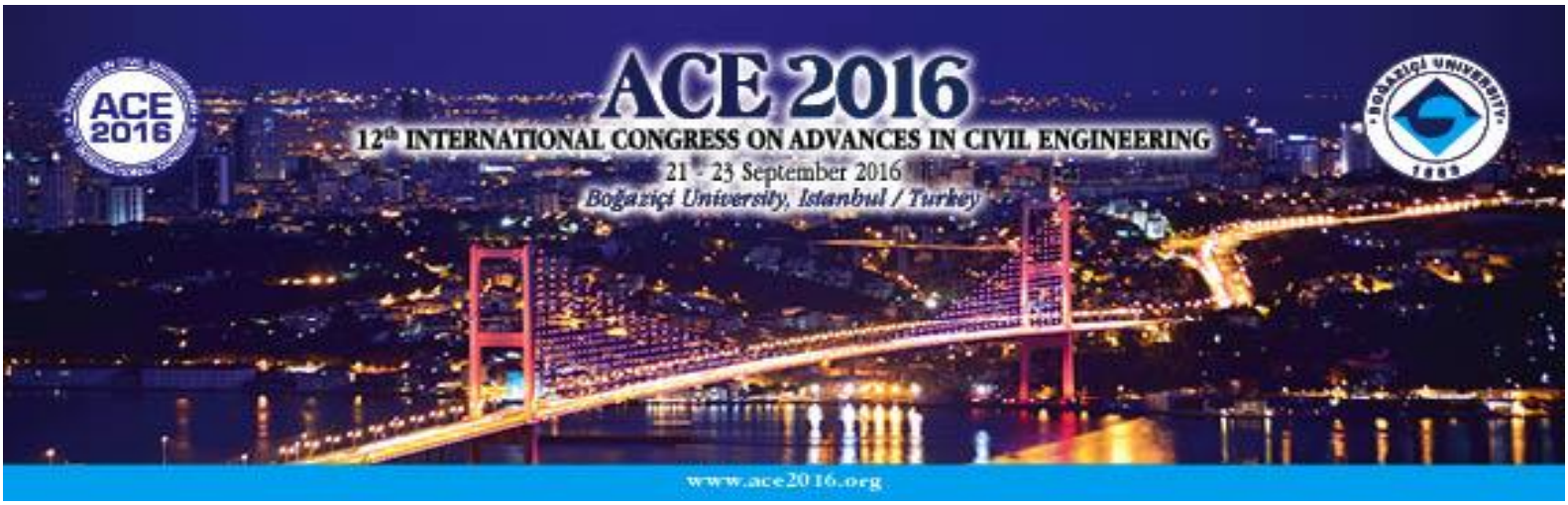

A Review of Traffic Applications on Urban Mobility

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Abstract

Communication technologies advances at unprecedented rates each year. Coupled with advanced technology, Smartphones have emerged and experienced a dramatic increase in worldwide use. There are already more than 1.08 billion smartphone users in the world, out of which, 91.4 million are from United States. According to Turkish Statistical Institute, there are 65 million mobile users in Turkey and one out of five, approximately 13 million, have a smart phone. There are a variety of applications for smartphones ranging from finance, medical, education, commercial to urban mobility. There are more than 100 traffic applications in the world and approximately 10% of them are developed by engineers in Turkey. Some traffic applications allow drivers to use live maps & real-time traffic updates to improve the quality of their journey. For instance, taking current traffic conditions into account, people can view traffic jams, road closures or accidents on their way, enabling route planning for traveling by foot, car, or public transport. This study aims to investigate the impact of traffic applications used in Turkey on urban mobility through users' comments.

Keywords: Urban Mobility, Traffic App, Real – time Information, Traffic Congestion

1. Introduction

Congestion is still often listed as the ″Number One″ concern of urban areas, particularly of suburbanites (Cervero 1991). Different policies and measures (e.g. Intelligent Transportation Systems) have been proposed to deal with congestion and to understand how people react to it (Golob 2001; Logi and Ritchie 2002; Maitra, Sikdar, and Dhingra 1999; Mokhtarian, Raney, and Salomon 1997; Noland 1997; Quiroga 2000; Salomon and Mokhtarian 1997; Scott, Kanarouglou, and Anderson 1997; Stern 1999). One of the ITS implementations involves providing pre-trip information to the drivers prior to their departure. Once this is provided, adaptation strategies include: change in departure schedule, change in the transport mode, route change, stop car use, and no change (travel as usual). Several studies have investigated how people use this information and what changes they make to their trip as a result (Anderson and Souleyrette 2002; Arentze, Hofman, and Timmermans 2004; Mokhtarian, Raney, and Salomon 1997; Noland 1997; Palma and Rochat 1999; Sinuany- Stern, Stern, and Spharadi 1999).

En-route information constitutes information provided to the individuals during the trip. This type of information is most commonly provided by advanced traveler information systems (ATIS) which provides necessary information for travelers, at home/office or en-route. This information forms a good basis for the travelers to determine their trips, mode and route choices, in order to reach their destinations safely and efficiently (Alder and Blue, 1998). For an individual, ATIS can enhance the efficiency of the travel, as well as relieving the stress related to travel. To the system, ATIS can help in reducing travel times, delay, fuel consumption and emission (Adler and Blue, 1998). Public and private resources are devoted to the collection and dissemination of real-time travel information. Such information may have the potential to alleviate at least part of the increasing traffic congestion in urban areas. (Khattak, 1991). Numerous measures can be taken to address problems due to traffic congestion and therefore reduced mobility. An essential step is to create the ability to forecast traffic conditions with significant accuracy and reliability. Various challenges stand in the way of this type of effort. A significant portion of the transportation network has little or no dedicated infrastructure for collecting traffic data. Areas equipped with this infrastructure generally cover only highways and have high installation and maintenance costs despite providing data of variable reliability. An alternative to using dedicated communication infrastructure is to leverage an existing system such as the cellular phone network (Herring et. al., 2009).

In this study, traffic applications that improve urban mobility were investigated with respect to their features. People who interpreted and evaluated these apps were also analyzed. The purpose of this study is to find the relationship between each traffic application used in Turkey and other features; positive and negative comments, five – star rating scale, gender and travel modes that describe the apps' features whether public transit or private car.

2. Methodology

A preliminary analysis is performed for traffic applications in Turkey which consist of two parts with respect to their usage area. Those include features of traffic apps for public transport modes and private car modes. Public transport types contain offering new options on public transit or telling someone the stop before the station. Traffic apps for private car modes involve sharing real – time traffic and road information and enables finding the shortest and the cheapest route for saving time. This is followed by descriptive statistics analysis which shows the relationship between independent variables and their frequencies. Then using the developed regression models, the associated tests were employed to understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed. Details of the methodology and the statistical tests used for each part are explained in the sections.

3. Data Collection

The data for this study was obtained from the websites which include all traffic applications people downloaded such as "Google Play Store" and "Similar Play". Ranging from the most preferred traffic applications to the least ones are obtained from these websites and their features for the travel modes, including both public transport and private car modes are received by means of these. Download counts of traffic applications which are determined as count range, namely, data type is categorical variables and given five – star rating scale are also obtained. In addition to these, gender of the travelers who use the traffic applications and their interpretation concerning positive and negative comments are taken from those web sites.

3.1. Traffic Applications for Public Transport Modes

One of the features traffic applications have is the features of public transport. Public Transit Applications have some common features including displaying information about bus routes, time schedules of the bus stations and traffic conditions, etc. Table 1displays the common features that traffic applications for public transports have.

Table 1. Common features for Public Transit Applications

APP Name	**Types of Apps**	**Common Features**

Mobiett	Public Transit Apps	These type of traffic applications work with İstanbul Metropolitan Municipality Istanbul Electric Tramway and Tunnel Establishments' (İETT) data. With the most robust and precise information from the public transit app, travelers can get the information about bus route and time to arrive the bus station. The apps show up to date bus, metro, ferry, minibus and other schedules which allows people to detect traffic jams and offer the most optimal route to traveler's destination. It reports traffic jams, accidents, closures and everything else that happens in public transport. Combining all transit options together in a single app, public transport apps give total control over travelers' travels so travelers can would not worry when using public transportation.. Real Time Arrival information (where available) lets travelers know when to be at the stop so travelers can spend their time doing something more else than waiting.
İstanbul Ulaşım		
Moovit: Otobüs Metrobüs & Tren		
TRAFI		
Otobüsüm Nerede?		
Buradan Oraya Yolculuk Planlama		
Nasıl Giderim ?		

3.2. Traffic Applications for Private Car Modes

One of the features traffic applications have is the features of private car. Private car applications have some common features including giving real – time traffic information, warning about road hazards or traffic jams and also present the shortest and cheapest way for the travelers' choice. Table 2 shows those common features that traffic applications for private cars have.

Table 2. Common features for Private Car Applications

APP Name	**Types of Apps**	**Common Features**
KGM Türkiye Trafik	Private Car Apps	Private car types of traffic applications offer street maps, a route planner for traveling by foot, car, or bike and an urban business locators for numerous countries around the main country. With new additional features, travelers can also search the cheapest gas station along their route to save money and top-rated restaurants or local businesses, wherever one is. They can mark a location as a "favorite" if they have the exact address. Some applications use an Internet connection to a GPS navigation system to provide turn-by-turn voice-guided instructions on how to arrive at a given destination. The application's traffic congestion map shows the route marks with different colors displaying the current traffic along the route.The traffic is measured by data from local road services such as highway cameras, as well as speed and location information from other devices that are accessing Maps for Mobile. By means of the private car traffic application, travelers choose several journey options that consider traffic jams and public transport connections and it keep updated with real-time information on heavy traffic, accidents, speed cameras, road blocks, etc.
İBB Cep Trafik		
Trafik Rehberi		
Hız Kamerası Türkiye		
ABB Türkiye		
BİTAKSİ		
GOOGLE MAPS		
YANDEX MAPS		
GOOGLE MAPS NAVIGATION		
YANDEX NAVIGATOR		

3.3. Interpretation for Traffic Applications

Interpretation concerning positive and negative comments are obtained from websites that negative interpretations are taken as being opposite of positive interpretation and these are presented in Table 3.

Table 3. Interpretation for Traffic Applications

Positive Interpretation	
Accuracy/Reliability	Giving all the outcomes that it enables travelers to get the information about bus route, time to arrive the bus station or giving real - time traffic information, including traffic jams, accidents, and closures as being accurate and reliable.
User Friendly	The app usage and its interface are quite understandable and it is easy to use.
Detailed	All details, including street maps, density maps and all other details that existed in the apps.
Negative Interpretation	
Unreliable/In accurate	Outcomes are given as inaccurate and unreliable.
Deficient	The app usage and its interface are quite deficient and inadequate.
Not Detailed	The apps do not include any detail in their interface.

4. Statistical Results

The data set comprises of the traffic applications based on their features, download counts, gender, given stars for each app and interpretation, including both positive and negative ones. 510 responses are given for each variables. In this section, frequency distribution of these data set and relationship between variables are presented by using cross tabulation.

There are 17 traffic applications that people generally use in Turkey. Figure 1 shows the frequency of traffic apps based on their intended purpose. While 41. 2 % of traffic apps are used for the features of public transport modes, 58.8% of apps are used for private cars. When analyzing the download counts of application, approximately one fourth of apps (23.5 %) are downloaded in the range of 10M to 50M and 1M to 5M. Respondents evaluate the traffic applications with giving a star ranging from 1 to 5. Most positive experiences are given five stars, while one star is given if any problems are encountered. People associate a five – star with “strongly good” and a one – star with “too poor”. Almost 45% of people gave the five star for the apps and the frequency of given star percentage decrease with the star rating scale. 5.7 % of people evaluated one – traffic applications only with one star. Interpretation for the apps also gives an idea about feasibility of applications. In this research positive interpretation contains being Accurate/Reliable, user friendly and detailed. In addition, negative interpretation includes the opposite of the positive ones such as being unreliable/inaccurate, deficient and undetailed. People generally interpret the apps as user friendly and mention their accuracy/reliability. On the other hand, approximately one fifth of respondents (17 %) interpret the apps as deficient. The frequency of interpretation for traffic apps are presented in Figure 1.

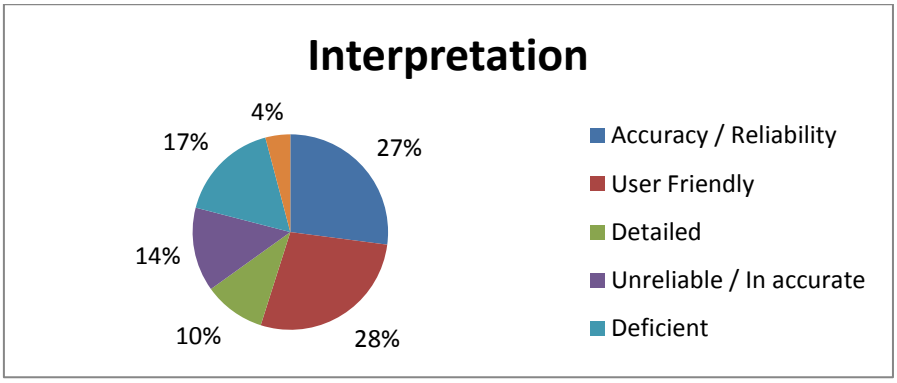

Figure. 1. Frequency of Interpretation for Traffic Apps

Rating or grading schemes are mostly made up of compulsory and voluntary requirements (Ingram 1996). However, people generally express their appreciation or dissatisfaction about traffic applications through five star rating scale or criticizing its features voluntarily at the comment section. The star rating system should provide an accurate appraisal of the property that is consistent with the expectations of the user, thus, they need to be monitored regularly in order to check if standards are being maintained or improved over time and do not deteriorate. (Kozak & Rimmington 1998). In a similar way, interpretation for the traffic apps almost gives the same results about apps. Positive recommendation and given high star rates always make a good impression. The relationship between star rates and positive/negative interpretation are shown in Table 4.

Table 4. Relationship between five – star rating scale and interpretation

Star	Interpretation						Total
	Accuracy / Reliability	User Friendly	Detailed	Unreliable / In accurate	Deficient	Not Detailed	
too poor	0	0	0	20	6	3	29
poor	0	0	0	25	13	7	45
medium	2	2	0	22	33	10	69
good	36	51	22	4	26	1	140
strongly good	100	89	30	0	8	0	227
Total	138	142	52	71	86	21	510

Interpretation of each traffic application gives information about its feasibility and usage area. The applications in this study have both positive and negative interpretations. Negative comments on the app makes people consider the inadequate attributes it has. Most of the people generally control the comments on application in their mobile device before downloading the apps. With the help of the cross tabulation, positive and negative comments for each traffic applications can be shown in Table 5. In this regard, “Google Maps”, “Moovit” and “Yandex Navigator” are found to be accurate and reliable, as well as, “Buradan Oraya Yolculuk Planlama”, “Bitaksi” and “Hız kamerası Türkiye” are found to be more user friendly. Moreover, in the light of the interpretations, “Trafik Rehberi” is found to be the most detailed traffic application. However, in the negative interpretation perspective, “Otobüsüm nerede?” is thought to be the most unreliable/inaccurate. In addition, “KGM Turkiye” is also found to be deficient than others.

Table 5. Interpretation for each traffic applications used in Turkey

	Interpretation						
APP Name	Accuracy / Reliability	User Friendly	Detailed	Unreliable / In accurate	Deficient	Not Detailed	Total
Mobiett	7	7	2	7	4	3	30
KGM Türkiye Trafik	10	6	1	3	7	3	30
IMM Mobile Traffic	7	8	5	4	6	0	30
İstanbul Ulaşım	9	7	4	4	4	2	30
Moovit	12	11	2	3	1	1	30
TRAFI	10	10	2	2	5	1	30
Trafik Rehberi	4	7	12	4	3	0	30
Otobüs nerede	3	3	0	13	8	3	30
Buradan Oraya Yolculuk Planlama	7	13	4	1	4	1	30
Hız Kamerası Türkiye	6	13	3	2	6	0	30

Nasıl Giderim?	3	7	2	9	5	4	30
ABB Trafik	5	7	3	7	7	1	30
Bitaksi	10	13	0	1	6	0	30
Google Maps	13	7	2	3	4	1	30
Yandex Maps	11	8	3	2	6	0	30
Google Maps Navigation	9	7	6	3	5	0	30
Yandex Navigator	12	8	1	3	5	1	30
Total	138	142	52	71	86	21	510

A multiple linear regression and correlations analysis was performed to generate the linear relationship between interpretation of traffic applications and the influencing factors. However, data in this model are all categorical variables, therefore, dummy variables should be formed due to understanding the effect of dependent variables on each independent variable. It is shown in the table below that interpretation of being inaccurate (IAC) and being not detailed (NDT) are significant which are less than cut-off (<0.05). The reference (default) category in this regression is five-scale star. The equation for the normal multiple regression is:

$$Y = -1{,}848 \times IAC - 1{,}605 \times NDT \quad (7)$$

Table 6. Coefficients of Dummy Variables (DV: five-scale star)

Category	**Type**	**Coefficients**	**P-value**
(Constant)		4,033	,000
Accuracy Dummy variables	Dummy Variable	,632	,365
User Friendly Dummy variables	Dummy Variable	,530	,448
detailed Dummy variables	Dummy Variable	,467	,506
Inaccurate Dummy variables	Dummy Variable	-1,848	,009
deficient Dummy variables	Dummy Variable	-,840	,231
not detailed Dummy variables	Dummy Variable	-1,605	,025
Public transport dummy variable	Dummy Variable	-,033	,833
Male dummy variable	Dummy Variable	,051	,525
Google Maps dummy variable (found to be most accurate)	Dummy Variable	,146	,341
Bitaksi dummy variable (found to be most user friendly)	Dummy Variable	,080	,603

Trafik Rehberi dummy variable (found to be most detailed)	Dummy Variable	,228	,144

The coefficients presented in Table 6 indicate that the coefficient for all positive interpretation such as being accurate, user friendly and detailed have positive values of coefficient. Therefore, for every unit increase in each positive interpretation, assigned unit increase in star scale is predicted. In the perspective of positive interpretation, giving accurate outcomes of traffic applications enable people to give a higher star rate than other interpretations people made. Another feature that brings about higher star scaling rates is being user friendly. In this context, for every unit increase in making interpretation for traffic application as being accurate, a 0,632 unit increase in star scale is estimated.

In the perspective of negative interpretation, as expected, all negative interpretations such as being inaccurate, unhandy and undetailed have negative values of coefficient. Inaccuracy causes the users to give the lowest mark on star scale rating. Furthermore, for males, the estimated star scale rating would be 0,051 points higher than for females. Namely, men give a higher star rate than women do. What's more, using types of traffic applications can influence giving star rates in a different way. People who use "Google maps", "Bitaksi" and "Trafik Rehberi" give generally high star rate for those of traffic applications, already, they found as the traffic applications as most accurate, user friendly and detailed respectively. In this regard, using "Trafik Rehberi" enables people to give a higher star rate than other use of traffic applications. It can be concluded that being the most detailed of traffic apps bring about receiving higher marks on star scale rating. What is more, traffic applications whose features are suitable for public transit have negative coefficient values. In other words, for the public transport features that app has, the estimated star scale rating would be 0,033 points lower than features for the private cars. . Namely, Traffic applications for private car receive higher star rate than public ones.

Table 7. Model Summary Table

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,832[a]	,692	,678	,683
a. Predictors: (Constant)				

In addition, Table 7 shows model summary that tells us the goodness of fit. 69.2 % of the variance in interpretation of traffic applications is explained by the selected independent variables. The other 30.8 % remains unexplained.

Table 8. ANOVA Table

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	509,319	22	23,151	49,673	,000[b]
	Residual	226,973	487	,466		
	Total	736,292	509			
a. Dependent Variable: Star						
b. Predictors: (Constant),						

Table 8 presents how well the regression equation fits the data. This table indicates that the regression model predicts the dependent variable significantly well. Because of the fact that p-value is less than 0.05 and indicates that, overall, the regression model statistically significantly predicts the outcome variable

5. CONCLUSIONS

Urban mobility indicators stand out more traditional standards. Thus, instead of dealing with isolated, social, economic and environmental aspects, new indicators tackle technological characteristics. In this study those indicators are traffic applications related variables including traffic applications used in Turkey, user comments,

five – star rating scale, users' gender, apps' features and download counts. The data which were obtained from related websites and application stores include all traffic applications people downloaded in Turkey. It was investigated in order to understand the advantages of traffic applications which are used to solve the traffic congestion. In the survey, traffic applications which consist of two parts with respect to their usage area, including features of traffic apps for public transport modes and features of traffic apps for private car modes were analyzed. Some applications related features were also obtained from there. The regression model has been developed and was used to represent the correlation between interpretation for the traffic apps and other independent variables.

The gender difference can also influence star rating in a different way. Men give higher star rates than women do. In addition, as expected, making positive interpretation increase the star rate highly and also making negative interpretation decrease the star rate. "Google maps", "Bitaksi" and "Trafik Rehberi" give generally high star rate for those of traffic applications, already, they found as the traffic applications as most accurate, user friendly and detailed respectively. In addition, traffic applications for private cars take higher rates than public ones. In consequence, urban mobility affects traffic applications and their related features.

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