Analysis of multistage chains in public transport: The case of Quito, Ecuador

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Introduction

In recent decades private car use has grown strongly in Latin America. Public policies intend to encourage the use of public transport (PT). Proven measures as successful to promote PT include providing a wide range of transport modes in integrated public transport systems with high quality of service. Integrated transport systems require intensive use of multistage trip chains. Hence the importance of analyzing multistep chains on public transport

Objectives

- Understand urban transport modal choice process and determine statistical trends
- Define characterization of the trips in multi-modal public transport chains in the city of Quito

Quito's Mobility Background

By 2015, 2.9 million daily trips in PT and 1.5 million trips in private transport (cars). Some characteristics:

Non motorized

- More than 200,000 peatonal daily trips
- Bici Q system with 500 public bicycles

Private cars

- About half million cars (2015)
- Motorization rate rose from 145 to 240 vehicles per 1000 people in last 12 years

Public Transport - PT

- 2800 buses
- BRT system (Metrobus-Q) with 83 km of trunk lines in segregated corridors. +200 articulated buses and 100 electrical trolleys

Data

- Main data taken from Mobility Household Survey in 2011 (EDM11).
- EDM11 used sample size of 75323 people in 240 neighborhoods in Metropolitan District of Quito and urban areas of municipalities of Mejia and Rumiñahui. Confidence level of 95%
- EDM11 data collected in a mix of direct interview (at home), and by phone or internet (remote)

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Methodology

- Two parts analysis: first one with descriptive statistics and second (and most important) by an analysis of traveler's decision about whether or not to make a transfer, using statistical regression function and software analysis of databases (SPSS)
- User decision of making transfer or not, is worked as a binary function where 1 represents the fact to make transfer and 0 when there is no transfer.
- Theory of Random Utility is used to treat empirically discrete choice, since according to the mentioned theory the researcher assumes that the utility of alternative j for the individual q has the expression:

$$Ujq = Vjq + Ɛjq \quad (1)$$

Where:

Ujq is utility function

Vjq is the representative or systematic utility

Ɛjq is the random term in which unobserved by the researcher effects are included

- Variables depend on attributes of alternative j and socioeconomic characteristics of individual q.
- There are several logistic regression models, but according to references Binary Logistic Regression is the most effective.
- Utility function for determining if transfer is performed or not, shall be composed for some variables such as travel time, travel cost, availability of own vehicle and others. Mathematical formulation proceed as follows:

$$UTR = \beta 0 + \beta 1t + \beta 2C + \beta 3d + \ldots \quad (2)$$

$$P_{TR} = \frac{e^{U_{TR}}}{1 + e^{U_{TR}}} \quad (3)$$

Results

First part: Descriptive Analysis. Big difference between multi-stage trips and single stage trips

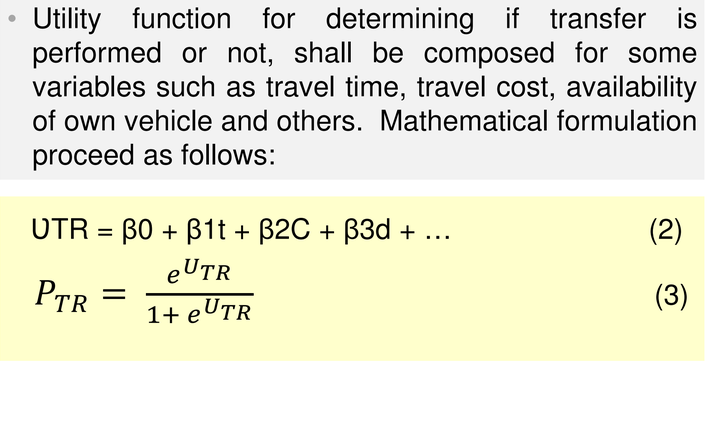

Figure 1: Modal share comparison between single stage trips and multistage trips, source: EDM11

Travel time distribution for multi-stage trips:

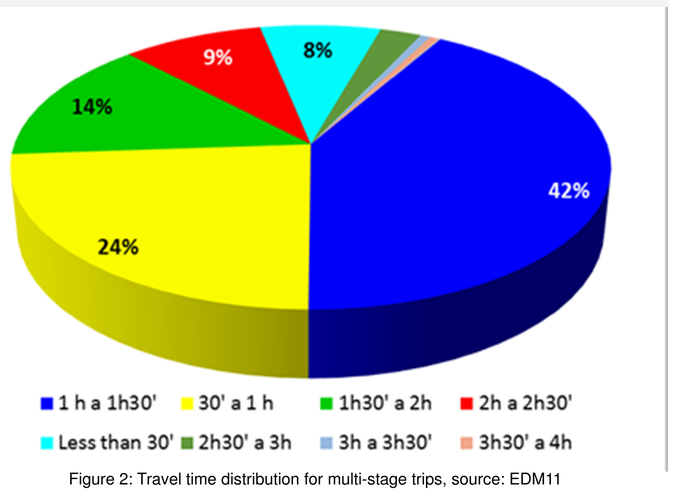

Figure 2: Travel time distribution for multi-stage trips, source: EDM11

Second part: Binary Logistic Regression.

It were considered all travelers who have made a trip the day of the survey, regardless of how they used. A total of 144,205 cases.

The preferred statistical parameters were beta (B) along with the exponential form of beta, the significance and the standard error

Several models were run in SPSS, experimenting with different transport, demographic and socioeconomic variables. Best model results are shown:

Table 2: Equation variables and parameters for best model

	B	Exp (B)	Significance	Standard Error
Travel time	0,695	2,004	0,000	0,009
Walk time	-0,184	0,832	0,000	0,010
Price paid	2,412	11,155	0,000	0,019
Availability of car or motorcycle	-0,205	0,815	0,000	0,029
Gender	-0,111	0,895	0,000	0,020
Age	-0,301	0,740	0,000	0,011
Origin zone	-0,009	0,991	0,000	0,002
Destination zone	-0,059	0,943	0,000	0,002
Education level	-0,083	0,921	0,000	0,005
Constant	-7,911	0,000	0,000	0,074

Conclusions

- Formerly there were not found scientific research articles about multistage chains in Quito.
- Descriptive statistics of EDM11 data allowed find relationships between groups of citizens with some mobility variables.
- The analysis of modal PT chains let found that a fifth of city trips were made using transfers. The number of travelers is substantially reduced as it increases the number of transfers and stages.
- Finally last section dealt with Logit analysis and variables correlation. Development of a base model on which is learning and making improvements shown the ideal path in this type of work for the purposes proposed.
- It is noticed that variables related to transport have a preponderant weight in the decision about whether traveler does or does not transfers. Meanwhile in demographic and socioeconomic variables, the preponderant are gender and age of the traveler.

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