Classification tree analysis of factors affecting parking choices in Qatar

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ABSTRACT

Qatar has experienced a significant population growth in the past decade. The growth has been accompanied by an increase in automobile ownership rates leading to parking problems especially in the capital city of Doha. The objective of this study was to find the factors affecting people's choice of parking in this rich developing country when different parking options are available. Two commercial centers located in the city of Doha, Qatar were selected for this study; the City Center mall and the Souq Waqif shopping center. Each location has two different parking options available. Parking options vary in many features including distance to destination, paid/free, covered/open, paved/unpaved, and guarded/unguarded. In addition, the parking options also differed in the ITS infrastructure deployed in the form of intelligent parking space detection system to assist visitors to navigate to an available spot. A survey was handed out to randomly selected visitors at the main entrance of each of these shopping areas to obtain a random sample of study participants. Binary classification tree models were developed to understand the factors associated with binary parking choices at both of these commercial centers. In addition to the demographic factors associated with the parking choice; the reasons for choosing a particular parking option were also explored through the survey. The analysis of survey data presented herein provides an interesting insight into parking choices of the visitors that can be used in planning future parking facilities sand managing existing parking locations. Among the reasons cited by respondents for making their parking choices, "Intelligent Parking Space Detection" was chosen as one of the factors affecting people's choice of parking significantly more often than amenities such as "Wider parking spot". The findings indicate that future parking investments may be better directed towards smart parking solutions.

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1. Introduction

Qatar, like most countries with rapidly growing economies, is facing serious parking problems. The number of daily trips in Qatar jumped from 1777,000 trips per day in 2000–5498,000 in 2012. There were 287,500 vehicles on the road in Qatar in 2000, compared to 879,039 in 2012 (Shaaban and Hassan, 2014). The number of cars is increasing, but the parking spaces are not sufficient to accommodate this increase. Due to insufficient parking spaces in the designated lots, the problem of illegal parking is rampant. With the increased number of cars in Qatar, additional parking areas are being added.

In the context of planning for future parking spaces, it is important to understand the factors affecting people' parking location choices. Parking choices in the rapidly growing cities around the world are not well studied. Most past research deals with this issue in the context of the developed countries (Arnott and Rowse, 1999; Hensher and King, 2001; Lambe, 1969). However, with the rapid growth of automobile this is now becoming a critical issue to address in the developing world as well. Towards that end, the objective of this study was to find the factors affecting people's revealed choice of parking when different parking options are available. Two commercial centers in the city of Doha were selected for this study; the City Center mall and the Souq Waqif shopping center. Each of these locations has two different parking options with different characteristics available at each location.

The paper is organized as follows; first details of the two shopping areas are described along with the available parking options. The next section provides details of the survey followed by preliminary analysis and description of the classification tree algorithm. Data mining methods such as classification tree have not yet been used to understand parking choice selection even as they remain popular for several transportation (e.g. Zhou et al.,

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2009) and consumer behavior related applications (e.g. Currim et al., 1988). The most important factors associated with parking selection at the two shopping locations are then identified and analyzed. In addition to the demographic characteristics, the response to the question whether or not a feature of the parking option figured in respondent's selection decision is also explored. Discussion and conclusions from the analysis in the form of lessons for planning and management of parking locations are provided at the end.

There is no question that parking availability may determine a customer's willingness to visit a business, and it is often a sought after feature in urban areas. For years, it has been a standard practice for cities around the world to require developers to provide a minimum number of parking spaces in the new residential and commercial developments. These policies were intended to prevent spillover parking on the street and to respond to the market demand for parking. However, it has become apparent not only that parking problems still exist in many such locations (Waerden et al., 2003) but the problem of traffic congestion may have also been made worse by it (Shoup and Pickrell, 1978). Therefore, instead of mandatory minimums; parking should be planned based on clear understanding of consumer behavior and preferences.

This study attempts to further enhance this understanding by identifying factors associated with parking selection where consumers have a choice between price (at the City Center mall) or proximity and amenities (at Souq Waqif Shopping Center). With multiple parking options available, the choice is made based on the desirability of the options involved. The planning for parking is complicated by the fact that the desirability is also dependent on the demographic characteristics of the consumers. The survey instrument described in the next section is designed with this issue in mind. As detailed later, the survey is designed to gain not just the reasons for choosing particular parking, but also identifying what demographic factors affect those choices.

2. Data collection

2.1. Parking areas studied

The first location, the City Center mall, is the largest mall in Doha with five levels, over 370 stores, and a multi-level parking garage with a capacity of 2000 parking spaces (see P2 in Fig. 1). The City Center mall welcomes an average of 45,000 visitors daily and up to 70,000 visitors on peak days like public holidays. The parking garage P2 is close to the destination (inside the mall building), paid, guarded, covered, and paved. This parking garage is also equipped with intelligent parking space detection system to assist the

visitors to navigate to available parking spaces. On the other hand, many people use a nearby vacant land to park their vehicles for free (see P1 in Fig. 1). P1 is far from the destination, unguarded, unpaved, open, and of course without any Intelligent Transportation Systems (ITS) support for the drivers. The users, parking at this location, are required to walk approximately 250 meters on the existing sidewalk and cross a signalized intersection to reach the City Center mall. It should be noted that the temperature reaches 50 degrees Celsius (122 degrees Fahrenheit) during the summer in Doha. The capacity of P1 was difficult to determine since the area is not marked or paved.

The second location, Souq Waqif, is an important shopping center in Doha. Literally translated to "the standing market," this shopping destination is the most crowded spot in the city. It is home to dozens of restaurants, hotels, and shopping areas as well as a host to several art galleries and events. It is considered one of the top tourist destinations and the main heritage landmark of Doha. There are two main parking areas serving Souq Waqif, one at ground level adjacent to Souq Waqif (see P4 in Fig. 1). The capacity of this parking area is 600 cars. This parking is close to the destination, paid, guarded, and paved. Another new underground car park with an underground air-conditioned walkway connecting to Souq Waqif became available in 2012 (see P3 in Fig. 1). P3 consists of three underground basement floors that can accommodate up to 1500 vehicles. This parking option is somewhat far from destination but is paid, guarded, and paved. This parking garage, P3, is equipped with intelligent parking space detectors, which are installed in each parking space, to show a green light for unoccupied spaces. It should be noted that the parking fees at the two locations are the same. Users parking at P3 are required to walk approximately 300 meters in an air-conditioned underground walkway to reach the Souq Waqif shopping center.

2.2. Methods

In this study, a questionnaire was carried out at the two major commercial spaces in order to identify the factors associated with parking selection when consumers have a choice between price, proximity, and amenities. To obtain a representative sample of the population who visits the two locations, it was decided to use the face-to-face interview method. Mail-in questionnaires, phone interviews, and internet-based surveys were not considered since it would be difficult to collect the information about the parking usage.

The questionnaire included questions regarding gender, age, nationality, and income. These demographic questions were an important aspect of this questionnaire and were designed to
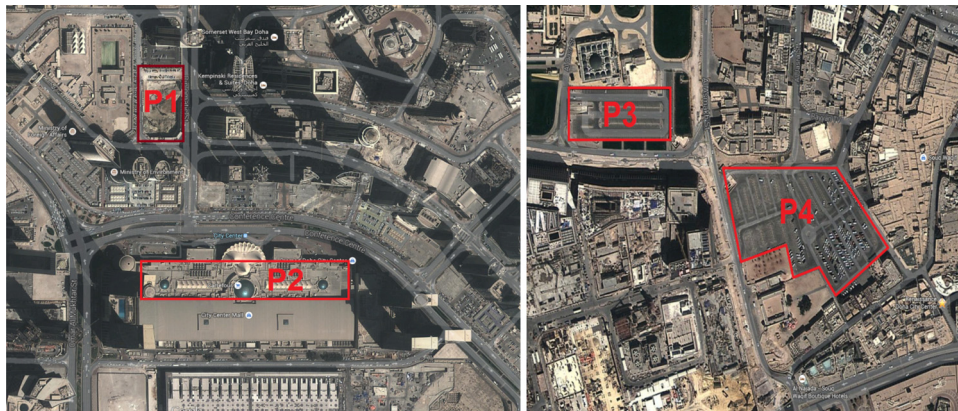

Fig. 1. (a) City Center Mall Parking options, (b) Souq Waqif parking options.