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Suitable Business Site Selection Using GIS

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ABSTRACT

Economic growth of a country mainly relies on development of businesses. Increase in number of successful business help in increasing employments. The services, products and taxes contribute in improving economic stability and growth. So, the need is to encourage the establishment of new business and facilitate them with new technologies. One of the important features is to select the appropriate place or site for the establishment of a new business. The selection procedure of a site would include the surrounding of the place. We would have to keep in mind the accommodations in the surrounding area, type of people as well as the similar businesses to lover the competition. All these components play an important role in the development of the business. The best technique in computer science for location analysis is Geographic Information System (GIS). The GIS helps us to visualize as well as get the required details about the desired location. So, we are hereby trying to solve the problem of searching suitable sites for business establishment by building an application using GIS technology to select suitable business site depending on the particular criteria. The user will be able to get the location of the site selected based on his particular criteria.

Key Words: Geographic Information System (GIS), Geoserver, Geopandas, Openlayers, Multi Criteria Analysis (MCA)

1. INTRODUCTION

Site Selection for any business type plays a prime role in its growth. When a suitable location is selected for establishment of a new business, at the same time the surety of its successful future can be made. Each Business type has some common criteria to find a suitable location which can be used to help us find this location using some computational operations. As the discussion for computation of location is going on the main technology that comes in mind is GIS (Geographic Information System). The GIS technology could is one which can help us with the visual as well as theoretical data related to any place or location. This data is of a great use to obtain a suitable location.

The data with geographical nature is easier to understand by the end users. The end users are generally not familiar with the statistical or analytical representations which is the reason why many of the common people do not prefer the computational solutions. The easy to understand and good to visualize solutions can be found out using the GIS technology. This GIS technology would be then combined with the popular analysis technique based on multiple criteria. This criterion would be based on requirement of the user and the business types.

With the help of some basic and business type specific criteria we can perform analysis on the available data. The need of sufficient and valid data is an important factor in building this system. This data is then used to perform multiple analysis operations to get the desired resultant location.

We have tried to implement the easiest algorithm and steps for multicriteria analysis in this system so that a common person can also have the basic knowledge of the followed procedure so that he could me more assured of results. The combination of small vector data analysis tools are combined to build up the strong algorithm for Multiple Criteria Analysis. We have applied tis algorithm using Python to build up our system [13], [14], [15], [16].

2. LITERATURE REVIEW

Many more authors have tried to build up such systems, to solve the problems of site selection for different aspects and requirements of business.

Sarath.M, Sameer Saran and K.V.Ramana presents a System in which the methodology followed was Analytical Hierarchical Process (AHP) and Sensitivity analysis. The result shown was on the map where areas were categorised to highly suitable, moderately suitable, less suitable and not suitable areas [1].

Luyao Wang 1,2, Hong Fan 1,2,* and Yankun Wang 1,2 presented a system which followed the method of Feature Selection and Normalization, PCA of Features, BP Neural Network, Cross-Validation and Spatial Accessibility. As a result the sites were divided into three classes and were represented on the map as High Potential, Moderate Potential and Low Potential areas [2].

Swapnil AwaghadeII, Priyanka DandekarI and PinakRanadeII have presented a system where they have used weighted overlay analysis, Multicriteria Analysis and Euclidian Distance analysis, using which they represented the resultant areas on the map in the form of suitable ATMs[3].

Aleksandar Rikalovic*, Ilija Cosic, Djordje Lazarevic presented "GIS Based Multi-Criteria Analysis for Industrial Site Selection" whtere they have performed GIS-MCDM on the vector and raster data in their systems to get the result in the form of vector suitability map and raster suitability map which represents the suitable areas in different colours[4].

Raid Almalki1,*, Joseph Piwowar 2 and Julia Siemer 2 presented a system where they have used analysis using MCDM on suitability and restrictive criteria to gain the results in five categories as Unsuitable, Less Suitable, Moderately Suitable, Suitable and Very Suitable represented in different colours [5].

Xuguang Bao and Lizhen Wang*has used the co-location mapping technique named as DS4. The accuracy is counted in the form of min_dist and min_prev 10 times for each data division[6].

Jonathan Kemp1), has used a technique using GIS named as constraint mapping for data analysis and Multi Criterial matrix Evaluation (MCE) for site selection. The result of this proposed system is given in the form of weighted score for each site from which the site with maximum percent suitability is to be considered [7].

K N Sayl, A S Mohammed and A D Ahmed have used the process of weight overlay in which the different weight was identified according to different criteria and then the Analytical Hierarchy Process was used to estimate these weights of criteria. Then the pair wise comparison matrix was formed to specify the result. The result was shown in the three cour map denoting the thre criteria sites as Suitable, A little Suitable and Non-Suitable Sites [8].

Arunendra Singh1,* , Richa Singh1 and Pronaya Bhattacharya2 has used a DSS model which is made using MS Excel Sheet and then applied a formula to calculate weight of each criteria and then analyse them to calculate max weight. And accordingly, the best locations with their weight are shown in a table [9].

Tian Feng, Tomasz Bednarz have used the Particle swarm Optimization and trained the cGAN to predict convex, concave and multizone parts and the result was shown on the map as suitable and unsuitable zones in different colour [10].

Karimi, F., Sultana, S., ShirzadiBabakan, A., & Royall, D. has rated the land units based on different criteria using the parametric approach. Where the land area with maximum units is considered as optimal area. The result shows the map with suitability index where the maximum suitability index is provided to the most suitable site [11].

3. METHODOLOGY

3.1. Study Area

For experimental purpose some of the area that has to be taken into consideration so that the system productivity can be proved is termed as the study area. For the area of study, we have used the data for city Nagpur, this city is located 21.1458° N, 79.0882° E. Which has the centre of Indian peninsula named as Zero Mile. The Orange City which has the 13th largest population in India and is the second Capital of Maharashtra. According to the Times of India Research it is the fifth fastest growing city in the world from 2019 to 2035 with an average growth of 8.41%. Also, it is one of the 10 cities selected for the Smart city Projects in India.[12] So, according to above criteria this is the best pace to apply this system to study its results accuracy. As the fifth fastest growing city of the world would definitely have the higher growth rate in new businesses. So, this system could help this city to increase its growth rate with a higher speed.
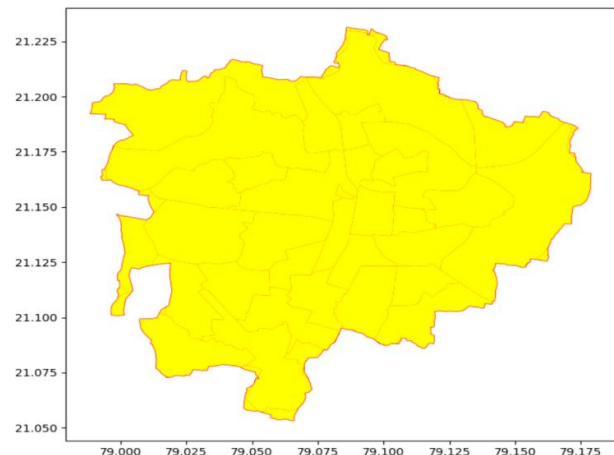

Figure 1: Nagpur City – (Study Area)

3.2. Data Used

Various Data required for the study of proposed system was collected by different means. For the purpose of study, the Vehicle Tyre Shop Business is targeted in this paper. So, the data collection was according to the requirements based on the criteria for establishment for new tyre shop. The location would be accepted and rejected based on the required criteria. For which the data of Existing Tyre Shops, Major Roads of the city, Existing service Centres and Showrooms and the Data for Buildings was collected and prepared. The preparation removes all the unwanted and improper Data and provides us with a filtered data. This Data can directly be used for analysis. Such as here we filtered the buildings data for shops and market places only. All this data is then published to an opensource server Geoserver so that it can be accessed from anywhere in the world via Internet.
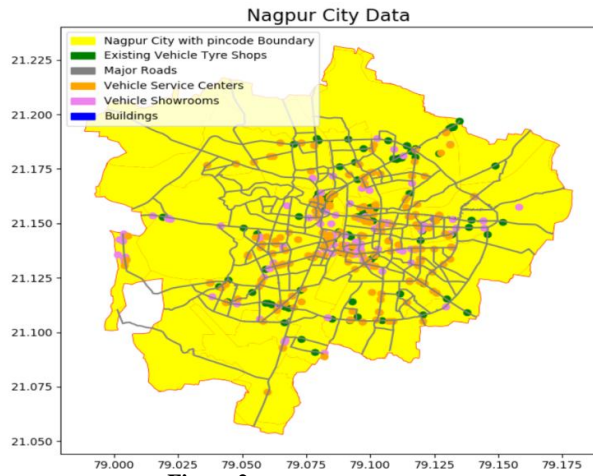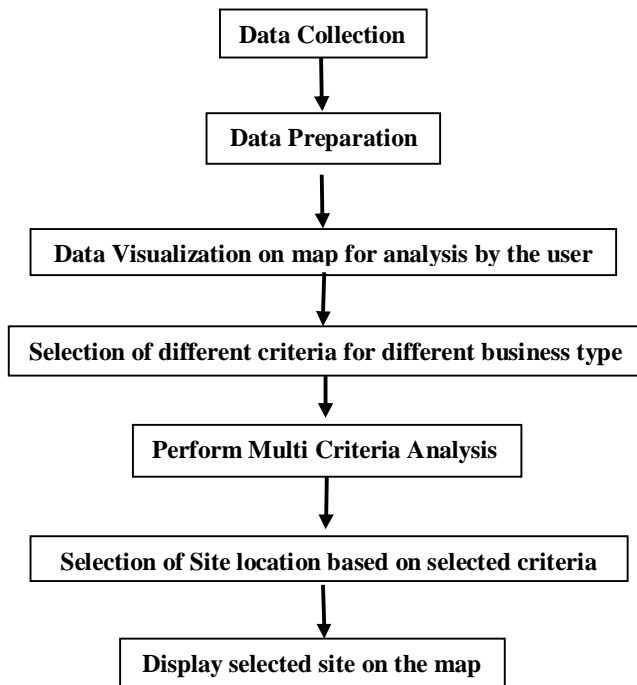
Figure 2: Data for Nagpur City

3.3. Methods Used

This paper has made an effort towards using the computational services for the development of business sector, no matter of which category it is. The major technology used here is GIS. The GIS Technology helps in visualising the data and results effectively. And to get the effective results we have applied some simple steps as:

```
Data Collection
      ↓
Data Preparation
      ↓
Data Visualization on map for analysis by the user
      ↓
Selection of different criteria for different business type
      ↓
Perform Multi Criteria Analysis
      ↓
Selection of Site location based on selected criteria
      ↓
Display selected site on the map
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These steps define how the work would be carried out. As we already discussed about the Data Collection and Data Preparation and also representation of data on the map as shown in above figures. Now the next step is selection of criterion for analysis of this data. This criterion will then decide the steps for analysis. The Criterions are selected on the basis of user requirements and business types. The requirements of each business type have some common criteria, such as similar shops should be some distance away and the related shops should be near. Also, the Shop site should be in a market area and near to a major road of the particular city. Other than these common criterions the user specific criterions can also be added. We have tried to add two of the basic criterions based on the user requirements as 5 kms away from the city centre and a specific selected area of the city.

Now at the point of implementation of these criterions we have used some basic vector analysis tools such as buffer, Clip, Intersect and Erase. Using these tools efficiently, results into a useful outcome. The steps of MCA are:

1. Create Buffer Around points you need the shop near or away.
2. Intersect Those Buffer zones with Roads.
3. These Intersected roads output will be the area that has to be included or excluded.
4. The exclusion area roads should then be erased from Inclusion area roads.
5. The output of this erase tool will then be Intersected with the buildings data for shops and Market Places.
6. Now the intersection output is considered as output of analysis based on basic criterions, which could be further combined with user specific criterions.
7. Now, to implement user specific criterions the city center point is applied a buffer of 5 kms which is then intersected with the last intersection output area we got from analysis of basic criterions.
8. This Intersected area is then erased from the basic criterion output.
9. The resultant area than has to be intersected with the specific area portion selected by the user.
10. The resultant would be our required output area.

Here, the output of some tools taken as the inputs of other tools create a chain or model which can be Implemented accordingly for any of the business type. Here the buffer zones created around the existing shops is 5 kms. To remove this area from the search, this buffer area is intersected with the roads so that the 5 kms distance is calculated via the roads and not randomly to any side of the existing shops. Now similarly, the buffer is created around the related shops in 3 kms radius to prioritize this area. But similar to previous step we can not take this area from any side of the shop so the intersection is done with the roads. Then these outputs give us the exclusive and inclusive road data. Which then is given as an input to the erase tool. This erase tool will remove the exclusive roads if present in the inclusive roads data. This output data is then provided as an input to the intersection tool with another input as the shops and market place buildings data. The output of this intersection will provide us with more specific area for site selection. Here, we get the output of basic criterions. Now, we have added two user specific criterion as mentioned in the steps above for which the buffer is added with 5 kms radius to the point representing the city centre which would then be intersected with the result analysis of basic criterions. This intersection output

is then again intersected with the specific area polygon of the city to get final output areas. These areas are considered as suitable sites for establishing new Vehicle Tyre Shop Business.

4. RESULTS AND DISCUSSION

The System successfully provides us with the solution to suitable business site selection using the GIS Technology. The output we get is in the form of polygons selected on the basis of MCA performed on the available spatial data taken into consideration for study of this system. This result has area polygons plotted on the map representing the selected suitable sites for new Vehicle Tyre Shops Business establishment as this business type was considered for the study purpose. This system is able to provide results for any type of business to be focused on. The accuracy level of the result of this system is pretty good then the previously proposed similar systems. This system focuses on user requirement priorities combined with the basic traditional criterions considered for Business Site Selection. Combination of these two types of criterions helped us to build up such system with greater result accuracy.
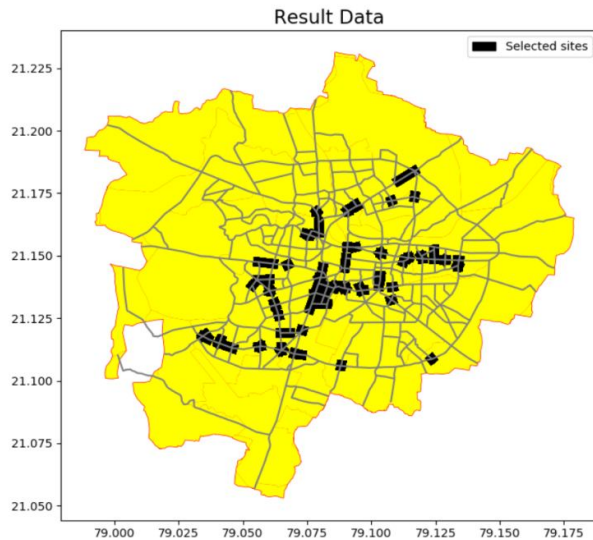

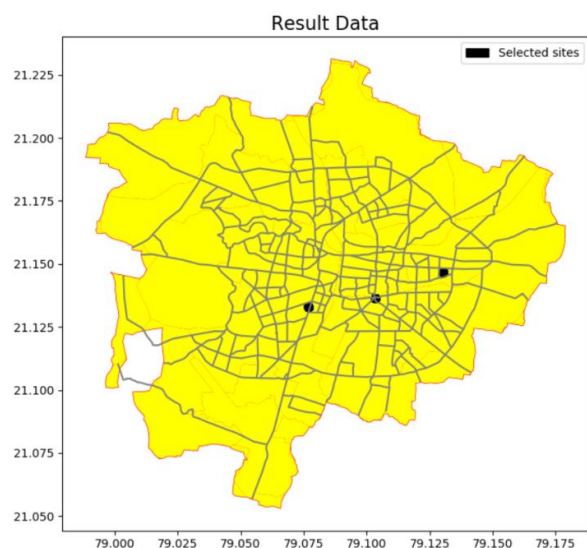**Figure 3:** Selected Sites Based on basic Criterions

Figure 4: Selected Sites after applying user's Criterions

5. CONCLUSION

This system helps to simplify one of the most strenuous process of Site Selection in establishment of a new Business. The appropriate site selected for a new business assure its development ang growth in the near future. The easier way to solve the problem with all the possible and required scenarios kept in mind can be achieved with this system. The system can be applied for any geographical region and any business type with user specific criterions using the data for that particular geographic location. This system can be easily modified according to business and user specific requirements. The modification of the system will have the minimal issues as it is created using the basic tools and their combinations used for vector data analysis in GIS.

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