Evaluating the Differential Accessibility Levels of Existing Public Transport Before and After an Aerial Ropeway Transit Service

A Case Study of Varanasi

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Introduction to Aerial Ropeway Transit (ART)

Aerial Ropeway transit (ARTs) are considered to be emerging alternatives for augmenting transit systems in congested cities in the Global South, especially in zones with limitations on service coverage due to road width constraints or topography.

Benefits of Urban Ropeways

- Envisaged as a tourist attraction in cities,
- Considered as an environmentally friendly method of commuting and city-wide transit system redesign
- Helps to traverse challenging topography such as steep hills and rivers
- Reduce spatial inequity in transit coverage among marginalized communities
- Improve tourist revenue by providing a vantage point for the travellers to obtain a bird's eye view of the city
- Reduce crime rates in geographically excluded neighbourhoods
- Reduce traffic congestion in cities since it does not share right-of-way with vehicles in road network
- Cost of construction is 1/3rd of that of a Metro Rail Project
- The infrastructure is easy to set up and takes up lesser geographical space on the ground.

A news website poster stating the new development in Varanasi

Research Background

Aim of Research

To address the issue of differential accessibility levels of public transport (across different parts of the city) and such as aerial transit termed as Aerial Ropeway Transit (ART) by creating different sets of future scenarios for transit markets and examining how shifts in subjective expectations, demographics, levels of service, and mobility service proliferation might affect demand for transit

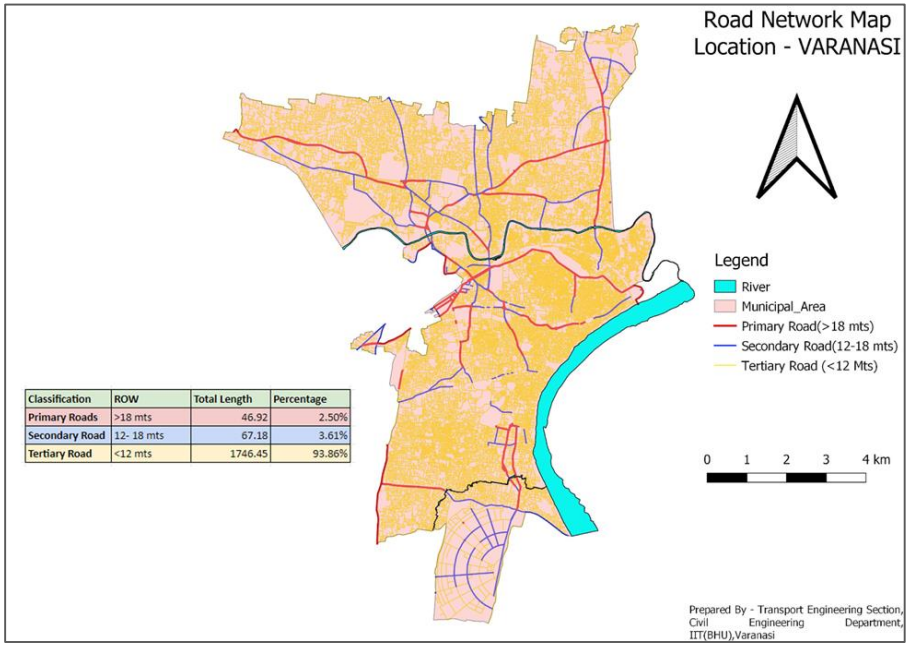
Research Motivation and Literature

In the Literature referred for the research, very little is available on the transition of a traditional ground-based transit network to a ropeway-enabled system and what would be the quantifiable impacts on overall transit accessibility.

Addressing the long term goals of the City(Varanasi)

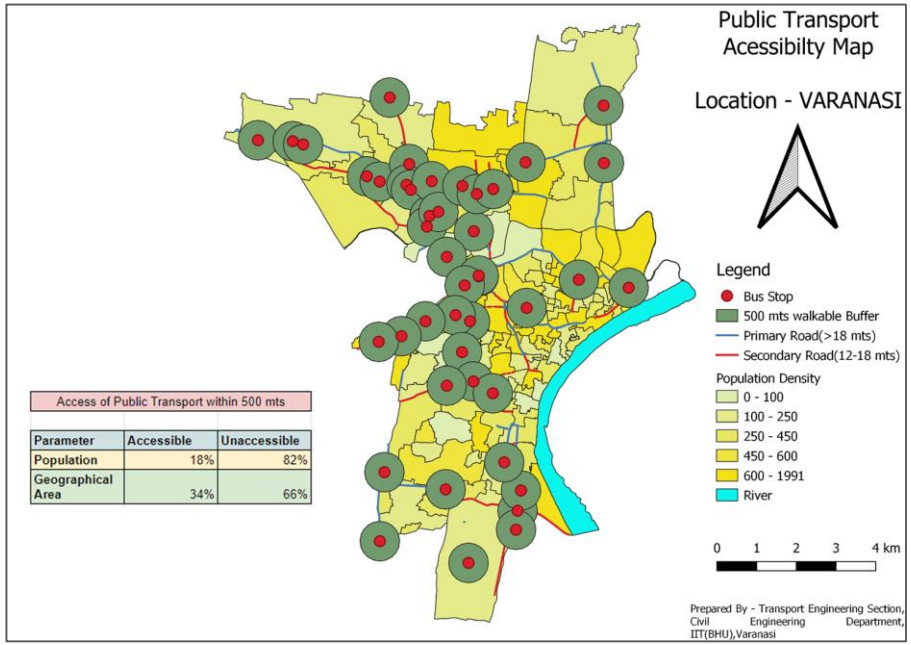
As tourism is central to the economy of the city, this paper aims to analyze the present connectivity of the major heritage sites within the city and how it is going to improve with the upcoming ropeway.

Varanasi specific problems addressed



Classification	ROW	Total Length	Percentage
Primary Roads	>18 mts	46.92	2.50%
Secondary Road	12- 18 mts	67.18	3.61%
Tertiary Road	<12 mts	1746.45	93.86%

Figure - Road Network in the city of Varanasi



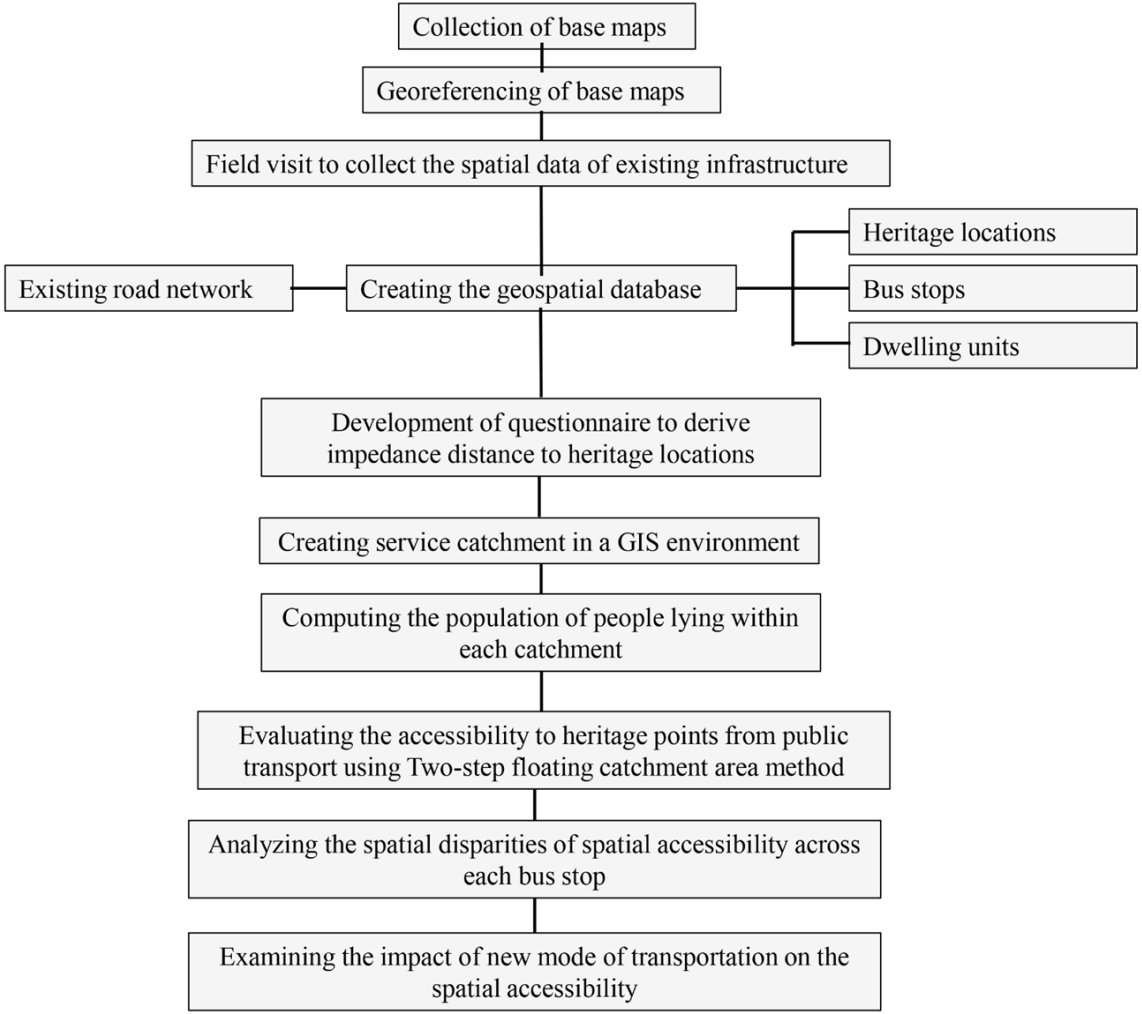
Access of Public Transport within 500 mts

Parameter	Accessible	Unaccessible
Population	18%	82%
Geographical Area	34%	66%

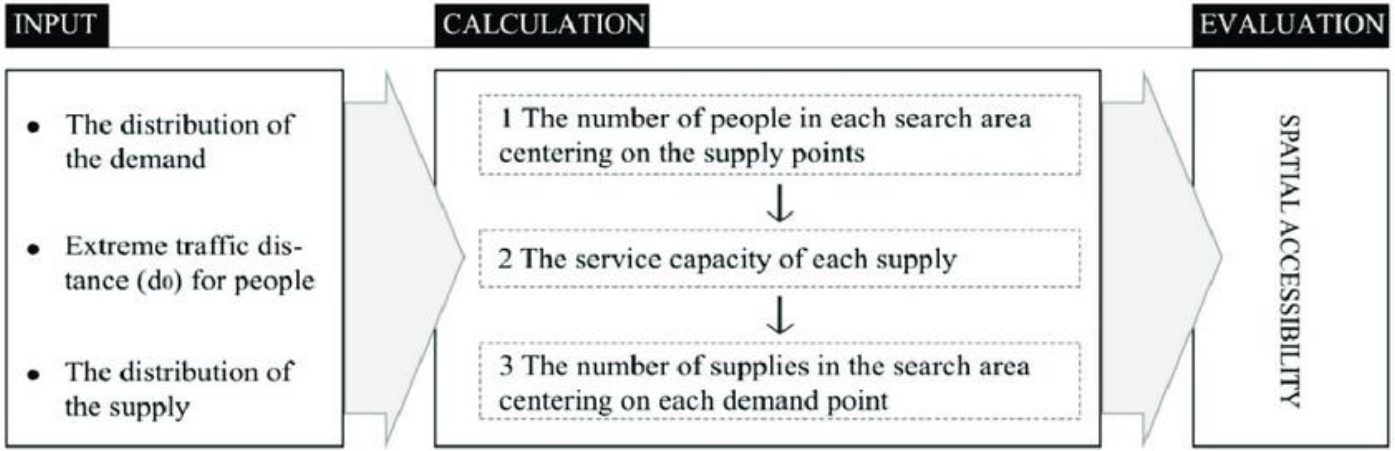
Figure - Location of the bus stops and their accessibility

Suggested proximity for public transit stops - 400 mts(URDPFI Guidelines 2014)
Road network hierarchy composition

Methodology



2SFCA Analysis



Step 1: *Computation of Facility to population ratio*

$$R_j = \frac{S_j}{\sum_{k \in \{d_{kj} \le d_0\}} P_k}$$

Where k is the total number of heritage sites, is the threshold distance from a heritage site "j". P_k is the population at a location k falling within the catchment $(d_{kj} \le d_0)$. R_j is the facility to the population ratio.

Step 2: Accessibility Index of population

$$A_i^F = \sum_{j \in \{d_{kj} \le d_0\}} R_j$$

where, A_j^F is the accessibility of j[th] transit station to the heritage sites

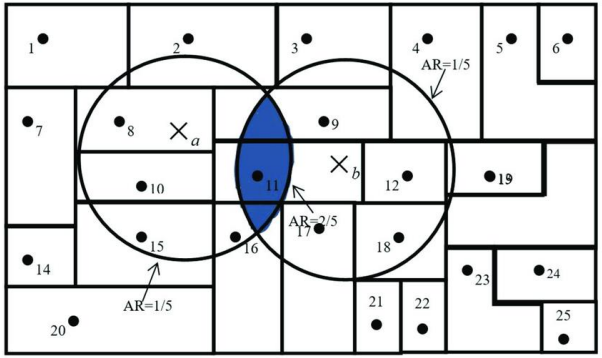


Figure - Diagrammatic representation of 2SFCA analysis

Primary survey(N=310)

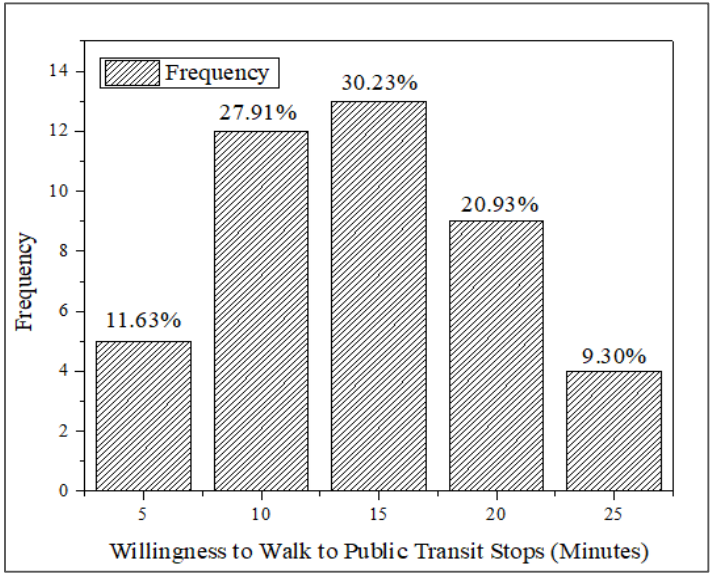


Figure - Willingness to walk to public transport stops;

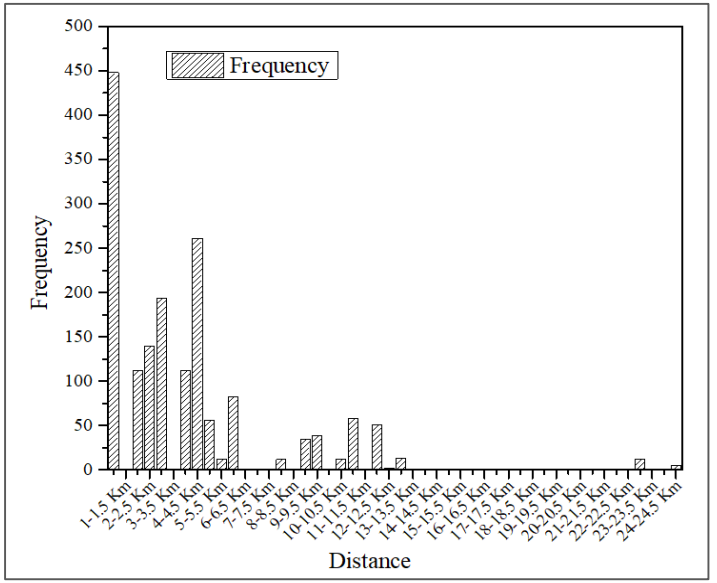


Figure - Travel pattern of the residents of the city to the major Heritage sites.

Nature of sample -

1. diverse in terms of age, gender, profession etc
2. collected from most of the residential neighbourhoods of the City

The results of the survey were used to determine the cut off distance for the catchment area formed

Datasets prepared

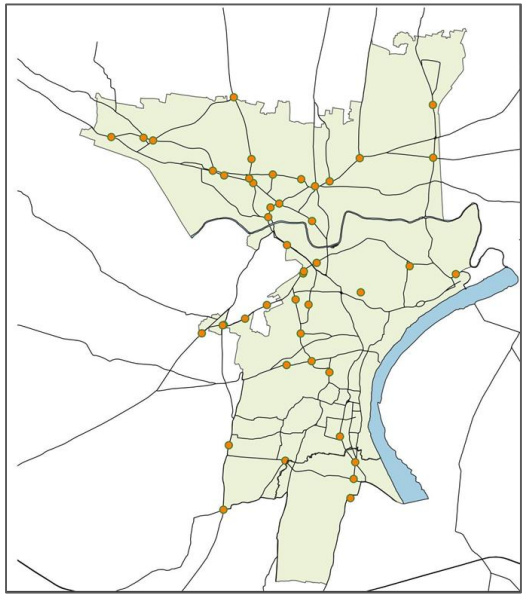


Figure - Location of existing bus stops in Varanasi

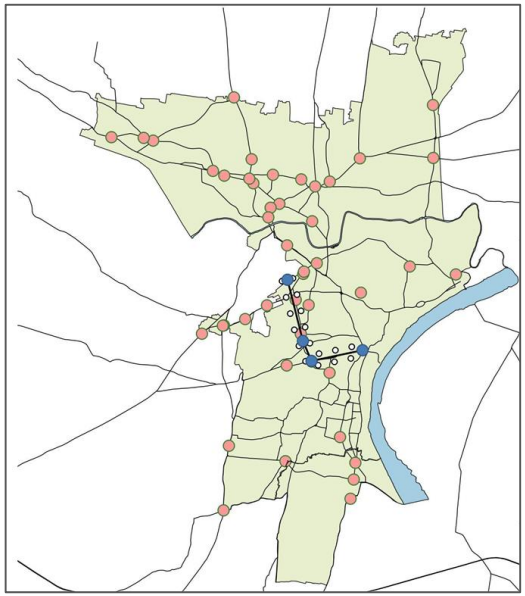


Figure - Location of the Ropeway Phase 1 Stops

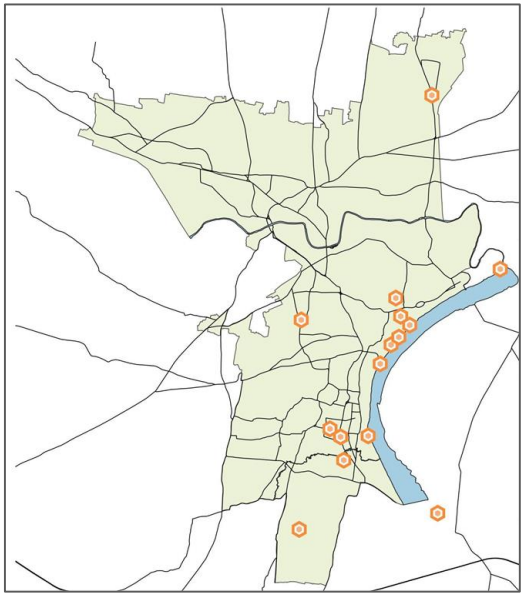
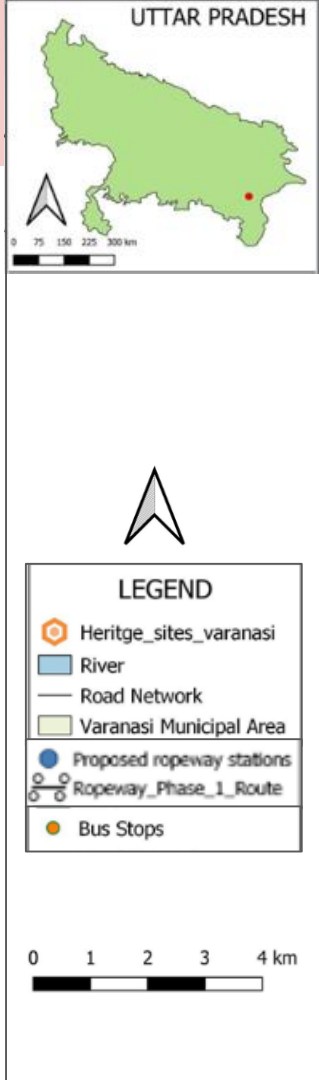


Figure - Spatial location of Heritage Sites in the city of Varanasi



Detailed analysis

- Collecting the shapefile of Plots
- Giving them weight according to the avg household size in Varanasi
- Calculating the centroid of the plot polygons
- Collecting the road network dataset
- Creating a simple network dataset
- Creation of walkable 1200 mts bus buffer
- Calculation of population within the buffer
- Creation of travel buffers from heritage sites and Public Transit stop and overlaying them for analysis.

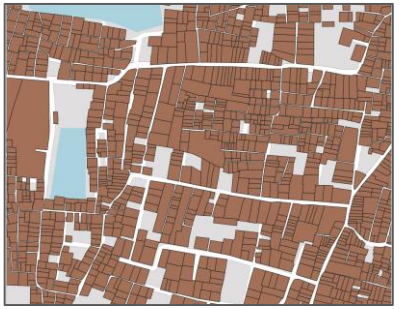


Figure - Varanasi Plot shapefile at zoomed in scale

Figure - Centroid calculated for the collected residential plots

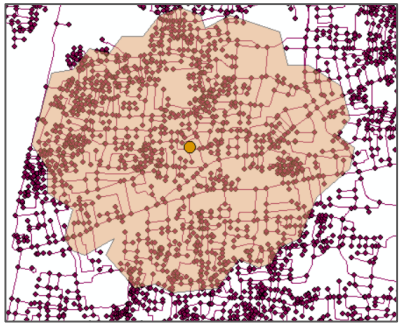


Figure - Representative image of the 1200 mts service area buffer

Figure - Road street network of Varanasi(Zoomed in scale)

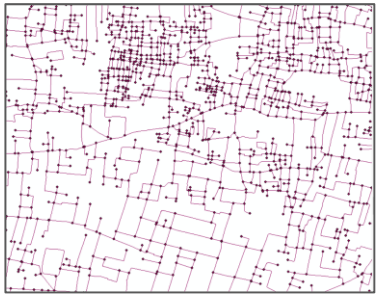


Figure - Network dataset with paths and junctions created for the road network dataset

Results

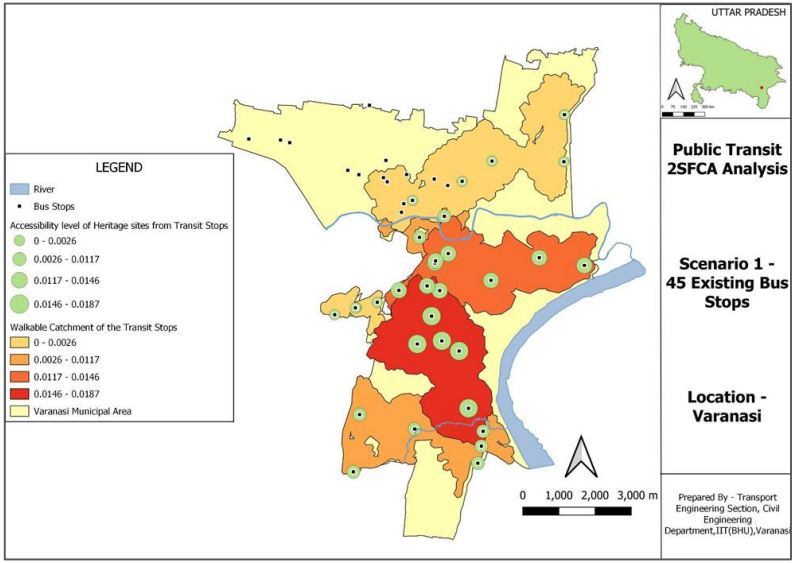


Figure - Public transit 2SFCA analysis (Scenario 1 – 45 Existing Bus Stops)

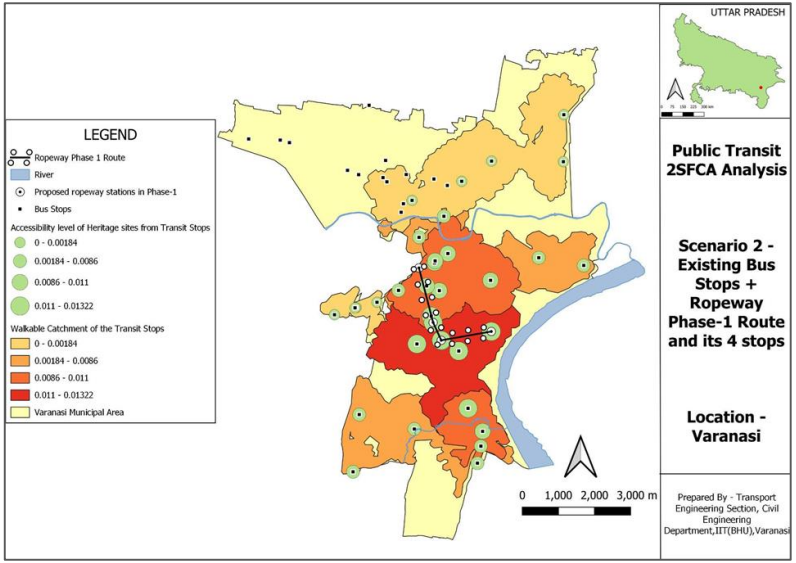


Figure - Transit 2SFCA analysis (Scenario 2 – 45 Existing Bus Stops + 4 RWPT Phase I stops)

Qualitative observations

- Accessibility with respect to public transport seems to improve with the upcoming ropeway.
- The catchment area of the ropeway stops has the highest accessibility as most of the heritage sites are in proximity.

Results

Quantitative Observations

Difference in service level of city level Public transit Network

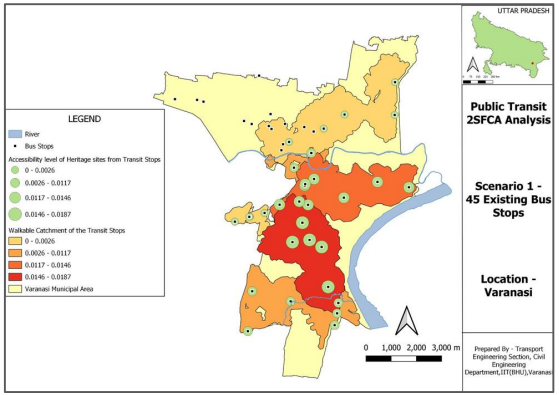
Level of service increase	Scenario-2 Ropeway Phase 1 (4 stops)
Increase in service area (Pan City) in km2	1.07
Increase in served Population (Pan City) in persons	92,799

Table 1 - Change in service levels in different scenarios

Comparing Spatial Accessibility using descriptive statistics

Parameters	Scenario-1 Initial 45 Bus Stops	Scenario-2 45 Bus Stops Phase-1 RWPT Stops (4)
Mean	0.329	0.365
Median	0.137	0.252

Table 2 - Mean and Median Accessibility levels in various scenarios



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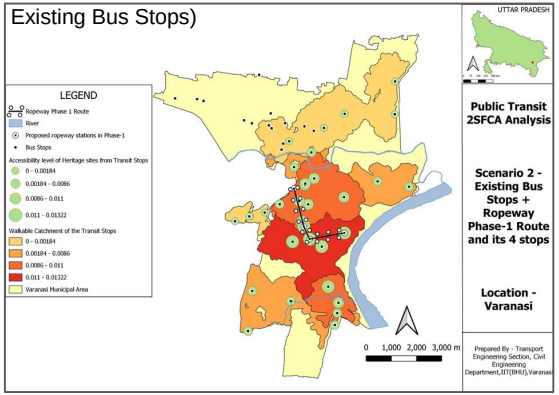

Figure - Transit 2SFCA analysis (Scenario 2 – 45 Existing

Conclusion

- The Paper presented an approach to measure spatial accessibility to a specific facility(Heritage sites in the case of Varanasi), using Public Transport.
- This paper presented a method for accessibility analysis using a Modified Version of 2SFCA analysis, which is more accurate as the population center here is taken as the public transit stops and the actual population living in its catchment area is considered for analysis. Whereas in the traditional method the ward centroid was taken as the population center.
- Comparing the analysis before and after the introduction of ropeway services , and comparing the accessibility with simple statistics of mean and median helps us to quantify the increase in accessibility.
- This proposed method helped us to quantify the spatial accessibility increase in terms of area and the exact population count which would be benefited with the accessibility to the Public Transit stops for the first time from their place of residence.

Thank You