UNIVERSITY OF MORATUWA

Faculty of Information Technology

IN 4720 Geographic Information Systems

FINAL REPORT

USING GIS FOR RECOMMENDING SUITABLE LOCATIONS FOR A SHOPPING MALL NETWORK FOCUSED ON MADE IN SRI LANKA PRODUCTS

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1.0 Introduction

Geographical Information Systems are used today at several planning applications and taking advantage of information technology for geographic data analysis. GIS system enables the handling of both spatial and non-spatial data in a more convenient way to derive important relationships between geodata. The proposed system is going to suggest some most preferred places to build a shopping mall network specifically for made in Sri Lanka products using spatial data.

A shopping mall is a collection of retail stores. It is usually the largest building complex in the region. The large shopping centers containing cinemas, entertainment areas, restaurant areas, and parking areas called malls combine many small shopping stores under one roof and include various activities. Shopping mall complexes are having various kinds of quality products that are sold by different multinational vendors. But the intension of proposed Shopping Mall center is to give the same shopping experience with only made in Sri Lanka products.

Sri Lankan products including Clothes, Jewelries, Tea, Spa and salon products, herbs, and all other kinds of products that made in Sri Lanka will be available in the Shopping Mall. Main intension of the concept is to open made in Sri Lanka products into a international shopping experience.

The business model canvas for proposed business has given below.

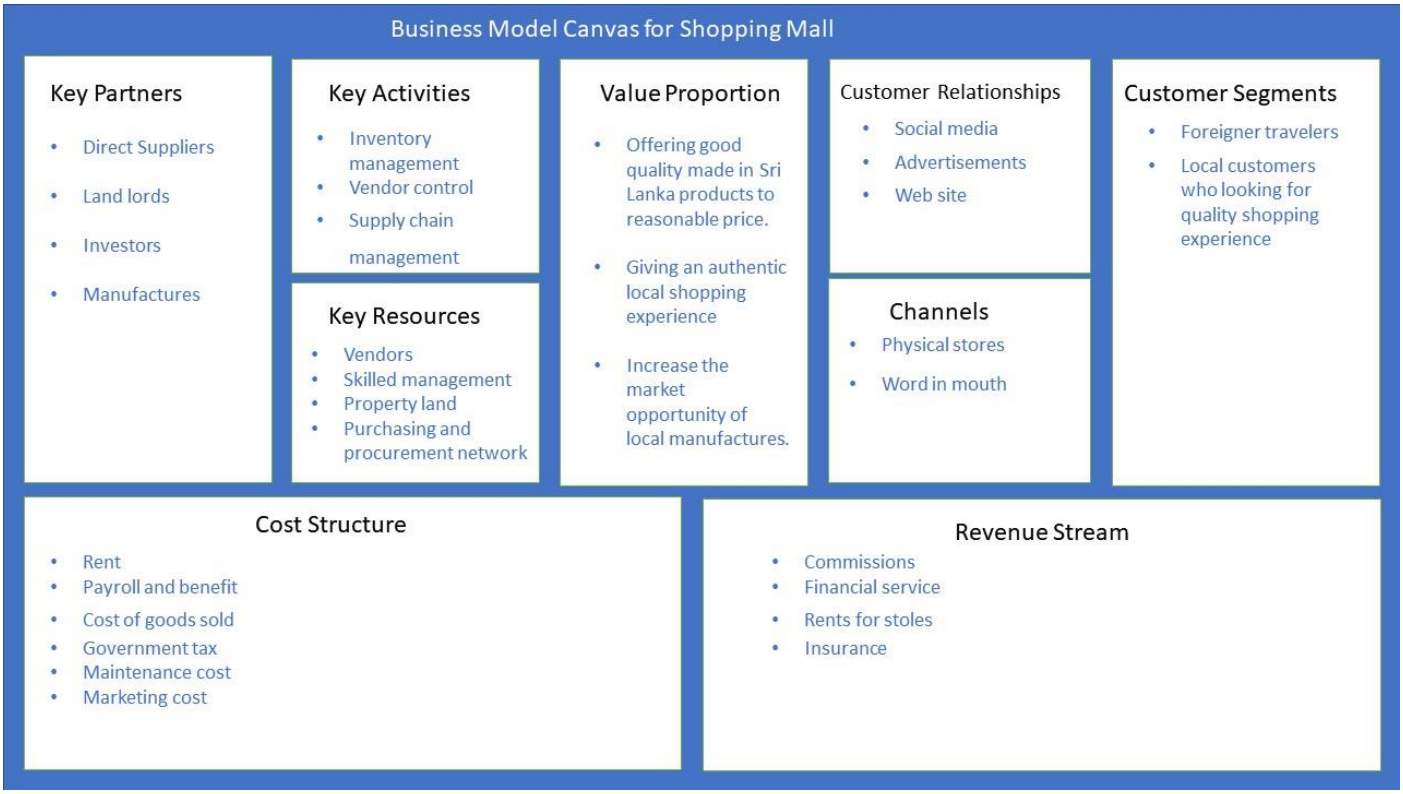

Figure 1 Business model canvas for shopping mall

2.0 Problem in Brief

For the purpose of building a shopping mall there are certain factors which need to be concerned. Most of the time, cinemas, parking areas, restaurant areas, entertaining areas are included in a shopping mall except shopping stalls. The biggest challenge is to find a suitable land for the purpose of building a large shopping mall of the aforesaid type. In order to make this a success, we have to find a free land which is near to roads. Moreover, the chosen land should exclude forests, streams while being far from existing shopping malls, near to higher population area and near to accommodation places. This is considered as a time-consuming activity. So, our project is based on finding the most suitable land areas for building a shopping mall for Made in Sri Lanka Products.

3.0 Methodology

2.1 Data Set Used

The following table indicates the used datasets, reasons, types of data and reference to the dataset.

Layer	Reason for data	Type	URL
District boundaries	To determine specific district boundary	Polygon	https://data.humdata.org/dataset/sri-lanka-administrative-levels-0-4-boundaries
Population	To select high-density area	Grid CVS	https://energydata.info/dataset/sri-lanka--population-density-2015/resource/89d1527d-9029-4771-8b45-4d84dadc9140 http://www.data.gov.lk/dataset/urban-population-2012
Existing shopping malls	To select new location far enough from the existing shopping malls	Points	https://data.humdata.org/dataset/hotosm_lka_points_of_interest
Roads	To be near the major roads	Lines	https://data.humdata.org/dataset/sri-lanka-roads
Land use	Avoid used lands	polygon	https://mapcruzin.com/free-sri-lanka-country-city-place-gis-shapefiles.htm
Buildings	Avoid current building locations	polygon	https://data.humdata.org/dataset/hotosm_lka_buildings
River and Streams	Avoid rivers and streams	lines	https://data.humdata.org/dataset/sri-lanka-water-bodies-0-0
Nature	Avoid forests and nature parks	polygon	https://mapcruzin.com/free-sri-lanka-country-city-place-gis-shapefiles.htm
Hotels and rest houses	To be near to hotels and rest houses	points	http://www.data.gov.lk/dataset/accommodation-information-tourists/resource/2a31b4c5-4625-48a5-a49d-d7a8fded05cf#{view-map:{latField:!Latitude}}

Table 1: Data sets to be used

2.2 Analysis Types

Spatial Analysis is the process of turning raw data into useful information. It is the core of GIS because it includes all of the manipulations, transformation and methods that can be applied to geographic data to add value to them, to support decision and to travel patterns and anomalies that are not immediately obvious.

There are different types of spatial analyses. Those are recognized as follows.

1. Transformation.
2. Queries and Reasoning.
3. Measurements.
4. Descriptive Summaries.
5. Optimization.
6. Hypothesis Testing.

1. Transformation

Transformation are simple methods of spatial analysis that change data sets by combining them or comparing them to obtain new data sets and eventually new insights. This analyses type is used simple geometric, arithmetic or logical rules and they consist operations that convert raster data to vector data or vector data to raster data likewise it can be do the both conventions.

2. Queries and Reasoning

Considering all the types of spatial analysis, Queries and Reasoning are the most basic of analysis operation in which the GIS is used to answer simple questions posed by the user. In here no changes occur in the database and no new data are produced.

3. Measurements

Measurements are simple numerical values that describe aspects of geographic data. It consists measurement of simple properties of objects, such as length, area, shape and the relationship between pairs of objects, such as distance or direction.

4. Descriptive Summaries

Descriptive summaries attempt to capture the essence of a data set in one or two numbers. They are spatial equivalent of the descriptive statistics commonly used in statistical analysis, consist the mean and the standard deviation.

5. Optimization

Considering the Optimization techniques are normative in nature, designed to select ideal locations for objects given certain well-defined criteria. These are widely used in market research, in the package delivery industry, and in a host of other applications.

6. Hypothesis Testing

Hypothesis testing focuses on the process of reasoning from the results of a limited sample to make generalization about an entire population. It allows us, for example, to determine whether a pattern of points could have arisen by chance based on the information from a sample. This is the basis of inferential statistic and forms the core of statistical analysis, but its use with spatial data can be problematic.

2.3 Proposed Solution

The applicability of each spatial analysis methods is described below.

2.3.1. Usage of Transformations

Transformations are simple methods of spatial analysis that change data sets by combining them or comparing them to obtain new data sets and eventually new insights. In our project, we are planning to calculate the population density. The above calculation is identified as a transformation with regard to spatial analysis. In terms of population density calculation, we are planning to classify each area. For the purpose of calculating the population density we are planning to take the total population of the area according to the current census data and divide it by the total physical area. While evaluating the distribution of the shopping malls, the distribution of the shopping complexes which depends on the population density is considered as the most important factor.

And also, in order to find a vacant land, we use transformation to combine all land data such as forests, farms, agricultural lands, buildings etc.

2.3.2. Usage of Queries and Reasoning

This can be considered as the most basic of analysis operations where no new data are produced. In our system the analysis of the total population will be done by using queries and reasoning. Identification of the relationship between population density and currently existing shopping malls is the main objective of analyzing the total population.

2.3.3. Usage of Measurements

In our project we are planning to analyze the distribution of shopping malls for measuring the distance between shopping malls. Moreover, distance from proposed lands to hotels and also the distance from proposed lands to main roads will be identified using the above spatial analysis technique which includes simple numerical values that describe the aspects of geographic data. We are planning to identify the distance between points by using the distance tools of the software.

2.3.4. Usage of Reclassification Method

Based on the population, existing shopping malls and distance of the road, we are planning to analyze our data set with the reclassification method. This will include a rating scale question type that will function by getting values into a ranking scale of 1 to 5, for each of the above aspects which consist of population, existing shopping malls and distance to the road. The rank 1 will be the lowest suitability while the rank 5 will be the highest suitability. The range of suitability values are as follows,

1 = Lowest suitability
2 = Very low suitability
3 = Moderate suitability
4 = High suitability
5 = Highest suitability

2.3.5. Usage of Optimization

The optimization techniques which are normative in nature and which are designed to select ideal locations for objects given certain well-defined criteria will be used in selecting ideal vacant land locations in our system.

4.0 Implementation

4.1 Finding districts with more hotels and rest houses

As the initial step in implementation, we selected districts which contain more than 74 hotels. For that purpose we used the vector analysis tools and queries. The resultant layer is shown below.

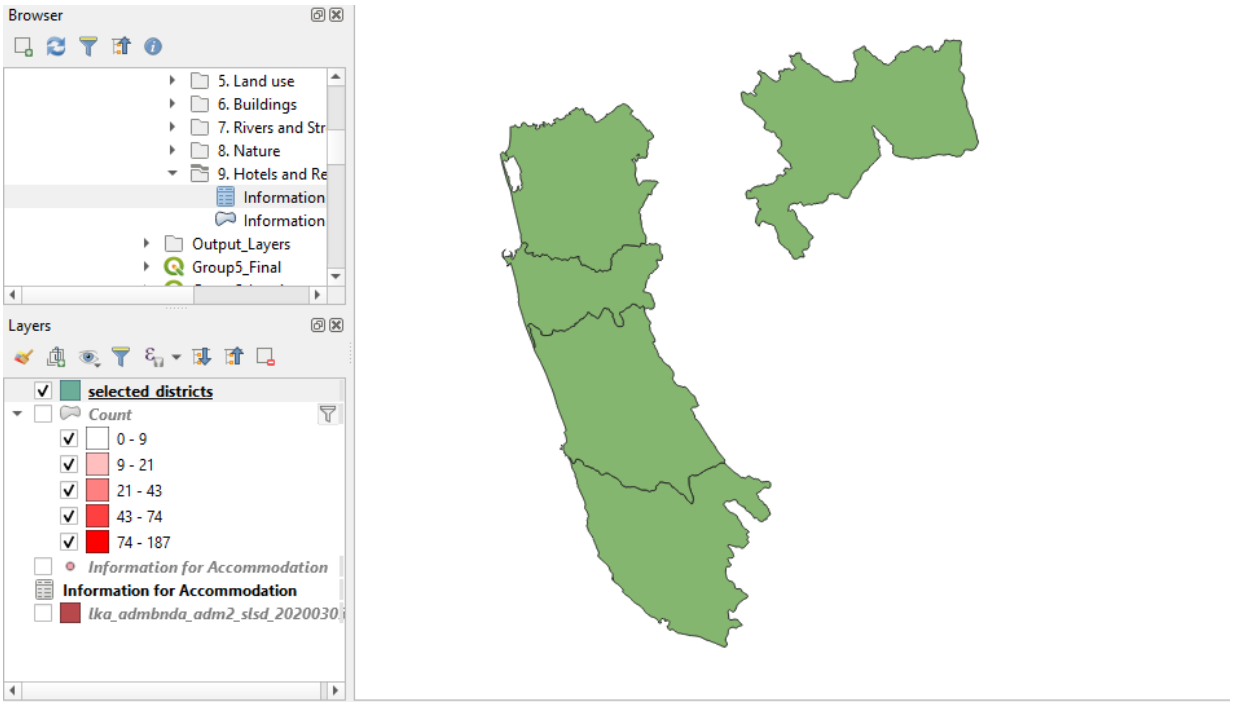

Figure 2 Finding districts with more hotels and rest houses.

4.2 Removing parts which contain forests, from the earlier selected areas

The land areas which do not contain forests were derived from the above selected districts, by utilizing the Difference operator in Geoprocessing Tools.

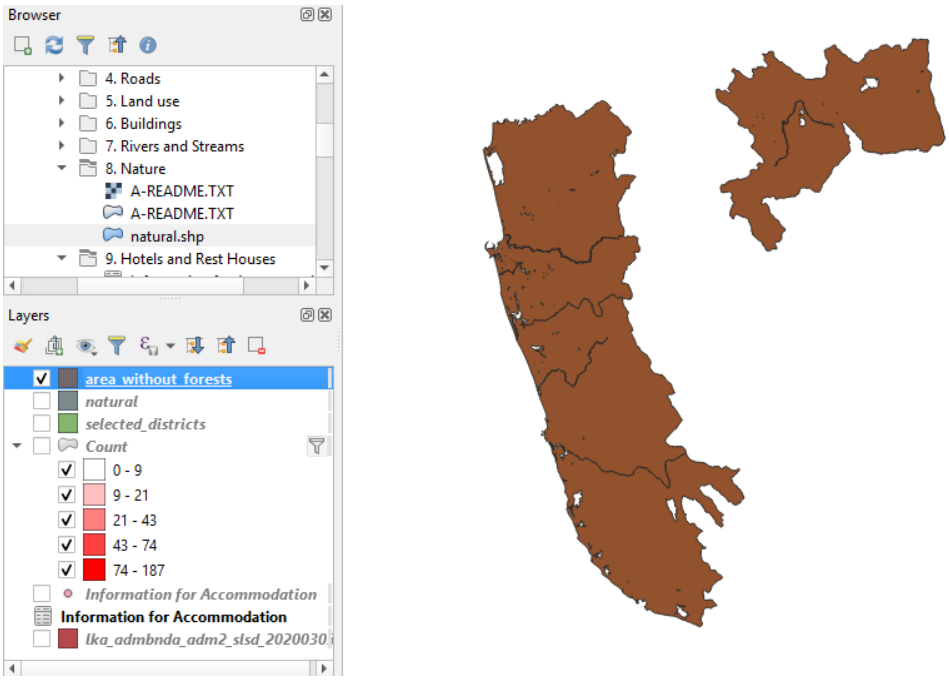

Figure 3 Removing parts which contain forests, from the earlier selected areas

4.3 Removing parts which contain buildings

The next step of our implementation was to remove land areas which contain buildings, from the land areas which were derived in step 4.2. For that purpose we used the Difference operator of the Vector Geoprocessing Tools. The resulting output layer is shown below,

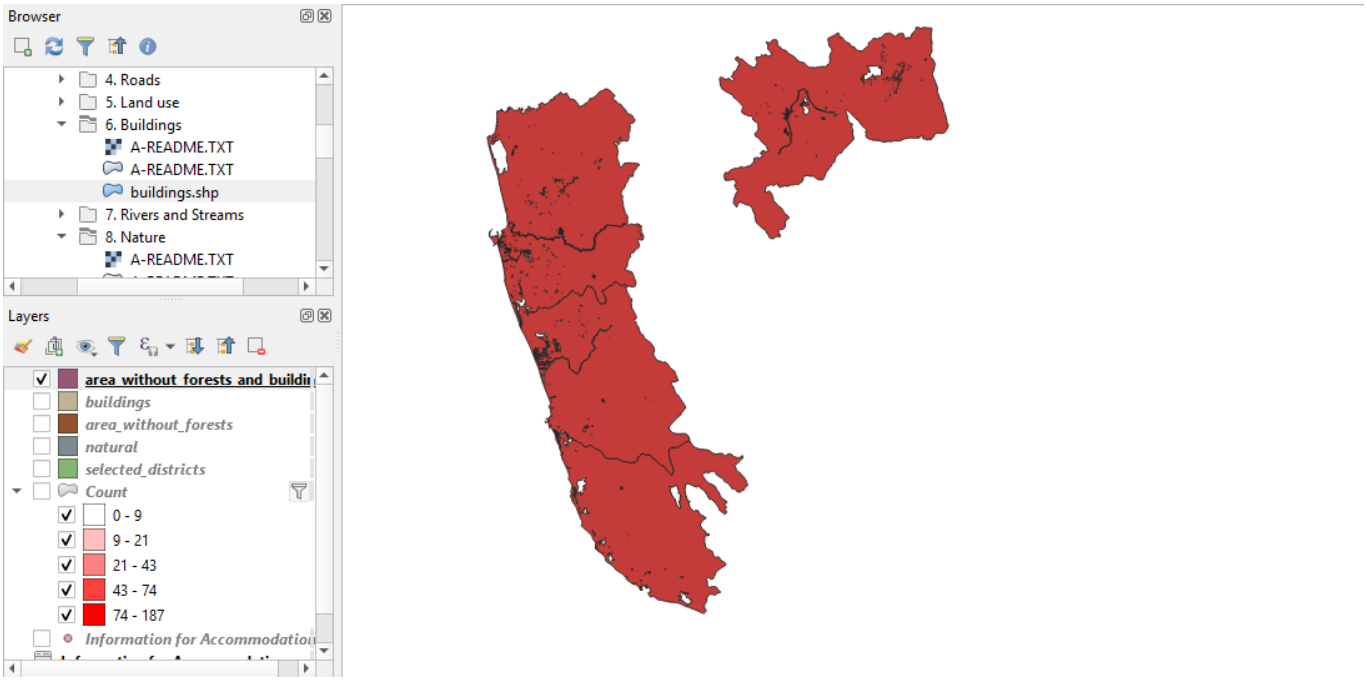

Figure 4 Removing parts which contain buildings

4.4 Removing already used lands

The next objective during the implementation of the project was to remove the already used lands,from the land areas which exclude forests and buildings. The resultant layer, after applying the Difference operator is as shown below.

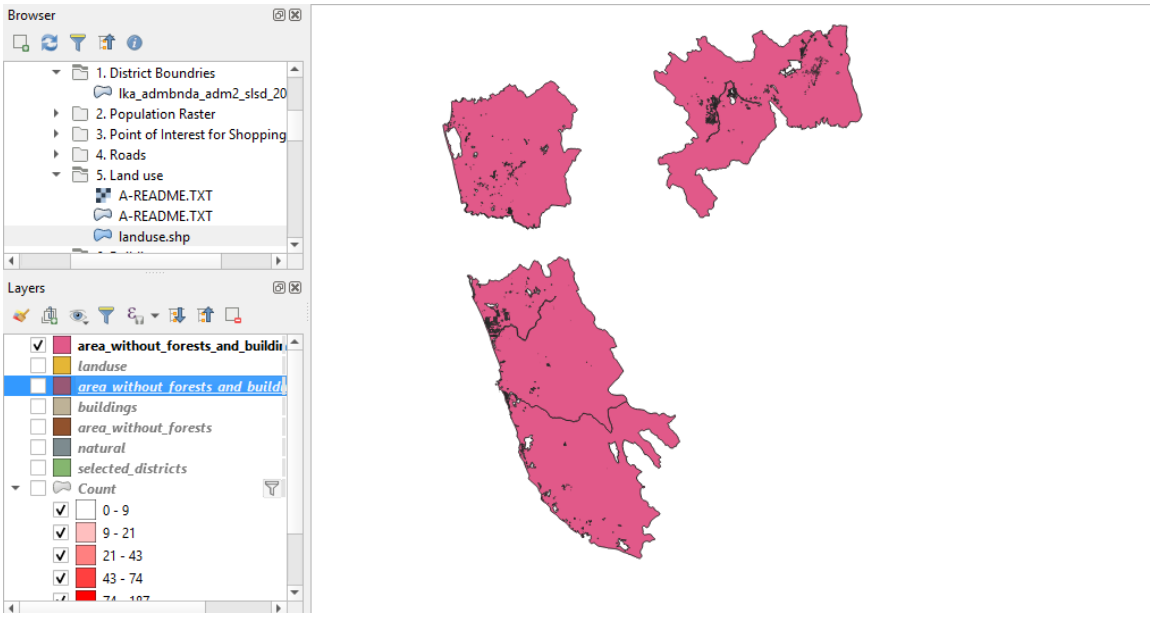

Figure 5 Removing already used lands

4.5 Selecting Places far from shopping malls

In the resultant layer, existing shopping malls in the selected areas were derived as shown below.

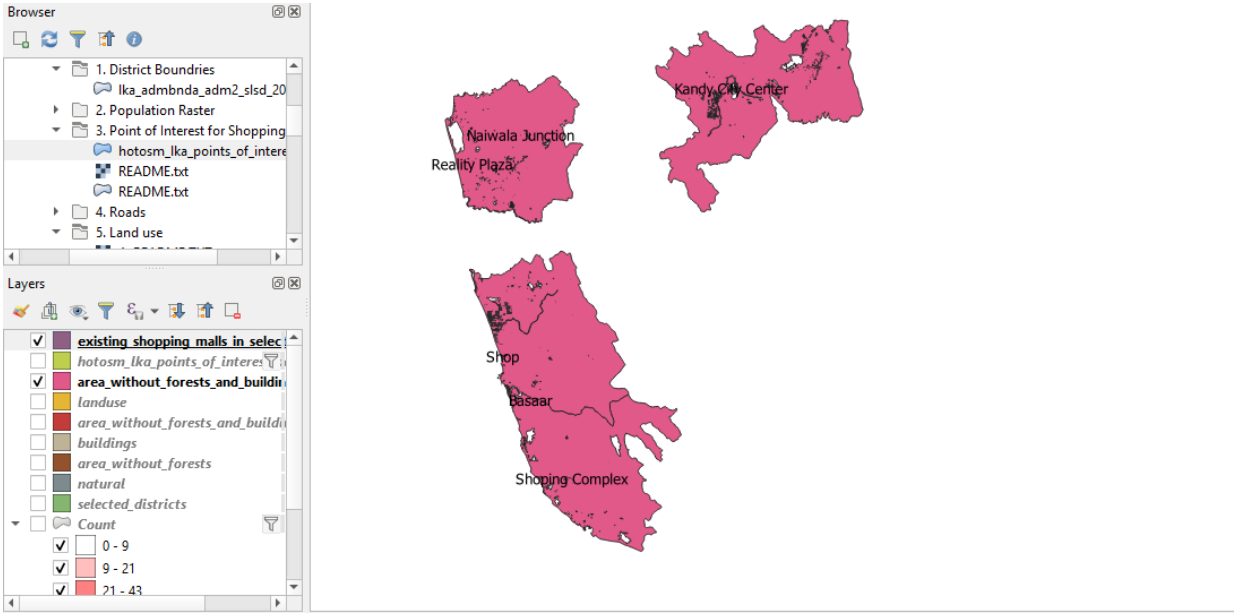

Figure 6 Selecting places far from shopping mall

4.6 Setting a buffer around shopping malls

As the next step in implementation, we added a buffer around the existing shopping malls, as shown in the layer below.

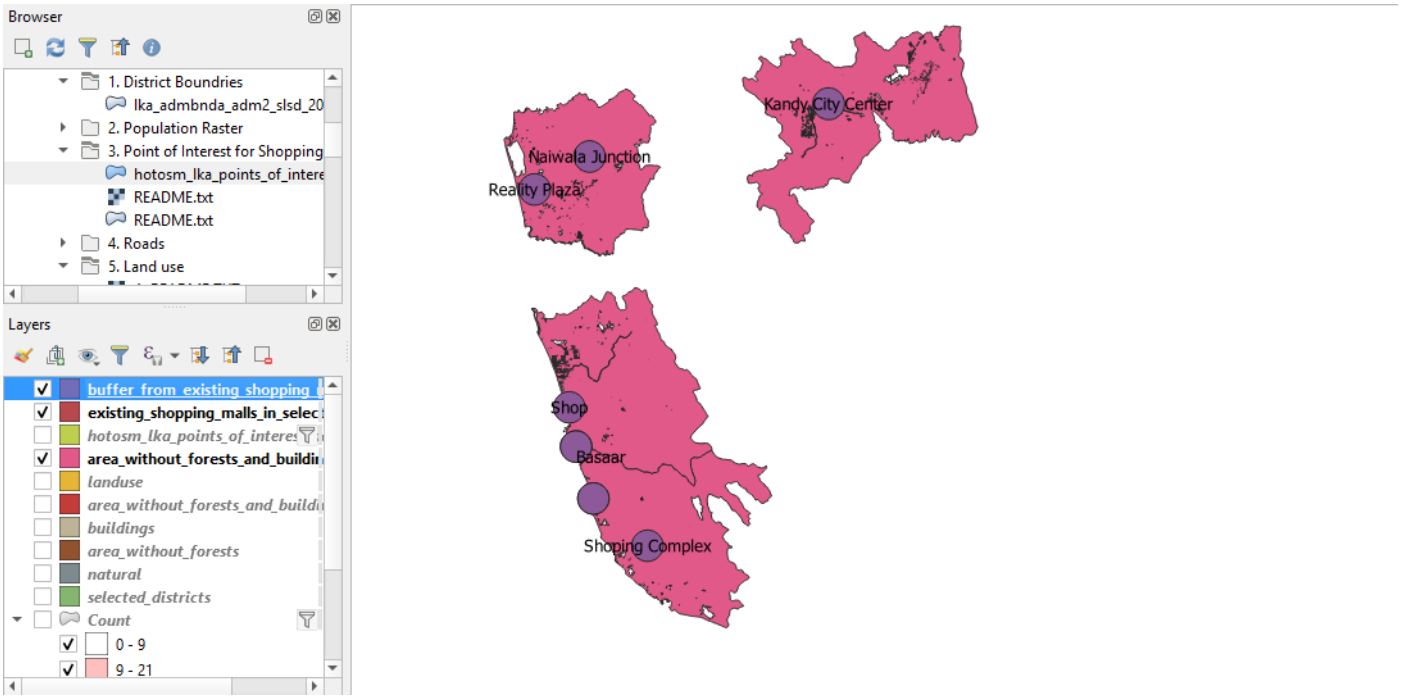

Figure 7 Setting a buffer around shopping malls

4.7 Removing the buffered areas

As the next most crucial step in implementation, we identified the areas which exclude the existing shopping malls in the selected lands. For that purpose, we removed the buffered areas by utilizing the Difference operator. The resulting output layer is shown below.

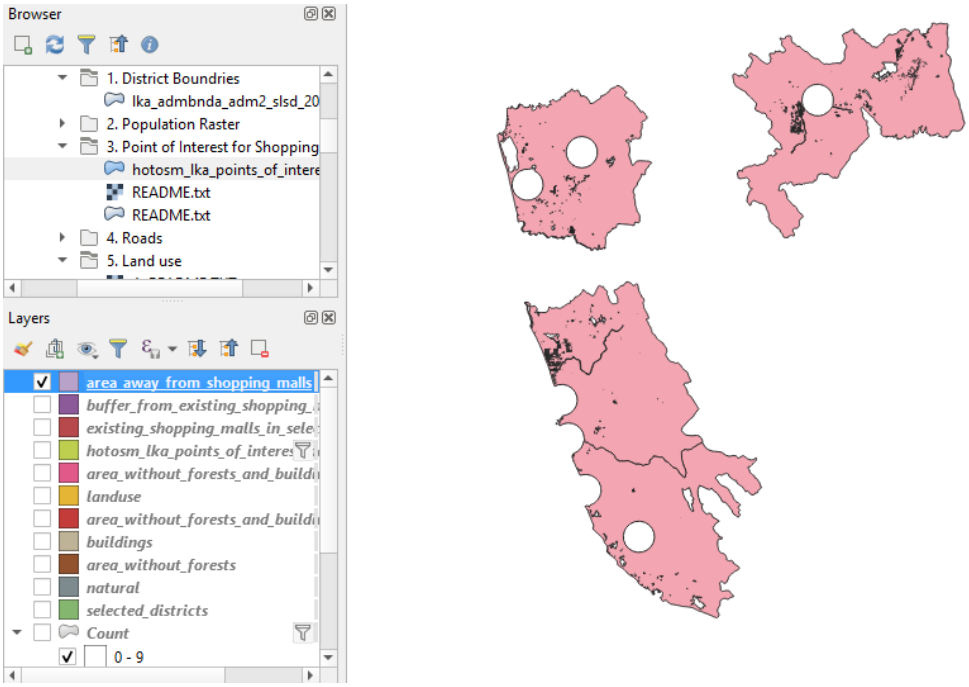

Figure 8 Removing the Buffered areas

4.8 Counting population for the purpose of finally determining the areas for malls

We get count of population of areas, that we already filtered out.

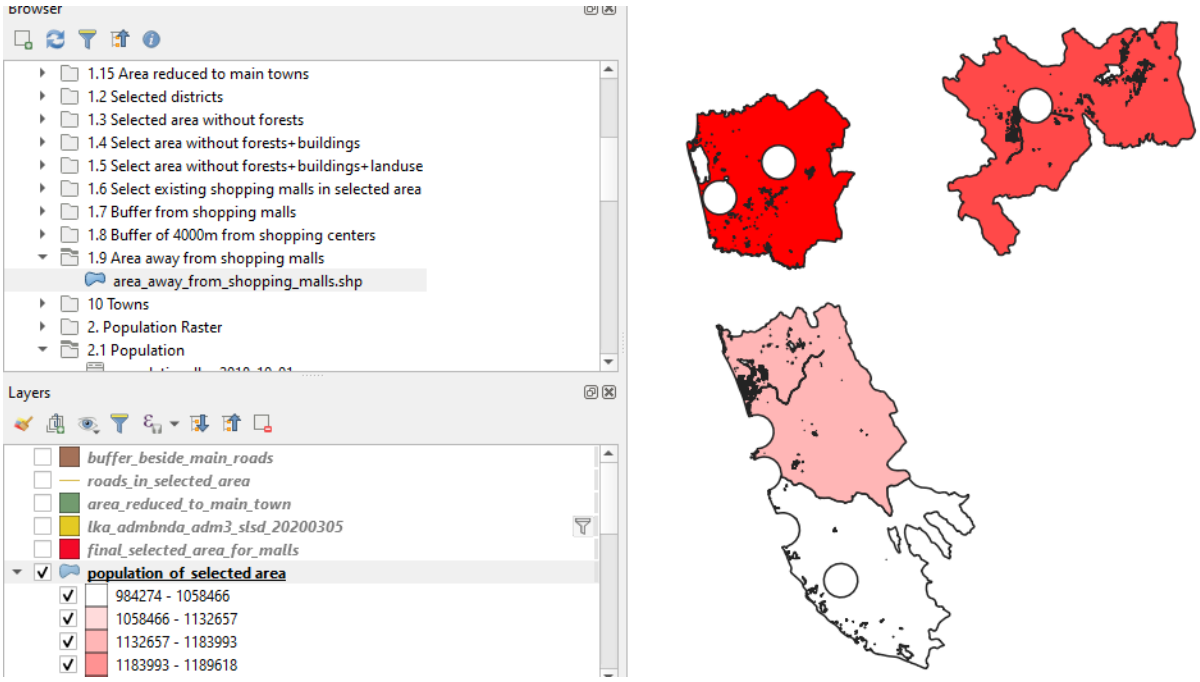

Figure 9 Population of selected area (classified according to population)

Based on the population count, we derived the highest populated districts, to locate malls. The resulting layer which contains the final selected areas for locating shopping malls is shown below.

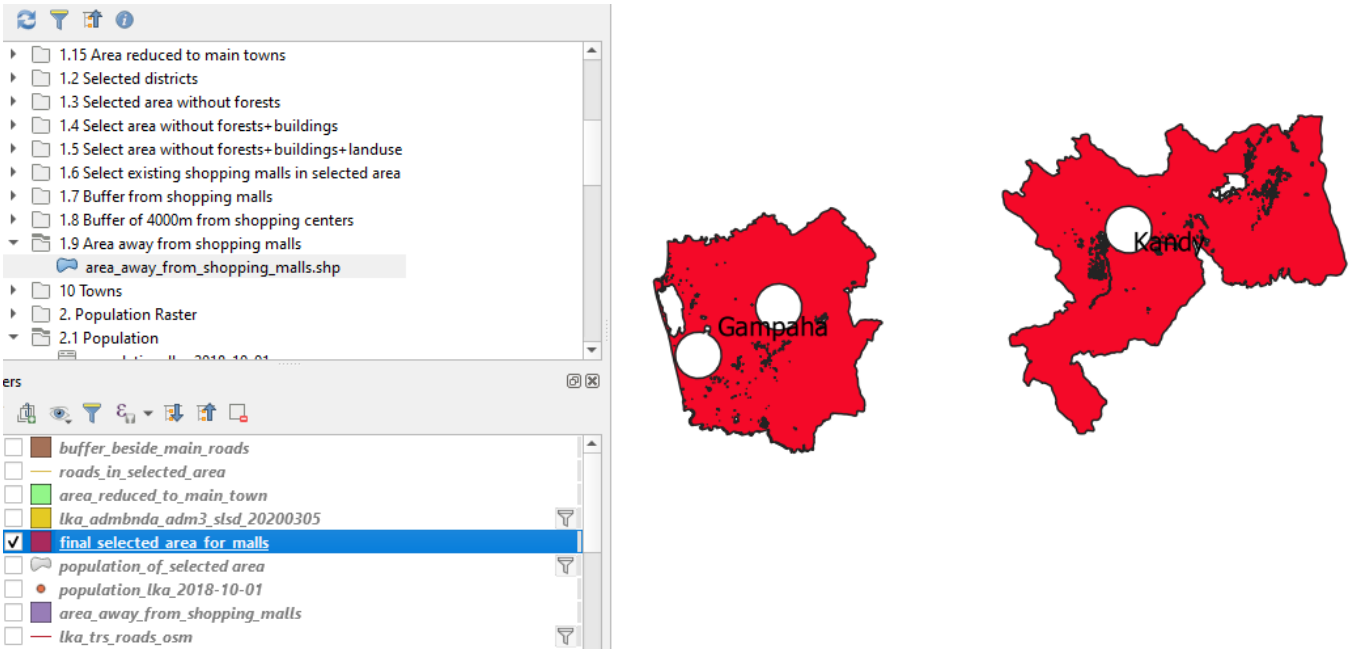

Figure 10 Selected area for shopping mall according to population

4.9 Reduce the area into a main city in the particular district

We use Gampaha city in Gampaha district and Kundasale city in Kandy district. They were selected because the are the main and crowded cities in particular districts.

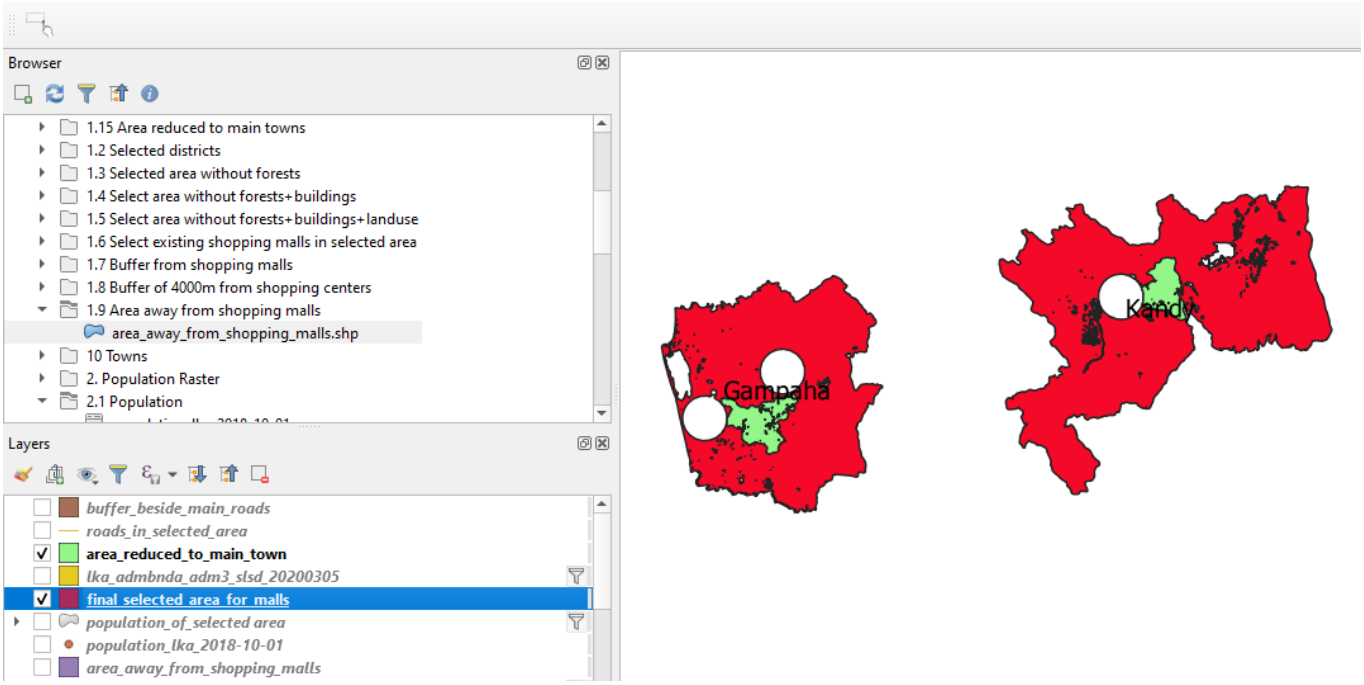

Figure 11 Selected cities

4.10 Roads in the selected area

Finally, the roads in the selected areas are being determined, and then a buffer alongside the road is applied. Thus, the shopping malls will be inside the buffer.

Figure 12 Roads in the selected area

A suitable location to establish a shopping mall can be selected from the suggested area, within the 50m buffer from road.

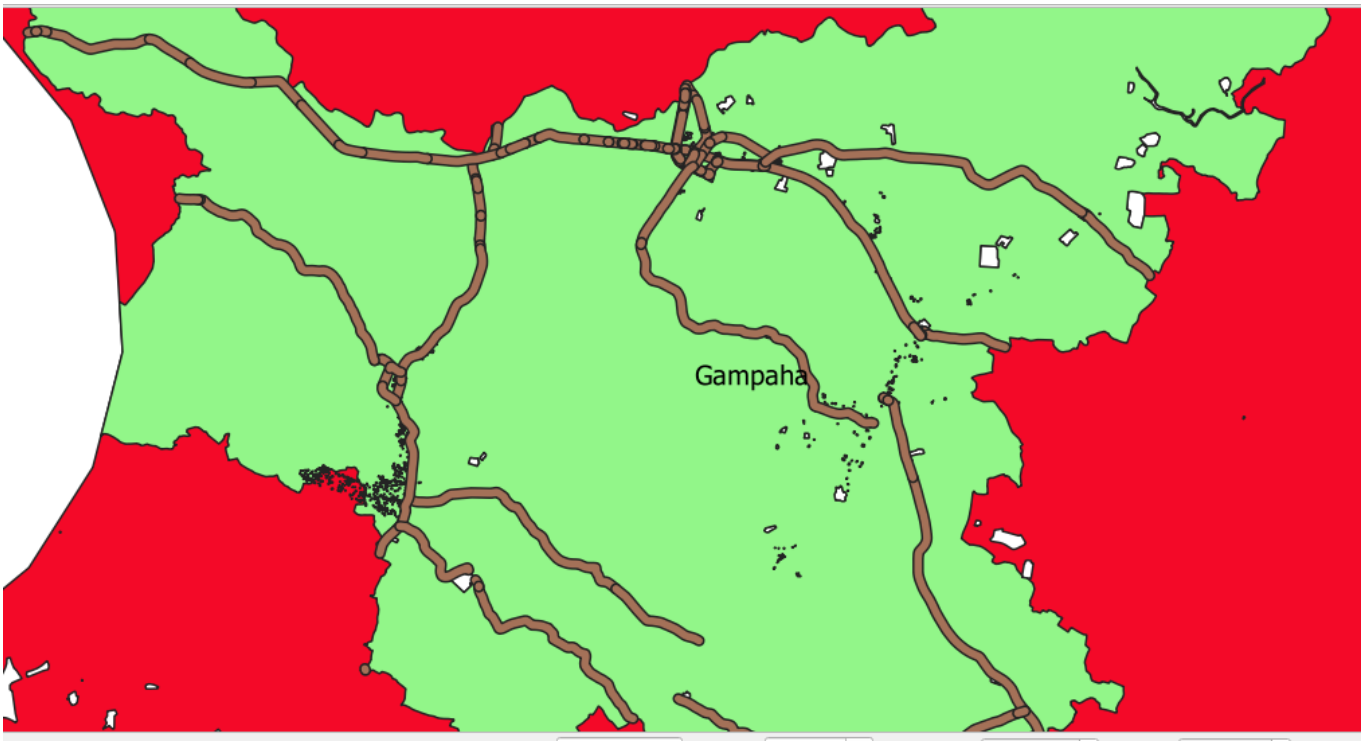

Figure 13 Enlarged area in Gampaha

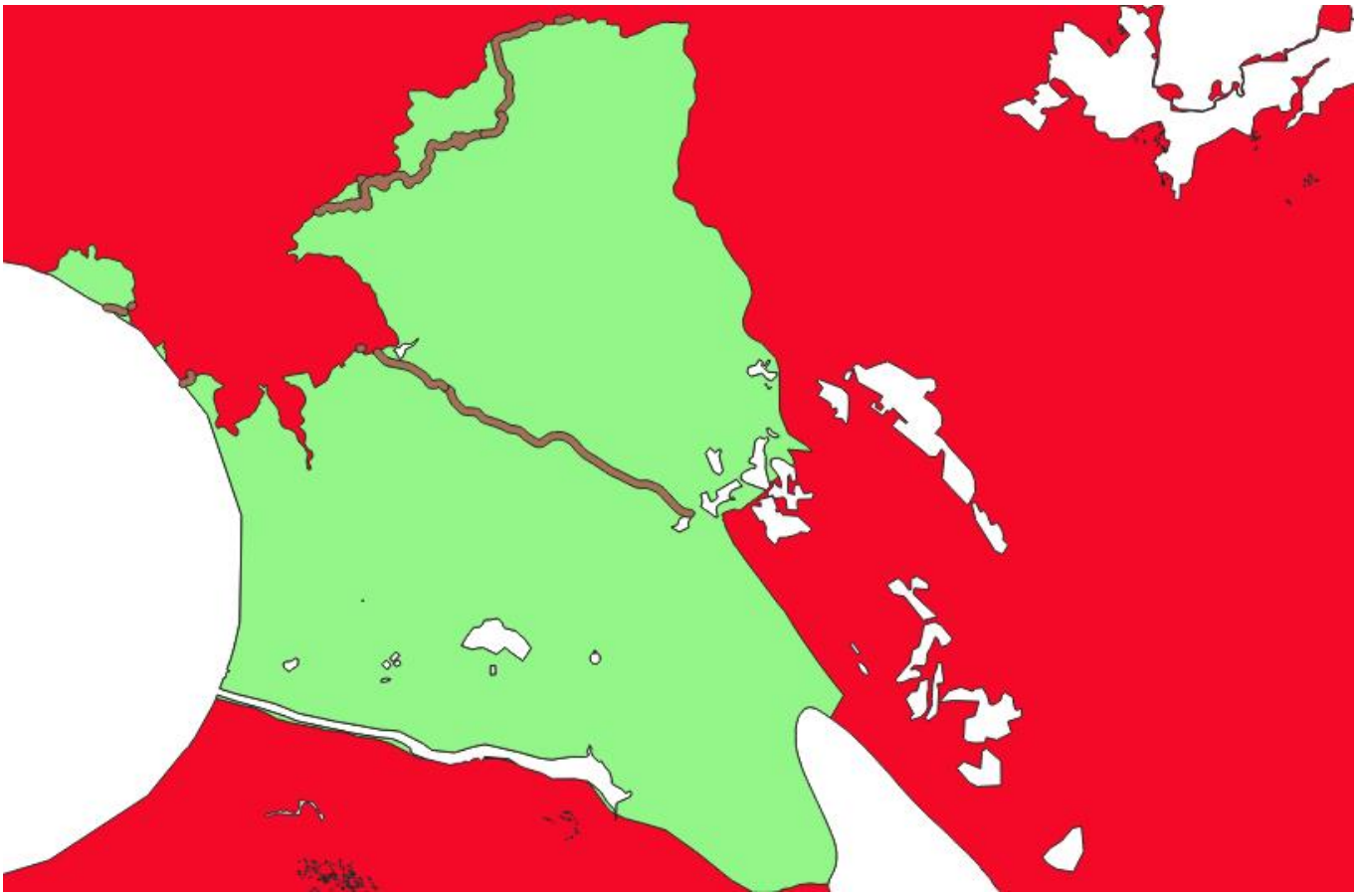

Figure 14 Enlarged area in Kundasale

5.0 Challenges faced and their solutions

After coming up an idea of the solution we proposed the first challenge that we have faced is find the relevant spatial data. We wanted to find a data set about free land. For doing that we couldn't find that data directly. So that, we supposed to get a free land by using building data, forests data, rivers and stream data. We supposed to get that land expect the areas of existing buildings, forests, stream and streams.

There is another challenge and it is about some feature of the data sets are displayed as invalid. It is happened when dealing with the building data set and the land use data set. In that case, we have to ignore that features in the above-mentioned data sets by using the "invalid feature filtering" option. After that continue the implementations without that error.

There are some issues are raised with some data sets. CRS of some data sets are displayed as invalid or unknown. This is happened with the first finding population data set. Due to that we have to find new data sets for the populations in Sri Lanka to avoid that error and to continue the implementation.

Another challenge is that sharing our individual implementation parts and build the final outcome. We decided the project path and divided the implantation to a small part. Everyone is assigned their parts and after their implementation they should update google doc to share among group members. Then other have to follow it and implement their parts. After that implementation was completed.

6.0 Reference

McKie, D., n.d. Buffering in QGIS Desktop. In: *The Data Journalist.* s.l.:s.n., p. 155.

Mohamed Y. Mohamad, F. A. K. A. S., 2015. A GIS Application for Location Selection and Customers' Preferences for Shopping Malls in Al Ain City; UAE. *American Journal of Geographic Information System ,* pp. 76-86.