Dimensioning of Bike sharing Systems using a Dynamic Systems Perspective

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Abstract

The basic premise of the smart bike sharing concept is **sustainable transportation**.

**Public bike sharing systems** have been adapted successfully in places where a large proportion of short trips has been identified.

This work is part of a project in **León, Guanajuato in Mexico**, where socioeconomic conditions in the area, the adherence of its society to this transportation mode as well as the urban trace and physical conditions encourage the adoption of a bike sharing system.
Abstract

The SD approach project involves:

- A previously determined set of stations at *known* locations.

  - A *dynamic simulation model* for evaluating and determining the ideal number of bicycles and identifying the stations with the highest occupation levels and the number of parking slots per station.

  - A final evaluation of unmet demand, service level and system utilization.
Methodology

- Identify Demand
- Use of energy and CO2 emissions
  - SOC Consumption factors
- Dimensioning of BSS using a Dynamic Systems Perspective
  - Feasible points, capacity and associated costs
- Analysis and evaluation of results
  - Conclusions and Recommendations

Mexican Government

Initial Proposal
World Map (Bike Sharing systems)

- **Montreal**
  - 5000 Bikes
  - 400 stations
  - 600 Km

- **Denver**
  - 500 Bikes
  - 50 stations
  - 163 Km

- **Río Janeiro**
  - 250 Bikes
  - 19 stations
  - 140 Km

- **Barcelona**
  - 6000 Bikes
  - 400 stations
  - 177 Km

- **Lyon**
  - 4000 Bikes
  - 343 stations
  - 265 Km

- **Olso**
  - 1200 Bikes
  - 120 stations
  - 250 Km

- **Daejon**
  - 224 Bikes
  - 18 stations
  - 192 Km

- **Milán**
  - 1400 Bikes
  - 104 stations
  - 123 Km

Business challenge solved
Business challenge solved

Study Case

Dimensioning of BSS using a Dynamic Systems Perspective

82.5 Km de Bike Paths.
303 km planned for 2030
Business challenge solved

23 macro-areas
Business challenge solved

Proposed Model

**INFLOW**

1.- Demand Forecasting “E-bikes zones”
2.- Determine the factors that measure the environmental impact of the use of the bicycle system

**Process**

Dynamic simulation of system behavior
- Initial capacity of bicycles per station.
- Number of parking slots
- Number of bikes per station at the end of the day

*Initial proposal:
Software: Any Logic*

*Second stage:
Math Lab simulink*

**Results**

The results of the simulation model are the parameters used on the optimization model.
Business challenge solved

Dynamic Simulation Model Assumptions

**Settings**
- Average speed 15 km/hr.
- Travel time is known.
- The Demand is known using the Master Plan of bicycle path 2030 Leon, Guanajuato

**Conditions Model**
- 1 day Simulation
- 1 station by Macro Area
- Three scenarios: Expected, Low and High Demand
- Dynamic demand function of time

**Factors Analysis**
- Quality of service:
- Bicycles in transit
- Unsatisfied demand
- Utilization level of Bicycle stations
Why you chose AnyLogic

• Graphics Animations (Improve the simulation model)
• University Licenses
• Multi Method Modeling
• Database connection
• Modeling flexibility
Why your work is significant

• BSS have been introduced as part of the urban transportation.
• BSS are used to lessen the use of *automobiles* for short trips inside the central business district, thereby alleviating *traffic congestion* and *reducing noise/air pollution*.
• BSS are viewed as an innovative inner-city transportation mode to meet many commuters’ needs and to integrate them with other public transit systems.
• The model is an input for designing and evaluating a BSS in the 5th largest city in Mexico.
Benefit achieved

- The analysis of a number of different demand scenarios
- The ability for changing several structural parameters
- Identification of the busiest stations in the system
- Utilization of each station
- Visual displaying of performance metrics
AnyLogic model
AnyLogic model
AnyLogic model

Modelo de Simulación Dinámica Sistema de Bicicletas

El siguiente modelo muestra la simulación dinámica de un sistema de bicicletas eléctrico dentro de la ciudad de León, Guanajuato, México.
Modelo de Simulación Dinámica Sistema de Bicicletas Compartidas
Questions and Answers
Thank you!

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