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The Retail Site Location Decision System

Oleksandr Turytsia*

Abstract

Location plays a key role in success of a business. No amount of property features such as building, grounds, decorating, or price can overcome the negative impact of a poor location. This work aims to develop a system that implements a methodology to assist retailers in making informed location decisions.

*xturyt00@stud.fit.vutbr.cz, *Faculty of Information Technology, Brno University of Technology*

1. Introduction

What are the three most important factors in selling real estate? Location, location and location. This is applicable not only in real estate but also retail business [1].

Deciding where to locate business has been always a problem that people continuously tried to solve all over the world. Throughout the time great majority of retailers would make a decision based on personal experience and instinct, regarding the process very much as an "art". People would mainly use very subjective techniques, some of them are no more than "hunches" based upon experience [2].

As information systems evolved, research procedures became more sophisticated. For retailers, this presented a challenge: without using location decision procedures to improve objectivity, they risked falling behind businesses that adopted such methodologies [2]. Retailers must carefully select and coordinate these tools to ensure they complement each other and provide a comprehensive view of the decision at hand, otherwise, they risk making false decisions or mistakes.

A solution is to build a system to aid retailers in making informed location decisions. Such system could utilize one of procedures, which are designed to assist retailers in the decision-making process, particularly in identifying optimal business locations.

This work adopts one notable methodology outlined in the journal "Applied Geography" titled "The Retail Site Location Decision Process Using GIS and the Analytical Hierarchy Process". This procedure enables users to analyze multiple datasets, utilize GIS features for location selection, and input their preferences into the system, which makes the procedure flexible and suitable for every retailer who chooses to utilize it [3].

2. Preliminaries

2.1 Procedure Overview

The methodology implies two key concepts based on spatial dispersion: *Geo-demand* and *Geo-competition*. Geo-demand is a location of potential customers, while geo-competition is a location of business competitors [4]. Each concept is going to contain data points that can be outlined on a map within separate layers. First layer will contain density of the customers on a map, the second layer should contain estimated trading areas of the competitors [3].

Once they these two layers identified, third layer can be obtained by their joint analysis [4]. The third layer should reveal areas where commercial service is poor and population density is high. These areas are then considered good for outlets.

Identified area can help decision-maker select potential locations for his outlet and define attributes for them.

Once attributes are provided, decision-maker must define relative priority of each attribute, which serves as an input to *Analytic Hierarchy Process* (AHP) that evaluates all the attributes on each site and outputs locations with their relative rating. Location that contains the greatest value of the rating is considered to be the most desired. The consistency of the output fully depends on the user [3].

2.2 Geo-Demand

Geo-demand can be defined as the location of potential customers who purchase a product or service in a specific market. Data can be acquired from local city database [3].

2.3 Geo-Competition

Geo-competition is the location of the competitors of a business and the delineation of their trade areas in a particular market. Trade area can be defined as the geographic area in which a retailer attracts customers [4, 3].

Trading area can be identified using probabilistic model presented by David L. Huff:

$$P_{ij} = \frac{\frac{S_j}{T_{ij}^{\lambda}}}{\sum_{j=1}^{n} \frac{S_j}{T_{ij}^{\lambda}}} \tag{1}$$

Where P_{ij} is a probability of a consumer at a given point of origin i traveling to a particular shopping center, S_j = the size of a shopping center j, T_{ij} = the travel time involved in getting from a consumer's travel base i to a given shopping center j, λ = a distance decay factor.

2.4 Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) in this procedure is responsible for rating possible locations. It evaluates every site and finds the most favorable for the user based on provided attributes and their relative weights.

Let's consider following example, suppose there are three projects: Project A, Project B and Project C with defined attributes of duration, cost, and expected quality Table 1. The goal is to choose optimal project.

	Project A	Project B	Project C
Duration	5	3	7
Cost	7	5	3
Quality	3	7	5

Table 1. Project attributes.

Let's use 1-9 scale to compare criteria, define the significance of other attributes and put it into the table Table 2:

	Duration	Cost	Quality
Duration	1	0.333	0.200
Cost	3	1	0.333
Quality	5	3	1

Table 2. Criteria that are compared in pairs.

Now let's calculate the sum of each column and divide the value of each cell by the sum of the values of the corresponding column and then by calculating the average values of the rows, it is possible to find the specific weight of each of the criteria Table 3.

Duration	Cost	Quality
0.106	0.261	0.633

Table 3. Weights of each of the criteria.

Taking each of the estimates with the specific weight of the criterion found earlier, and adding them up in a project-by-project manner, we get:

$$\text{Project A} = 0.106 \cdot 5 + 0.261 \cdot 7 + 0.633 \cdot 3 = 4.256$$

$$\text{Project B} = 0.106 \cdot 7 + 0.261 \cdot 5 + 0.633 \cdot 3 = \mathbf{6.054}$$

$$\text{Project C} = 0.106 \cdot 3 + 0.261 \cdot 7 + 0.633 \cdot 5 = 4.690$$

Project B will be selected. The same logic applies for outlets.

3. Implementation

A system for informed decisions in site selection process is developed as a full-stack web application.

Front-end is implemented using Typescript, React and leaflet library. It allows users to interact with spatial data. It has a dynamic map displaying various data layers and components presenting information relevant to each stage of the decision-making process, such as possible location selection, site attributes definition and etc.

Back-end is implemented using Python and FastApi library. It serves as the central engine driving the system, offering a way to configure and adapt to different cities and datasets associated with specific categories of products. This flexibility enables the creation of multiple instances of the application for diverse cities and product categories defined within the back-end.

4. Conclusions

This work introduces system that implements procedure to aid retailers in making informed location decisions. The development of such a system represents a significant step forward in empowering retailers to make more informed location decisions. By incorporating advanced methodologies and small retailers can gain a competitive edge in selecting optimal business locations.

However, as with any technological solution, there remains room for improvement in terms of both performance and functionality.

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