Optimal Location for Bike Sharing Stations in Downtown Kalamazoo
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Abstract
At present, emphasis is on increasing physical activities and expanding access to goods and services through non-motorized modes in order to enhance safety, social sustainability in transportation equity, environmental justice, and public health. Hence, there is an interest in developing bike sharing systems to encourage non-motorized activities in cities. This study focuses on developing a bike sharing system for city of Kalamazoo. One key parameter for a successful system is to identify optimum locations for bike sharing stations. This paper presents implementation of location-allocation models and spatial analysis tools to determine the most suitable locations for bike sharing stations within the city. Locations identified from these models can be used by city planners and stakeholders as supplementary information for planning a new bike sharing system.

Bike Sharing System
Bike sharing is a system designed for point-to-point short trips using a for-rent fleet of bicycles strategically located at docking stations throughout a well-defined project area and within reasonable distance from each other. Prior to launching a bike sharing program, at least the following key points need to be considered as part of planning:

- Identify dense areas such as areas with high population, job rates, commercial/retail activity, and pedestrian activities. Also, areas that are located at close proximities to colleges or universities, tourist attractions, recreational facilities, and hospitals need to be included.
- Identify number of short trips within and between these dense areas.
- Identify available bicycle infrastructure (bike lanes, shared-use paths, etc.)
- Identify connectivity with other modes of transport.
- Identify social equity such as low income housing, percent living in poverty, and percent of non-English speakers.
- Identify areas with slope no greater than 4%

Methodology
Defining initial service area

Location Allocation Models
Location-allocation models are used to identify the optimal location for new facilities such as fire stations, schools, hospitals, etc. In this study, maximize coverage and minimize facilities models are used to identify optimal locations of bike sharing stations from a group of candidates. The models main constraint is the desired walking distance defined as a quarter mile. The following are the location allocation models used in this study:

Maximize coverage model
\[
\text{Maximize } \sum_{j} y_j \quad (1)
\]
subjected to the following constraints:
\[
\sum_{i} x_{ij} \geq y_j \quad (2) \quad \text{for all } j \in J
\]
\[
\sum_{j} x_{ij} = P \quad (3)
\]
where,
- \( J \) = set of demand locations,
- \( i \) = set of candidate stations,
- \( P \) = number of stations to be allocated,
- \( x_{ij} = 1 \) if station allocated at \( j \), otherwise,
- \( y_j = 1 \) if demand is covered at \( j \), otherwise,
- \( S \) = desired walking distance,
- \( d_{ij} \) = distance from demand node to candidate facility,
- \( N_j = \{ j \in J \mid d_{ij} \leq S \} \) set of candidates which can cover demand \( j \),

Minimize facilities model
\[
\text{Minimize } \sum_{j} x_j \quad (4)
\]
subjected to the following constraints:
\[
\sum_{i} x_{ij} \geq 1 \quad (5) \quad \text{for all } i \in I
\]
where,
- \( I \) = set of demand locations,
- \( J \) = set of candidate stations,
- \( x_j = 1 \) if node \( j \) is a facility site, otherwise,
- \( D \) = set of demand nodes,
- \( d_{ij} \) = distance from demand node to candidate facility,

Outcome
The maximize coverage model allocated 190 Location of Interest to 25 stations (Figure 8). The minmax facilities model allocated 190 Location of Interest to 11 stations (Figure 9).

Future tasks
1. Evaluate the possibility of implementation.
2. The study did not include data representing social equity such as low income housing, percent living in poverty, and percent of non-English speakers. When planning is conducted for system expansion the above parameters to be included
3. Evaluating demand to determine number of bicycles per station
4. Business model evaluation
5. Conducting a survey to evaluate acceptance by public

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