6. ANALYSES OF BUS NETWORK OPERABILITY IN CHICAGO AND BARCELONA

The *Chicago Transit Authority*, CTA, is the company in charge of the urban bus network in Chicago. It provides service for 152 bus routes along 3.658 km, using a fleet of 2.017 vehicles. Every year about 300 million passengers use the CTA's bus service within the City of Chicago.

The bus network layout follows the square grid pattern of the city streets. The bus routes are placed on main streets, every mile (1,609 km) approximately, following a north-south or east-west direction. There is a higher density of bus routes within downtown Chicago and along the lakeshore, since these areas concentrate most of the businesses, offices, and recreation facilities. Therefore, there are several routes that include downtown Chicago and/or a fragment of the Lakeshore on their course.

The system's average commercial speed is about 20 km/h, but for some of the most popular bus routes, the CTA has implemented a Bus Rapid Transit system, known as express bus service, in order to increase the speed and improve the quality of the service. These routes stop only at major cross streets, eliminating close to 75% of bus stops associated with local route and increasing average travel speeds by 24% to almost 40 km/h in some cases. *Figure 8* shows a sample express route, route X55, and the bus stops associated to it, compared to the regular route 55 which has 8 stops to the mile.

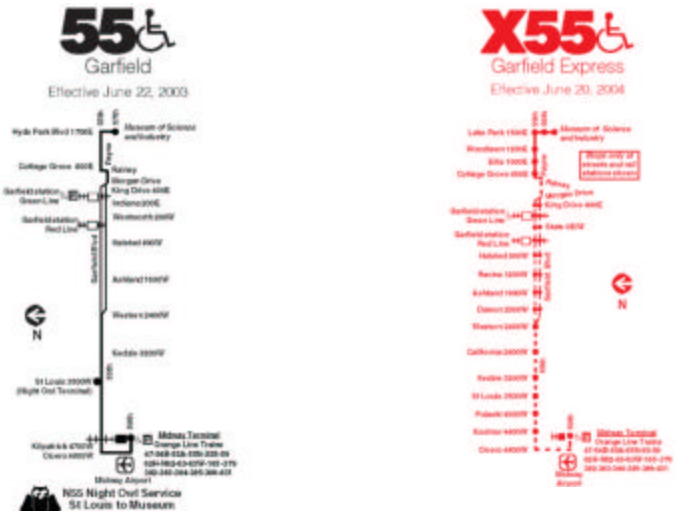

Figure 8. Routes 55 and X55 for the city of Chicago
Source: Chicago Transit Authority.

Transports Metropolitans de Barcelona, TMB, is in charge of providing service within the urban limits of Barcelona. In 2004, the bus network was composed of 103 bus routes covering 890 km, using a fleet of 1001 vehicles. The annual ridership for TMB bus network is about 200 million passengers.

The bus routes in Barcelona are generally running along the main structuring streets, and can be classified in three categories: transversal, sea-mountain, and radial. This classification is due to the different types of urban layouts that can be found in the city: only the *Eixample* has a square grid pattern, whereas other neighborhoods in the city, specially the older ones, have a more chaotic structure. The bus routes are therefore classified according to the origin and destination points between which they offer a service. That is to say, if a certain bus route has its origin in a place around the mountains and its destination near the sea, it will be classified as a sea-mountain route, regardless of the zigzagging that needs to be done to get there. For the specific case of the *Eixample*, the sea-mountain (S-M) routes and the transversal routes turn out to follow the grid streets in a straight way, similar to the north-south and east-west routes in Chicago. A better description of the routes and their characteristics can be found in Llorca Martín's (2004) study paper.

As for the service speed, although the overall average commercial speed is about 12 km/h within the bus network, if only transversal and sea-mountain routes are taken into consideration, the average speed increases up to 20 km/h. Transversal routes are faster than S-M routes by almost 40% on average (17 km/h to 24 km/h). However, the value for the commercial speed used in the model will be 12 km/h in order to contemplate the fact that the vehicles merely go through the *Eixample* as a part of their complete route, which has the average speed of 12 km/h.

The service speed is also vulnerable to the time of the day. Obviously, during peak hour the speed decreases significantly. As an example, *Figure 9* shows the commercial speed flow over the day for a specific bus route in Barcelona, route number 9.

In the case of Barcelona, Bus Rapid Transit system is not yet implemented as a measure to increase the commercial service speed. There is only one exception, route number 65, which operates between the city center and one of the city's suburbs, *El Prat de Llobregat*, where Barcelona's International Airport is located. Route number 65 is complemented by route number 165, which offers the express service between both cities.

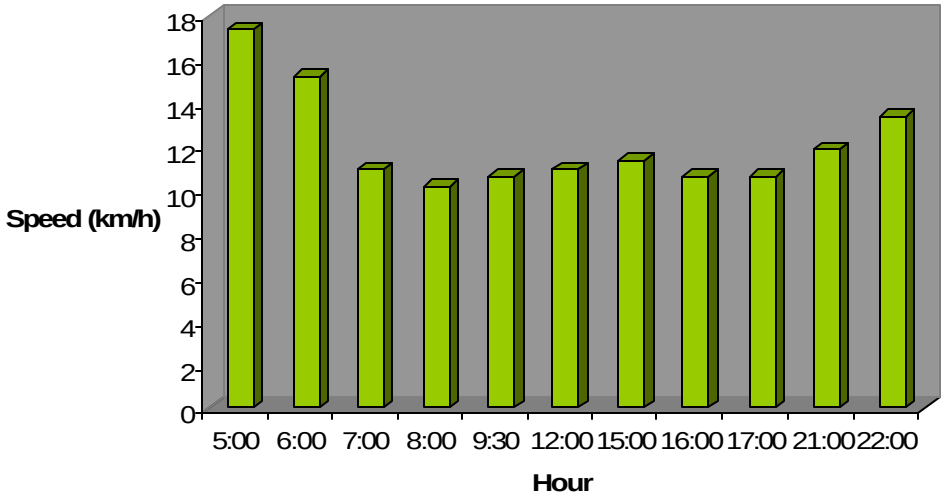

Figure 9. Commercial speed flow along the day for bus route number 9.
Source: Transports Metropolitans de Barcelona, 2004.

As a summary of the two bus network characteristics, it can be highlighted the similarity of their orthogonal structures as well as the vehicle speed. The number of routes and kilometers covered are not comparable on account of the difference on the geographic areas covered by the cities. *Table 6* shows the summary of bus network operability data from both cities.

Table 6. Bus network operability.

	Chicago	Barcelona
Number of routes	152	103
Kilometers covered	3.658	890
Fleet	2.017	1.001
Annual Ridership	305 million	205 millions
Commercial Speed	20 km/h	12,18 km/h

Sources: Chicago Transit Authority, 2004; Transports Metropolitans de Barcelona, 2004.

It is necessary to mention the importance of the commercial vehicle speed on the performance of the bus transit system. It is one of the most influential variables on the quality of the service, and it is directly related with the operator's costs as well as the users' costs.