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Geographic information systems in warehouse site selection decisions

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Abstract

The warehouse site selection decision is not merely the question of choosing sites. It involves the comparison of the spatial characteristics of a market with the overall corporate and marketing goals of the firm. A geographic information system-aided process to the warehouse site selection decision is presented and the use of the presented process is demonstrated with a practical example. Various factors likely to affect customer service and costs are defined and subsequently integrated into an overall evaluation.

Keywords: Geographic information systems (GIS); Warehouse site selection; Warehouse location; Decision support system (DSS); Logistic systems

1. Introduction

The commitment to logistics and marketing management shown recently by organizations, has stimulated a heightened awareness of the importance of warehouse site selection decisions in the formulation and implementation of effective business strategies. The appropriate number and geographic sites of warehouses are determined by customer, manufacturing and competitor locations, product requirements, types of transportation, and sales level [1,2]. From a policy viewpoint, warehouses should be established in a logistical system if they can render service or cost advantages.

Warehouse site location analysis, particularly with the increased availability of computer-based techniques, can provide invaluable information to assist warehouse and marketing management with their decision-making process. Computerized maps can display hidden relationships between customers or competitors and territories. "Geographic information system (GIS) is a group of procedures that provide data input, storage and retrieval, mapping and spatial analysis for both spatial and attribute data to support the decision-making activities of the organization" [3]. In this sense, GIS can support logistic and marketing managers to evaluate placement options for warehouse stores, based on costs (transport, labor, utilities, etc.), and on customers and competitors demographics.

Typical location analysis problems can be characterized as very complex and data intense. Modeling and analysis techniques must be employed to effectively deal with such complexity and data intensity in order to identify the best alternatives.

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According to Ballou and Masters [4] a number of commercial software products exist that are specifically designed to address the location analysis problem. A variety of different approaches and models have been suggested to assist in the evaluation and measurement of location decisions.

Decision support systems (DSS) incorporate both data and models. They couple the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions and to support managerial judgment.

The aim of this paper is to develop a geographic decision support system for the warehouse site selection process, enabling the manager to use quantitative and qualitative criteria in order to classify alternative warehouses or visualize the best one.

2. Georgraphic decision support system for warehouse location evaluation

The warehouse site selection decision is affected by qualitative and quantitative criteria depending on the total distribution cost and the customer service [5–7].

The tools used to support location analysis generally, fall into the categories of rule of thumb procedures, checklist models, analog models, gravity models, optimization and linear programming techniques, simulation and rule-based models [8,9]. The size and the complexity of the site evaluation model is simply another kind of business decision. The best model is the one that is cost effective for a particular location decision it faces.

The integration of GIS and decision support software promotes collaborative GIS, focuses on problem-solving efforts, and establishes an alignment between personal and group goals. The intent of this paper, is to describe a system that integrates GIS and decision support software in a form of user interface, thus promoting collaborative GIS techniques. Decision models for final recommendations can be input with minor code writing and linked to the original geographic data sets. Software tools allow the visualization of these geographically oriented decisions. A spatial decision support system based on multi-criteria evaluation can be reactive, proactive, and/or interactive. Adding decision support to the GIS allows for the necessary mixture of quantitative and qualitative criteria for multicriteria evaluation and later on for multi-objective analysis [10,11].

The developed software allows participants to visualise, explore, query, and analyse the data spatially. The users can select features according to their attributes or based on their proximity to other features. Places where certain features coincide can also be selected.

2.1. Software tools

In order to integrate a GIS and a DSS for the evaluation of a warehouse location, the following software tools have been used:

ArcView 3: ArcView is a powerful, easy-to-use tool. ArcView gives the user the power to visualize, analyze, explore and query data spatially. A key feature of ArcView is that it is easy to load tabular data, such as dBASE files and data from database servers, into ArcView so that the user can display, query, summarize and organize this data geographically.

MapObject: MapObject is a set of tools and mapping objects which allow the user to add maps in his application and to manage the map with the linked data base. Map Object applications can be greatly expanded when advanced programming is involved, such as Visual Basic, Delfi, C++. MapObject consists of an object linking and embedding (OLE) control (OCX) by the name Map Control and about 30 OLE Automation Objects.

Visual Basic: A powerful programming language, especially when it is used under WINDOWS. Within the Visual Basic OLE Container, the developer can combine MapObjects, other custom controls and to use OLE Automation Objects of other programmes such as Microsoft Office in order to develop various applications.

MapObject and ArcView3, customised with Visual Basic 5.0, allow users to construct various scenarios or proposals which can then be collected, combined, discussed, and prioritised. Decision rules for final recommendations are recorded automatically and linked to the original geographic data sets.