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Public Transport Accessibility Index for Thiruvananthapuram Urban Area

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Abstract: *Transportation planning is an important part in the development of a region. An effective transport system and associated urban forms will improve the economic and social opportunities. Accessibility and mobility are the two main parameters which contribute to the effective transportation system. In this paper, the accessibility to the public transportation system is identified for the selected study area with the help of an indexing system. The sub-area in the region was thus graded based on their accessibility and the obtained values are found to resemble the real world.*
Keywords-*Accessibility, indexing system, public transport system, transport planning*

I. Introduction

Accessibility is concerned with the opportunity that an individual or type of person at a given location possesses to take part in a particular activity or set of activities. Accessibility takes on board the land use-transport connection and handles trip numbers and travel time as indicators. Measurement of access to social services for each household can help in adjust and better accommodate under-served regions. Important factors affecting accessibility are mobility, transport options, land use, and affordability. Affordability of a transit depends on the ability of the person to pay the cost for the particular trip. Public transit system development is focused on providing equal opportunity to all these economic groups. Thus the system should be accessible to all economic groups. Accessibility can be directly related to both the qualities of the transport system like the travel speed, and the qualities of the land use system like densities and mixes. At the same time it can also be directly related to economic goals (access to workers, customers, suppliers), social goals (access to employment, goods, services, social contacts), and environmental goals (resource-efficiency of activity/mobility patterns). The present study focuses on the accessibility to public transportation system in the selected area.

II. Scope and Objectives of the Work

The scope of the present paper is confined to measurement of accessibility levels of the population in the Central Business District (CBD) areas in Thiruvananthapuram City, Kerala to public transportation. The paper addresses the following two objectives:

1. To know about the different levels of accessibility to the public transportation system.
2. To prepare an accessibility index for the proposed area.

III. Findings from Earlier Studies

Accessibility is a term used in transport and land-use planning, and is generally “ease of reaching”. Accessibility is the suitability of the transit system in helping people get to their destinations in a reasonable amount of time. It is a function of the mobility of the individual, spatial location, opportunities relative to the starting point of the individual, and the times at which the individual is able to participate in the activity. Accessibility helps in identifying the interrelation of transport and land-use.

Accessibility measures can be grouped into five categories: travel-cost approach, gravity or opportunities approach, constraints-based approach, utility-based surplus approach, composite approach. The gravity or opportunities approach summarises the contour or cumulative opportunity and gravity models. The constraint-based approach is equivalent to time-space measures, while the utility-based surplus approach uses the utility measures with a greater focus on individual behaviour and decision-making. Composite approaches attempt to combine time-space and utility indicators into a common model.

In a paper regarding Advances in public transport accessibility assessments for development control, Public Transport Accessibility Level (PTAL)is one of the criteria for evaluating the accessibility PTAL is calculated by summing a series of indices for bus, train, underground and rail services to obtain an Index Number was explained by (G Christopher and S Geoff),2008[1]. The Index Numbers are compared with a banding regime to obtain a PTAL grade. Walk distance, the number of services and their frequency, walking speed and the reliability of service are all used in the calculations. They suggested a quantitative assessment method for public transport network accessibility as an alternative to PTAL, which could be used in transport assessments to assist with planning applications.. A new approach for measuring public transit accessibility was developed by A M Sha and E. L Nicholas (2008) [2] with the help of an index called Local Index of Transit Availability (LITA), The Transit Capacity and Quality of Service Manual (TCQSM) and Time-of-Day Tool, This research stays away from the methods involving software based analysis tools and considers methods whose calculation procedures are straight forward and require some basic use of GIS software.

Another example of GIS based accessibility measures was developed by L Wei (2009) [3] based on the GIS-based floating catchment method to assess areas with shortage of physicians. This paper demonstrates the principle of the floating catchment methodology (FCM) with a simple case study in northern Illinois. FCM defines the basic unit within which to calculate this ratio as a circle of some reasonable radius centered on the census tract centroid. A case study was done by Alan T. M Rex (2010) [4] based on the methods for increasing public transport access and their likely effects. In areas in which public transport access is high, performance improvements were realized by altering the placement of stops and modifying route service.

L Jonathan, G Joe, S Qing, (2010) [5] had done a work on the metropolitan accessibility. In the paper they compared transportation accessibility outcomes for 24 of the largest metropolitan regions in the United States. This study bases it accessibility metrics in the gravity model which is a powerful conceptual tool because it simultaneously accounts for both the transportation network and its surrounding land-use conditions.

In the paper regarding "Modelling walking accessibility to public transport terminals" by S Sony and O Piotr (2005) [6] explained about the equivalent walking distance (EWD). They developed a model called the walking access model. From the research they concluded that characteristics of walking route could be incorporated into public transport accessibility measurement. Equivalent walking distance can be a method that can measure public transport accessibility more precisely and comprehensibly.

The accessibility indices are used in measuring the ease of residents going from one place to another. By analysing the accessibility indices, one can review a network system of transportation in the regions under study. There are different methods used for finding the accessibility to a particular facility. The methods are identified from the literature review.

- Transit service indicator
- The Land Use and Public Transport Accessibility Indexing Model (LUPTAI)
- Accessibility index from (database extracted directly from the satellite imagery and the highway network
- The transit level-of-service (TLOS)
- The Local Index of Transit Availability (LITA)
- Public Transport Accessibility Levels (PTALS)

The present paper deals with the application of PTAL for evaluating the accessibility in the selected study region. The method provides a detailed and accurate measure of the accessibility to the public transportation opportunities.

3.1 Public Transport Accessibility Levels (PTALS)

Public transport accessibility levels (developed in 1992, by the London Borough of Hammersmith and Fulham and the method is adopted by London Transport) are a detailed and accurate measure of the accessibility of a point to the public transport network, taking into account walk access time and service availability. Walk times are calculated from specified points of interest to all public transport access points: bus stops, rail stations, light rail stations, underground stations, within pre-defined catchments. The PTAL then incorporates a measure of service frequency by calculating an average waiting time based on the frequency of services at each public transport access point. A reliability factor is added and the total access time is calculated. A measure known as an Equivalent Doorstep Frequency (EDF) is then produced for each point. These are summed for all routes within the catchment and the PTALs for the different modes (bus, rail, etc) are then added to give a single value. The PTAL is categorized into different levels.

The PTAL depends on walking time from the point-of interest to the public transport access points, the reliability of the service modes available, the number of services available within the catchment and the level of service at the public transport access points which is the average waiting time.

Steps involved in calculating the PTAL

1. Define the point of interest
2. Calculate the walk access times from the Point of Interest (POI) to the service access points (SAPs)
3. Identify valid routes at each SAP and calculate average waiting time
4. For each valid route at the SAPs calculate the minimum total access time
5. Convert total access times to the Equivalent Doorstep Frequencies (EDF) - to compare the benefits offered by routes at different distances,

6. Sum all EDFs with a weighting factor in favour of the most dominant route for each mode
7. PTALs are then determined using banded levels.

Total access time is made up of a combination of factors: combining the walk time from the POI to the SAP and the time spent waiting at the SAP for the desired service to arrive.

Total Access Time	=	Walk Time + Average Waiting Time	(1)
EDF	=	30/Total Access Time (minutes)	(2)
AI	=	EDFmax+ (0.5 * All other EDFs)	(3)

IV. Study Area

The study area selected is Thiruvananthapuram city, the capital city of Kerala. The city is characterized by its undulating terrain of low coastal hills and busy commercial valleys. Thiruvananthapuram district has a gross area of 2192 sq km (5.64% of the area of the State). The city consists of 100 wards. The CBD area of the city is mostly spread along the M G road and NH 47 (from East fort to Kesavadasapuram) and hence the corporation wards encompassing this stretch are taken as the study area. Fig 1 shows the site selected for the study.

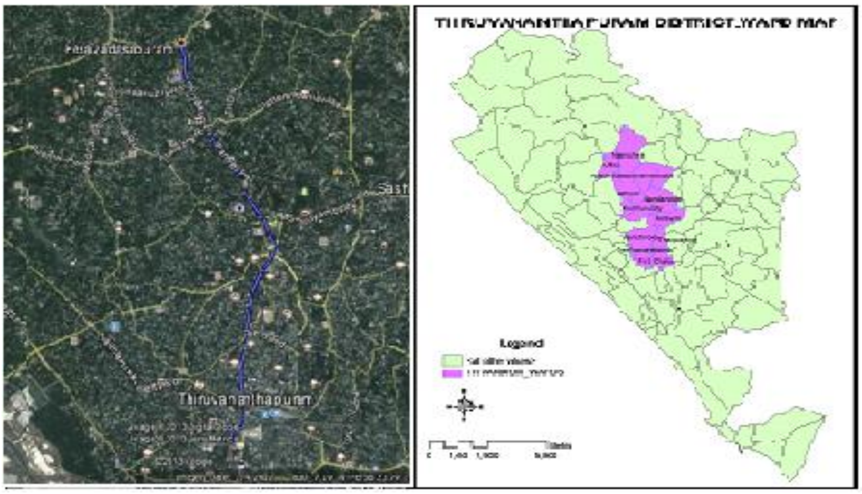

Fig 1. Site selected for the study

The study area includes a total of 13 wards

1) Fort
2) Chalai
3) Thampanoor
4) Sreekandeswaram
5) Palayam
6) Nanthankodu
7) Muttada
8) Pattom
9) Kesavadasapuram
10) Vanchiyoor
11) Ulloor
12) Nalanchira
13) Kunnukuzhi

V. Data Collection

A household survey was done to collect the data from all these thirteen wards which have direct access to the selected stretch. Based on the population in the selected wards the sample size is fixed. From all the trips generated public transport trips are filtered. The household survey was done with the help of a well structured questionnaire form. The questionnaire includes the trip information and the household data. The trip information includes the trip purpose, origin, destination, mode, waiting time at the bus stop and also the walking time to the bus stop. The total number of houses surveyed was 560.

5.1. Data Analysis

The PTAL methodology is adopted for finding the accessibility index. For each of the wards, the average waiting time to each direction and the average walking time to the bus stop are calculated from the data collected. This forms the input for finding out the PTAL.

5.1.1. PTAL Calculation

The total access time and the EDF are calculated based on (1) and (2). The final Accessibility Index or the PTAL value is calculated by taking the sum of all EDF values, which is a modification of (3), to suit the field values as

$$\text{AI} = \sum EDF \tag{4}$$

The calculated values of PTAL for all the ward are given in Table 1 and is represented in Fig 2. The table also includes the percentage of public transport trips generated in the particular ward. The variation of the PTAL value and the percentage of public transport system of each ward are almost in same pattern.

Table 1.Calculated values of PTAL

Sl. No.	Ward name	PTAL	Percentage of Public Transport Trips
1	Fort	22.27	29.09
2	Chalai	14.12	31.41
3	Thampanoor	18.37	36.30
4	Vanchiyoor	15.39	32.81
5	Sreekandeswaram	11.82	32.63
6	Palayam	13.70	32.39
7	Nanthankodu	16.12	38.33
8	Muttada	10.21	30.28
9	Pattom	15.57	27.31
10	Kesavadasapuram	14.01	31.32
11	Ulloor	16.83	29.28
12	Nalanchira	13.10	30.76
13	Kunnukuzhy	10.03	29.20

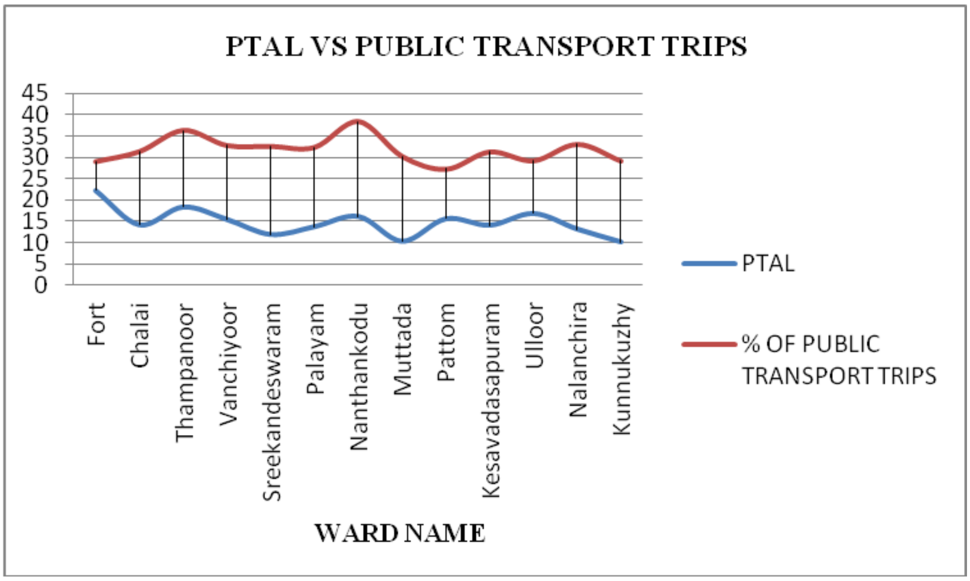

Fig 2: Comparison between PTAL and Percentage of Public Transport Trips

Fig 3 and 4 shows the ArcGIS window and the map created in ArcGIS 10.1. PTAL is given as one attribute and map showing the accessibility index of different wards is created.

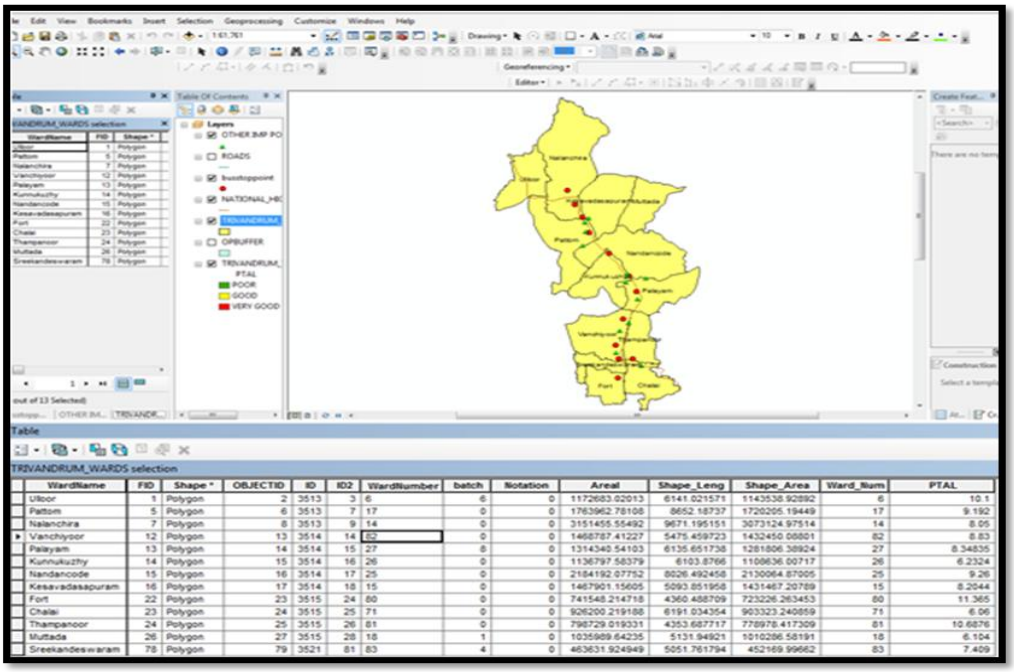

Fig.3: ArcGIS window along with Attribute Table

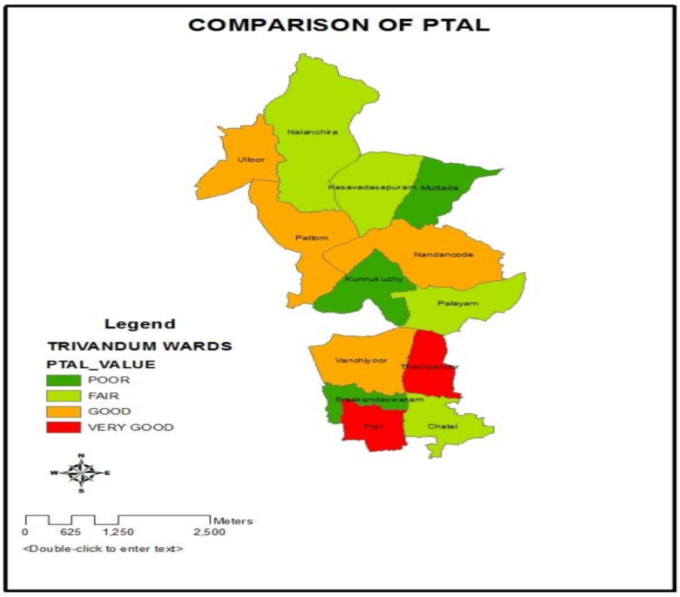

Fig.4: Ward map showing different levels of PTAL

It can be seen that the obtained PTAL values and the percentage of public transport trips for the wards does not show much of a significant correlation. This may be because, the people are meeting their demands either within their ward, which does not require much of public transportation or may be meeting them by other modes of transport.

VI. Results and Conclusions

The accessibility to public transportation in the selected study area was determined based on household data and the PTAL method. The PTAL values for different wards are calculated using the modified formula. From the data analysis it is found that Fort, Thampanoor, having highest accessibility to the public transportation system with the values 22.27 and 18.37. The wards with low accessibility are Kunnukuzhi, Sreekandeswaram, and Muttada with values 10.03, 11.82, 10.21.Percentage of public transport trips in these wards are also less compared to the other wards. Thus it can be inferred that PTAL is a good measure of the accessibility to the public transportation system. The disadvantage of the method is that for wards having high values of PTAL does not have significant correlation with the percentage of public transport trips.

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