450	0.1704	0.1614	0.1646	0.1641	0.1614	0.1619	0.1749	0.1601	0.1632	0.1574
	F3	0.0247	0.0936	0.0897	0.0840	0.0931	0.0845	0.0823	0.0973	0.0897	0.0921	0.0926
	Total		0.6364	0.7019	0.7549	0.7211	0.7065	0.7668	0.7671	0.7397	0.6751	0.5767
Station comfort (SC)	SC1	0.0052	0.0147	0.0140	0.0135	0.0145	0.0130	0.0114	0.0154	0.0133	0.0150	0.0142
	SC2	0.0136	0.0390	0.0398	0.0371	0.0400	0.0352	0.0316	0.0419	0.0377	0.0394	0.0305
	SC3	0.0353	0.1312	0.0991	0.0910	0.0959	0.0980	0.0776	0.1008	0.0927	0.0903	0.1058
	Total		0.1849	0.1529	0.1416	0.1504	0.1462	0.1205	0.1581	0.1437	0.1447	0.1505
Trip comfort (T)	T1	0.0212	0.0784	0.0777	0.0811	0.0803	0.0807	0.0822	0.0741	0.0780	0.0756	0.0743
	T2	0.2305	0.7123	0.6708	0.6962	0.7584	0.6593	0.7377	0.7838	0.7861	0.6708	0.7492
	T3	0.1379	0.4439	0.4260	0.4177	0.4549	0.3984	0.4687	0.4880	0.4701	0.4219	0.3447
	T4	0.0624	0.1990	0.1722	0.1815	0.1934	0.1753	0.1871	0.2177	0.2077	0.1753	0.2339
	Total		1.4336	1.3467	1.3765	1.4870	1.3137	1.4757	1.5636	1.5419	1.3436	1.4021
Personnel behavior (PB)	PB1	0.0159	0.0607	0.0603	0.0611	0.0627	0.0611	0.0592	0.0594	0.0586	0.0597	0.0516
	PB2	0.0027	0.0102	0.0100	0.0101	0.0106	0.0104	0.0104	0.0099	0.0100	0.0096	0.0108
	PB3	0.0107	0.0399	0.0401	0.0395	0.0403	0.0399	0.0407	0.0395	0.0405	0.0395	0.0423
	PB4	0.0047	0.0146	0.0154	0.0139	0.0150	0.0149	0.0136	0.0139	0.0147	0.0139	0.0177
	Total		0.1253	0.1258	0.1246	0.1286	0.1263	0.1239	0.1227	0.1237	0.1227	0.1224
Train comfort (TC)	TC1	0.0305	0.1205	0.1193	0.1232	0.1238	0.1205	0.1159	0.1211	0.1232	0.1171	0.1220
	TC2	0.0671	0.2757	0.2656	0.2643	0.2790	0.2602	0.2461	0.2622	0.2757	0.2777	0.2649
	TC3	0.0104	0.0395	0.0368	0.0379	0.0384	0.0377	0.0359	0.0393	0.0391	0.0389	0.0259
	TC4	0.0197	0.0639	0.0657	0.0683	0.0651	0.0691	0.0631	0.0677	0.0738	0.0623	0.0592
	TC5	0.0104	0.0386	0.0369	0.0392	0.0395	0.0377	0.0373	0.0358	0.0368	0.0369	0.0285
	Total		0.5382	0.5243	0.5328	0.5459	0.5251	0.4984	0.5261	0.5486	0.5330	0.5005
Overall satisfaction score *			3.2001	3.1473	3.2184	3.3445	3.1168	3.2479	3.4316	3.3728	3.0946	3.0336

*The overall satisfaction score was evaluated over 5 points.