

A GIS approach to shopping mall location selection

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Abstract

Taking the advantage of information technology, geographic information systems (GIS) enable the handling of both spatial and non-spatial data for constructing thematic maps depicting a variety of demographic information relating to population, housing, and economic activities. Its application on the technical area in the construction industry is evident, while its usefulness to the non-technical area (e.g., business, economics) is being explored. In view of the potentiality of the GIS, this paper presents its utility for shopping mall location selection, which is one of the core business activities of developers for long-term capital investment. A GIS-based system uses electronic mapping technology in producing interactive multi-layer maps so that queries are set to find optimal solutions for problems. It combines spatial and non-spatial data to construct visualized information that can be easily analyzed by decision makers and that cannot be achieved in table or list forms. In the current paper, a project is demonstrated to create features associated with household incomes, demand points, etc. Queries are then created for finding solutions for four location problems: (1) minimum distance, (2) maximum demands coverage, (3) maximum incomes coverage, and (4) optimal center.

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1. Introduction

Construction projects involve huge amount of long-term capital investment and the annual accumulated spending always represents a certain percentage of gross domestic product (GDP). On that account, each part of a project life cycle must be careful to determine before undertaking. Owing to the complicated nature of a construction project, decision-making becomes a significant but difficult process. Among those numerous decisions having to make for a project, a core decision that has to be made by developers is always undervalued, which is location selection.

Location selection is necessary in both public and private projects. For example, the Fire Department needs to select a site for locating a fire station, while a bank would like to attract more customers by locating their branches strategically. Nevertheless, many of these location selections are done by simple analysis in terms of rudimentary calculation, past experience, or even predilection.

Other than simple methods, more sophisticated ones have also been proposed, which make use of statistical and mathematical tools (e.g. [1,2]). Yet, these methods are not user-friendly in certain ways, especially when presenting the progress or results to the management. Taking the advantage of information technology, geographic information systems (GIS) enable the handling of both spatial and non-spatial data, leading to its specific roles in data management and integration, data query and analysis, and data visualization [3]. A GIS combines spatial and non-spatial data to construct thematic maps depicting a variety of demographic information relating to population, housing, and economic activities.

Its application on the technical area in the construction industry is evident (e.g. [4–6]), while its usefulness to the non-technical area (e.g., business, economics) is being explored. In view of the potentiality of the GIS, this paper presents a research that explores its utility by demonstrating an illustrative project that uses a GIS for shopping mall location selection. The following sections are organized to present: (1) a background of shopping mall location selection, (2) a description of the GIS technology, (3) an

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application of a GIS for super mall location selection, and (4) solutions for four different location selection problems.

2. Shopping mall location selection

Due to the emergence of modern lifestyles, retail shopping has shifted from shopping at small independent shops to large retail outlets and from patronizing at shops nearest to one's place of residence to regional shopping malls. Understanding the behavior of shoppers may satisfy a substantial profit margin for retail investors. For more than half a century, research on shopping behavior has been regarded as the study of consumer behavior and patronage behavior.

According to Brockman et al. [7], most of the research examining the relationship between consumer behavior and shopping mall has spent on studying motivational factors of consumers for shopping in retail shopping centers. Earlier research can be found from Dommermuth and Cundiff [8] who studied consumer interests and Cox and Cooke [9] who studied driving time, through to Grossbart et al. [10] who examined consumer perceptions, attitudes, and behaviors relating to the area surrounding the shopping center and Bellenger et al. [11] who identified the two distinct shopper types being economic versus recreational shoppers.

Later research extends to cover wider aspects of consumer behavior. Feinberg et al. [12] found that malls serve as a place for stimulating social behavior. Brown (1991) further studied shopper circulation in desired shopping centers, finding that movements of most shoppers restrict to a relatively small part of a mall. Roy [13], on the other hand, investigated characteristics of shoppers on mall shopping frequency. Bloch et al. [14], regarding a mall as a consumer habitat, found that considerable heterogeneity exists among mall consumers. The work of Burns and Warren [15] attributed shoppers' behavior to shop in regional shopping malls to individual's need for uniqueness. Finn and Louviere [16] examined the relationship of mall retail outlets and mall image by comparing discount department stores and major department stores. Results indicated that discount department stores, opposite to major department stores, had a consistently negative impact on such center perceptions as high quality, wide selection, good service, and latest fashions.

Research focusing on patronage behavior can be traced back to Huff [17] who developed a disaggregate-probabilistic patronage model based upon earlier gravity models (e.g. [18–20]). During the past four decades, other patronage models have also been established (e.g. [20–23]). Many of which have based their models on the central place theory, which links to the variables of selling space and travel time. Other patronage research underwent empirical tests. For example, Wakefield and Baker [24], examining the effects of tenant variety, mall environment, and consumer shopping involvement on shoppers' excitement and desire to stay at a mall, found that tenant variety is

mostly related to shoppers' excitement, while mall environment is mostly related to shoppers' desire to stay.

For the benefit of shopping mall research, combining the two study areas (i.e., consumer behavior and patronage behavior) moves to a more valid application of the existing knowledge. This is consistent with Finn and Louviere [16] who envisaged the creation of consideration sets in identifying shopper segments, which help locate the dissemination of shoppers within a geographical region. On that account, a GIS is one of the most appropriate methods for shopping mall location selection.

3. The Geographic information systems (GIS)

The GIS technology is appropriate for a variety of usages including resource management, land surveying, and business planning. For example, a GIS might allow planners to create maps for specific use, while another GIS might be able to determine the size of wetlands necessary to be protected against damages and pollution from new district development.

By definition, a GIS is a computer system capable of assembling, storing, manipulating, analyzing, and displaying geographically referenced information (i.e. data identified according to their locations) [25]. It makes use of digital mapping technology to provide options for decisions. Practitioners are increasingly relying on the total GIS solution since there were commercial vendors providing the GIS technology.

A GIS supersedes other information systems by enabling the handling of both spatial and non-spatial data, leading to its authoritative roles in data management and integration, data query and analysis, and data visualization [3]. It combines spatial and non-spatial data to construct thematic maps for communicating complex geographic information that cannot be worked in table or list forms [26].

The way that maps and other data have been stored or filed as layers of information in a GIS makes it possible to perform complex analyses. Even if image data that have already been converted from paper to digital form are not available, a GIS can produce digital maps by incorporating spatial data. Tabular data, such as shoppers' behavior obtained by means of surveys, are then entered into it to act as the information for different layers.

Fig. 1 exhibits a multi-layer architecture of a GIS, which is adapted from Li et al. [3]. Each of these layers represents a single theme in a region comprising similar features such as customers, streets, buildings, etc. Li et al. [3] described the functions of a GIS. Specifically, a GIS adopts database management systems to establish its own data indexing system, in which queries (commands) can be undertaken by retrieving values of stored data. Data are stored in physical storage devices according to their locations in space and are managed using numerical or alphabetical order. For example, it can help locate hospitals within 5 km or within 30 min drive from a center point. Moreover, the separate

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