

An Analysis of Suitable Location for Establishing Telecommunication Tower at General Sir John Kotelawala Defence University, Southern Campus

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Abstract— Wireless telecommunication is broadly utilized around the world and Sri Lanka, particularly due to increased use of mobile users, and the conversion of mobile phone into a primary essentiality of a person. High population density of the urban or suburban areas requires the establishment of telecommunication towers because the service providers consider low manufacturing cost and give maximum benefit. The telecommunication tower is the key device for supplying mobile users with a telecommunication network. The requirements of telecommunications towers are growing parallel to the growth of mobile users every year. This project aims to explore the coverage of the existing towers and to propose a new suitable location to establish a telecommunication tower that supplies the best coverage and capacity by optimizing the resources and cost-effectiveness. The study investigated Sooriyawewa area distressed with insufficient coverage from the existing towers for daily necessity, which causes the necessity to establish a new telecommunication tower. Data were collected from open-source platforms and the Survey Department of Sri Lanka, processed with ArcMap 10.5 licensed software. Population, Existing tower locations, Roads, Land use, Reservations, Elevation, Schools, and waterbodies were used as the data layers, and data was analysed using both vector-based and raster-based approaches in Geographical Information Science (GIS) environment. Conclusively, factor maps were prepared and the optimal locations were identified for establishing telecommunication towers, and validated with the existing locations.

Keywords: *coverage, telecommunication towers, service providers, Geographical Information Science (GIS)*

I. INTRODUCTION

The current situation in Sri Lanka highlights the rapid increment of telecommunication systems in the past decade. During the covid-19 pandemic period, the world changed their living patterns as new normal with referring technologies. Mobile phones have become the primary need of a person (Mauludiyanto, Prakoso, and Faricha, 2018). Students learn with e-learning methods, workers do their jobs online, etc. So, telecommunication fulfills huge service for developing the existence. According to the statistical overview 2020, Mobile Broadband Subscriptions (for 3G, 4G) is 11,484,649, and the Number of Cellular Mobile Telephone Subscriptions is 27,678,977 (Communications and Providers, 2020). The telecommunication tower is the key device for supplying mobile users with a telecommunication network. The requirements of telecommunications towers are also growing with the growth of mobile users every year.

The telecommunication service providers are highly concerned about the cost of the tower establishment and the population density of the required area. And, they consider accessibility for the towers, elevation, and weather conditions of the area. SLT (Sri Lanka Telecom), Mobitel, Dialog Axiata, Hutchison Lanka, Etisalat Sri Lanka, Bharti Airtel Lanka, Lanka Bell, Suntel are the service providing companies in Sri Lanka ('Sri Lanka - Telecoms, Mobile and Broadband - Statistics and Analyses', 2017). In the urban

areas, they use high-rise buildings for implementing telecommunication towers because it is a low-cost method.

Establish and maintain the telecommunication network is not an easy task and selecting a suitable location for establishing a telecommunication tower is a challenge. Because needs to cover the most demanded areas including the highest signal quality with low cost. Cost, technology, rules and regulations, spatial data are the considering factors for selecting a site (Janah A, Asassfeh, 2017). If unable to decide the suitable site, it may affect financial and economic problems, environmental damages, health issues, and customer satisfaction.

The purpose of this project is to evaluate the optimal site for establishing a telecommunication tower, near the Sooriyawewa area and validate the existing tower locations of the study area. Normally, the maximum high-quality coverage from a tower is 10km and there is no existing tower location in that range from the southern campus. So, that was the problem for our case study, and a 25km radius area from the southern campus was selected as our study area. The study area is covered with portions of Southern, Uva, and Sabaragamuwa provinces. There are special features in this area for the analysis. First, this area is flat, not consistent with higher geological barriers for disturbing the analysis, this is a dry zone (Senanayake, 2015) and not affected by environmental hazards such as floods, landslides. Second, normally the area is called a rural area, but nowadays it is changing.

Geographical Information Science (GIS) is used for examining the data and it is an efficient software that can do several analyses. It efficiently stores, retrieves, analyses, and displays information according to our purpose. The software can manage a large amount of spatial data from various sources and its saves time.

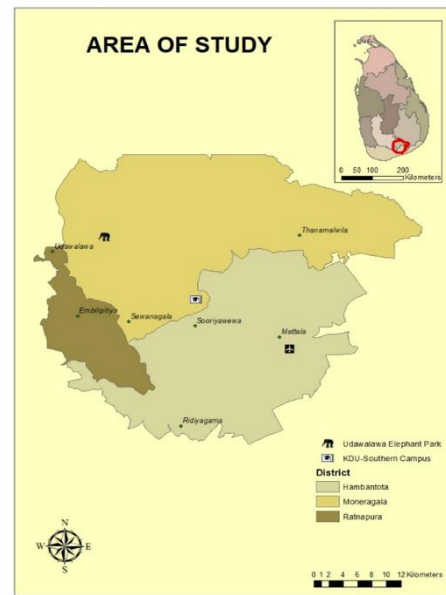


Figure 1: The Study Area

A. *Significance of the Research*

Lack of signal coverage and poor signal strength is caused to face a lot of difficulties for mobile users/ internet users who live around the Sooriyawewa area.

Sir John Kotelawala Defence University, Southern Campus is situated in Sooriyawewa, Sri Lanka, and the lecturers, Undergraduate students, and the other parties face some issues for their academic studies caused by the signal problems. This was the main problem what we observed. Due to the covid-19 pandemic period, lectures and school lessons are conducting through online education systems. So, the schools and the students around this area face the same problem, unfortunately. There are lots of important places around this area like Mattala airport, Mahinda Rajapaksa international cricket stadium, Sevanagala sugar factory, schools, public library, and hospitals. And there are some tourist attraction locations like Madunagala hot water springs, Ridiyagama safari park. Normally, the population density of an area is caused for establishing telecommunication towers. Service providers highly concern highest population density and the huge network users for implementing telecommunication towers. Furthermore, we are unable to consider Sooriyawewa as a rural area due to people

frequent in this area daily and need a strong network connection for their issues. The project aims to select suitable locations for establishing telecommunication towers and provide proper mobile signal coverage for the users. In this case, 5km range is applied for existing towers, because towers have 5km range good broadcasting facility.

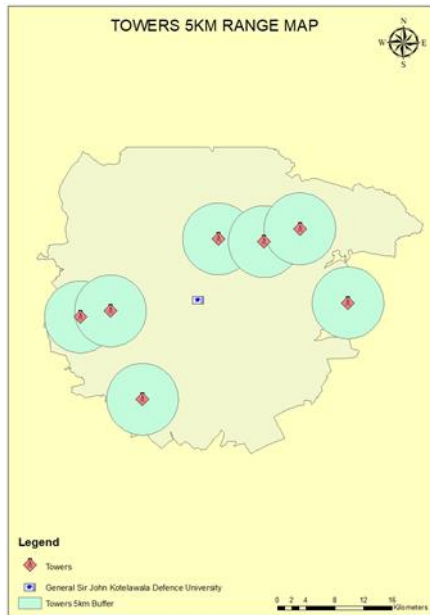


Figure 2: Existing Towers in 5km radius in study area

B. Research Objectives

To propose a suitable location for establishing a telecommunication tower with strong network coverage for General sir john Kotelawala defence university.

To examine the suitability of the existing telecommunication towers, in the study area

To evaluate the suitability of each land parcel for establishing telecommunication towers

II. METHODOLOGY

First, it was required to orient the data layers we are going to use for this research. However, for this research, we had to use buildings, hydrological features, land use, reservation areas, roads, GND map, existing tower locations, Digital Elevation Model (DEM), and finally the exact location of Kotelawala Defence University (Southern Campus). Initially, forming a 50m

buffer for every building was important. Then we have erased the building buffer, hydrological features, and reservation areas from the area of concern layer and made a separate map for each layer. The next step was to extract suitable land area from the land use map. Also, a 500m buffer was created for the roads which consist of primary, secondary, and tertiary roads within the area. After obtaining the above-mentioned outputs, it was important to convert the vector data into raster data to conduct a weighted sum analysis.

Since we have obtained a result for the weighted sum, it was important to consider the 5km buffer from university premises. Thereafter, considering the ground elevation of this area to establish the telecommunication tower. Therefore, we had to obtain a result with the DEM values and the previous results obtained from weighted sum analysis.

Table 1: Efficient criteria and considering factors

Criteria	References
Transportation	(McGregor, 2016)
Population	(Tayal, Garg and Vijay, 2017)
Waterbodies	(Tayal, Garg and Vijay, 2017)
Land Use	(Tayal, Garg and Vijay, 2017)
Reservation	(Tayal, Garg and Vijay, 2017)
Elevation	(Tayal, Garg and Vijay, 2017)
Schools	(Katiyar, 2015)
Existing tower locations	(Sangeetha M, B. M. Purushothaman, 2014)

Getting reliable and timely information is one of the main criteria for rural development. Information on geospatial forms that allow different maps, GIS data and applications to be generated and used and details about Rural area that characterize the social and economic background, the physical environment and rural services and facilities are vital to rural area planning and development. The researcher (Singh, Bhatt, and Maheshwari, 2015) used Geographical information science to do the research and concerned about some factors.

- Availability of barren lands - telecommunication tower requires a certain area for the establishment
- Cost of construction - service providers highly concern about the expenses. Construction expenses, maintenance expenses, labour fees are the most common costs.
- Accessibility - the tower near to the roads is very important because of easiness of the repairs.
- Topography - before the establishment, one must concern about the topography whether it is suitable or not for the construction.

ArcGIS software has been used for this research work and the processing part. Used the DEM to obtain the elevation of the area and used digitizing and geo-referencing google earth data to obtain the data and convert it as shapefiles.

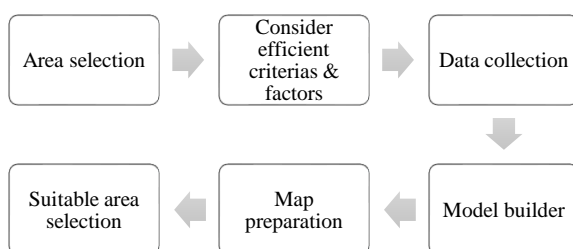


Figure 3: Methodology adopted over the Study

After getting all things done and bringing into the GIS platform, then data was analysed using weighted overlay analysis and the map of suitable locations were generated for tower establishment.

III. RESULTS AND DISCUSSION

Mainly open-source data that available freely used for the analysis integrate with the data provided by the survey department of Sri Lanka.

To collect the presently available towers and the range of them used google earth platform as a data collection source. Then by digitizing relevant tower locations data were obtained. There were several towers located throughout the area of study. However, there were not any telecommunication towers located within the 5km range to receive strong signal coverage. But for the reliability of our project, we had considered the towers situated nearby.

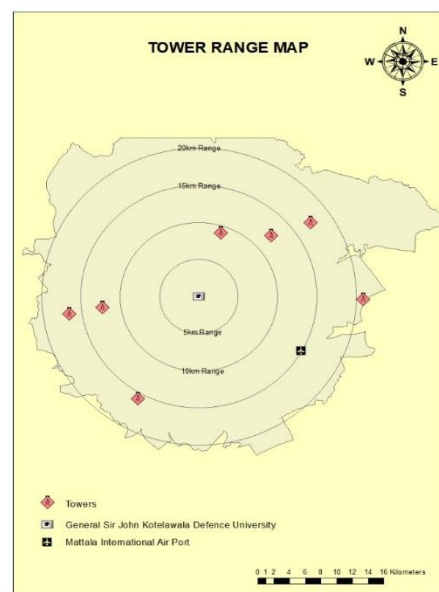


Figure 4: Existing Tower Range Map around Study Area

The Digital Elevation Model was a key factor when considering the elevation of the ground of the area concerned. We have used the Shuttle Radar Topography Mission (SRTM) DEM open-source data for the analysis as the elevation source of the study.

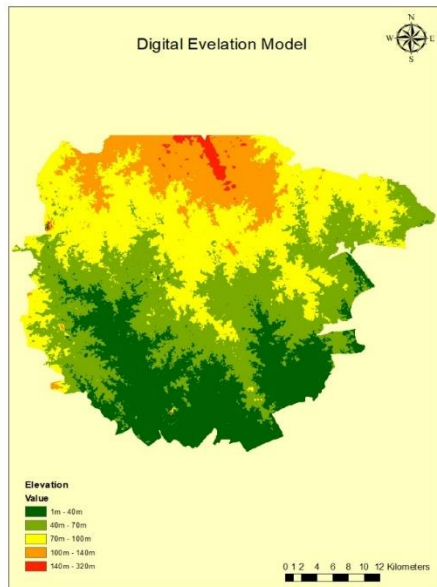


Figure 5: DEM of the study Area

The study area consisting of 104 GN divisions when considering an area of a 15 km circular path away from the General Sir John Kotelawala Defence University (Southern Campus). However, we had to consider the population increasing of every GN division as the mobile network providers are highly considering this factor when establishing a new telecommunication tower. We have found the census data related to these areas and found that the population has increased in every GN division over the years.



Figure 6: GN divisions over the Study Area

Then consider the water feature situated within the area. Since the telecommunication towers are built avoiding these areas as it is hard to reach the places and maintenance is highly costly.

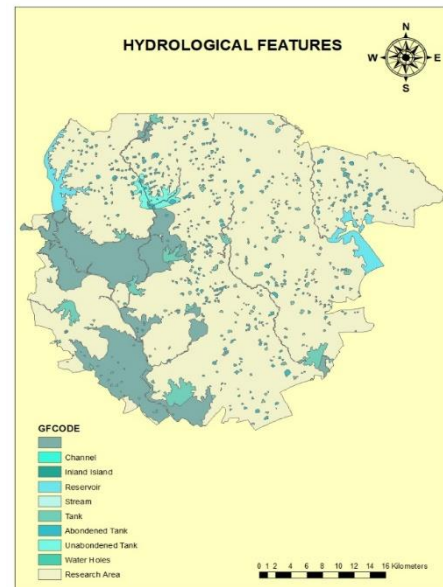


Figure 7: Hydrological Features associated in the Study Area

The study area consisting of different types of land use and while conducting our project, we had to eliminate several lands uses features to obtain better output. So, we had to restrict only to coconut cultivated area, chena, grassland, home garden, scrublands.

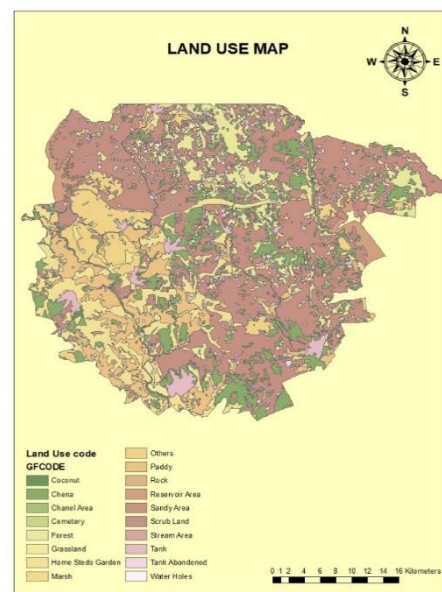


Figure 8: Land use Landcover types associated in the Study Area

The project area has mainly consisted of forest reserves. Therefore, as we were highly considered on environmentally friendly construction, we had to refrain from using forest reserved lands.

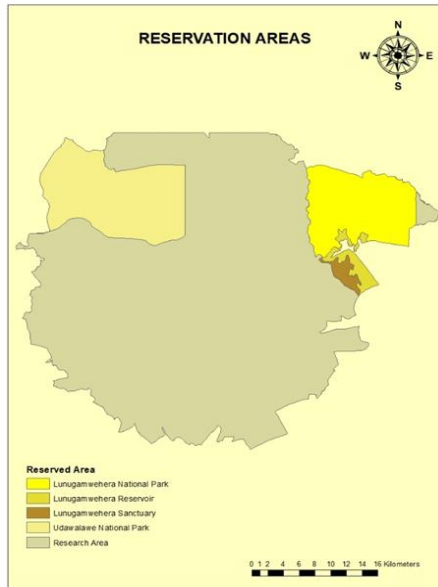


Figure 9: Conservation areas of the Study Area

Due to the pandemic situation arrived in the country, the education sector of the country has been shifting to a different level. Therefore, it is really important to have a better mobile 4G connection around the school premises. Since this quite deviates from the urban area, we have



Figure 10: The available Schools at the Study Area

assumed that the students reside nearby the school and conducted the research.

The area of study has mainly consisted of a 20 km buffer zone around the headquarters building of General Sir John Kotelawala Defence University, Southern Campus. By using the weighted overlay analysis in the ArcGIS environment obtained a suitable location for establishing a telecommunication tower in the study area.

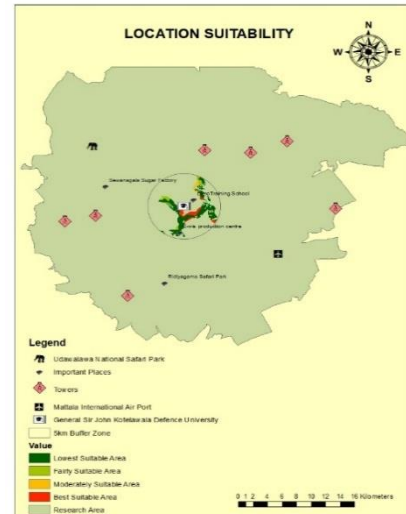


Figure11: The Location Suitability Map

After the analysis done with the respected data layers, it had given the idea that six out of seven of the previously located telecommunication towers were within the suitable locations. Therefore, it was an as important factor to prove that the procedure we had followed when conducting this research was reliable.

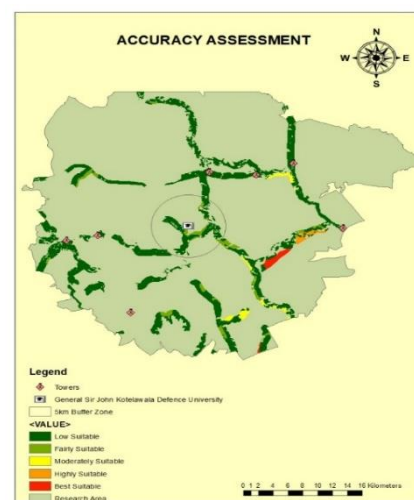


Figure 12: Check the accuracy of the resulted suitable location with the available tower locations around the Study Area

Further, it was crucial to consider the elevation factor when finding the best suitable location to establish the telecommunication tower. Therefore, it was obtained four areas with different suitability to establish the new tower.

IV. CONCLUSION AND RECOMMENDATIONS

This project includes how to select a suitable area for establishing a telecommunication tower around General Sir John Kotelawala Defence University, Southern Campus by using different criteria. The ArcGIS software is very useful for conducting this study. ArcGIS software is very convenient for students to use for their project works.

These areas generally satisfy the minimum requirements for site selection. If select the suitable areas for establishing a telecommunication tower, it will enhance and make easier the studies of the students who are engaged in their higher educations and also it will develop the study facilities of the schooling aged people who were disturbed due to COVID-19 pandemic. In this base of analysis, the suitable area was selected by giving a priority to the university students. But the best opportunity could be obtained up to 5km from the campus premises and others can also obtain the opportunity, but the quality may be varied with time and the number of users. Our idea was to establish a tower within the area owned by the University but, it was obtained outside of the university premises. But this analysis considers eight characteristics for selecting a suitable location for a telecommunication tower.

The progress of the development control needs to be monitored and evaluated annually and to take remedial actions to rectify incompatible development activities. For monitoring the application of the regulation within the zones need to analyse properly by the GIS tool. GIS is very helpful for analysing and make predictions. Zoning and their regulations and promoting or discouraging the activities need to do then and there with the evaluation of GIS.

In this study, there are some limitations. First thing, there is not highly different variants of

height and there are not high-rise buildings. Therefore, not much consider about the elevation.

ABBREVIATIONS AND SPECIFIC SYMBOLS

GIS - Geographical Information Science

SLT - Sri Lanka Telecom

QC - Quality Control

QA - Quality Assurance

BTS - Base Transceiver Station

NDVI - Normalized Differential Vegetation Indices

3D - Three Dimension

RS - Remote Sensing

GPS - Global Positioning System

DEM - Digital Elevation Model

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