Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 25 (2017) 4196–4206

Transportation Research Procedia

www.elsevier.com/locate/procedia

World Conference on Transport Research - WCTR 2016 Shanghai. 10-15 July 2016

Mapping bus transit services in Hyderabad – an illustrative example of the use of open geospatial data

Harsha Devulapalli [a], Girish Agrawal [b,*]

[a] *Hyderabad Urban Labs, First floor of #10-5-7/1, Gulshan-E-Khaleel Complex, Masab Tank, Hyderabad, Telangana 500028, India*
[b] *Shiv Nadar University, Department of Civil Engineering, PO Shiv Nadar University, Greater Noida, Gautam Buddha Nagar, UP 201314, India*

Abstract

Most public transit agencies in India do a poor job of making even basic route information available to the public. The transit mapping exercise reported here demonstrates that crowd-sourcing can be used to generate useful data at very low cost. Bus routes, including route frequency information, are identified and mapped, and the maps used to identify areas of the city which are not well served by the transit system. Available information about the socio-economic status of the underserved areas is used to fulfill a secondary objective of showing that mapping of public transit and paratransit networks can offer insights into how considerations of equity, access and safety can be integrated into transit planning in urban areas where spatial data is hard to come by, especially in cities of the global south

Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.

Keywords: Mapping of urban transit network; crowd-sourcing to overcome data scarcity; finding gaps in transit network; informal transit systems

1. Introduction

Hyderabad is a metropolitan city in India with a population of about 6.5 million (Census of India, 2011). Approximately 35 percent of all trips in the greater metropolitan region of Hyderabad are made using the city bus service, and about 2 percent are made using the Multi-Modal Transport System (MMTS), the suburban commuter rail system in Hyderabad (LEA Associates, 2013). The city bus service, operated by the Andhra Pradesh State Road

* Corresponding author. Tel.: +91-981-819-1395
E-mail address: girish.agrawal@snu.edu.in

Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.
10.1016/j.trpro.2017.05.369

Transport Corporation (APSRTC), provides about 44,000 trips every day for approximately 3 million commuters (LEA Associates, 2013). Growth in the modal share of two wheelers (34 percent) and cars (8 percent) has restricted further expansion of the modal share of public transport (LEA Associates, 2013).

The impetus for mapping the frequency and routes of the bus network in Hyderabad was an attempt to see how much of the city could be accessed without the need to resort to travel via a private motor vehicle. A secondary goal was to develop a map showing transit interlinkages so that users of one mode of transit could figure where they could transfer to a different mode. Such a map would be useful not just for people who are new to the city, but also for daily users who generally only used certain bus routes but frequently miss connections because of the lack of a reliable, published route time table. The latter problem of a lack of time tables is of more recent origin. APSRTC stopped publishing time tables in 2009, and despite changes in bus routes and frequency, has not updated the time table. Although APSRTC has not provided any official reason, the off-the-record claim is that the number of changes affect only a small fraction of the existing route network, and so the expense of preparing and distributing a new time table is not justified.

The following sections discuss the process of data generation, the social considerations and analysis of the observations.

2. Data generation

Lacking reliable, updated route and frequency information, the only current way for most bus service users in Hyderabad to find out if a bus would go to a certain place is to ask the bus driver or conductor, or other passengers in the bus. A frequency network map could help in solving this problem to a certain extent as it presents data in a format that is readable and understandable. It also makes users aware of the availability of public transit options and helps ease their movement around the city.

Cities in the global north have agencies that are rapidly adopting General Transit Feed Specification (GTFS) as the de facto standard of storing and disseminating transit data. There is a tremendous boom in the rapidly evolving transit information sector. More and more agencies are opening up their data in order to share the benefits of transit analysis. However, in case of cities in the global south, availability of data is itself a huge challenge. Very few public transit agencies work with mappable data, and even fewer publish such data. Most agencies do not have the in-house capability to handle transit data. In the case of Hyderabad, APSRTC does not have a public database of all bus routes with timings in the city. APSRTC even stopped publishing bus-route timetables in 2009. There are two Android applications available for commuters to figure out bus timings and connections, but the information is outdated and limited to a few heavily-travelled bus routes. Following the increasingly common practice among transit agencies in India of outsourcing essential functions, a private company has been contracted to create a database of bus stops and routes. But, to date, the database has not been spatialised nor any part of it made available in an easily accessible format. More importantly, APSRTC or its contractor have not demonstrated any willingness to use the data for transit planning, or to do anything beyond just collecting and storing it. When this database was accessed for the work reported here, it was realized that the database was faulty and inconsistent in that place names were often wrong, route information was contradictory, and the bus stop locations were outdated. After extensive cleaning of the database, the bus stop data was geocoded by a group of volunteers and this updated data forms the geospatial database of bus routes in Hyderabad discussed herein. We describe below the process of making the frequency map and the geocoded database.

2.1. Making the frequency map

Frequency, span of service, speed, reliability and ease of access are parameters that can be used to judge a transit network. Of these, frequency and span are the ones that a majority of riders use to judge the usefulness of a network. Frequency governs how much time one has to wait and also determines whether the system is capable of functioning as a network.

Most bus transit networks have services that can be classified as follows:

- A frequent network – Buses that run at a moderate to high frequency. These are buses that operate at a frequency of less than 15-20 minutes for most of the day. These buses run at this frequency mostly because of demand of transit in these corridors
- Infrequent buses – These buses have no fixed timings and run at random times throughout the day
- Peak only service – These buses run frequently only during the peak commuting hours

All of the bus routes in Hyderabad were classified using the above three categories. Of these, 41 routes run at a frequency of less than 10 minutes during peak hours and between 10 and 20 mins during the rest of the day, while another 62 run at a frequency of between 10 and 20 minutes during peak hours and between 20 and 30 mins for the remainder of the day. Figure 1 shows a selected section of the frequency map developed for the project reported here. The thick red lines in Figure 1 indicate the routes where buses run at less than 10 minutes frequency during peak hours. Routes where buses run at a frequency of between 10 and 20 minutes during peak hours are represented by the thinner blue lines.

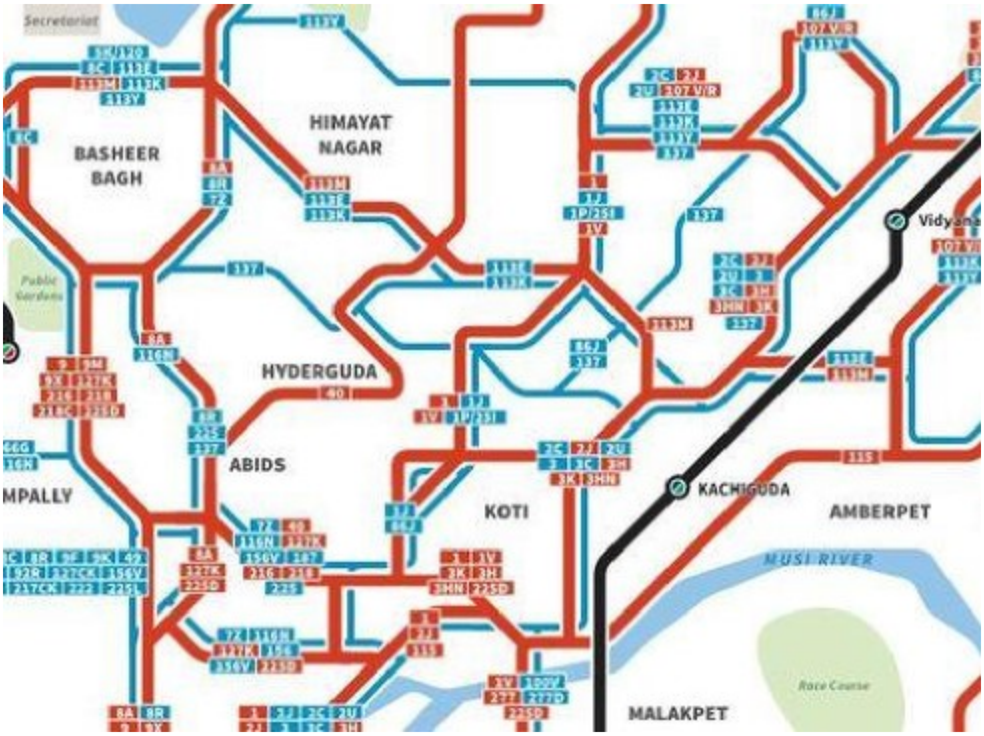

Fig. 1. Frequency map of selected bus routes in Hyderabad

Most transit maps either follow a conventional transit diagram approach or a true geographic approach. While the transit diagram map keeps thing simple easy and understandable, they distort the geography of a city. The geographic maps are not aesthetic to look at and at times can be difficult to interpret for the lay user. Therefore, as shown in Figure 2 below, a hybrid style of mapping – combining elements of both transit mapping and geographic mapping – was used in the work reported in this paper.

The hybrid map has route bends to indicate bends in the actual road. This allows the map to communicate the geography of the city and retains the original locations of the bus stops. Such a map nonetheless acts like a diagrammatic map by keeping roads to standardized angles whenever possible. This allows for visual simplicity and reduction in size of the map.

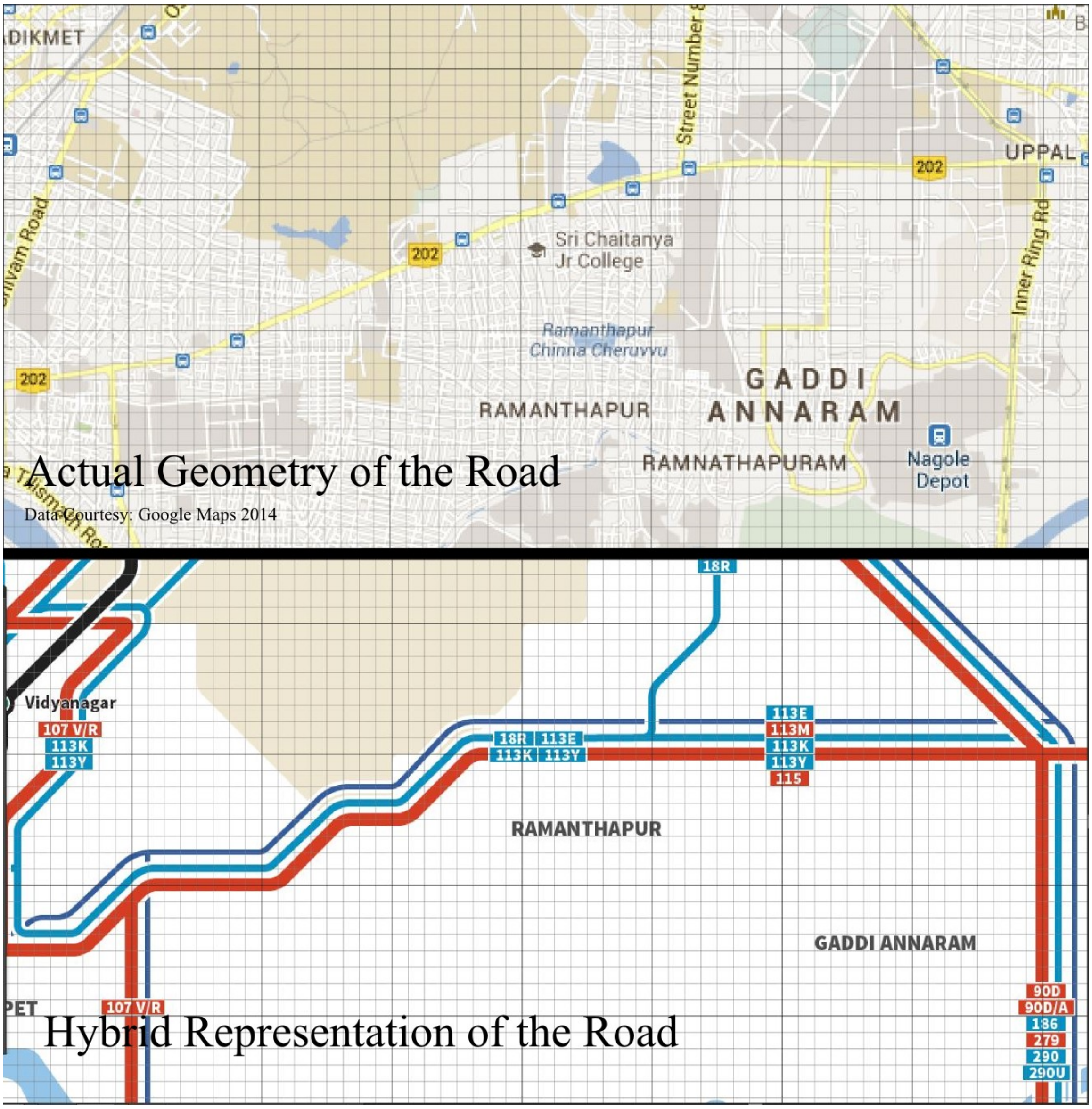

Fig. 2. Illustration of hybrid style of mapping

2.2. Making the Geospatial Database

A database containing all the bus routes and stages was obtained from APSRTC. As per the original Excel file provided by APSRTC, there were 3104 bus stops in Hyderabad. Extensive cleaning and field verification revealed that the data had multiple redundancies, for instance, a bus stop would be referred to with multiple names and thus listed as multiple bus stops. Spelling mistakes and other human errors were also present in the data. After cleaning, the number of bus stops in the Hyderabad Metropolitan Area came down to 2,407. The challenge then was to geocode the locations of these bus stops. Volunteers were sought from Engineers without Borders who recruited thirty student volunteers from the Mufkhamjah College of Engineering and Technology in Hyderabad to geocode the data.

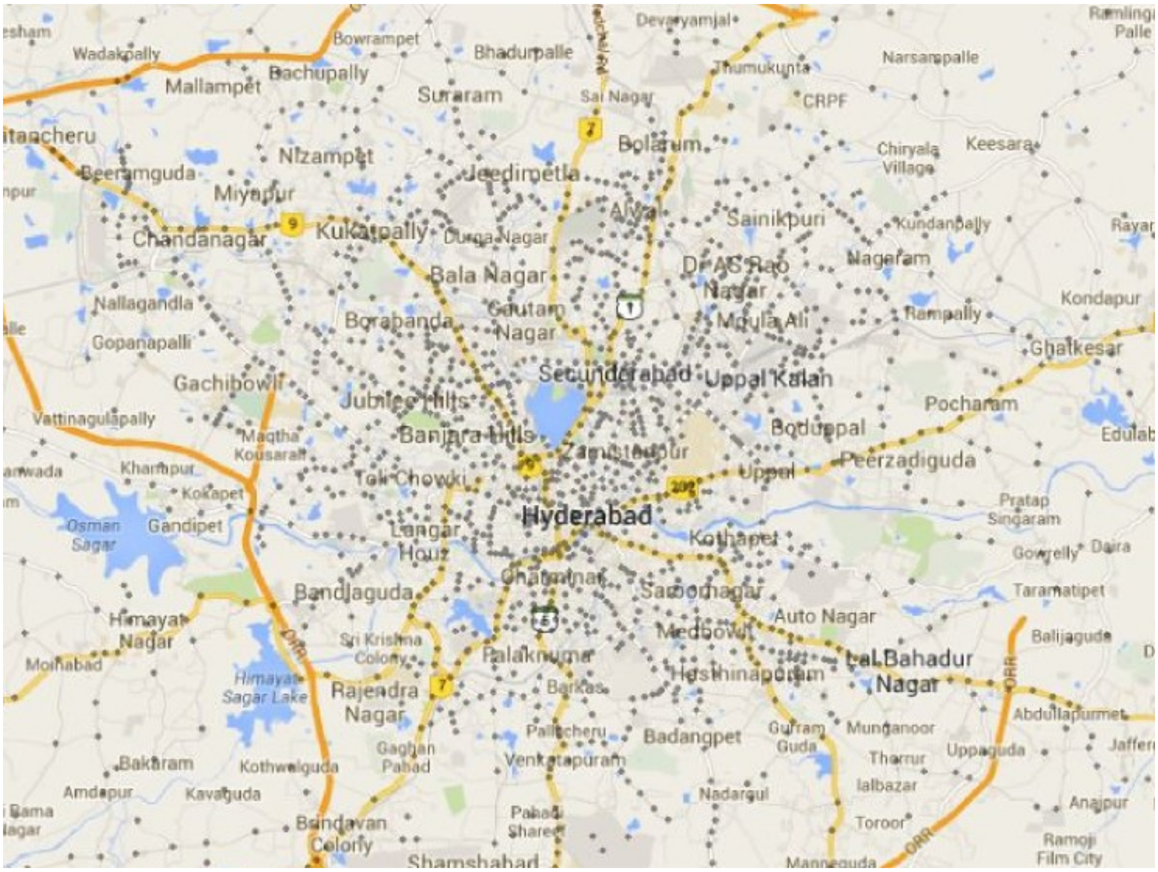

Fig. 3. Bus stops in the Hyderabad metropolitan area

The students were taught how to use CartoDB, an online mapping tool, and then were allotted bus depots. There are 26 bus depots in Hyderabad, with each depot servicing about 70-100 bus routes. By simply putting a pin on the map to indicate a bus stop, the student volunteers managed to geocode almost all the bus stops in Hyderabad city region with a high degree of accuracy. In instances where the exact location of a bus stop could not be determined due to a lack of markings and multiple encroachments onto the street and sidewalks, road junctions closest to the bus stop were marked. Figure 3 shows the map with the geocoded bus stops. In addition to fulfilling the data needs of the project, this process demonstrated that the newer digital mapping technologies allow for involvement of the actual process. This has endless possibilities for democratic practices in urban planning.

3. Social Considerations

In terms of access to public transit, Hyderabad city has little to offer for anyone other than able bodied young men and women, and that too only between 5 am to 11 pm. There are no public transit night services, buses are not disabled friendly, access to bus stops frequently requires some degree of athletic prowess to get past various obstacles, and services are infrequent or nearly absent in precisely those parts of town where residents have the least access to private means of transport.

3.1. Access in Terms of Location

As per the frequency map, there are huge swathes of the city that do not have access to frequent bus network. Hitech City, the centre of the satellite township called Cyberabad with a large concentration of IT and BPO service companies, has to make do with minimal bus and train services and rely predominantly on informal transit services such as autorickshaws. The unavailability of formal public transit and consequent reliance on informal services also leads to a degree of physical insecurity as evidenced by the increase in the incidence of attacks against women in this part of town (The Hindu, 2013; Newswala.com, 2013).

The linkage between community economic status and availability of public transit can also be deduced to some degree from the frequency maps. When a slum cluster map of Hyderabad is overlaid on the frequency map, it shows that public transport options are missing in the areas of the city with the biggest slum clusters – Karwan, Dhoolpet and interior areas of Mehdipatnam.

3.2. Access in Terms of Time

The frequency network map is immediately useful for people who have a regular work schedule. For people who work the night shift – paramedics, mall workers or call-center employees, the map becomes a blank sheet as there are no public transport services available after about 11 pm. Most of these night-shift workers cannot afford taxis or other expensive means of personal transport, and use either personal transport in the form of bicycles and motorized two-wheelers, or on shared autorickshaws. Some employers do provide contracted transport services in the form of small passenger vans, but most do not. For instance, only one mall in Hyderabad, Inorbit, provides transportation to its workers for the night shift. The others have to resort to all sorts of ways to negotiate with this restriction on mobility.

4. Analysis

4.1. The Frequency Map

While the frequency network map produced during this project is useful for people to get around Hyderabad without worrying about unpredictable wait times and uncertain connectivity, it also reveals some instructive patterns.

1. The areas under the old municipal corporation of Hyderabad had an extensive frequent bus network. Every primary and secondary road had either high, moderate or both buses passing through them. An exception to this was the areas around Charminar, Karwan and Dhoolpet. It could be because of the narrower lanes/roads in these areas compared to the rest of the city. The Charminar Pedestrianisation Project has also prohibited buses from plying on certain roads and has rerouted them. See Figure 1.
2. The western part of the city such as Banjara Hills and Jubilee Hills have lesser number of high frequency routes due to the affluent nature of these areas. However, all commercial roads in the area provide frequent transit options to people who work in these areas (Figure 4).
3. Areas around Secunderabad Cantonment are exclusively served by moderate frequency routes. It is likely because of lower population density in the cantonment (Figure 5).
4. The newer parts of town Cyberabad and around had even thinner density of frequent bus routes. It could be because the growth in these areas was due to the IT boom of the early 2000s and RTC has not actively promoted buses here (Figure 6).

4.2. The Geospatial Database

Once the spatial database was created, bus stop accessibility maps were created using a range of catchment areas. Four of these maps, showing circular catchment areas with radii of 250m, 500m, 750m, and 1,000m are shown in Figures 7, 8, 9, and 10, respectively. Please note that these maps use a straight-line distance rather than the actual walking distance to define the catchment area, and so should be treated as first-order approximations. Nonetheless, they do provide a good illustration of bus transit coverage in Hyderabad. A second stage of this project will refine these maps to determine catchment areas based on actual walking distances.

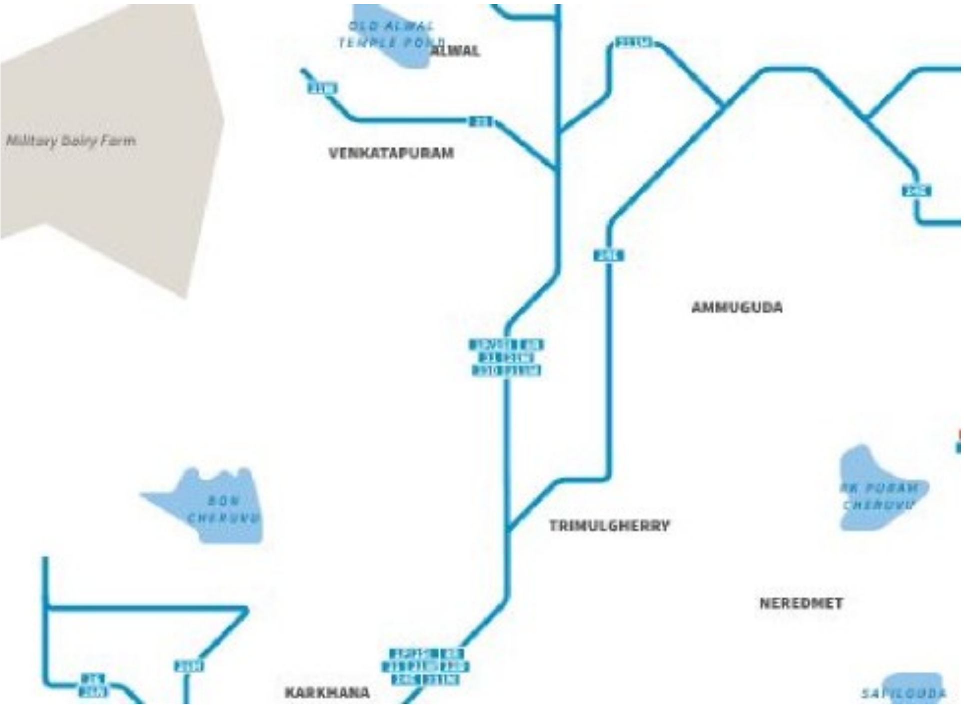

Fig. 4. Affluent areas with good bus transit options along commercial roads

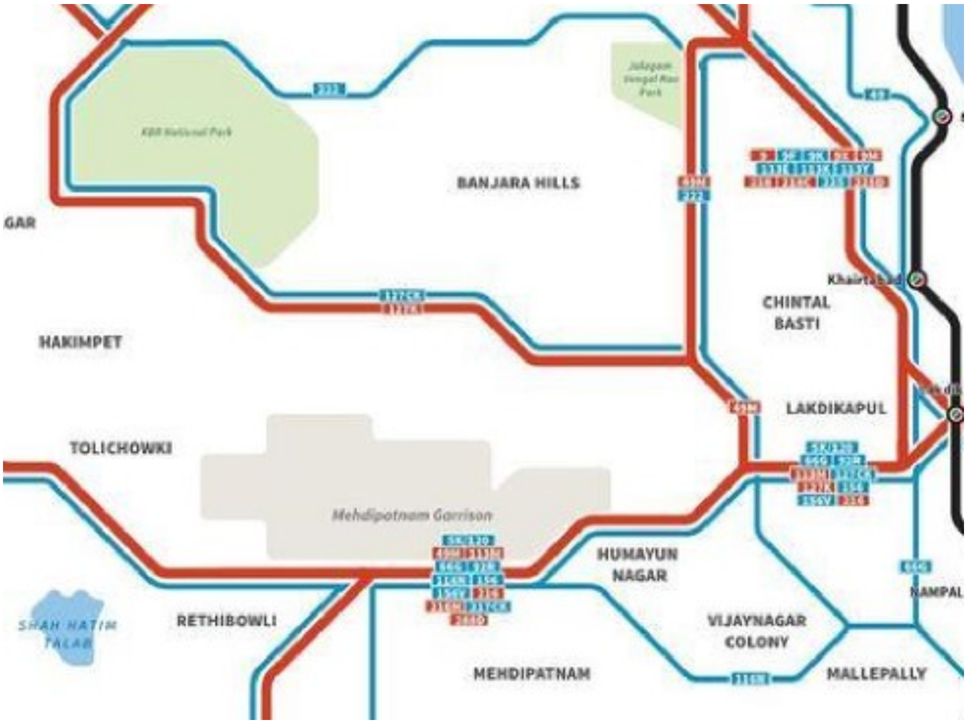

Fig. 5. Example of low population density area served by moderate frequency bus routes

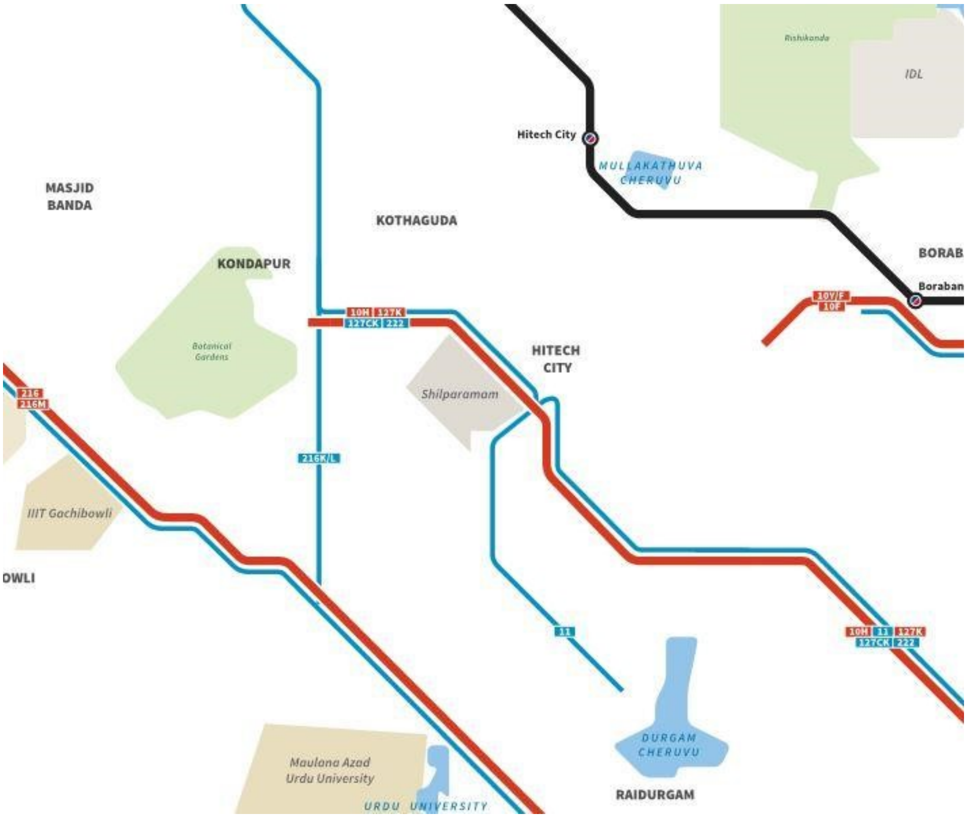

Fig. 6. HITech city and environs with minimal high frequency bus services

5. Equity, access and safety in Hyderabad

How do people travel in areas of Hyderabad with no transit available? The answer is Shared Auto Rickshaws. Popularly known as “share autos,” these come in two varieties – 4 seaters and 7 seaters. Share autos ferry people along several major and minor transit corridors. Seven-seater share autos are legally authorized to function as shared auto rickshaws with multiple pick-up and drop-off points, whereas four-seater autos are only authorized to operate like taxis in that they can legally only provide point to point service for a single passenger or group of passengers. These shared auto rickshaws are a major transportation option for people living in the Hyderabad metropolitan area.

As an experiment, the research team sent a message on a Facebook group asking people to contribute share auto rickshaw routes they knew of – within 8 hours, details of 85 routes in the city had been uploaded. All of these have been mapped on to the bus frequency network map. The shared autorickshaw routes are easily represented on the bus frequency network map as shown by the thin violet line in Figure 2.

The following are some insights which were gained from adding share autorickshaw routes to the frequency map:

1. Share Autorickshaw routes thrive where there are few bus routes with frequent service, such as in the interior areas of Mehdipatnam – Karwan, Dhoolpet and Mangalhat.
2. They provide a great alternative to buses in the western part of the city where the public transport network is relatively sparse.
3. There exist several routes within the core city for the share auto rickshaws, most of which are provided by four-seater autorickshaws.

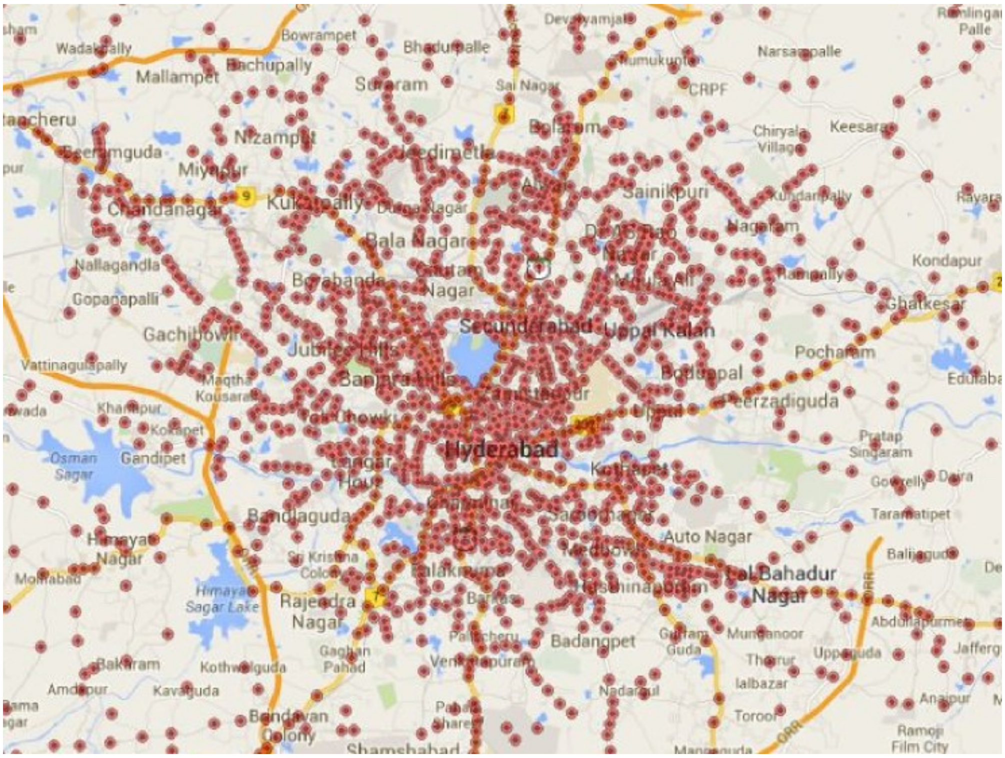

Fig. 7. Transit coverage using a 250-m catchment around bus stops in Hyderabad

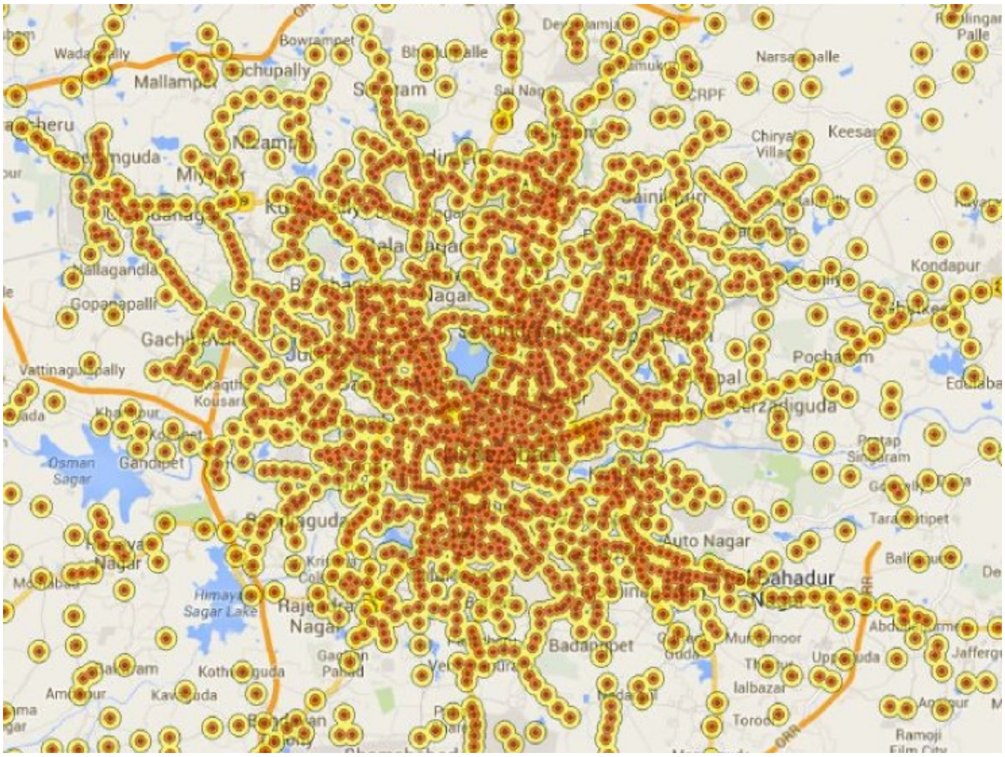

Fig. 8. Transit coverage using a 500-m catchment around bus stops in Hyderabad

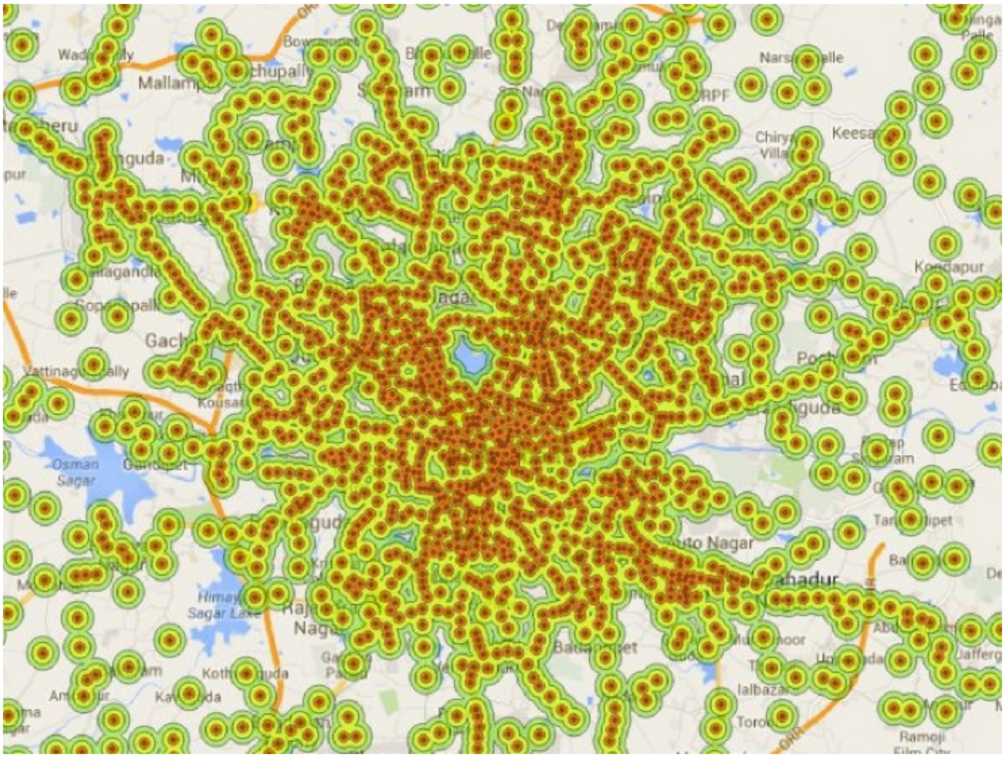

Fig. 9. Transit coverage using a 750-m catchment around bus stops in Hyderabad

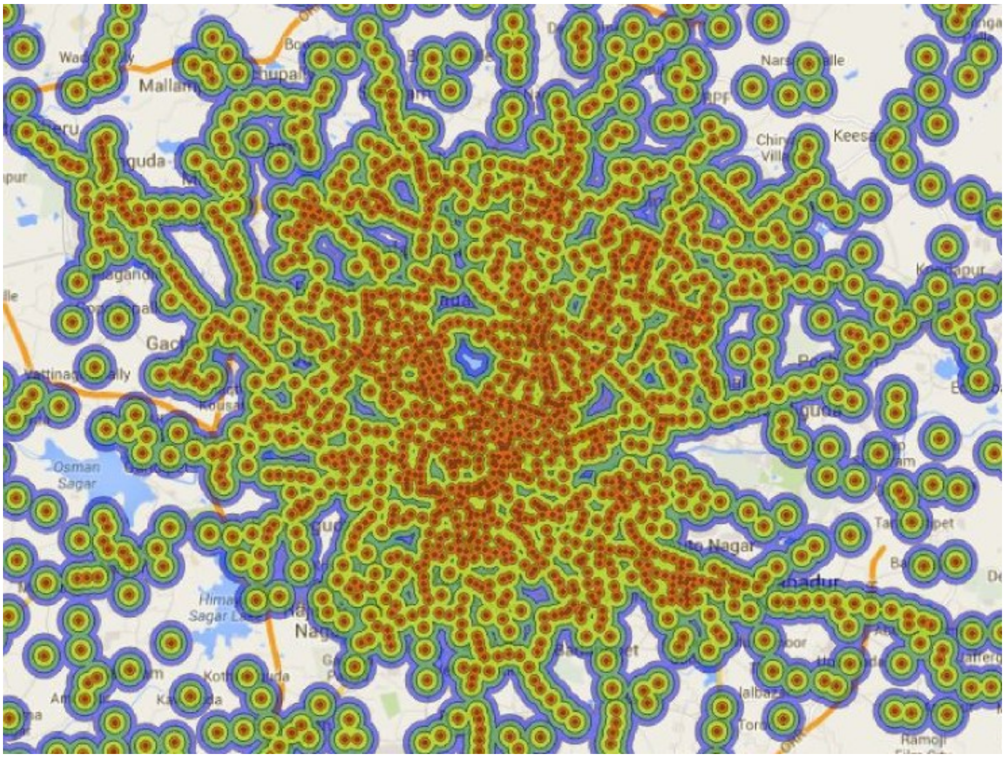

Fig. 10. Transit coverage using a 1,000-m catchment around bus stops in Hyderabad

There seems to exist a system under the chaos as revealed by mapping of the available share auto information in that the routes follow the population density. However, given that these share auto rickshaw routes are the efforts of private actors operating without any formal coordination, they manage to be efficient only to a certain degree. Proper network design and formal recognition would not only help them become much more efficient, but also provide a degree of certainty to the users in terms of schedules and fares.

As revealed by the bus frequency network mapping exercise presented here, formal transit deserts are havens for informal transit systems which spring up to meet demand. Questions to be examined further include issues of why certain areas remain underserviced by formal transit systems

6. Conclusion

That a mapping exercise such as the one described here can reveal much more about a major urban areas formal transit system than the researchers originally envisaged is indicative of the usefulness of open spatial data. Such open spatial databases can unlock the possibilities of all sorts of experiments with available such data. Is there a correlation to the location of a bus stop and the crime around it? Do areas with strong public transport have lower crime rates and are safer for passengers? Why do certain areas remain underserved by formal public transit systems? It could also help the city plan its future bus stops better or adjust the location of current ones.

Open transit data will allow agencies to move from tightly controlling data as they currently are to generating and releasing data. It can provide transparency and accountability and is intended to empower citizens through data. Open data ecosystems are more likely to encourage innovation and enhance birth of new ideas, tools and approaches.

Flock or crowdsourcing is capable of generating immense amounts of data at lower costs and lets transit users participate directly, and actively, in the betterment of a transport network they use daily.

References

Census of India, 2011. "Table 2, Cities having population 1 lakh and above." *Provisional Census Report*, Government of India, August 2014. http://censusindia.gov.in/2011-prov-results/paper2/data_files/India2/Table_2_PR_Cities_1Lakh_and_Above.pdf. Last accessed October 10, 2015.

LEA Associates 2013. *Draft Final Report Volume 1 Main Report - Comprehensive Transport Survey of Hyderabad Metropolitan Area 2011, 2013*. http://www.ctshma2011.com/down_file.php?download_file=DFR_Executive_Summary.pdf. Last accessed October 10, 2014.

The Hindu, 2013. *Crime against women on the rise in Cyberabad*, December 28, 2013. http://www.thehindu.com/news/cities/Hyderabad/crime-against-women-on-the-rise-in-cyberabad/article5509213.ece. Last accessed October 10, 2015.

Newswala.com, 2013. *TITA appreciates Cyberabad Police for Women Safety*, December 19, 2013. http://www.newswala.com/Hyderabad-News/TITA-appreciates-Cyberabad-Police-for-Women-Safety-Campaign-53597.html. Last accessed October 10, 2015.