GIS FOR MULTI-MODAL ACCESSIBILITY TO JOBS FOR THE URBAN POOR IN AHMEDABAD, INDIA

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ABSTRACT

Transport plays an integral role in the levels of mobility and socio-economic participation in any given society. Yet, traditional urban transport planning has neglected this important role and has limited its focus on the efficiency of the transport network itself, thereby overlooking the more difficult to measure socio-economic implications. This paper reports on the use of accessibility metrics for quantifying the effect of public transport and urban development interventions, such as BRT and social housing projects, in lowering the spatial mismatch between low income residents and their jobs, with examples from a World Bank commissioned project in Ahmedabad, India. In addition, we show how GIS-based network modelling techniques can be used in measuring levels of accessibility for this purpose. Our findings show that the presented metrics and developed tool can highlight critical investment and policy reform needs for developing cities in India and beyond.

Keywords: GIS application, Accessibility, Urban Poor, BRT, India

BACKGROUND AND INTRODUCTION

A city's urban transportation system plays an integral role in enabling the mobility essential to socio-economic participation. Recent research has focused on the concept of social exclusion, which can result from a lack of access to urban opportunities (employment or otherwise), frequently caused by inadequate access to transport infrastructure and systems (Wati, 2009). As urban populations in developing countries continue to grow, both congestion and land prices are expected to increase, helping to exacerbate the transport-related social exclusion of the urban poor.

Despite the importance of these issues, most urban transport planning has avoided measuring these impacts directly, and has limited its focus to understanding the efficiency of the transport network itself. The study described here attempts to address this void, measuring the ability of the transport system in Ahmadabad, India to connect low income residents and employment opportunities. The key results and methodology are described in this paper.

Low-income dwellers in cities in India typically experience high levels of social exclusion. They are forced into long daily commutes to and from low-paying jobs on overcrowded public transport systems for which fares continue to rise. In recent years, Ahmedabad, like many other cities in India, has embarked on an urban renewal program with the explicit intention of providing more sustainable and equitable transport and housing solutions to the population at large, and the urban poor in particular. Initiatives sponsored under this urban renewal program across India include the development of Bus Rapid Transit systems, investment in non-motorized transport infrastructure, and the provision of new affordable housing. All these programmes share an objective: how to provide a high impact, cost effective program that supports the overall policy objective of reducing social exclusion of the urban poor.

Better integration between urban development and transport may provide a way of preventing the low income and excluded groups to be locked out of the activities that are essential to support a good quality of life (Lucas, 2004). Accessibility analysis of the type carried out for this study can help to quantify this integration by analyzing the land use and transport system simultaneously, developing metrics that measure, for example, the number of destinations (generally jobs, but also other urban services) that can be accessed in a given time using a given mode of transport. The impact of new developments - new BRT lines, new affordable housing - can be thus compared using a standard set of metrics, highlighting the different impacts of each. In a sense, then, the tools developed in this study can help assess the effectiveness of the different programs currently being developed in India to reduce the social exclusion described above. The presented metrics and developed GIS tool can thus help highlight critical investment or policy reform needs in the cities.

This paper reports on a small pilot project, focusing on a technical proof-of-concept, with support of The World Bank. Even though the results should be viewed as preliminary, the tools developed, show great promise for further detailed work both in Ahmadabad and elsewhere in India.

SUSTAINABLE TRANSPORT POLICY IN AHMEDABAD

Ahmedabad is the largest city and former capital of the Indian state of Gujarat located on the bank of Sabarmati river in the western part of India. The river divides the city in two halves, which mostly get referred to as East Ahmedabad and West Ahmedabad. Ahmedabad with currently more than 5.5 million inhabitants (figure 1) is the fifth largest city and seventh largest metropolitan area in India, and is one of the important trade and commerce centres in India. Its flourishing textile industry collapsed in the late 1980's, but the present city still accounts for 19% of the total urban workers in the state, and hosts several key textile, chemical, engineering and pharmaceutical industries.

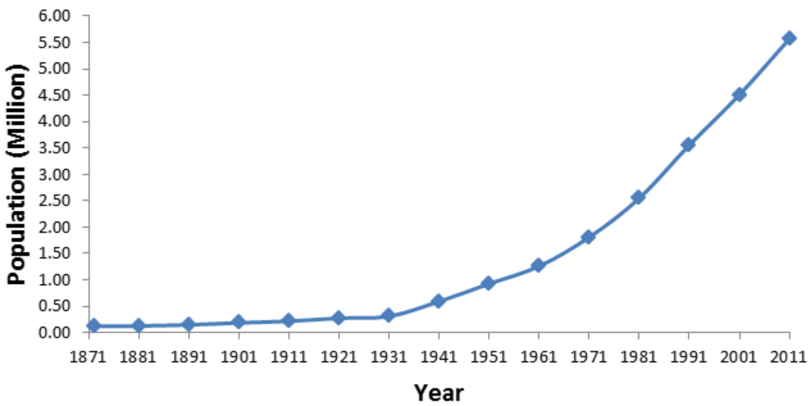


Figure 1: Ahmedabad population growth since 1871; Source: Census of India

The emerging urban fabric of Ahmedabad is more orderly, has pedestrian friendly design, with a dense and good mix of land use in the locations that developed in the pre-colonial era. However, the development of the city after independence has been piecemeal and has lacked vision of a balanced development of the metropolis (Pandya, 2002). The built form pattern is marked with lopsided and heterogeneous development. The population density ranges from 2,293 persons per hectare in certain locations in the walled city area to densities of 150 to 370 persons per hectare in the western part of the city. Ahmedabad still has a substantial urban poor population; about 25% of the total population (AMC et al., 2006) live in slums and an additional 14% live in tenement houses, or chawls (Mahadevia, 2001; Mohupa and Government of India, 2010), spread over the city.

Figure 2: Existing and proposed public transport systems in Ahmedabad

In terms of transport, present mean trip lengths in Ahmedabad are low compared to for example Bangaluru, Hyderabad and Pune (Pai, 2008) but the fast sprawling city and rapid rise in motorized vehicle ownership and use are matters of concern. There are two mass transit modes currently in operation in the city, i.e. the Ahmedabad Municipal Transport Service (AMTS), with around 540 buses, and routes oriented mostly to serve the central portions of the city, and a Bus Rapid Transit System (BRTS), which now runs successfully on the connecting radials. In addition, Ahmedabad has advanced plans for the construction of a metro system (MRT) linking Ahmedabad and neighbouring Gandhinagar.

The BRTS project is implemented under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM). This urban renewal mission also supports several slum improvement programs, such as the Basic Services to Urban Poor (BSUP), which includes the Socially and Economically Weaker Section Housing (SEWSH) project, which is considered in this study. In this project in total 976 buildings are built to relocate 78,080 poor residents from nearby slum locations.

The key question in this study is what are the anticipated impacts of investing in sustainable transport initiatives such as BRTS and MRT to the accessibility of the urban poor in Ahmedabad? This is done by demonstrating how readily available network and GIS analysis tools can quantify and graphically illustrate the effects of different public transport improvements in addressing this problem.

Specifically the impacts on accessibility of the urban poor to employment locations through public transport (AMTS, BRTS, MRT) in combination with non-motorized access modes (cycling, walking) from their housing locations (general or specifically BSUP) are addressed.

ACCESSIBILITY AS A MEASURE OF SOCIAL EXCLUSION

The interaction between land use and transport is highly complex. Everything that happens to land use has transport implications and vice versa. Urban development generates travel, and travel generates the need for new facilities, which in turn affects accessibility and may attract further development. These interconnections are particularly vivid in a city like Ahmedabad where rapid urbanization and urban restructuring are transforming the urban area. At the same time urban infrastructure is being reshaped in response to fast economic growth and further urbanization.

Sustainable transport policy can only be effective if it manages to thrive in this complex reality. Geographical Information Systems (GIS) provide a good platform to calculate and visualize metrics of transport sustainability in response to different proposed interventions, i.e. for Ahmedabad these are the next phases of the BRTS development, the introduction of a metro, the revitalization of the AMTS, provision of cycling-related feeder systems, low cost housing projects etc.

In this study the level of accessibility of different low-income groups in the city is used as an indicator of social exclusion. To date, simplified infrastructure focused mobility indicators (typical mobility metrics that focus on travel speeds and modal splits alone) have generally been used in most analyses, as they are easy to understand, measure, and communicate (Geurs and Ritsema van Eck, 2003). However, from the perspective of households and firms, the transport system itself is not important – its importance is that it provides them with access to spatially and temporally dispersed opportunities. Accessibility metrics that consider this give planners the opportunity to use it as a policy design tool (Straatemeijer, 2008; Groenendijk et al., 2003). Furthermore, accessibility metrics allow distinguishing between social-economic groups, hence studying social exclusion. In addition, recent advances in GIS make the use of high quality visualizations possible that can be more readily used and understood by planners, policy makers, and the general public. The rapid development of these tools is a benefit for all those interested in understanding the complex interactions that take place in cities.

Accessibility indicators and applications

In a highly dynamic globalized economy, adequate access to spatially and temporally dispersed resources (consumers, jobs, suppliers) is a vital condition for firms and households in order to thrive or even just to survive (Castells, 1996). Accessibility is the potential for interaction between these resources and is influenced by the qualities of the transport system (reflecting the travel time or costs of reaching a destination) on the one hand and by the qualities of the land use system (reflecting the location and numbers of potential destinations), on the other hand (Handy and Niemeier, 1997). Accessibility can therefore be used as an indicator of the integration between land use and transport. To date, simplified infrastructure focused mobility indicators have generally been used in most analyses, as they are easy to understand, measure, and communicate. Examples of such infrastructure-based indicators are the level of congestion, travel time, or travel cost, all of which have strong methodological disadvantages (Geurs and Van Wee, 2004) as compared to the accessibility metrics presented here.

There are three important reasons for considering other accessibility metrics than the infrastructure-based ones (Straatemeijer, 2008):

- From the perspective of households and firms, the transport system itself is not important – its importance is that it provides them with access to spatially and temporally dispersed opportunities.
- Accessibility defined in this way gives planners the opportunity to assess the effects changes in transport and land-use system have on the potential for interaction, and can be used as a policy design tool (Groenendijk et al., 2003).
- For politicians, citizens and firms it may be easier to discuss the quality of access to education services and markets than it is to discuss the inefficiencies of the transport system.

A whole range of improved accessibility measures – as compared to the infrastructure based accessibility indicators – have been proposed in scientific literature. However, more complex indicators also require more analytical skills from users (Handy and Clifton, 2001) and they place high demands on available data. Activity-based measures provide an important class of measures as they analyze the accessibility of locations, typically on a macro-level such as Traffic Analysis Zones (TAZ). Typical measures are the cumulative opportunities (or contour) measures that, for example, measure the number of jobs within 30 minutes by car from the origin location, and the potential measure (or gravity measure) that discounts these opportunities over time (or distance) using a distance-decay function. This is done to count an opportunity closer by as more important than an opportunity at a distant location. More complex location-based measures explicitly incorporate capacity restrictions of supplied activity characteristics to include competition effects (Geurs and Ritsema van Eck, 2003). Potential accessibility measures have been used in several recent applications such as in Tel Aviv and Ha Noi for assessing the difference between potential accessibility by car and public transport (Benenson Et al., 2010; Hong Ha Et al., 2011), in Boston, Los Angeles and Tokyo to compare potential accessibility to jobs versus different urban form (Kawabata and Shen, 2006), in Finland to study the relation between potential accessibility by road and railway to population change (Kotavaara Et al., 2011), and in China to develop an Urban Accessibility Planning Support System (Shi Et al., 2012).

In this study we chose to apply activity-based metrics as they explicitly link locations of opportunity (i.e. jobs and locations of the urban poor), while considering the resistance of space (i.e. travelling through a multi-modal transport network).

LOCATIONS OF THE URBAN POOR

In Ahmedabad about 40% of the population resides in informal settlements. It is believed that most of the urban poor reside in these locations. The two dominant types of informal settlements are slums that involve illegal occupation of the marginal areas of the city by migrants and squatters and chawls that are residential units originally built for workers in the mills and factories. Most slum dwellers tend to settle along the waterways in the city, on the vacant land or on low lying areas (Bhatt, 2003).

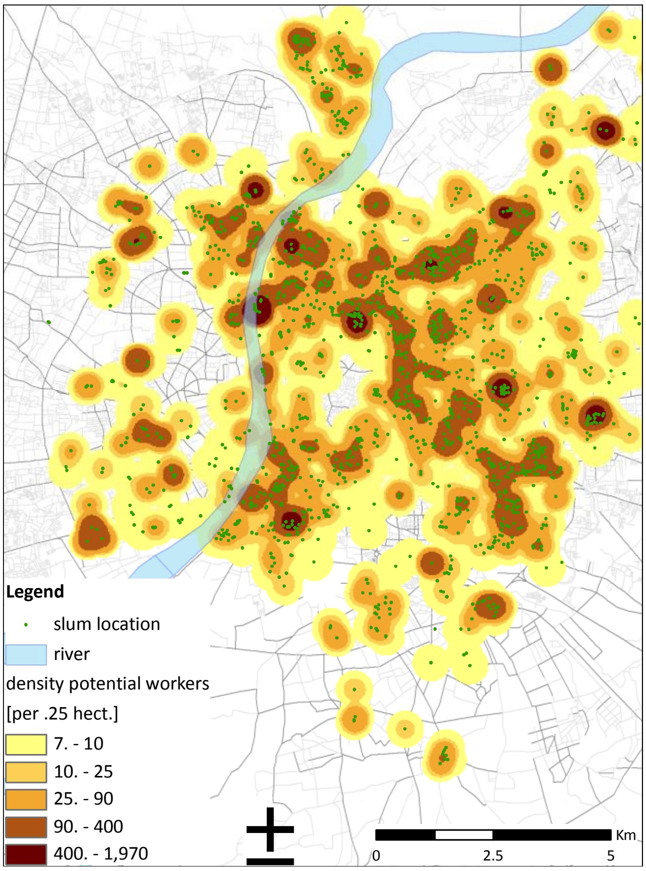


Figure 3: Kernel density of all potential urban poor workers per .25 hectare.

To identify the locations of the urban poor in Ahmedabad it is assumed that the urban poor mostly live in these slum and chawl areas in the city. The data on their locations were collected from CEPT University in Ahmedabad as part of the *Slum Free City: Ahmedabad* project. The survey data for these areas contains the number of huts in total, the number of huts that are poorly built (kutchha), the number of huts that are of good construction (pucca) and one class in between (semipucca). The three types of housing conditions are used as proxies to classify the urban poor into the least-poor (occupying pucca housing), middle-poor (occupying semipucca housing) and very poor (occupying kutchha housing) categories, and to estimate the number of (potential) workers assuming 2 potential workers per hut irrespective of housing type, following (Bhatt, 2003).

Figure 3 shows clusters and (kernel) densities of (potential) workers (all urban poor classes combined) in the city based on the slum and chawl locations.

LOCATIONS OF EMPLOYMENT OPPORTUNITIES

To identify employment opportunities and map their locations at an appropriate spatial scale, job locations, job types and their densities were derived using 2011 property tax data of Ahmedabad. These data were spatially disaggregated to obtain job density grids (using 100m x 100m grid cells) and clusters by known employment sector data, i.e. distinguishing industrial, retail, government, education, transport and logistics, and office and commercial jobs. The employment data per grid were then grouped into three categories: salaried (education, banks, government, hotels and commercial), self-employed (one for each retail job) and casual labour (storage godowns and industries) jobs, a typical urban employment subdivision that can be linked (but not exclusively) to the identified worker categories, i.e. the least poor, middle-poor and very poor respectively, following Ray (2010). These categories represent different levels of wages or poverty rates and uncertainty of income. The percentages of these job categories and worker classes in Ahmedabad are depicted in the chart in figure 4, where matching colours indicate matching job categories and urban poor classes. There is a surplus of potential jobs, which obviously may also be occupied by the non-poor workers. Competition for jobs as such is not considered in this study.

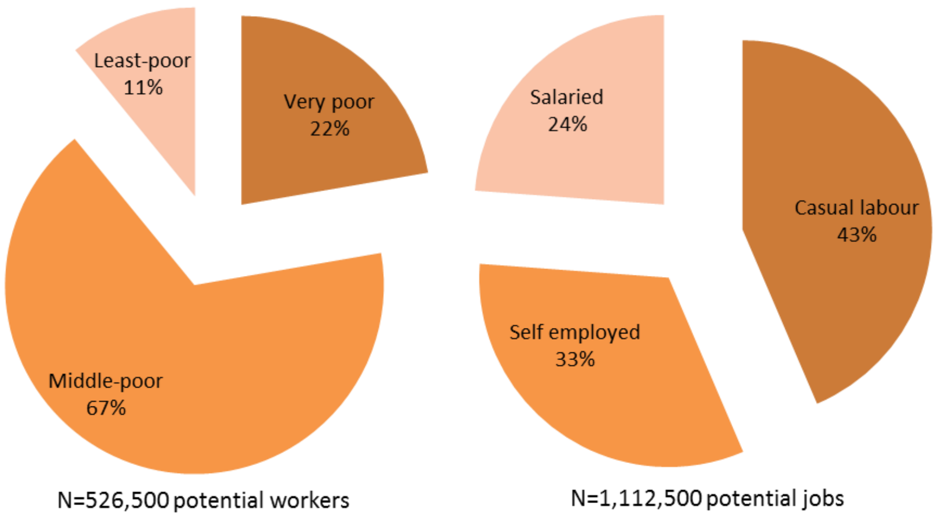


Figure 4: Distribution of urban poor classes and employment categories.

For the accessibility analysis both the locations of the urban poor and employment locations have been aggregated to a 400 x 400m grid.

MODELLING PUBLIC TRANSPORT SYSTEMS

A transport system consists of a network, routes, nodes and terminals. Each specific mode in a transport system represents a sub-system of the whole transport system with its own network and routes and with contact points or exchange points at the nodes or terminals where it is possible for people to change from one mode to another. In the case of Ahmedabad, the following modes are considered:

- Non-Motorised Transport (NMT) modes (walking and cycling), operating mostly on sidewalks for walking and on the general road network for cycling with the exception of some bicycle paths along the BRTS.
- The Ahmedabad Municipal Transport Service (AMTS), operating fixed routes on the general road network.
- The Ahmedabad Bus Rapid Transit System (BRTS), operating fixed routes on dedicated BRTS infrastructure. Phase 1 of this system is currently in operation, while phase 2 is under construction.
- The Ahmedabad Metro rail (MRT), which will be operated on dedicated rail infrastructure.

There are no private motorised modes used in the model. It is assumed that the urban poor hardly own and use those. The influence of these motorized modes on the average operating speeds of the other modes such as cycling and AMTS is considered though. A GIS network dataset that contains all four modal networks has been developed, i.e. a geo-database including the general road network layer (used for modeling access and egress trips by walking or cycling), the AMTS network, the BRTS network and part of the proposed MRT network. All networks include stops or stations where trip makers can enter, exit or transfer within or between the modal networks. As such, a fully connected and functional 3-dimensional multi-model network model has been implemented in a GIS (Figure 5).

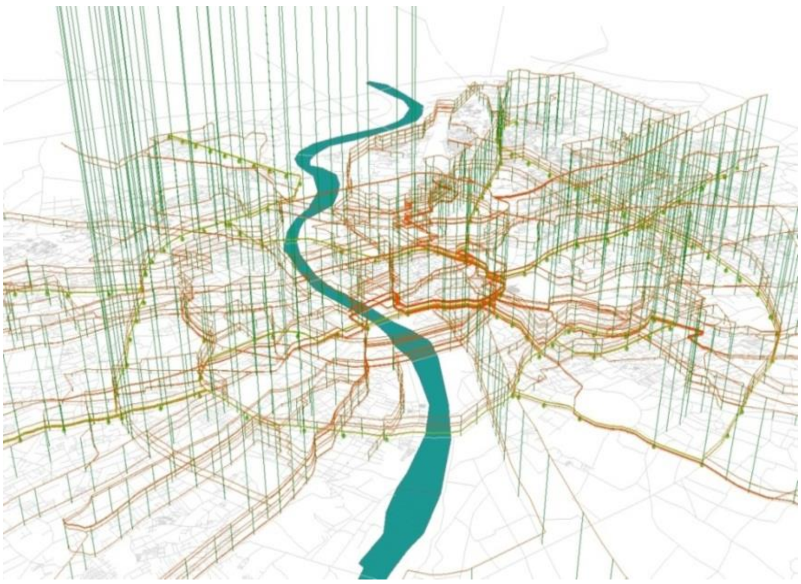
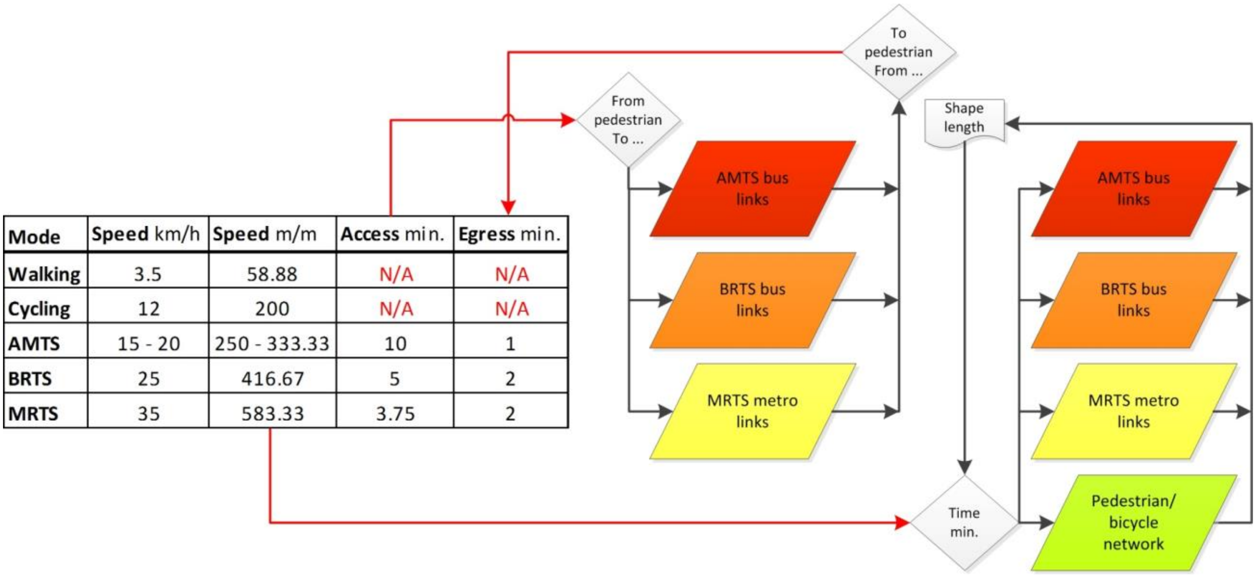


Figure 5: The 3-D representation of the public transport model for Ahmedabad

Travel time and distance are considered as the main impedances in this model, although the database allows for adding other attributes such as distance-based fares etc. The time cost is the sum of all time spent using a mode or transferring between modes. Figure 6 shows how the various transport system attributes are combined into one multi-modal network model. The multi-modal network model is complemented with walking or bicycle access and egress times, while waiting times (access to a platform and egress from a platform) are assumed at half the frequency. In this way the GIS database can be used to link the urban poor locations and their respective job locations.



Mode	Speed km/h	Speed m/m	Access min.	Egress min.
Walking	3.5	58.88	N/A	N/A
Cycling	12	200	N/A	N/A
AMTS	15 - 20	250 - 333.33	10	1
BRTS	25	416.67	5	2
MRTS	35	583.33	3.75	2

Figure 6: Modelling of network impedances

ACCESSIBILITY TO JOBS OF THE URBAN POOR

Two types of accessibility metrics have been implemented and mapped for several scenarios (varying between mode combinations, poverty classes and locations of interest). The first contour-based accessibility metric maps the area that can be reached in different time bands of travel (10, 20, 30, 45 and 60 minutes) around one or more fixed locations. Travel times are calculated in the multi-modal network model, based on the estimated travel speeds and attributes such as average waiting times at bus stops. The number of jobs within reach of one contour can be calculated by counting the number of jobs (by employment category) in a GIS overlay operation. The second potential accessibility metric is an extension to the contour measure and discounts jobs that are further away from a location using a negative exponential decay function that is fit to represent Ahmedabad conditions. The two types of accessibly metrics are implemented in model scripts.

Three examples of possible applications are presented here to demonstrate the functionality and use of the model. A comparison of levels of accessibility to jobs by multi-modal combination, including a defined access and egress mode (walking or cycling), by class of urban poor (thus employment category, see Figure 4) and by location is shown. For the latter we look at the city as a whole as well as at the 21 SEWSH locations.

Counting job opportunities to and from SEWSH locations

Using the contour-based accessibility measure the number of job opportunities of the potential working population (all three urban poor classes together) in 21 selected SEWSH locations is derived. Various travel time bandwidths are distinguished. Figure 7 shows two contour maps for one central SEWSH location (Ahmedabad cotton mill – SESWH No. 5) showing the impact of the current and planned investments in the BRTS and MRT systems on job accessibility as compared to the situation with walking and AMTS only. The spatial extent of the job opportunities reachable within one hour travel time clearly increases as, particularly near the current and planned corridors, travel times reduces. To see the effect on job accessibility in terms of the number of opportunities we spatially overlay with the employment map (all three urban poor classes combined) to get the chart in figure 8. The chart shows the total number of job opportunities reachable for each of the 21 SESWH locations in stacked bars indicating the different travel time bandwidths. For all 21 locations together, the BRTS and MRT investments increase the level of job accessibility for the urban poor within 30 minutes travel time by 16.5% as compared to the AMTS situation only, while this figure is almost 50% for trips up to 60 minutes.

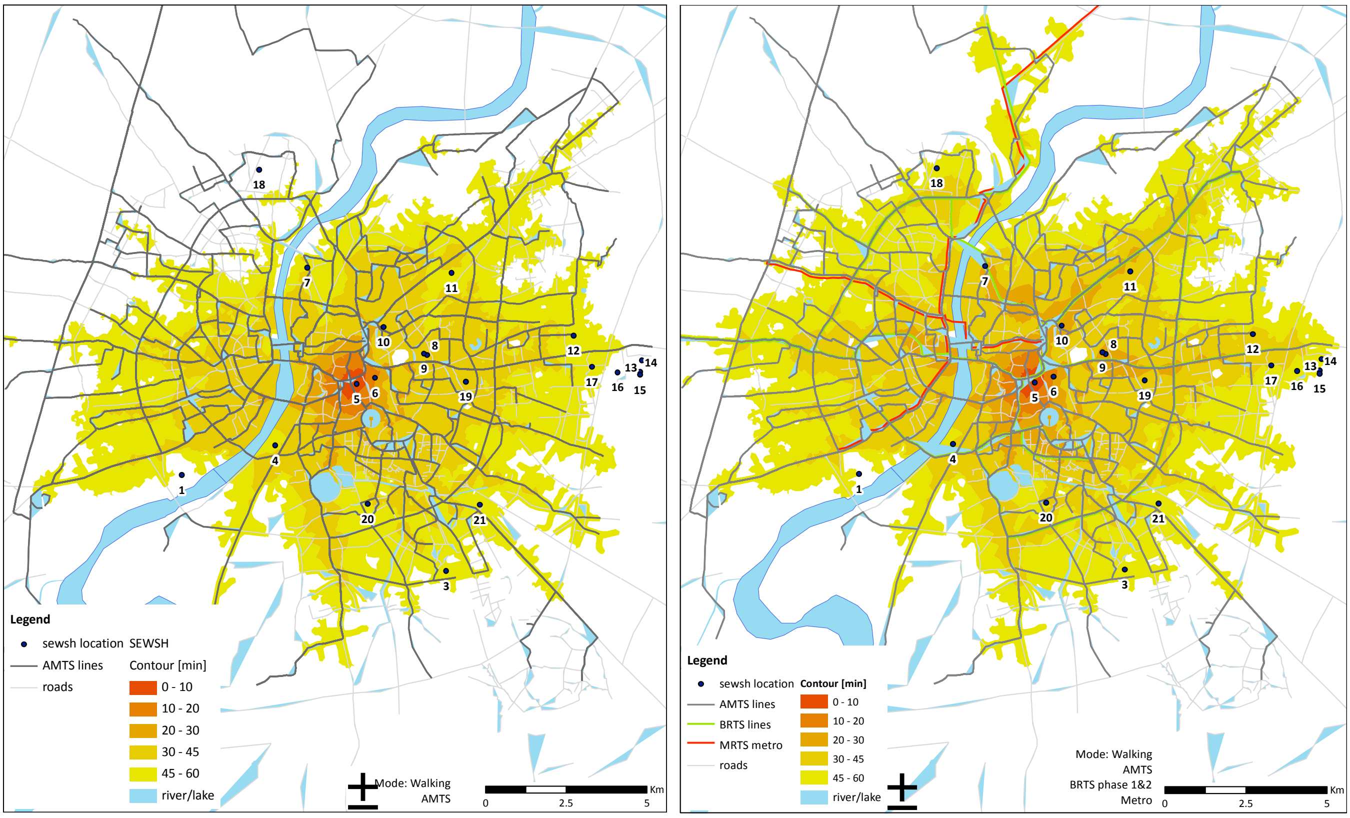


Figure 7: Contour–based accessibility plots for Ahmedabad cotton mill (No. 5) for walking and AMTS only (left) and all current and planned public transport modes + walking (right) for different contour bandwidths (all urban poor workers combined). Names of the SEWSH locations are given in the Appendix.

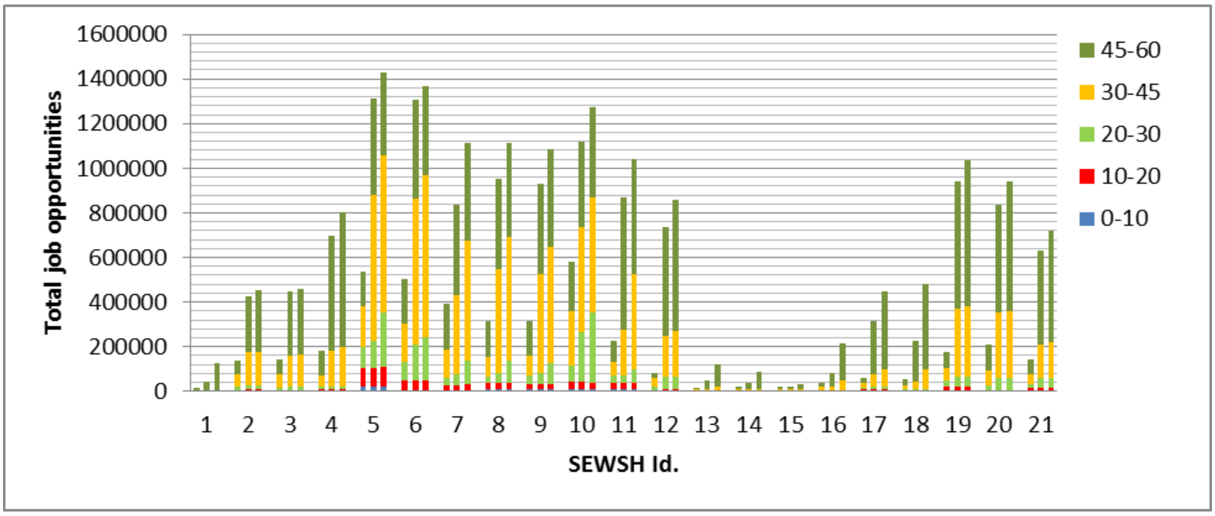


Figure 8: Contour–based accessibility levels per SEWSH location for different contour lengths (in minutes) in stacked bars. walking (left), walking + AMTS (middle) and all modes (right) (all urban poor workers). Names of the SEWSH locations are given in the Appendix.

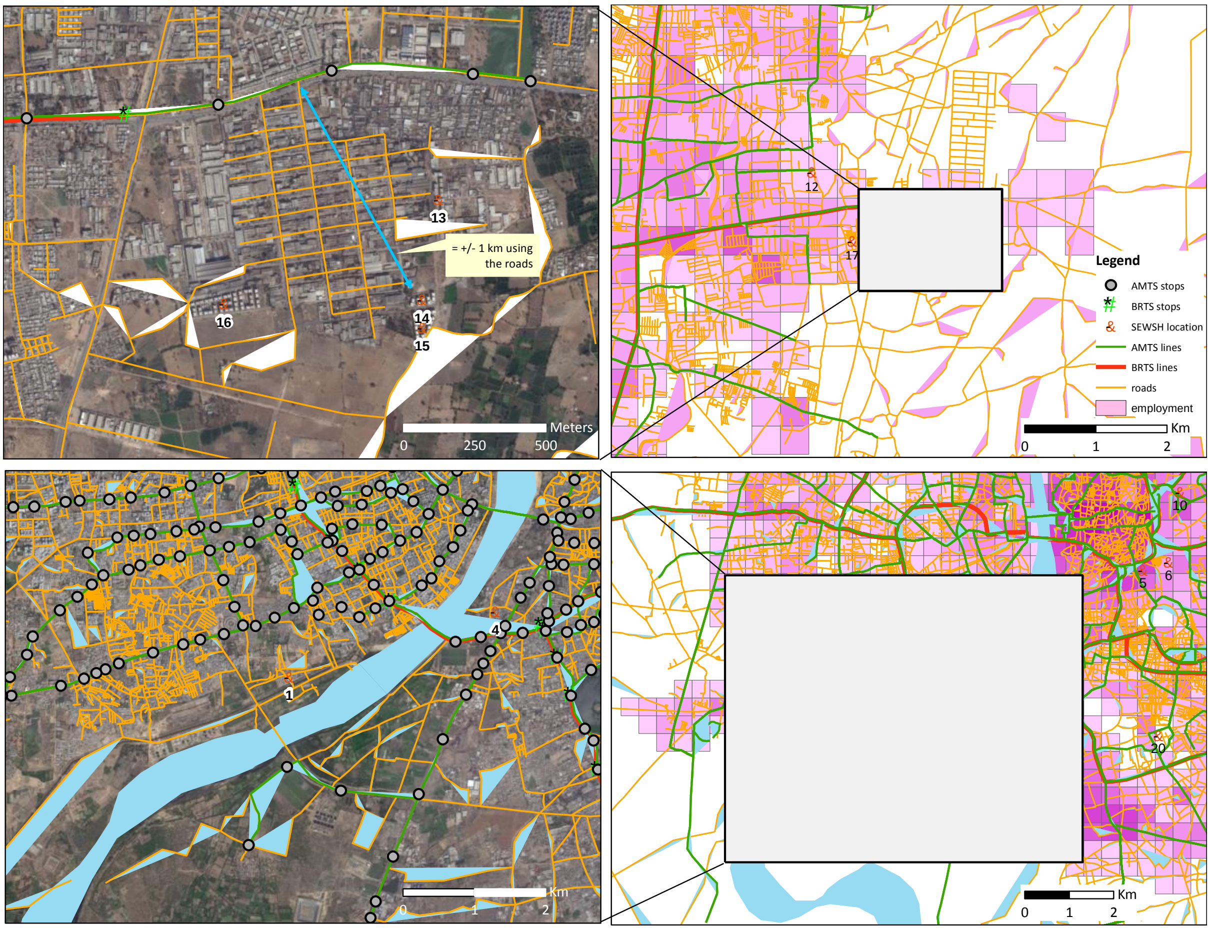


Figure 9: SESWH locations 1, 13-16 showing the BRTS network and planned station (green triangle) and the existing AMTS route (grey circles); job densities indicated in pink colour intensities (all urban poor workers). Names of the SEWSH locations are given in the Appendix.

Five locations (SESWH locations No. 1, 13-16) stand out in the analysis and show low overall levels of job accessibility. Detailed analysis of these locations in Figure 9 further reveals that they are located relatively far away from current or planned public transport stops, and also in areas with relatively lower job densities.

City-wide potential accessibility analysis

The potential accessibility measure explicitly combines job opportunities of the poor and the difficulty of travel. Job opportunities are discounted with increasing travel time using a negative exponential decay function; a distant job is valued less than one close by. A decay factor of -0.03838 is used, whereby it is assumed that a job 60 minutes away is 10 times less attractive than a similar job in the present location. This factor has not been calibrated here, as it would require an extensive survey on job utility versus travel impedance, but feels realistic. The differences in this potential accessibility value can be substantial across modes. Figure 10 visualizes the potential number of jobs by the least-poor worker class accessing salaried jobs in Ahmedabad comparing walking only with that of the currently implemented public transport system (AMTS + BRTS phase 1). The 3D visualization shows job concentrations in the base layer and depicts potential job accessibility per grid cell by walking only in the purple bars (colour intensities and height indicate the level of potential accessibility) while the floating green squares show the added level of job accessibility offered by the current AMTS and BRTS phase 1 systems. Clearly, the contribution of the AMTS and BRTS phase 1 systems to potential job accessibility is highest in the areas surrounding the centre locations with high job-density. More jobs can be reached in a shorter travel time, and these are valued higher because of the decreased travel time to reach them. The average overall contribution of the AMTS and BRTS phase 1 to the level of potential job accessibility for the urban poor class compared to walking alone is estimated at 138%.

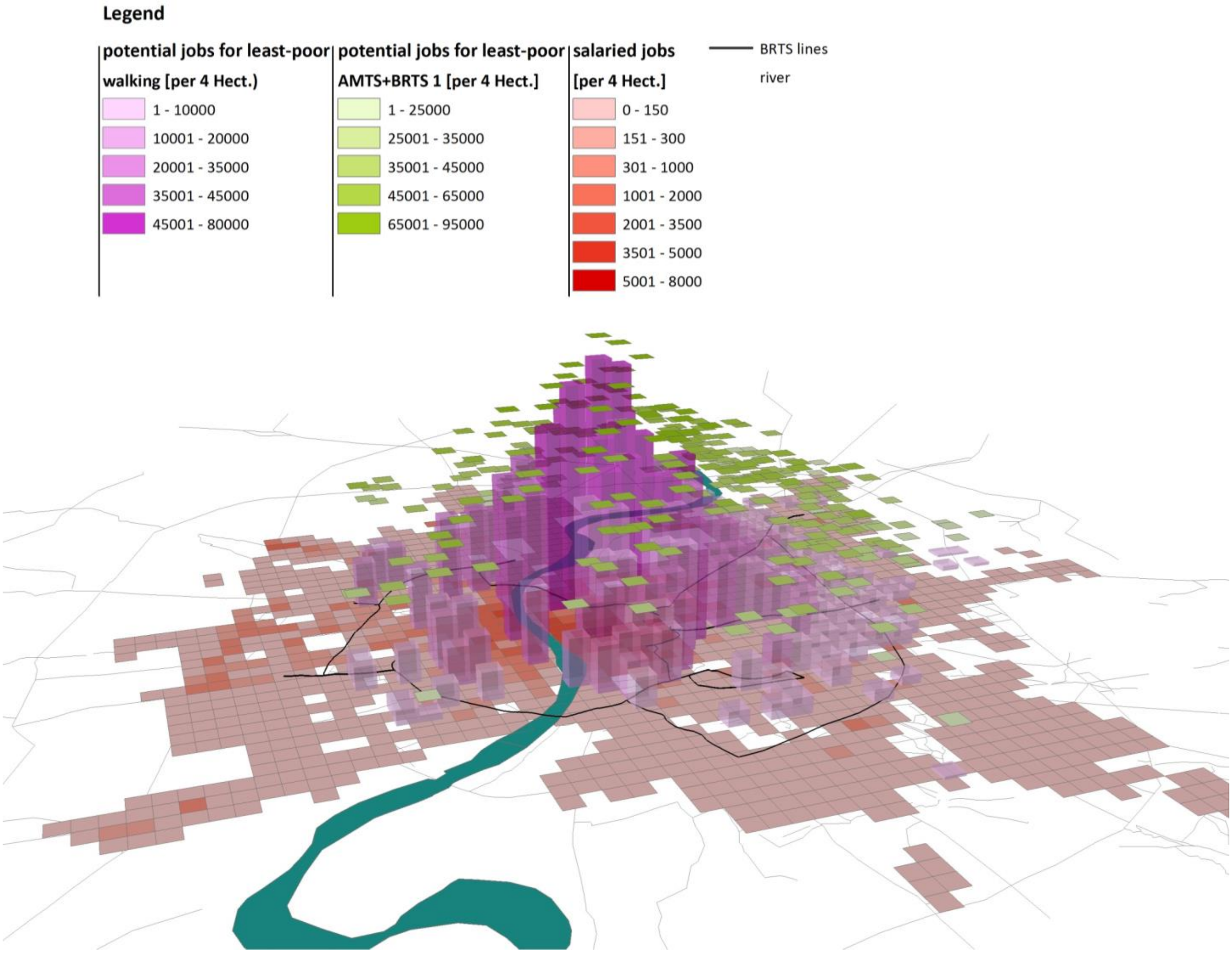


Figure 10: Job-based potential accessibility for the least-poor worker class, comparing walking only with current public transport options (AMTS and BRTS); also showing the density of salaried job opportunities in red in the base layer.

Next, figure 11 shows the gain in potential accessibility levels for all urban poor classes combined from the situation with walking and AMTS only to the situation where the BRTS and MRT have been implemented fully. The top maps in figure 11 show the potential jobs for the two different mode combinations, while in the bottom map both scores are divided. Clearly, the BRTS and MRT corridors are visible in the resultant map. This indicates that the effect of the BRTS and MRT systems on potential job accessibility is substantial in these areas. The average overall contribution of the BRTS and MRT systems to the level of potential job accessibility (for the whole city) compared to the walking and AMTS combination only, is estimated at 8%.

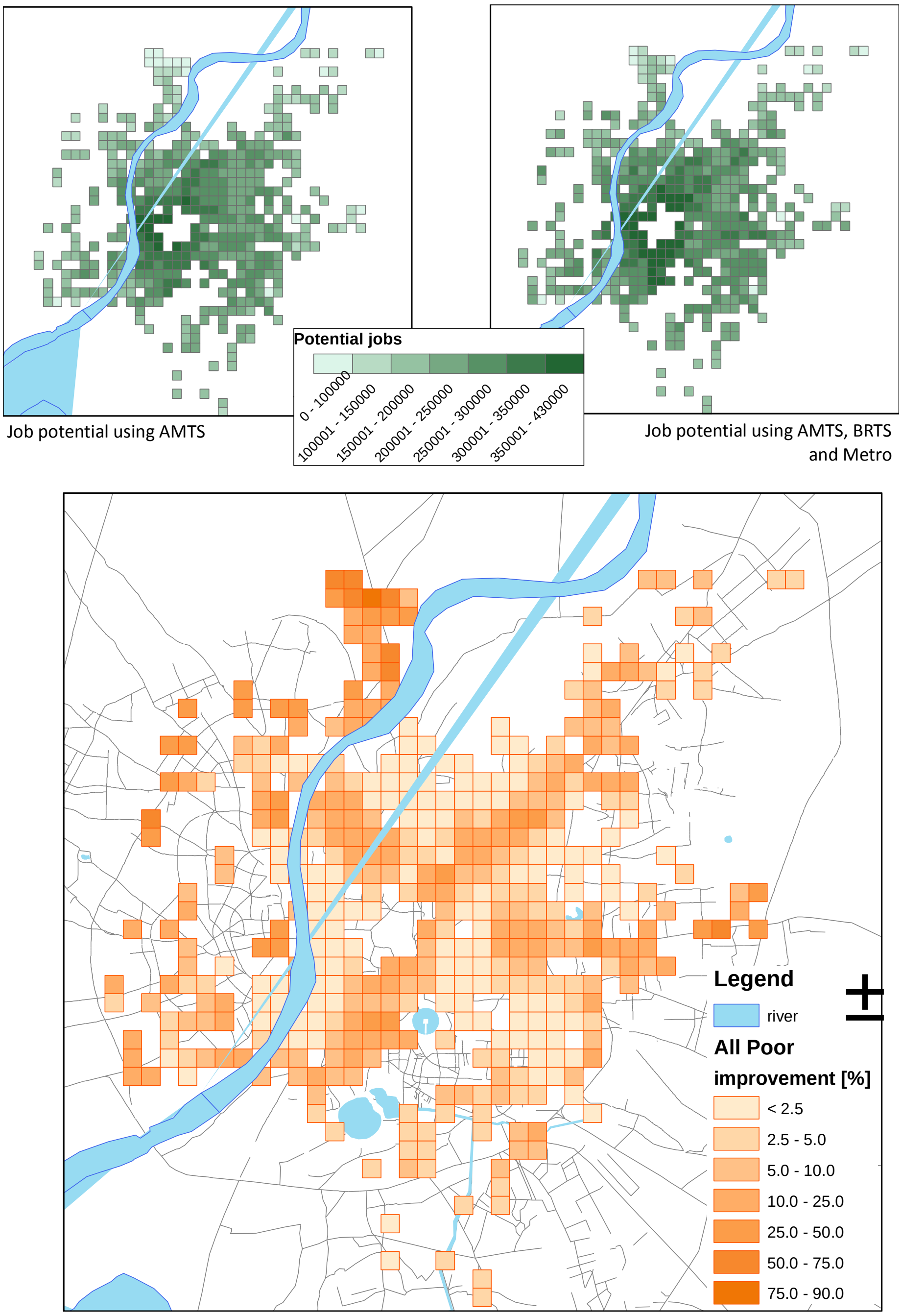


Figure 11: Ratio of job-based potential accessibility for all urban poor workers comparing all public transport options with walking and AMTS only.

Finally, the three urban poor classes, who live in different locations and who are employed in different job categories are looked at specifically. Analysing the expected gain in their potential accessibility levels from the current AMTS and BRTS phase 1 systems to one with the BRTS phase 2 and MRT phases 1 and 2 fully implemented, reveals a potential increase of 5.1% for the least-poor workers, 5.7% for the middle-poor workers and 3.9% increase for the very poor workers. The very poor workers (accessing casual labour jobs) will benefit less than the other 2 groups of the planned extensions, while the middle-poor workers (accessing self-employment jobs) benefit the most.

Effect of promoting bicycle feedering for SEWSH locations

To show the impact of facilitating cycling options from and to the bus stops and metro stations on the level of potential job accessibility, figure 12 shows the relative share of cycling-related potential accessibility to that of walking-related potential accessibility for the 21 SEWSH locations in the city in the situation that all proposed public transport interventions have been implemented. The assumption is here that cycling is three times as fast as walking. This is reasonable, especially when proper cycling facilities are made available throughout the city. On average the level of potential accessibility for the 21 locations improves by 135%, which is substantial. Interestingly, this is particularly caused by the improved access and egress in the 5 locations, mentioned in example 1 (figure 7), which have low (contour-based) accessibility levels (NOs 1, 13-16). These locations are relatively far from public transport stops. The improved bicycle access and egress makes that more jobs are reachable in the shorter travel time band widths, thus discounted less.

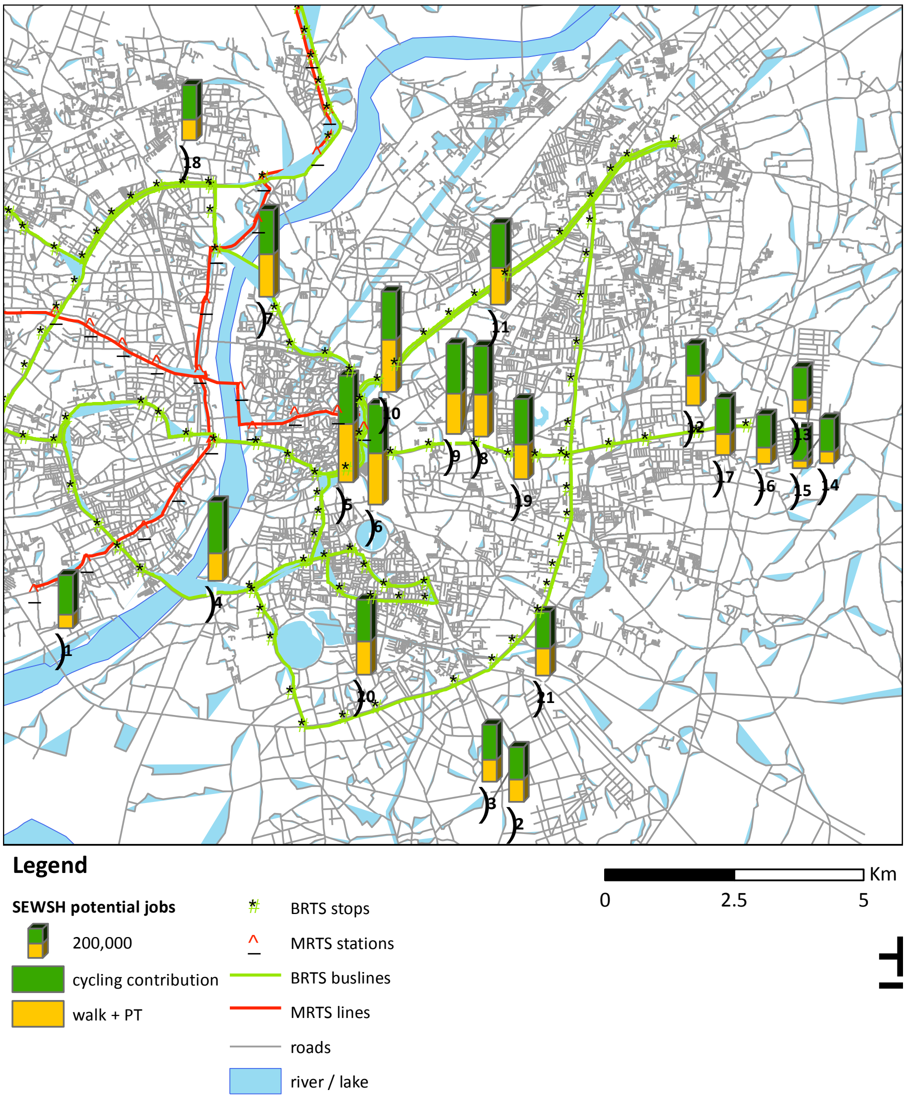


Figure 12: Potential accessibility in SEWSH locations for all urban poor workers. Comparing walking and cycling feeders to all public transport options. Names of the SEWSH locations are given in the Appendix.

CONCLUSIONS AND RECOMMENDATIONS

The objective of this study was to measure the effect of public transport (BRTS and MRT in particular) on the level of job accessibility for the urban poor in Ahmedabad, India.

In order to carry out this task, different spatial data sets on the locations of the poor, their employment opportunities and the various transport systems needed to be synthesised and developed in a GIS environment. A fully functional integrated public transport system was developed that allows for the analysis of accessibility levels over the different systems and provides the user the opportunity to evaluate the competition between systems on the basis of their contribution to improved levels of job accessibility.

Our findings show that there is variation between accessibility to jobs for the different urban poor groups. Compared to walking, public transport does improve job accessibility, particularly through the extensive AMTS network, that can be accessed relatively easily from all locations in the city. The current and planned investments in BRTS and MRT improve this accessibility to jobs considerably further, but mostly in the catchment areas of these systems.

The present results consider walking as an access and egress mode. When cycling is introduced – the current modal share of cycling being around 19% of the total trips in Ahmedabad – potential accessibility levels improve further as cycling provides a good last-mile access and egress to and from the BRTS and MRT stations, combining the strengths of both systems.

Public transport fares have not been considered in this analysis. Fares have not been built into the model and also affordability of the various public transport systems for the poor has not been evaluated. Including fare information may therefore affect the results of the contributions of BRTS and particularly MRT to the level of job accessibility as these fares are generally higher than for AMTS, let alone for walking or cycling.

Which lessons can be learned for policy making?

Accessibility to PT and even to cycling is a pressing issue for the urban poor in Ahmedabad as they experience a highly constrained mobility, mainly caused by issues of affordability, as described in Mahadevia Et al. (2012). This constrained mobility has implications on their actual levels of accessibility to jobs. This study has analysed the potential levels of accessibility that the land use - transport system in the city provides to the urban poor. Particularly affordability issues pose barriers to realizing this potential, while additional improvements to the land-use transport system itself can increase the potential further as described below.

It is clear from the analysis that the current and planned public transport interventions do benefit the poor in terms of their accessibility to jobs. These benefits are significant, despite the low spatial extent of the BRTS and MRT systems, except for those areas that are both lacking good access to the bus and metro stops and where the job densities (in the specific categories) are low, forcing them to make long journeys.

To improve the benefit of systems like BRTS, particularly for the urban poor, its spatial coverage should expand and more attention needs to be paid to the routing of the various systems in view of the locations of the urban poor and their jobs, also keeping in mind that several of the informal settlements and part of low cost housing projects such as the BSUP. Their formalization should be done in conjunction with the future planning of transport.

Feeder functions of cycling and walking, in access trips, but potentially also in egress trips should be considered more seriously and specific policy needs to be developed to make BRTS more accessible to cyclists. Such policy could involve the safeguarding of current cycling infrastructure facilities and the provision of new facilities, safe crossings, parking facilities and the like. In addition, the implementation of public bike schemes could be considered at strategic locations.

Besides it is clear that the AMTS system already provides a high level of job accessibility to the urban poor. Investments in good feeder systems, particularly for pedestrians, and investments geared towards further improvement of the existing AMTS (e.g. planning and scheduling) as well as possible integration with the BRTS and MRT systems are seen as good ways forward.

To push the agenda of social inclusion of the urban poor forward, this study shows that local planning effort should concentrate on public transport improvement, the NMT feeder function as well as integrated urban land use and transport development strategies, acknowledging the home and job locations of the urban poor as to bring employment opportunities closer to the urban poor and vice versa.

The results of this pilot project demonstrate that accessibility metrics provide valuable insight to decision makers on key issues that concern levels of accessibility for the lower income groups and on the role public transport and feeder systems can play in this.

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APPENDIX: NAMES OF THE SEWSH LOCATIONS

1. Shahwadi
2. Vatava
3. Vatva Site A & Site B
4. Calico Mill
5. Ahmedabad Cotton Mill, Sarangpur
6. Kesar Hind Mill Ni Chali
7. Rustam Mill
8. Vivekanand Mill
9. Raipur Mill
10. Saraspur Mill
11. Vijay Mill
12. Odhav-1, 187
13. Odhav-3, 23
14. Odhav-3, 37
15. Odhav-3, 38
16. Odhav-3, 51
17. Odhav-3, 86
18. Vadaj BSUP
19. Ajit Mill, Rakhiyal
20. Ishanpur
21. Bag-e-Firdosh