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Short Article

Optimum Allocation of Super Stores in Dhaka City: An Application of Geographic Information System (GIS) and Heuristic Model

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Abstract

For well functioning of a city, it is very important to ensure the optimum location of different public facilities. Super markets follow the theme of arranging all kinds of products under one roof for the consumers. The objective of this study is to determine the availability of super stores and analysis of locations of super stores in Dhaka City. The study explores the optimum location of super stores to minimize inconveniences faced by the residents to access super stores. Optimal locations of super stores are identified by using Heuristic Model. In the study area, super stores have grown haphazardly and people are not getting their desired services. On the other hand, owners of super stores failed to earn their preferred profit. The study integrated GIS methods and Heuristic Model to determine demand wise distribution of super stores in the city.

Introduction

Public facilities like the super stores are very indispensable for a city. The super stores should be conveniently located for easy access of the dwellers to the facilities. There are some specific criteria of location selection and space requirement for super stores. Selection should be made applying appropriate standards and considering local situation. This may be based on population of catchment areas of the service, convenient distance and accessibility. In Dhaka, super store provision is poor in the sense of accessibility, affordability, facilities, convenience and environment. Residents are not getting their desired service due to improper distribution of super stores. The owners of super stores are not able to get their expected profit and as well as consumers are also suffering for unplanned location of services. The concept of super stores in Bangladesh has emerged towards the end of 20th century. Today, the need for super stores has become a necessity for different reasons. Shoppers are quite dissatisfied with the present system of bazaars, corner grocery shops and general stores. (Chowdhury, et al., 2007). This research has been undertaken with an objective of exploring the optimal allocation of super stores by applying GIS and Location-Allocation model.

Data and Methodology

GIS is now the most widely used software for analyzing, visualizing and mapping spatial data such as retail location, transport networks and land-use patterns. The growing consumer orientation in business and service planning along with advances in GIS and spatial analysis techniques, have led to the promotion of the use of GIS in the area of business and service planning (Longley and Clark, 1995). To determine the availability

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and accessibility of super stores in the study area based on the population, the research applies integration of Geographic Information System (GIS) and Location Allocation approach for optimal allocation of super stores. Since Dhaka City Corporation area is quite large to census the location of all super stores, sampling was followed to get the information. The super stores in the wards of 2, 3, 4,5,6,7 and 8 of Dhaka City Corporation area were surveyed for the purpose (Figure 1). About 5% households of the study area were selected for survey using stratified sample technique. Questionnaire survey has been conducted on consumers of super stores, owners of super stores, and people who are not using the super stores.

Location Analysis of Super Stores

Superstore originally referred to as store that sold items in larger than normal size or quantity, refers to a style of physically large chain store, and by extension to the company behind the store. The terms Big-box store, mega store, and super center also refer to these retail establishments. The word super store literally means a large shop selling food, drink, household goods, etc. People choose what they want from the shelves and pay for them as they leave. Basically, a super store is a one floor large area consisting of the daily goods that are bought by households. The daily goods include all the fast moving consumer goods like households, groceries, stationeries, cosmetics, etc. These also include fresh meat, fruits, and vegetables to frozen food stuff. With over twenty super stores that follow the theme of arranging all kinds of products under one roof for the consumers operating in full swing, the shopping style of Dhaka city dwellers has changed dramatically (Chowdhury, et al. 2007).

Super Store Development Considerations

The "Super store" is a relatively new phenomenon in retail sector. There are numerous configurations and approaches to the planning, design, and construction of these facilities. In many communities, the constructions of these facilities have significant social and economic implications. They also can have significant hydrologic impacts for the development of the site and for the inertia they can potentially create for the development of surrounding properties. Some of the basic characteristics of super store development can be as follows:

- The building typically occupies a large floor area
- Derive their profits from high sales volumes, rather than price mark up
- Large windowless, rectangular single-story buildings
- Standardized facades based on corporate standards
- Reliance on auto-borne shoppers
- Highly impervious with large parking and building footprints
- No-frills site development that eschews any community or pedestrian amenities.
- Varying market niches; categories include discount department stores and warehouse clubs (www.lowimpactdevelopment.org)

The study area for this research includes ward number 2, 3, 4, 5, 6,7and 8 of Dhaka City Corporation (DCC) is situated in Pallabi and Mirpur *thanas* within Dhaka Metropolitan Development Plan (DMDP) area. The study area is a built up area with mostly residential development except on both sides of western embankment along Turag River. A review of the existing land use pattern of this area shows that residential development is the most dominant land use. The prominent neighborhoods of the study area are: Mirpur cantonment, Mirpur section 1,2,6,7, Pallabi part-1 and extension, eastern housing, Rupnagar, and Uttor Bishil. Socio economic condition of the sample respondents of the study area is considered in this study.

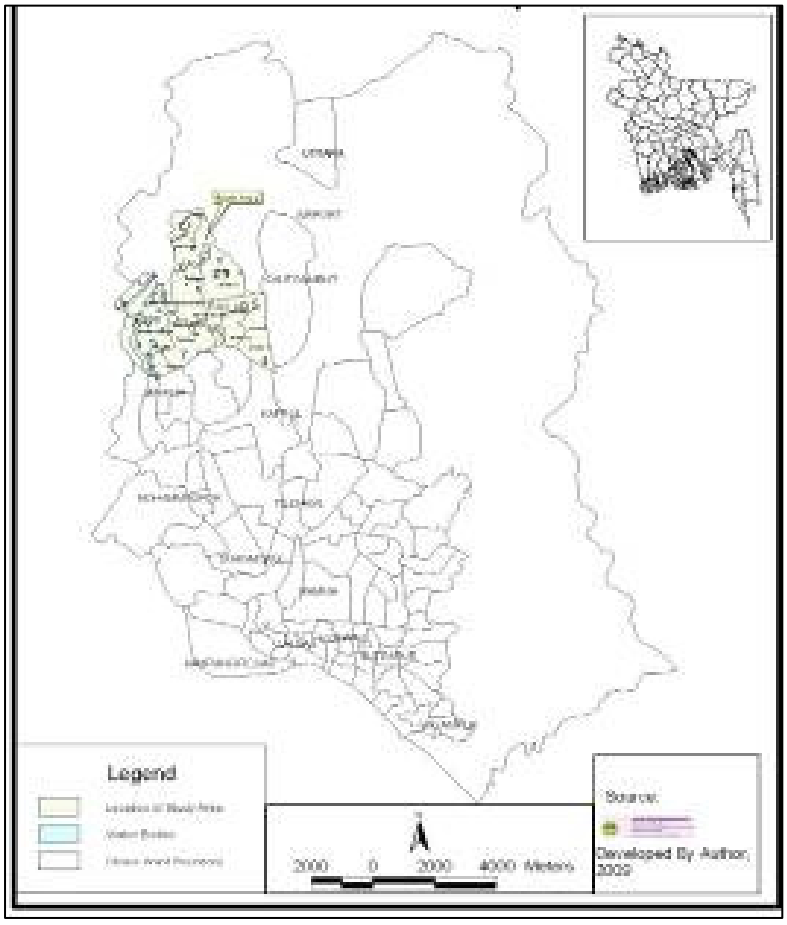

Fig. 1: Location map of the Study Wards of Dhaka City

The type of service would be taken depends on their income level and awareness. Figures 2-5 show the survey findings on super stores and its stakeholders. Data has been collected during the survey in February, 2009.

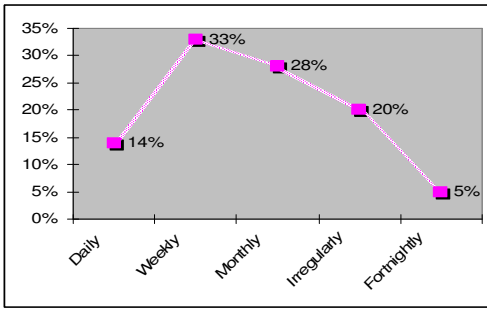

Fig. 2: Reason to choose super stores

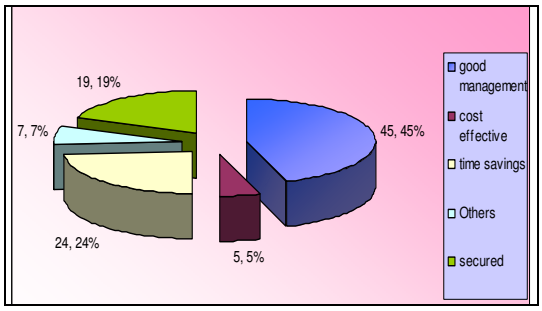

Fig. 3: Frequency of visiting the super stores

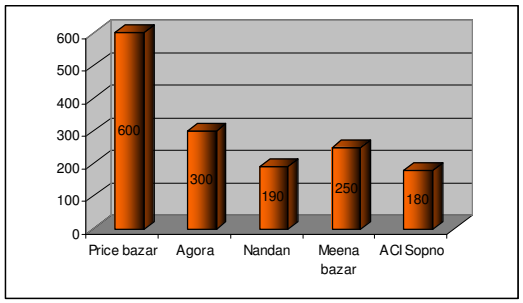

Fig. 4: Average number of buyers visiting super stores

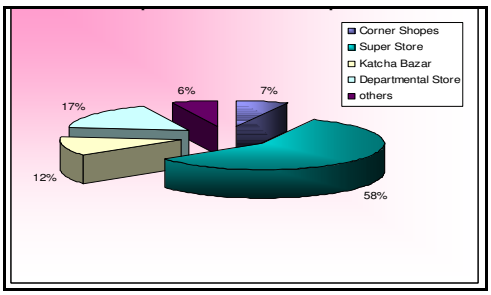

Fig. 5: Desirable shopping corners for the respondents

An analysis was made in the study on the locations of the super stores with respect to the super store going consumer of the study area. It formulates the weight for supply and demand points and the requirements of super store within the study area. The weight W_i for demand points were determined based on the super store going family in each demand point. In case of weight of supply points of the area, a fixed weight a_{ij} for all the supply centers were determined. It also represents distance from demand point to super store of the study area. It deals with the optimum location of super store by applying Alternating Heuristic Model, justifying the location of super store with GIS and from planning point of view. In Alternating Heuristic Algorithm model, the location of super store is a locational problem involving the assignment of n super stores to m population, where $n<m$. Facilities to be located are the "supply centers" and places with fixed locations. Finally, it compares the existing locations with reallocated location of super stores.

New locations are calculated for the supply centers by solving the single-facility location problem for each group of demand points;

$$x_j^* = \frac{\sum_{i=1}^{n} \frac{a_{ij} w_i x_i}{d_{ij}}}{\sum_{i=1}^{n} \frac{a_{ij} w_i}{d_{ij}}} \qquad y_j^* = \frac{\sum_{i=1}^{n} \frac{a_{ij} w_i y_i}{d_{ij}}}{\sum_{i=1}^{n} \frac{a_{ij} w_i}{d_{ij}}} \qquad d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$$

$a_{ij} = \{1$ if demand point i is closest to supply centre j and 0 otherwise$\}$ $w_i =$ Weight associated with each demand point $d_{ij} =$ Distance between demand point i and supply centre j.

The study area consist of five super stores which act as the supply points and eight demand points which consist the super store going household of each block of the study area. The demand points were selected to justify the location of super store. Distances were calculated between demand points and supply points of the study area. All the super stores within the study area are calculated as the supply points and eight demand points from the community are used as the demand points. To calculate the distance between demand and supply points, $d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$ equation was used.

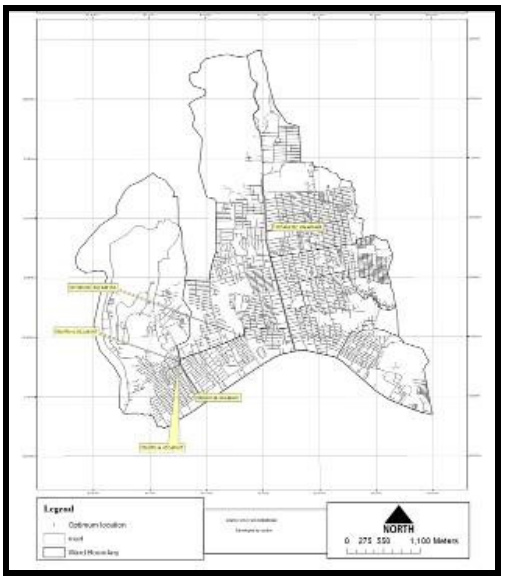

Fig. 6: Demand and supply points of Study Area

Fig. 7: Optimum allocation of super stores

To calculate new locations for the supply centers, the value of a_{ij}, d_{ij} *and* w_i were used, and to calculate the values of x^* and y^* Microsoft Office Excel was used. The optimistic Xi* and Yi*coordinates of super stores were achieved by using Alternating Heuristic model. Figure 7 shows the optimum location of the super stores. New locations are found out for the supply centers by solving the single-facility location problem for each group of demand points.

From the output of model, it seems that most of the locations are placed in residential areas. The floor spaces can have been rented out commercially to the super store owners for future investment. Further research could have been conducted for identifying the suitability of the locations for super stores. In this research, GIS was used to find out a practical solution to the problem.

Findings

The study explored the optimum allocation of super store by applying GIS and Heuristic Model on the basis of inconvenience faced by the residence to access the super stores and stipulated the solution of optimum allocation of super stores within the study area. In the study area, super stores are grown haphazardly, so people are not getting their desired services from the super store. On the other hand, owner of super stores failed to earn preferred profit. The output of the model shows that three super stores are enough for the study area if super stores are relocated. Alternating Heuristic model tries to find optimum location of the existing number of facilities. Optimum location is justified by GIS in this study that makes it meaningful in terms of planning point of view.

The central function of service facilities is to provide services to their users. The public facilities are often allocated according to the availability of sites, and locational factors are frequently neglected in the site selection of public facilities. This shortcoming can be

overcome by the integration of GIS with the location –allocation model as demonstrated in this study. The integration of GIS methods and location-allocation model will ensure the demand wise distribution of public facilities, not on the basis of availability of land.

Conclusion

Increased coordination between service providers and communities require proper planning in establishing more super stores in study wards of Dhaka City. Shopping behavior of the consumers can be an important consideration for planned development of super stores in the city. It is believed that this study will help policy makers in city planning decide on the location of public facilities including super stores, not only in new areas but also in the already developed but unplanned areas.

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