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ORIGINAL ARTICLE

Policy sensitive mode choice analysis of Port-Said City, Egypt



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Abstract This paper aimed at developing advanced Logit discrete choice models with several individual and mode attributes affecting the prediction of individual choice. The models have been applied to Port-Said (PS) city and have been used to investigate innovative transport systems such as Bus Rapid Transit (BRT) as a hypothetical mode situation beside the regular modes of transport (car and taxi). The methodology provides data collection of PS transportation mode system and develops Multinomial Logit Model (MNL), Nested Logit Model (NL), and Mixed Logit Model (MXL) using Visual-tm Software. The survey was formed by the Stated Preference (SP) technique conducted for individuals from all PS zones and the predictable travel mode choice behavior was analyzed. The findings showed that in PS, income is the most important attribute affecting the mode choice behavior model. The high values and positive signs of income parameters indicate that the higher income earners are more likely to use private car than taxi or bus. Contrary to most cases in developed countries, out-of-vehicle time that represents the accessibility shows higher impacts than the in-vehicle time as a result of poor access facilities in developing countries.

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1. Introduction

In the recent years, urban policymakers are faced with growing and complex problems of congestion. Therefore they have begun to ask for more sophisticated decision-making tools, including models to forecast travel demand and its effect under various circumstances. Discrete choice models have played an important role in transportation modeling for the last few years.

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They are specifically used to provide a detailed representation of the complex aspects of transportation demand, based on strong theoretical justifications. The art of finding the appropriate model for a particular application requires from the analyst both a close familiarity with the reality under interest and a strong understanding of the methodological and theoretical background of the model. The choice of transport mode is one of the most important classic models in transport planning because of the key role played by public transport in policy making [15].

This research rests on a scientific literature about travel choice behavior modeling, with particular reference to random utility models and stated preference methods [2,21]. In particular, it is based on urban transport demand modeling background.

Most literature has been stated the different factors affecting the reliability of mode choice process in developed countries especially for rural areas [2,1]. However in Egypt as a developing country, El-Esawey and Ghareib [9] studied the mode choice behavior in Greater Cairo Region (GCR). The study concentrated on sensitivity of cost changes when applying a new policy. It predicted the potential modal shifts in GCR under four hypothetical policy scenarios; increasing bus fare, increasing metro fare, increasing shared taxi fare and increasing individual income level. The results showed that "Age" appeared in all models with a positive sign indicating an increased utility with an age increase. This means that, in Egypt, an older person usually has more responsibilities. Gender also had a positive sign in all models indicating that the utility perceived by a male is higher than that received by a female when they both use the same mode of travel.

Li et al. [16] investigated another issue of mode choice reliability in terms of willingness to pay. This review focused on car, rail and bus, each by their single mode and revealed the importance of reliability in travelers' decision making.

This paper introduces Port-Said (PS) city mode choice behavior modeling. Its transport system is characterized as a "weak" public transport system with many problems including:

- (1) High percentage of personal mode such as car and taxi with no existence of large public transport such as Bus Rapid Transit (BRT) or Car Sharing systems.
- (2) The interference with the car traffic has a negative impact on frequency and comfort.
- (3) Lack of adequate/sufficient access facilities such as parking and footpaths to different service centers.

The first objective of this paper was to develop a hypothetical mode choice situation models. The models use innovative transport systems such as BRT as a hypothetical mode in addition to the regular modes of transport (private car and taxi). Private car and taxi represent more than 50% of the current PS transport system. For model development, the advanced discrete choice models including Multinomial Logit Model (MNL), Nested Logit Model (NL), Mixed Logit Model (MXL) will be employed using Visual-tm Logit calibration software. The second objective of this paper was to study the sensitivity of transport speed and time for several levels of income on the accessibility concept caused from new BRT policy.

This paper consists of five sections. In the next section, a background of discrete choice models is presented. Section 2 describes the study area and the data collection methodology. Section 3 explains the supposed BRT policy logit calibration and the derived model analysis. The impact of BRT policy is estimated in the fourth section. Conclusions and recommendations for future work are drawn in the fifth section.

2. Discrete choice models background

A variety of discrete choice models are widely used for transportation applications appreciation to their ability to reflect key determinants of individuals' choice behaviors while facilitating model estimation and/or providing a defensible behavioral basis such as random-utility maximization [20]. Discrete choice models are used for modeling choice experiment data. The research in this area began in the 1970s. Since then both the multinomial Logit and Probit models have been widely used in transportation, economics, marketing and many other areas to study both revealed and stated preference data.

Recently, the research in this field has paid special attention to the error term of the models in an effort to solve some of the problems of the discrete choice models and to make them more flexible. However, over the past ten years, gains in computing power as well as improvements in estimation techniques have led to the increased use of advanced nesting structures, and more recently, models based on mixture distributions such as Mixed Logit (MXL), but all depend on random utility maximization theory. These gains in estimation capability have also spurred new developments, for example in the form of advanced mixture models.

The random utility theory assumes a utility maximization principle if an individual chooses one alternative over another, and then the utility from the chosen alternative is greater than that from the unselected alternative. The obvious objective in discrete choice modeling is to analyze the individual's choice in relation to the characteristics (attributes) of the product (e.g., choice of a transportation mode in relation to its price, quality, comfort etc.) by using logit calibration software.

The logit modeling is the mathematical relationship that defines the probability of deciding which alternative to take based on attributes describing the features of the alternative, the choice model coefficients and the particular logit model form. The logit model describes a family of equations. When using a logit model the user needs to define which member of the family is being used. The most common forms are the multinomial logit, the nested logit, the cross nested logit, the mixed logit, and the latent class logit models.

Models of choice behavior require three key factors to be taken into account:

- (1) Objects of choice and sets of alternatives available to decision makers, known as choice set generation.
- (2) The observed attributes of decision makers on the same household and a rule for combining them.
- (3) A model of individual choice and behavior, and the distribution of behavior patterns in the population.

Many previous studies examined several commonly used discrete choice models including conditional logit, multinomial logit, and nested logit. The current study will look slightly at

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