Redesigning a Retail Distribution Network in Restricted Urban Areas: A Case Study on Beverage Distribution in the Historic Center of Quito

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ABSTRACT
Cerveceria Nacional's current distribution network in the Historic Center of Quito is characterized and evaluated from an urban logistics perspective. As a result from the analysis a new distribution scheme was designed using a multi criteria decision making approach applying AHP and several operation research models. Graphs were used to represent the network designs through the modeling process. The proposed network fulfills the municipality restrictions, diminishes route distances and balances daily delivery times.

Keywords: Logistics; urban distribution; emerging cities; network optimization.

1. Introduction

As urban settings will continue being the nerve center of economic development over the next decades, the associated increase in urban complexity will be a significant challenge to overcome for all city stakeholders. Estimates suggest that, for year 2050, more than 75 % of the population will be concentrated in cities [1]. This trend will imply more complex and intensive dynamics of goods and services across the cities, with associated impacts on traffic congestion, air pollution and business efficiency. Due to several characteristics, this phenomenon is and will be particularly challenging for large and mid-sized urban settings in emerging markets [2].

In Quito, Ecuador, mobility has been continuously reported as the main problem by its inhabitants over the past years. Municipal authorities have designed solutions for public transportation; however, initiatives to improve the urban flow of goods remain scarce. Consequently, goods distribution operations face increasing logistics challenges to reach its retail channel, thousands of small stores spread all over the city.

In this context, this study proposes a redesign of the current distribution scheme for Cerveceria Nacional (CN), one of the largest consumer packaged goods companies in Ecuador. The study will be delimited to CN´s operations in the Historic Center of Quito, as this urban region, due to its commercial and touristic relevance, presents one of the most logistically challenging scenarios for the company.

The study has been structured as follows. First, the urban area of interest is delimited and several commercial, demographic and logistics characteristics are identified, as a basis to define main logistical challenges. Next, three general

distribution schemes are developed based upon reviewed case studies. Then, Analytic Hierarchy Process, combined with a non-linear programming model is used to select the most convenient distribution scheme. Based on the selected scheme, the distribution network is reconfigured, at both tactical and operational levels, using linear and non-linear programming models. Finally, a discussion is provided on the limitations of the study and further lines of work.

2. Literature Review

2.1 Transferability Methodologies

Most of the research efforts in urban logistics have been developed by European-based collaborative initiatives such as CIVITAS, TURBLOG, BESTUFS, NICHES and SUGAR. These projects have also developed several transferability methodologies to facilitate transferring urban logistics best practices to other cities. These methodologies are extensively discussed in TURBLOG's fourth deliverable [3].

CIVITAS [4] developed a 10 step approach that begins with an initial diagnostic of the logistics problems followed by a characterization of the city. Then, the methodology suggests looking around for similar contexts and identifying measures with potential of transferability. Finally, the need of adjustment of the proposed package is analyzed. A different approach is proposed by BESTUFS where knowledge is transferred through the specialized Guide of Good Practices in Urban Logistics. NICHES uses a similar approach, transferring knowledge through a set of twelve innovative concepts [3].

In spite of the several structured approaches described before, to characterize the logistics structure of cities, these schemes have been generally tailor made with scarce potential of applying them on a global basis [7], which consequently limits the possibility to compare different cities and benchmark urban logistics solutions.

2.2 City Characterization

Macario developed a framework to find homogeneous logistic zones within a city based on three aspects: City Characterization, Agents needs and Product characteristics. Each aspect is defined by several criteria with specific possible values [8]. A logistic profile is then obtained in terms of the values assigned to each criterion [8]. A simpler approach is proposed by CIVITAS were cities are differenced using only two criteria, traffic density and transportation modality [4].

A more holistic framework is used by Wang and Shang in a Case Study in the Metropolitan Region of Beijing. Authors use performance variables to evaluate the progress toward success of city municipal measures [5]. The city current status is analyzed under two perspectives, urban development and transportation network performance. The former relates to topics such as life quality, economic growth and social development whereas the latter analyzes the reliability, efficiency, safety and operation of the transport network [5]. A set of indicators are used to describe each of the perspectives. Al the end, an indicator matrix is obtained and the current situation of the city could be thus characterized.

Transport analysis suggests a more complex modeling approach to characterize a city. This classic modeling work was applied in the City of Mexico in order to analyze its urban rail transport network [6]. Based on several important economic and demographic indicators, patterns of trips were used to model the city's demand and supply of transport [6]. An OD network was thus obtained. These networks allow one to identify the demographic growing zones, the need of transportation and the resources needed to improve the network as a whole. The scope and validity of the analysis require exhaustive amounts of data though.

Finally, an urban transport study in India suggested a different methodology to characterize cities. This methodology considers 6 factors: shape and size of the city, public transportation availability, congestion, city economic level and geographic location [9].

2.3 Relevant Urban Logistics Best Practices

Case Studies concerning distribution in restricted areas with touristic importance are revised. BESTUFS proposes a set of four objectives and its corresponding solutions to improve the access of