Suitability Analysis for an even distribution of Convenience Stores around the University of Tsukuba Campus based on Spatial Characteristics and dormitory proximity

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1. Motivation

Convenience Stores are playing a very important role in the lives of its market shares. Within the university campus they serve student and university workers. However, though they operate on a twenty-four hour basis, they are not evenly distributed within and around the campus. This presents an advantage for some students over others in terms of proximity and time. The purpose of this research is to locate suitable sites for additional convenience stores that will maintain a balance within campus.

2. Introduction

The location of convenience stores can be based on several factors. However a much more intuitive way is to study the spatial characteristics of dispersions of existing stores in relation to the natural factors which is the aim of this study. The field work shows some correlation to varied levels between their locations and the spatial features. These features will be analyzed to determine the criteria and their weights in the present pattern shown by their distribution. A weighted suitability model is used in ArcGIS to locate possible sites for future localization of convenience stores in the University of Tsukuba area. The result will be further restrained within 10 minutes Euclidean walking distance from dormitories.

3. Study Area

The University of Tsukuba area has been identified with an external buffer of 100 meters. This was determined after preliminary field visits to examine those convenience stores serving the university students and workers. The external buffer was considered because 90 percent of the stores fall outside the University boundary and within this buffer.

Fig.1 Study Area

4. Methodology

A field survey was conducted to capture series of data attributed to the location of the existing stores using a smart phone and global mapper mobile. The surrounding land use was also recorded for each store. The University boundary shapefile, the campus bus route, bus stations and buildings shapefiles were extracted from the CampusGIS database. It was evident from the survey that 100 percent of all the surveyed stores had a very strong attraction to residential concentrations while 40 percent to recreation. However, other criteria such as distances to the bus route and the nearest bus station to each store were also calculated. These distances were also used to set the buffers for restricted and most suitable sites. The 10m DEM was also used to create a slope which was clipped with the stores shapefile to determine the maximum slope. These criteria were used in the following model:

$$S = \sum_{i=1}^{n} w_i C_i \prod_{j=1}^{m} r_j$$

Where S is the suitability for site location, w_i is the weight of a criterion, C_i is the criterion and r_j are the restrictions. In the Restriction model, the university building footprints and the convenience stores were buffered as follows;

Table 1. Restriction criteria

Restriction Source	Min. Distance (m)	Max. Distance (m)	Analysis Distance (m)
Store	125	1400	125
Buildings	20		20

$$S = \sum_{i=1}^{n} w_i C_i \, (r_{stores} \, . \, r_{Buildings})$$

Table 2. Suitability criteria

Suitability Source	Min. Distance (m)	Max. Distance (m)	Range (m)	Rating	Weights (%)
Bus Route	0	375	375	3	10
Bus Station	45	570	525	2	10
Boundary	0	100	100	4	20
Slope%	**0%**	**17%**	**<=1%**	**5**	30
Landuse Variations	**Residential**	**100%**	**100%**	**5**	30
	Recreation	**40%**	**40%**	**2**	

$$S = \sum_{i=1}^{n} (w_{br} C_{br} \, . (w_{bs} C_{bs} \, . (w_b C_b \, . (w_{sl} C_{sl} \, . \, (w_{lu} C_{lu}) \prod_{j=1}^{m} r_j$$

5. Results and Discussion

A weighted suitability model using service areas within 10 minutes walking distance from the dormitories to the closest convenience stores and the above spatial criteria was used to identify the suitable sites. The result shows that the suitable sites are having similar characteristics with the existing stores location. The Restriction map is an indication of forbidden areas. These areas share less or no characteristics with the existing ones. The suitability map presents suitable locations without any restrictions and within 10 minutes walking distance from the dormitories. These areas have maintained similar spatial distribution characteristics as the existing ones.

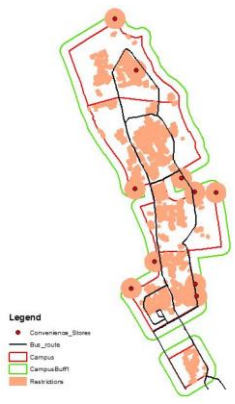

Fig.2 Restricted Areas

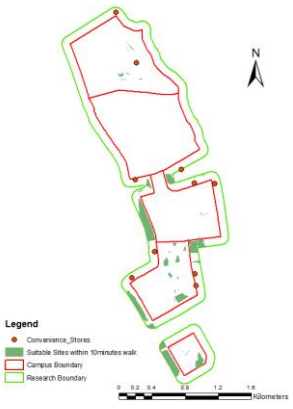

Fig.3 Suitable Areas within 10 minutes' walk