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Research Article

Investigating the Effects of Information and Communication Technology (ICT) on Citizens' Travel Pattern

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Abstract: This study makes an effort to investigate the effects of Information and Communication Technology (ICT) on daily urban travel patterns. The main research question is based on the capability of ICT in reducing trip production (generation and attraction). The results obtained from the analysis of the data extracted from a questionnaire given to a sample population of 300 people from *Golestan Town*, *Shiraz-South* of *Iran*- in 2011 revealed that there is a tendency towards decreasing the amount of urban travels through encouraging virtual travels and telecommuting. Most of the people who answered the questionnaire tend to have an economical approach towards the daily travel patterns through the use of at least one ICT method for special trips. On the other hand, the majority of the people questioned believed that ICT has not been full successful in replacing physical trips to supply various needs and can only be of use as a powerful supplement for the purpose of decreasing the amount of physical trips if the existing services are improved and enjoy a higher level of public satisfaction.

Keywords: ICT, service satisfaction, Shiraz, traffic congestion, travel pattern

INTRODUCTION

In today's world, the proper implementation of the information technology, which has been in progress since the 1980's, can be considered among the most important ways of achieving progress and development. The rapid expansion of the facilities and tools for information transport such as telephone, fax, cell phones and bank automatic teller systems and, most importantly, the internet during the past three decades has led to different special behaviors. Being aware of the range of applications for this technology can help find solutions to the existing problems in cities and in turn, lead to a higher quality of life for citizens and dispose of social problems. In this respect, it is inevitable to study, analyze and investigate the effects of information technology on traffic and transportation behaviors.

On the one hand, the main aim of transportation policies is improving accessibility (De Souza, 2005). In fact, urban management is in a constant challenge to manage the trips in the city and at the same time maintain a high quality of life for the citizens. On the other hand, in today's world, one of the main concerns for decision makers in the field of transportation is formulating strategies which are in accordance with reducing the costs from economic, social and spatial points of view. In this respect, telecommunication technologies are of significant importance due to their abilities in bridging the gaps, overcoming physical barriers and, therefore, reducing the costs. As ICT develops, travel patterns and dependence on physical movement are increasingly affected by telecommunication systems. ICT development has led to a hierarchical reduction in the amount of unnecessary trips with personal cars, the reduction of annual trips with personal cars, optimization of fuel consumption and, in turn, the satisfaction of citizens (Niles, 1994). In this respect, the present study makes an effort to investigate the effects of the implementation of ICT on the traffic behavior of citizens and also the relationship between the satisfaction of citizens and the level up to which the existing facilities are used.

LITERATURE REVIEW

The overall effects of ICT on transportation: Information technology, as the main origin of the information communities, is resulted from the emergence of computer systems, the development of telecommunication networks and the increasing need for the use of information. The studies conducted on the development programs of most countries reveal the key role of the information and communication technology on such programs. The vast and expanded nature of this technology makes finding an accurate definition of this technology quite difficult: information technology can be considered as all forms of creating, storing, transferring and implementing information in its different forms such as business information, audio

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conversations, still and motion pictures, multimedia presentations and other forms which are to be produced in the future (Fathian, 2003). The rate of transfer and distribution of electronic and radio flows is a criterion revealing the amount of telecommunication facilities used. In the same way, different methods and behaviors of physical movement can be considered as the amount and form of physical trip flow in urban settings. Both of these flows lead to an increase in spatial actions and reactions. The movement of people, goods and information between different places does not happen independently and can cause spatial contacts between different forces (Lloyd *et al*., 1972). Interactions may act in the same direction as traffic flow and supplement it, or can reduce or limit accessibility. On the other hand, these spatial actions lead to the reorganization of urban structures and the definition and formation of new centers in urban systems.

Ogunbodede (2002) believes that such movement and action can fill the spatial gap in urban structures. And the trip to workplaces, tourist spots, markets, commercial centers, schools and other such trips are symbols and samples of urban actions and movements. Citizen's spatial behavior, in terms of the amounts and kinds of trips to different destinations, is based on the concepts of threshold and amplitude.

According to the concept of Range (amplitude), there is a maximum distance which a customer is willing to cover in order to use and implement the services of a given activity. Accordingly, a person desires to use the services whose friction, including time and cost, he or she can overcome. On the other hand, threshold can be defined as the minimum required population in order to support a given activity (Ayeni, 1975). The thresholds and ranges for utilizing services can find different manifestations in spatial structures and transportation systems. ICT provides quick and easy and at the same time cost-effective facilities for the purpose of transferring a vast amount of information, having this benefit that, unlike transportation, when the distance increases, the costs do not necessarily increase (Gbadamosi, 2004). For this reason, a significant part of information technology, through the simulation of the environment, provides the possibility for virtually experiencing different hypotheses with high speed and insignificant costs. Designing, simulating, programming and decision making are among such applications of information technology.

In the discussions concerning the transportation of spatial phenomena such as the transportation of people, goods and information, distance is among the key factors. Distance friction is one of the determining factors when it comes to spatial behavior and other traffic flows. The emergence of telecommunication technology has led to some changes and development in traffic patterns in a way that the role of the factor of distance in the transportation of spatial phenomena has lessened. Similarly, urban transportation patterns have also gone through changes, being influenced by different dimensions of modern technology. Therefore, as the issue of physical distance shifts and fades, one can observe the reduction of the time needed for accessing suburban areas and also the reduction of social and economic inequality in urban areas. In this respect, the structure of urban control distribution is expected to change in accordance with traffic patterns as time goes by in order to go through a reorganization phase.

The mutual relationship between information technology and transportation has been more or less covered in urban planning studies and in some cases, different results have been obtained. A variety of studies can be found discussing the way telephone affects citizens' travel patterns (Ogunbodede, 2002; Gbadamosi, 2004; Hanson, 1998; Mokhtarian, 2004).

This effect has been put forward as a mutual coexistence between transportation and information technology. The first point to notice is that each of these has the potential and capacity to replace the other. The main capability of information technology is that it can lessen the need for movement. Supplementation is the second issue to notice in this mutual relationship. Information technology and transportation supplement each other through creating a travel method and making better choices in transporting people and goods between two locations. The third issue is increasing the efficiency. Chorus and Van Wee (2009) argued that ICT potentially has an impact on all four components of the concept of accessibility:

- The land-use component
- The transportation component
- The temporal component
- The individual component

However, different discussions revolve around the issue whether information technology encourages more trips or it actually reduces the number of trips. Observations have revealed that information technology possesses the necessary potential for removing distances in dispersed settlements (Hoyle *et al*., 1998). The level of its influence on travel patterns has variations. Although the different dimensions of information technology, compared to conventional replacements, can reduce the number of trips, a significant contradiction is to be noticed: the more successful the transportation policies are in reducing the density of peak hour traffic, the less motivation for

virtual work there would be (Hall and Pfeiffer, 2000). The concept of supplementation between trips and ICT can be seen in the studies of Farag *et al*. (2007) which have been conducted on online shopping and in stores. They realized that the online search for goods has had a positive effect on the amount of physical trips and at the same time has positively affected online shopping (Chorus and Van Wee, 2009). In another study in this topic, it was concluded that the replacement of working out of home with working from home is mainly dependent on individual characteristics. In other words, the results reveal that preferring one of these over the other is mostly due to personal characteristics rather than trip times or ICT capabilities (Chorus and Van Wee, 2009). To conclude, it is generally realized that ICT potentially affects all activities, not only work and shopping, but also entertainment and other issues (Mohammad *et al*., 2008).

The potential impact of ICT on travel patterns:

Replacing physical work with teleworking: According to William Mitchell, teleworking represents going back to a period before the historical separation of home and workplace which Lewis Mumford considers to belong to the 17th century (Mitchell, 2000). Teleworking can help avoid a significant part of the peak hours when people go to work. These times are responsible for a part of heavy traffic. Some workers, specifically part-time workers, may completely devote their time to working at home or working in local work stations. Others may have flexible working hours, meaning that they would visit a number of work places which are located in close vicinity for a few hours or a few days during the week. This helps reducing traffic and distributing working hours out of peak hours.

According to the statistics provided by the *Department of Transportation of the United States*, this country now possesses a total of more than 16 million tele-workers and in accordance with the previous growth reported by this organization (about 12% a year), the number of information technology users will reach 18 million people in 2018. This will lead to saving 12 thousand dollars per person a year.

Shopping and information and communication technology: ICT has advantages such as ease, comfort, speed, unlimited choices, more available information and the ability to search the prices and purchase the item with the lowest price. While considering the situation, ICT is capable of personalizing the activities and at the same time requesting people needed items. This can be in line with personal priorities or the priorities of a group or organization. On the other hand, in some cases, virtual shopping does not account for people's emotional needs and physical attendance seems inevitable. When people want to touch, taste, smell, scratch, check the appearance, feel the weight and see the function of the item, like other situations were people's emotional understanding is the case, virtual shopping cannot be a good option (Mokhtarian, 2004).

Leisure time and information and communication technology: Many studies have pointed to this fact that leaving home is not necessarily due to an obligation and is sometimes for the purpose of entertainment because one may want to get away from home and communicate with the environment in order to satisfy their needs based on their interests. On the other hand, the social needs of human beings become a reason for them to interact with other human beings. This need cannot be satisfied with information technology and virtual systems. For this reason, in such cases, the information technology fails to keep up and people act based on their interests and needs. Nowadays, one can observe a higher level of competitiveness in real shopping centers, as opposed to virtual shopping centers, which have managed to play a key role in social interactions through creating effective environments which can make up for people's needs. However, it must be noted that information technology cannot completely rebuild the effects of face to face interaction. As an example, one can mention complicated transactions or the possibility of the existence of ambiguity in the information (Larsen *et al*., 2007; Aguilera, 2008). On the other hand, many recent studies have emphasized that the applications and services of ICT lack a functional and objective equivalent in the physical world and this issue gives trip replacement a new perspective (Hjorthol *et al*., 2009). This means that newly emerged services and applications such as global internet games may be considered as the only replacement for normal leisure activities like studying.

MATERIALS AND METHODS

The case area: Shiraz, as the capital of Fars province and the cultural capital of Iran, with a population of 1.28 million (based on the census carried out in 2006), is among the important metropolitans of Iran. Shiraz is one of the most important cities of Iran which is well-known as the cradle of the Persian Civilization and its history dates back to 4'000 years ago. According to an official survey, the shares of the different modes of travel in this city are as follows: private cars and taxis: 60%, buses: 30% and the other modes: 10% which is an unsustainable trend in a longer term. Therefore, the

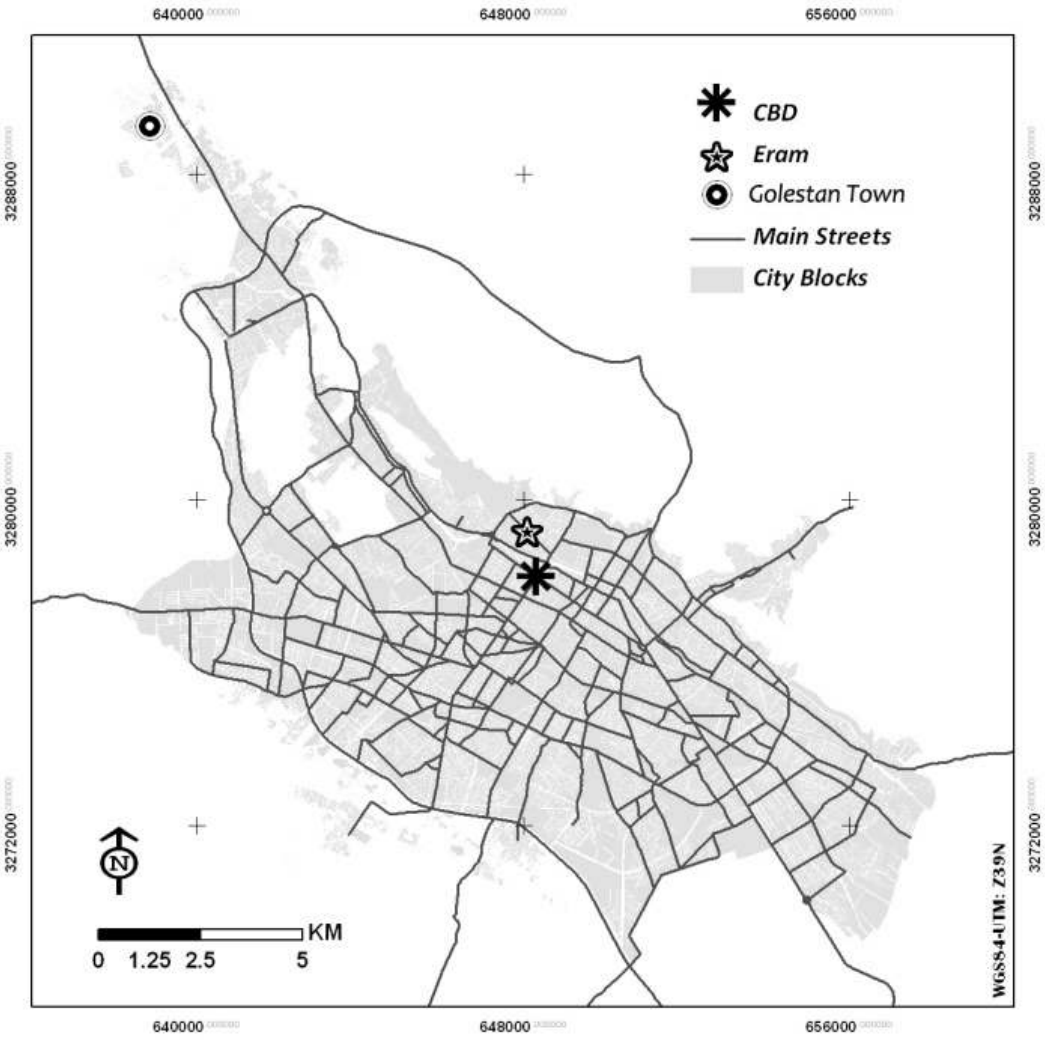

Fig. 1: The location of Golsetan town in Shiraz metropolitan area

public bus is the main mode of public transportation (Team, 2008). For the time being, public transportation in Shiraz relies mainly on the bus network and the subway system is not opened yet. The metropolitan area consists of 9 Zones each of which has its own municipal authority. *Golestan Town* is a newly built town in Shiraz and, according to the census conducted in 2006, has a population of about 37,000 people. From the view point of service-administration divisions, this town belongs to the zone 6 of Shiraz Municipality and is considered to be one of the most significant parts of this district. Zone 6 and specifically *Golestan Town* are chosen as the area under observation in this study due to the following reasons (Fig. 1):

- This district possesses the highest population growth rate among all districts in the city of Shiraz
- This district has the highest rate of literacy among all districts of the city
- After district 1, this district possesses the highest share of students of higher education
- This district possesses the highest percent relative of male and female employees and the lowest rate of unemployment
- This district has the highest number of employees in services sector

According to the above fact, zone 6 is the leading district with regard to urban development; therefore, a high rate of ICT use is expected to be used.

Data: The data for this research has been gathered through a special questionnaire designed for the purpose of acquiring the data about the effects of ICT

on travel patterns. This questionnaire has been provided in *Golestan Town* in August 2011. This town has been chosen for sampling in accordance with the aims of this study and also the ICT facilities and service available in it. The questionnaires were mostly filled near banks, ATM machines and internet pools. There have been two main reasons for this. Firstly, the people who use such places often look to overcome physical distance through the use of telecommunication facilities. Secondly, such places are suitable to interview people who prefer to use information and communication technology as an alternative for carrying out their affairs. For this purpose, the people who were questioned were chosen randomly and were tested by the questionnaire. In order to analyze the data, in addition to descriptive statistics, analytical statistics methods have also been used. The most important variables under analysis are: age, gender, education, occupation, household income, the number of cars in the household, the number of trips, the purposes for the trips, the means of transportation used for the trips and the level of familiarity, satisfaction and use in terms of ICT.

ANALYSIS AND DISCUSSION

Descriptive analysis: The issue of normal distribution of the data is among the most important issues when it comes to selecting and testing the hypotheses. In normal distribution, it is assumed that the data is selected from a population with *Gaussian* distribution. The distribution of the variables of age (-0.788) and occupation (-0.504) possess a higher dispersion in comparison with normal distribution, meaning the distribution curve is shorter in comparison with normal distribution. This group of distributions possesses a negative *Coefficient of Kurtosis*. The distribution of the variables of occupation (0.359), household income (0.220) and the number of cars (3.728) possess a lower dispersion in comparison with normal distribution, meaning that the distribution cure is longer in comparison with normal distribution. The *Coefficient of Kurtosis* for this group of distributions is positive. The gender distribution of the people questioned is 54% female and 46% male, which is somehow close to the gender distribution in the city of Shiraz. The age group of 21-29 has the highest level of ICT use (43%) among all age groups and the age group of above 50 has the lowest level of ICT use (13%). Additionally, the data reveals that the level of use of ICT facilities is higher in men than in women. People with the educational level of master and above have the highest level of ICT use in comparison with other educational levels and people with the educational level of high school diploma have the lowest level of ICT use. The occupation group of government employment has the highest level of ICT use among all occupation groups and the occupation group of unemployed possesses the lowest level of ICT use. Moreover, the higher the income of the household is, the higher their level of ICT use goes.

According to the answers, the number of times people leave home is more for men than for women. In total, 2% of people usually do not leave home, 45% leave home once a day, 41% leave home twice a day and 12% leave home three times a day or more. In addition, 22% of the people under analysis mentioned their reason for leaving home as business, 7% as official affairs, 37% shopping, 19% education and 15% recreation. Considering the official and shopping trips (44%) as the kinds of trips for which ICT can be used, it can be concluded that there is a significant potential for covering a part of these trips with ICT. According to the acquired data, 36% of the people under analysis use their own cars for their daily trips, 24% use taxis, 20% use buses and 12% walk, 5% use motorcycles and 3% use bicycles. Using personal cars has the highest level of frequency among all travel patterns while environment friendly patterns such as walking or using bicycles possess only 15% of all the trips.

It seems that there is a potential capacity for developing ICT systems among citizens due to the fact that 83% of the people answering the questionnaire are familiar with the applications of telecommunication means on a level above the average and 79% use telecommunication means on a level above the average. According to the acquired data, the highest level of use of telecommunication means is for regular phones and cell phones are ranked next.

Only a small number of the people answering the questionnaire (3%) do their ordering and shopping via the internet. The existing statistics reveal that 78% of the people answering the questionnaire are satisfied with the ATM machines in stores and 78% are satisfied with the ATM machines in banks on a level above the average. In general, it can be said that 94% of the questioned people are satisfied with accessing the telecommunication services in their living places on a level above the average and are satisfied with the quality of the services at the same level. On the other hand, 76% of the questioned people have stated that provided the telecommunication services improve, their level of use will increase significantly.

Correlation analysis: In this part, some of the results achieved from the research are mentioned. These results are outcomes of investigating on research questions as below:

Table 1: Correlation between usage of ICT and distance to ICT service centers

Correlations		Usage of ICT services	Distance to ICT service centers
Usage of ICT services	Pearson correlation	1	-0.040
	Sig. (1-tailed)		0.431
	N	300	300
Distance to ICT service centers	Pearson correlation	-0.040	1
	Sig. (1-tailed)	0.431	
	N	300	300

Table 2: Correlation between usage of ICT and level of satisfaction

Correlations		Usage of ICT services	Level of satisfaction
Usage of ICT services	Pearson correlation	1	0.252
	Sig. (1-tailed)		0.000
	N	300	300
Level of satisfaction	Pearson correlation	0.252	1
	Sig. (1-tailed)	0.000	
	N	300	300

Table 3: Correlation between usage of ICT and distance of the ICT services center

Correlations		Usage of ICT services	Tip generation
Usage of ICT services	Pearson correlation	1	-0.097
	Sig. (1-tailed)		0.006
	N	300	300
Tip generation	Pearson correlation	-0.097	1
	Sig. (1-tailed)	0.006	
	N	300	300

- Is there an inverse correlation between the distance of the ICT services center from the living place and the level of use of ICT?
  After conducting the linear correlation test between the two relative variables of distance from the living place to the ICT services center (including ATMs and shops equipped with Point of Service machines) and the usage of ICT it was revealed that the test result with the values of r = -0.040, p-Value≤0.431 and n = 300 is not meaningful although the mentioned correlation is negative (Table 1).
- Is there a direct correlation between the level of satisfaction and the level of use of ICT services?
  After investigating the level of satisfaction and the level of ICT services use it was revealed that the mentioned correlation is a direct linear association and is meaningful at a significant level (0.05) where r = 0.252, p-Value≤0.000 and n = 300 (Table 2). Therefore, the level of satisfaction with ICT services in different respects such as accessibility and quality will lead to an increase in the level of use.
- Is there a correlation between the use of ICT services and personal trip generation?
  To answer this question, a correlation test was conducted among the two variables. The result showed that increasing in ICT usage was associated with lower trip generation (r = -0.097, p-value≤0.000 and n = 300) (Table 3).

CONCLUSION

As the information and communication technologies develop in the country, homes can now be considered as suitable places for citizens to carry out activities which were previously only possible through physical attendance in a place away from the homes. The development in the applications and uses of cell phones, laptop computers and other means of communication has led to changes in the ways tasks are done and changes in the dynamic planning of activities through trips and outside home or work place. Information technology has also led to the growth and development of issues such as flexible and changeable working hours and tele-working. Blending ICT and transportation, in addition to reducing travel costs, prevents unnecessary trips and can be employed for the purpose of equitable distribution of facilities in the society. On the other hand, this blending, together with strategic planning towards preserving public resources, matching supply and demand in transportation and putting forward different methods of travel can ultimately open paths towards permanent development.

The results of this study, though limited to *Golestan Town*, prove this point that there is a good potential for replacing daily trips with virtual trips. In this respect, providing ICT services in a way that leads to the satisfaction of the citizens can have a significant role in reducing the number of trips in urban areas. Shopping trips and personal trips (with office work purposes) have the highest potential for benefiting from ICT services. How citizens accept ICT services is

different for different social groups. Employed people and the people with higher education show higher enthusiasm for using such services. Additionally, gender, age and occupation are of the other factors affecting the level of use of ICT services. This study can be developed and improved through the following procedures: expanding the sample population to the metropolitan of Shiraz, expanding the magnitude of the population, using more advanced statistical procedures in order to investigate the relations between variables and select better samples for analysis.

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