Uncovering the transformation of the urban socio-spatial network, actuated by riverfront development: The case of Ahmedabad's Sabarmati Riverfront

by

Freyaan Anklesaria

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Supervisor: Dr. Kayvan Karimi

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Abstract

In the last decade the Indian subcontinent has seen unprecedented urbanisation and a unique political situation. As cities often become models to project certain identities, one such case has been taken up here to understand this phenomenon through a recent urban intervention. The Sabarmati Riverfront development (SRFD) project has been a landmark in urban design in contemporary India as it is an instance where political agenda is furthered through an urban design project. The study analyses how this project altered the city's relationship with its river by altering the spatial structure of the city itself. It then proceeds to examine how the project performs on its goals of creating inclusive public space for the city. The spatial structure of the city and the alternations to it by the project, are described using a spatial network analysis based in Space Syntax theories and methods. The shift in centralities (from before to after the SRFD) are observed in conjunction with what is known from other layers of geo-located data such as ward wise population densities, point of interest clusters, observed movement counts and public transportation network. Based on this information the study examines to what extent the riverfront is integrated into, and hence accessible to, the city of Ahmedabad. The analysis highlights the major difference in the performance of the project at a global (city wide) scale versus a local (walk-able distance) scale, suggesting a need for better integration into the local context, this is corroborated by the network catchment from the nearest public transportation nodes. The findings also hint at a problematic private vehicle centric approach to urban design. These examinations of the riverfront's accessibility specify where and how it underperforms as an inclusive and vibrant public space. The attempt here is to identify the potentials for improving the performance of the riverfront as a public space in itself as well as its effect on the spatial structure of the city. In this light some speculative design strategies are tested.

Key Words: Urban riverfronts, Spatial Network Analysis, Ahmedabad, Sabarmati Riverfront Development, Space Syntax, Accessibility, Public Space, Urban Design.

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I dedicate this work to my parents.

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1 The basis of enquiry: The transformational role of Urban Riverfront developments

Through history it has been observed that river systems are crucial elements in the foundation and emergence of most cities (Kostof, 1991). The role of rivers is thus deeply intertwined with the urban social and spatial structure.

'The city was born "In between rivers" and, throughout history, most cities tended to be founded about or near rivers, with notable events along the river course chosen for location, such as wedges on the meeting of two rivers, sharp bends, high-points overlooking the river, islands or on the river mouth (Kostof, 1991, p. 39). Though referring here to the cities of Mesopotamia, the phenomenon is universal as evidenced by cities across the world.

With time, the reliance of cities on the river as a source of water and medium of transportation reduced significantly, rendering the river less instrumental. In cities where the river is no longer a medium for transportation or a primary source of water, the meaning of the river, hence also, its relationship with the city begins to change. In such cases the discourse on rivers becomes about restoration and improvement of the quality of the urban landscape. This includes- '*improvement of the current state of rivers and its surroundings through a general valorisation of the ecological, social, economic and aesthetic properties. This kind of preoccupation is also related with the dynamics of land-use transformation on marginal areas of rivers, where old industrial areas are seen as an opportunity to improve leisure activities, valued by people nowadays, and also to the improvement of aesthetics and the quality of public spaces that have clear effects on tourism and, therefore, on economic development of cities'* (Silva, Serdoura, & Pinto, 2006, p. 1). Most river cities today see this shift from earlier situation where the river served had a specific function to the current situation where river is seen for its potentials of speculated value (often aesthetic) addition.

In city-river systems (Silva, Serdoura, & Pinto, 2006), the role of river is pivotal not only to the geographic and morphological logic of the city but also to its functioning as a socio-spatial system. As a result, increasingly, the river banks are seen as underutilised opportunities of open space with potential for redevelopment and regeneration of the urban realm itself. From tapping into the various potentials of the natural resource to creating new public amenities to foster an identity for the city, riverfront developments work in several ways to consolidate the image of the city. The chosen image to be projected varies based on the interests and agendas behind the development. *'A recent trend in the urban development process has been to project cities as having the appropriate infrastructure to support global financial centres.'*

(Banerji, 2011, p. 3) This concept of Global financial centres and how the riverfront development in Ahmedabad becomes an instrument to project this image of the city is discussed in this study. The case being studied here is one such instance of a city where the river is no more instrumental in the way that it was during the establishment of the city but rather is being looked at as an opportunity for improving the aesthetic appeal of the city and creating public space for recreational activities thereby reshaping the city's identity.

In terms of population, Ahmedabad is the fifth largest city in India and has recently (2017) been declared a world heritage city by UNESCO. It is a city with a rich cultural heritage and historical as well as contemporary significance in the context of upcoming urban centres in South Asia. Over last 70 years the city has seen an extreme ideological transformation from its 'Gandhian era' to one that is increasingly associated with right-wing Hindu organizations which have mobilized and fostered religious animosity for political gains (Spodek, 2011) (Desai, 2010) (Chatterjee, 2012).With a history of communal riots and a mass killing of Muslims in the city as recent as 2002, the city is highly segregated along communal lines, particularly marginalizing its minority Muslim population (Laliwala, 2018). The city also has a stark east-west divide in socio-economic terms (See Figure 2) which coincides partly with its religious segregation (See Figure 29). There is a parallel narrative of Gujarat being a model for development, prosperity and effective governance, owing to the then Chief minister of state and now prime minister of India Narendra Modi and the Hindu nationalist political organisation called Bharatiya Janata Party (BJP) (Bhatkal, Avis, & Nicolai, 2012).

As the BJP established a strong hold in the state of Gujarat it projected a development-centric rhetoric which aroused the aspirations of the middle class. This manifested in projects of beautification and infrastructural developments all geared towards projecting Ahmedabad as a 'global city' which is doing better than the rest of developing India. The Sabarmati riverfront development (SRFD) project in Ahmedabad coincides chronologically and ideologically with these political developments.

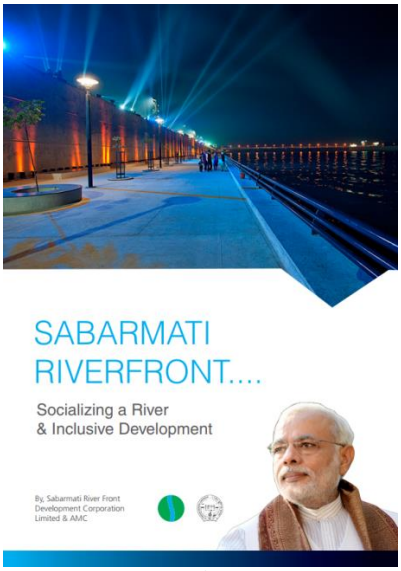


Figure 1: Cover page of a report about the project by SRDFCL (Sabarmati Riverfront Development Corporation Ltd.) and AMC (Ahmedabad Municipal Corporation).

Having significantly altered the relationship of the city with the river Sabarmati, this development is now being considered a model for future riverfront developments across the subcontinent. This development has been discussed widely in the light of its anti-poor attitude (Bhatkal, Avis, & Nicolai, 2012), its model of governance and implementation (Mathur, 2012), its environmental impact and its architectural appropriateness (Rao, 2012). However there have been no in-depth analyses focussed on the relationship between the physical interventions and their potential socio-economic implications. In order to understand this it is first necessary to have an objective description of how the project altered the spatial structure of the city. This can be complimented with an understanding of the demographic distributions of user groups, the history of the city and the project and the existing patterns of usage of the project.

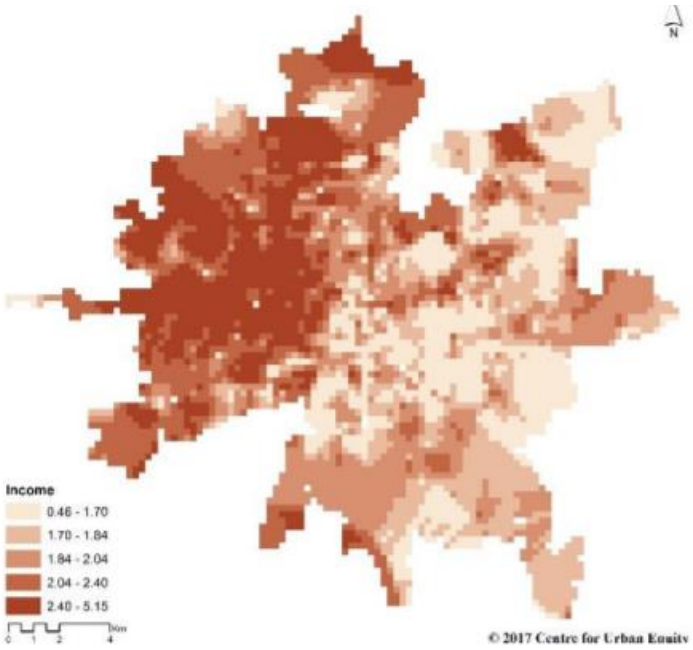


Figure 2 Income levels across the City of Ahmedabad: acquired from a report by Centre for Urban Equity (CUE), CEPT Ahmedabad.

1.1 Motivations, Aims, Scope and Limitation of the Study

The study at hand aims first to examine the same project from the perspective of the changes in city's spatial structure caused by this intervention and the projects accessibility to its users. Using other layers of data such as population density, public transportation etc. this study also intends to explain how the spatial transformation has inherent potential of socio-economic transformation. One pertinent sense in which this transformation is anticipated and examined is in the projects accessibility to the public. The reason for this is to understand whether a

politically successful urban intervention actually succeeds at its goals of social inclusivity necessary for creation of truly 'public' space.

The primary motivation behind this study is to understand the potential of this urban design project in restructuring the city's spatial and social realm. The personal motivation is to use a spatial network analysis to understand this transformation which I have witnessed as a resident of the city for 15 years. This is an attempt to add an objective, scientific and empirical layer to the prevalent understanding of the project. Such a study can be used to formulate speculative guidelines for similar developments in other major Indian cities which share an increasingly strained relationship with their rivers.

The aim of this research is to understand the effect of the Sabarmati Riverfront development on the city, seen from the perspective of its performance as an inclusive public space for the people of Ahmedabad. As this study relies primarily on a spatial network analysis, it is defined in a way that doesn't analyse the micro morphological characteristics of the riverfront project itself but rather mainly concerns itself with the urban spatial structure to see how the project is woven into the fabric of the city. The other data such as population, points of interest etc. are used to a limited extent only to supplement the main data which is the spatial network analysis.

1.2 Research Questions

A. How has the Ahmedabad riverfront project altered the city's relationship with its river by altering the spatial structure of the city itself?
    - Has the project caused a shift/ change of urban cores/centralities? If yes, what are these changes in the patterns of centralities?
    - Which are the parts of the spatial structure which are most effected by this project and how?

B. How does the project perform on its goal to create an inclusive public space?
    - To what extent are the newly created facilities accessible to the whole population of the city? Can this be a commentary on the inclusivity of the space reflected in the current usage pattern?
    - How does it impact the east west divide which is symbolic of the communal as well as socio economic divide in the city? Is this reflected in the way people use the riverfront?

1.3 Chapter overview

The first chapter began with a discussion on the significance of urban riverfront developments. It then introduced the case at hand, presenting the debates around this case as well as the gaps in the existing knowledge and how this research uses specific questions to address this gap.

The second chapter uses the existing literature from areas such as urban design and space syntax to summarize the existing knowledge in the context of their relevance to this research.

The third chapter introduces the case of the Sabarmati Riverfront Development Project in terms of its social, political, urban and environmental background and intentions.

The fourth chapter describes the steps for conducting the analysis in its technical and methodological detail and also describes the extent and limitations of the data sets used here.

The fifth chapter contains the core spatial analysis of this thesis and enquires in the direction of the first research question ascertaining the impact of the SRFD project on the city's relationship to the river.

The sixth chapter examines in line with the second research question, how the riverfront performs as an inclusive public space. This is done looking at the spatial potential (network centrality and transportation network) and also observations of people's behaviour.

The seventh chapter makes broader conclusions, returning to the ideas in the research questions, summarising the findings, but also making suggestions for future riverfront developments.

Added to this research is an epilogue, following the concluding chapter. It tests some speculative strategies of design interventions, examining their potential implications for the city.

2 Tracing existing knowledge on the Subject: A Literature Review

This chapter begins by asserting the significance of riverfronts in terms of their potential for restructuring the cities relationship with its river and as drivers of socio-economic impact. It then introduces and positions in relationship to each other, some scholarly assertions, pertaining to riverfront developments as urban interventions. It discusses a configurational approach towards urban projects, to interlace the theories informing riverfront developments, urban-design and configurational analysis. This is followed by a description of the fundamental theories and measures related to this approach.

2.1 Waterfront projects as urban interventions and image-making devices

Configurationally, cities have emerged positioning themselves in various relationships with respect to the river as described earlier (Kostof, 1991). However the river's potential for acting as a device for integration is confounded by the geographic/ spatial disconnection the river imposes between the lands on the two sides of itself. In this sense the river is both an integrating device as well as the root of the need for integration. In the context of rivers cities specifically, the *transposability* of the river is given by the number of river crossings within the city, and the number of crossings per unit length of river (Abshirini & Koch, 2016). In a simplistic way this means a greater density of crossings is indicative of a greater integration of the urban structure around the banks of the river, whereas a small number of connections between banks shift the focus of the city away from the river. (Silva, Serdoura, & Pinto, 2006) Bridges are the most morphologically characteristic feature of river- cities and they convey economic and cultural meaning in cities as well. (Chang SP, 2009) (Ioannidis, 2011) (Psarra, 2012).

Besides the morphological implications on the spatial structure of the city, the nature of spatial articulation of the riverfront has considerable cultural and symbolic importance. This is because in the case of any design intervention the river/waterfronts become the interface between the city and the resource (water) itself. In cases of riverfront and waterfront projects alike it has been noted that they hold the potential for rejuvenation of the urban realm in terms of its aesthetic value as well as its economic potentials. (Gospodini A. A., 2001). Speaking for the ability of urban object itself to act as an attractor it may be said that *'Irrespective of the particular functions and activities accommodated in space, avant-garde physical design of both*

buildings and open spaces can make urban space morphology in itself and of itself a sightseeing and tourist attraction' (Gospodini A. , 2001, p. 291).

The developments of the riverfronts along the Thames in London and the Siene in Paris and the Jeddah Corniche project are prominent examples of this phenomenon. In the case of Hong Kong's waterfront it can be seen that the economic and real estate agendas are prioritized more than the agenda of creating social infrastructure by means of recreational facilities which are only provided in an auxiliary manner (Cheung & Tang, 2015). It is also noticed that tourist are prioritized more than the locals as a user-group, thus suggesting the intent of using the waterfront development to project an image to the outside world (Cheung & Tang, 2015). This image is realized in the emergence of the harbor as a festival market type waterfront. Similarly in the case of Jeddah Corniche the project is seen to foster a cultural identity for the place (Mostafa, 2017). At a much smaller scale, the case of the Carter road waterfront in Mumbai presents a different model where the social sustainability of urban waterfronts is foregrounded as the facilities are managed and maintained by the local authority of the area (Shah & Roy, 2017). The various intentions behind these projects include: enhancing the existing social order of the public realm, serving the demand of increasing tourism and reconfiguring to accommodate the needs of the local people and tourists, improving the image of the city and its prospects for encouraging investments and real estate developments. Based on examples from various contexts it is seen that in the case of urban waterfronts, there are a wide range of stated as well as unstated intentions, all of which are directly or indirectly associated with re-imagining the city.

2.2 Urban design, as a configurational process

Having framed the perspective for viewing urban waterfront developments as having symbolic as well as instrumental agency, this section examines the theoretical and methodological standpoint for its analysis. As there can be varying and contradicting perspectives on matters of how riverfronts impact the city, it therefore becomes imperative to refer to theories which allow objective methodologies of investigation. It is also essential, in the case of this research, to adopt a theoretical framework which can explain the links between space and societal phenomena with specificity and empirical evidence. A configurational method of analysis of space can be employed, for it enables objective evaluation of the relational attributes of space and their associated social implications. This "is based on the theoretical foundations, analytical methods and modeling techniques of space syntax." (Karimi, 2012, p. 1). At the core of the ideas behind space-syntax methods are two

propositions: The first proposition is that space is intrinsic to human activity, not a background to it. The second is that space is shaped in ways that reflect the direct interaction between space and people, and through this the space we create, or the built environment, becomes humanised (Hillier & Hanson, 1984). Assuming space to be the fundamental generator of the city, space syntax has been used extensively to model and analyse cities. It provides descriptions of, "the logic of society through its manifestation in spatial systems: how the way spaces are put together – or the configurations of spaces – relates directly with how people perceive, move through and use spatial systems of any kind, ranging from small domestic spaces to large-scale cities (Penn, Hillier, Banister, & Xu, 1998)." (Karimi, 2018, p. 1).

Analysis of spatial configuration hinges on two measures of spatial network centrality namely the *integration* value and *choice* value. These two measures used in space syntax correspond to *closeness-centrality* and *betweenness-centrality* in graph theory. The integration value of a line is a mathematical way of expressing the depth of that line from all other lines in a system (Hillier & Hanson, 1984). In terms of their representation of movement potentials, integration has been defined as the closeness of a segment from all others in a system, thus representing the to-movement potential of a particular space (street segment). This measure is used to predict how often a route or segment would be arrived at by pedestrians (Hillier, WRG, Yang, & Turner, 2012) (Hillier & Iida, 2005). Choice is seen to have a stronger relationship to movement as it is calculated as the number of shortest paths that pass through the segment of all shortest paths between all pairs of segments in a system. This has been used to represent the "through movement" potential of a street segment, it predicts how likely it is that a pedestrian would pass through a segment on a trip to another destination (Hillier, WRG, Yang, & Turner, 2012) (Hillier B. , 2009) (Hillier & Iida, 2005).

Hillier identifies an invariant pattern in the values of integration across spatial systems and the social reasoning behind this pattern. He notes that the lines with highest integration value form the integration core of the spatial configuration of the settlement and the segregated lines cluster in the interstices formed by this core structure. Describing the social reasoning behind this pattern, he adds that the purpose of the integrated lines is to access the central areas of a settlement from its periphery, while at the same time staying close to the segregated areas to knit them together into the urban fabric. He postulates that the social reasoning behind this spatial pattern is to arrive at a pattern of co-presence. He notes that the core lines are those that are most used by people and hence also the ones on which movement-dependent functions like shops are located whereas the segregated areas tend to be primarily residential. He argues that the effect of the core is not only to structure the path of

strangers through the central areas of a settlement but at the same time ensure that they are in close interface with the moving inhabitants in these central areas coming from the segregated areas. He concludes his argument proposing that the spatial structure of a settlement exists in order to construct this interface (Hillier B. , 1989).

Depending on the kind of interface to be constructed, he proposes that space can either play an instrumental role or a symbolic role. As discussed above, space can either be structured to deal with the practicalities of moving people into and around a spatial system, or it can be organised to relate buildings of symbolic importance. Contrasting the properties of axial lines in instrumental and symbolic modes of operation, he explains that the major axial lines (integrated lines) strike orthogonally on buildings facades when they function as *symbolic axis* whereas, "they glance off major and minor buildings indiscriminately at open angles, suggesting movement beyond the point where the line strikes a building" (Hillier B. , 1989, p. 11) when they function as *instrumental axis*.

In continuation with this understanding of the function of the spatial structure a further nuance is added through the concept of pervasive centrality, where *'the function of centrality pervades the grid in a more intricate way than has been thought, and that multi scale centrality should be seen as a pervasive function of cities, with clear spatial correlates and not simply as a hierarchy of locations'* (Hillier B. , 2009). *Pervasive centrality is argued to be a 'naturally sustainable form relating economic and social activity to space in a way which minimises travel distances'* (Hillier B. , 2009, p. K01:3)

According to the *theory of natural movement* (Hillier, Penn, Hanson, & Grajewski, 1993), movement flows in different parts of a street network are systematically influenced by the spatial configuration of the network itself, and thus, the configuration of the urban grid itself is the main generator of patterns of movement. The distribution of the configurational value of integration is presented as the determinant of movement in urban grid other things being equal. The theory of *cities as movement* economies (Hillier B. , 1996), was built on this and presents that the generated movement patterns influences land-use choices which in turn attracts movement and sets in train a multiplier effect with, "further feedback on land-use choices and the local grid as it adapts itself to more intensive development" (Hillier B. , 1999, p. 108) He further argues that the corresponding migration of functions to movement-rich or movement-poor locations and the multiplier effect induced and perpetuating the clustering of similar functions, "the settlement would evolve into the dual form of a foreground network of linked centres, each scaled according to its position in the network, set into a background of residential space" (Hillier B. , 2008, p. 226). This tendency allows for a reading of cities as

movement economies, in that the economic potential of part of a spatial system can be speculated based on its movement potential which can be predicted from its configurational centrality.

In summary, a configurational approach to analysing an urban design intervention can bring to light the inherent potentials of socio-economic change triggered by a physical intervention before these changes are fully realised in the complex and multi-layered urban system.

3 The city of Ahmedabad and the Sabarmati Riverfront

This chapter situates the research topic in its socio-cultural and political context. It introduces the case to be analysed, i.e. the city of Ahmedabad. It describes the intentions and the design of the SRFD.

3.1 The city of Ahmedabad

The area around Ahmedabad has been inhabited since the 11th Century and formally established in 1411 AD. It emerged as an important economic and industrial hub in India with textile mills producing cotton which was exported globally. Besides the old walled city being declared a world heritage city as per the World Heritage Committee of UNESCO in 2017, Ahmedabad also has important works of modernist architecture.

In cities of developing countries, the concept of Global cities is being used to drive urban development. The drive in these cities is to project themselves as attractive destinations for international investment (Banerji, 2011). This development focussed rhetoric is prominent in Gujarat's politics and imagines the city as an '*urban landscape of tall towers, glossy facades, flyovers, elevated roads and beautiful waterfronts - the cities which are clinically sanitised of poverty and disparity.'* (Joshi, 2014, p. 116). (See Figure 3 and Figure 36)

Figure 3: A render of the imagined city Scape after the Riverfront development. Source: narendramodi.in/sabarmati-riverfront-to-get-a-walkway-new-water-rides-4920. Retrieved on 08.09.2019

Parallel to these developments is the dismal situation of public transportation and the high rate of increase in numbers of private vehicles causing congested roads in the city (Joshi, 2014). For these reasons it is important to see any urban development in Ahmedabad in terms of its impact on modes of transportation as well as examining how well it is accessed by public transportation. How the gaps in public transportation cause particular disadvantage and marginalization of the poorest citizens of the city is evidenced elaborately in studies of the

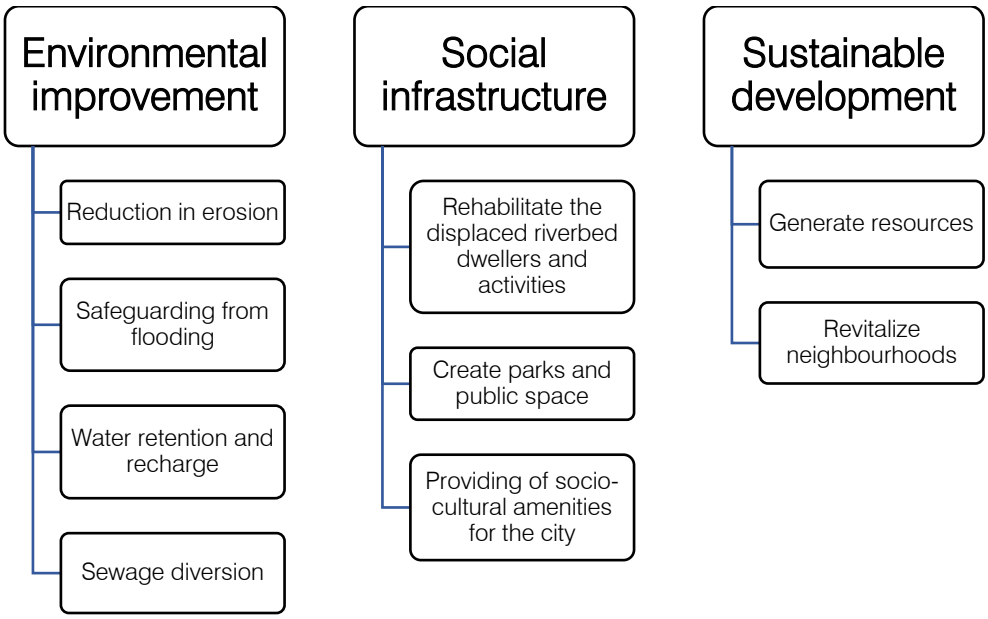
transportation systems for Ahmedabad's lowest income groups (Joshi, 2014). Reminiscent of questions of 'right to the city' (Lefebvre, 1968) these concerns for Ahemdabad's future make it imperative to look through a lens which acknowledges these disparities and systemic segregation as mentioned earlier.

3.2 Sabarmati and the Riverfront Development

Sabarmati is a seasonal river in western India, whose flow depends on the rainfall in its catchment area (the Aravali hills of Rajasthan).The river bed during its dry spells and the banks of the river at other times were largely occupied by informal settlements, used in small extents for agriculture and traditional laundry services. However the condition of the river bank was deemed increasingly unhealthy and polluted, besides being inaccessible to the general public.

'Untreated sewage flowed into the river through storm water outfalls and dumping of industrial waste posed a major health and environmental hazard. Lacklustre development took shape along the riverfront. Such conditions made the river inaccessible and it became a virtual divide between the two parts of the city. Slowly, the city turned its back towards the river.' (SRFDCL, 2014). Arising out of the intent to improve this situation, there have been numerous proposals for interventions on the riverfront, starting from the first one in the 1960's to the final one in 1997.

The expressed intentions behind the project are captured well in it's descriptions from the SRFDCL's website: *'The project aims to provide Ahmedabad with a meaningful waterfront environment along the banks of the Sabarmati River and to* **redefine an identity of Ahmedabad** *around the river. The project looks to* **reconnect the city with the river** *and positively transform the neglected aspects of the riverfront.'…'it aimed to* **claim the river back for the public***….. bring back* **focus to the city centre***, and create* **city level social infrastructure** *and recreation facilities'* (SRFDCL, 2014)*….. 'The Riverfront project presents a great opportunity to create a* **public edge to the river** *on the eastern and western sides of Ahmedabad.'… 'The Sabarmati Riverfront has the potential to create a* **singular identity** *for the city, bring people closer to water, bring back focus to the city centre, and create city level social infrastructure and recreation facilities.' … 'The project aims at making Ahmedabad's riverfront a public asset by reclaiming land and improving its overall accessibility'* (SRFDCL, 2014).



The broad intentions of the project are categorised and listed in a flow chart above based on information from the project website.

The execution of the project was a massive undertaking at the scale of the city. For the purpose of development of a river front project, the water from the Narmada canal (few kilometres upstream from the river) was tapped into and directed to this river, in order to create the image of a perennial river for the stretch passing through the city up to a barrage at Vasna. By channelling the river to a constant width of 263m, riverbed land was reclaimed to create 11.25 kms of riverfront on both the banks (See **Figure 4** and **Figure 5**). The total land reclamation is 202.79 hectares (SRFDCL, 2014).

The major intervention by the project is the addition of the north-south vehicular roads created along both sides of the river (See **Figure 6**). The project also adds some new roads leading up to the riverfront road to increase its accessibility. The key recreational facility added by the project is **a two-level,** continuous promenade (See **Figure 9**) at the water's edge along each bank of the river providing a 11.5-km long walkway. *Ghats*1 from the lower promenade provide access to the water and Boating stations have been provided for water-based recreation and transportation (See **Figure 9**). The other major facilities include parks, gardens (See **Figure 7**) and sports facilities built on the reclaimed land. The historic Ravivari market and the laundry facilities for the washing communities are some of the activities which have been transformed by the riverfront project. The new cultural and business related facilities added include trade and fair facilities and exhibition grounds.

1 The series of steps leading down to a body of water or wharf, such as a bathing or cremation place along the banks of a river or pond.

The largest strength of the project in terms of feasibility is the self-financing nature of the project. This is achieved by selling a portion of the reclaimed land for commercial development (See **Figure 8**) and using the generated revenue for funding the construction and maintenance of the riverfront development itself.

As has been mentioned in the introductory chapter, the project has been criticised from many angles. These include the displacement of riverfront dwellers, inefficiency of relocation efforts, gentrification and ecological destruction and disregard. It has even been hypothesized as an effort in re-branding the city, to divert negative attention from the 2002 riots. However, the project has been highly successful in branding Gujarat as a prosperous state with effective governance under Narendra Modi who was seen as the face of the project. Further discussions on the perceptions of the project can be found in the appendix.

Considering these claimed intentions and various contestations about the project, this study looks into the case of the riverfront in its current state, to evaluate its performance as a social resource within the spatial system of the city.

Figure 4: Edited aerial image from 2002. Source http://sabarmatiriverfront.com Retrieved- 08.09.2019

Figure 5: Edited aerial image from 2015 Source http://sabarmatiriverfront.com Retrieved- 08.09.2019

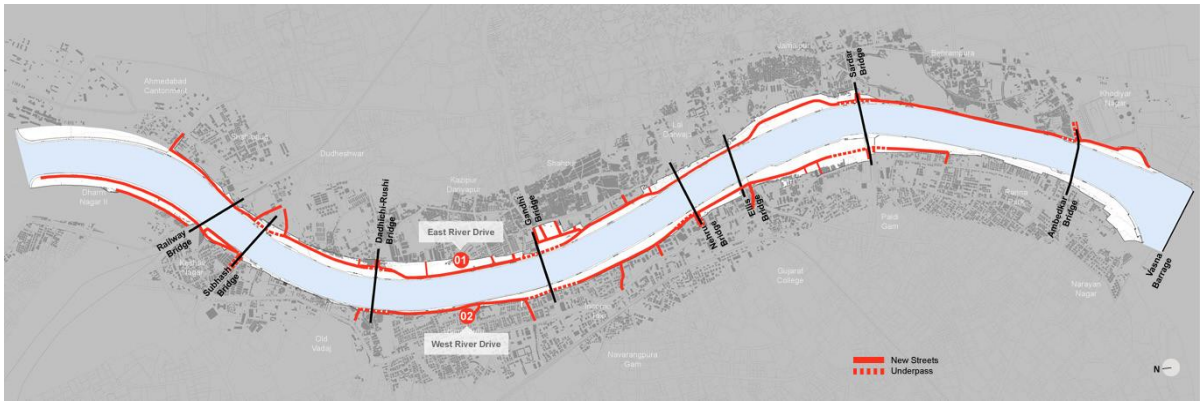


Figure 6: New roads added by the riverfront project. Source: http://sabarmatiriverfront.com/master-plan - Retrieved on 08.09.2019

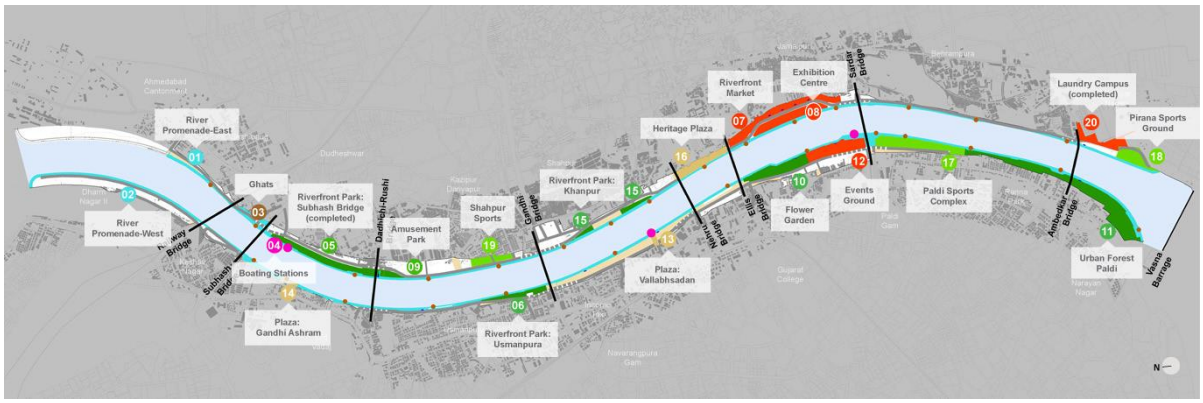


Figure 7: Gardens and cultural facilities. Source: http://sabarmatiriverfront.com/master-plan - Retrieved on 08.09.2019

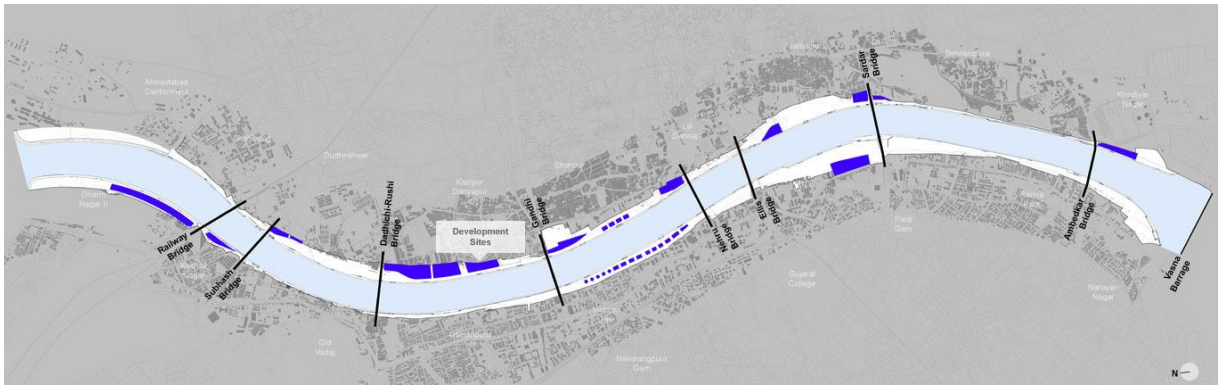


Figure 8: Development sites. Source: http://sabarmatiriverfront.com/master-plan - Retrieved on 08.09.2019

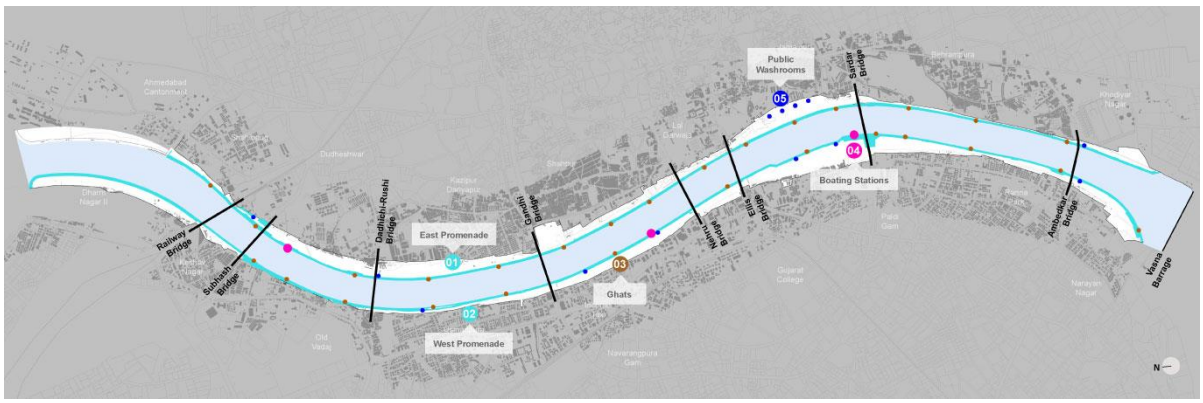


Figure 9: Promenades and Boating stations Source: http://sabarmatiriverfront.com/master-plan - Retrieved on 08.09.2019

4 Data and Research Methodology

Based on the background of the project being studied, this chapter explains the choice of methodology implemented here. It first describes the overall steps of the process of analysis, and then explains the technicalities of modelling, analysing and observing.

As has been found in the literature review, a syntactic analysis of the spatial network can be used to get empirical evidence which can link spatial changes to their potential for social consequence in a scientific way. This study therefore adopts such a method as the core of the analysis and uses other layers of data in conjunction with the spatial network analysis. A configurational approach to analysing space using the Space Syntax theories is adopted here. Amidst varied debates around the SRFD project this study uses spacy syntax to make an objective commentary on the spatial and social impacts of the project.

Some foundational ideas of space syntax methods are arrived at by adding spatial logic to concepts from graph theory and topology in mathematics. For an analysis of space a model is created which represents the topological relationships between elements (streets) comprising the spatial (urban street) network. Such a model, because it is created using the map of the city, has metric as well as angular attributes. An Angular Segment Analysis (ASA) is used for analysing the model, to calculate topological centralities while also factoring in angular change as it would be experienced while traversing through the urban fabric. This allows computational speculations about the movement potential of spaces comprising the urban system[2]. Space Syntax methodologies use measures from the ASA corresponding with *closeness-centrality* and *betweenness-centrality* of graph theory, they are called *Integration* and *Choice* respectively. The measures describe the *to-movement* and *through-movement* potentials of a street segment. The normalisation of these values offers an opportunity to compare different cities with different sizes and even individual streets from different cities; it also shows closer correlation with actual movement. This study uses normalised angular integration (NAIN) and normalised angular choice (NACH) values.

As the road network describes the continuous spatial structure this does not capture completely the nature of movement afforded by means of the public transportation network where the bus/train stops act as nodes and the streets like edges. Therefore, in order to have a fair representation of access through public transportation, a catchment analysis has been employed.

[2] Angular segment analysis (ASA) has shown relatively better relationships to movement pattern than the same properties in axial line analysis (Hillier et al. 2012; Hillier and Iida 2005).

4.1 Sequence of Inquiry with the methods and data used

The methodology implemented here is in two parts (**Figure 10** and **Figure 11**) responding to research question A and B respectively.

For the first part, two separate models are used to describe the spatial structure before and after the project based on the geographic patterns/distributions of centrality values. These descriptions and the following steps of identifying the nature and location of change are both done using the values of integration and choice from ASA of the models. Some qualitative factors of the micro-morphological attributes are referred to using photographs in conjunction with spatial network centrality values. The percentage change in integration is calculated to read the effects of the project on the spatial system.

The second part focuses on evaluating the performance of the project as an inclusive public space. Taking into cognizance the socio-political background described earlier, the changes to the spatial structure identified above are then seen along with the demographics, space-usage patterns and public transportation network.

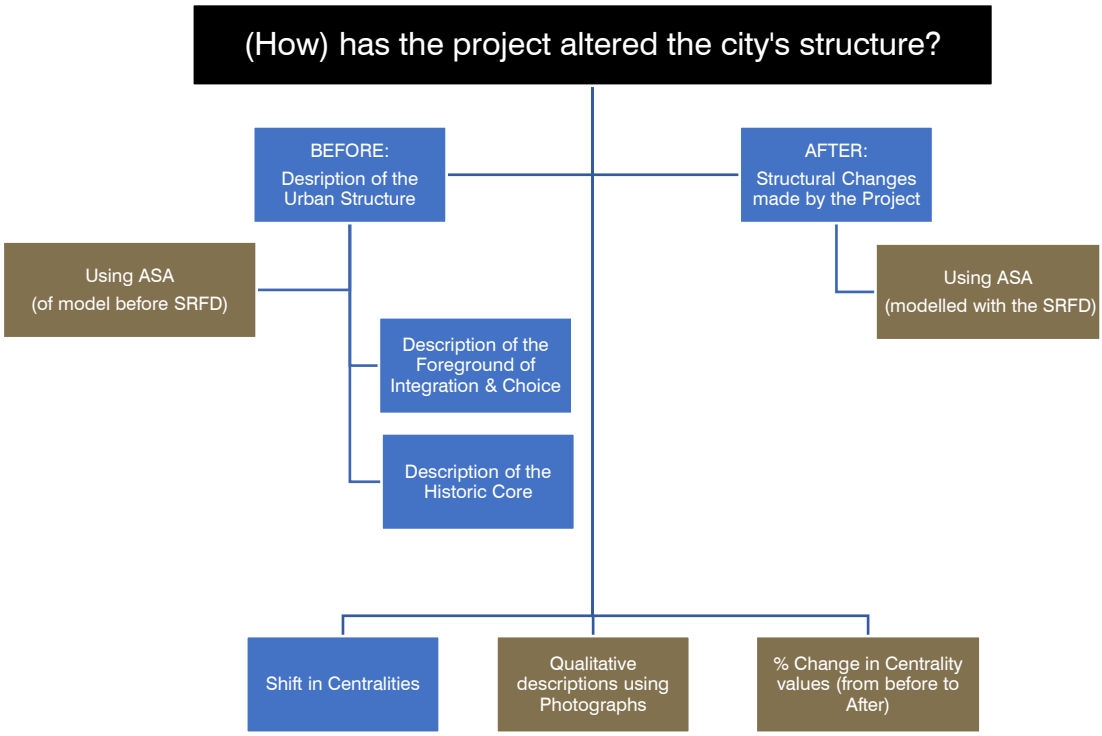


Figure 10: Methodology Diagram addressing Question A

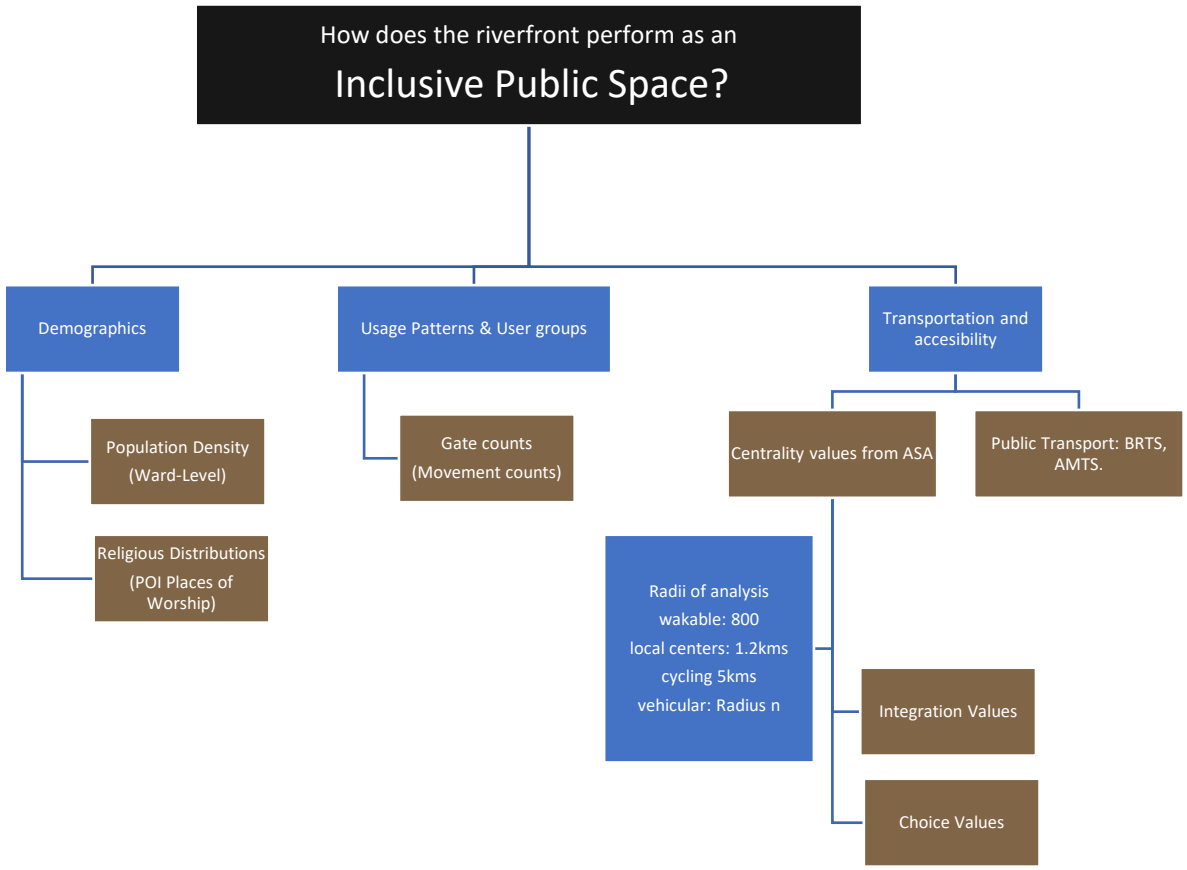


Figure 11: Methodology Diagram addressing Question B

4.2 Methods of processing to Spatial Data

For the case at hand a 2012 study based on the syntactic analysis of the walled city of Ahmedabad captures the traditional and organically evolved syntactic structure of the neighborhoods of the historic walled city (Raman and Dempsey 2012). However a comprehensive syntactic analysis of the entire city in the current state has not been done yet. In the absence of any previous publications of spatial network analysis of the entire city of Ahmedabad (with the exception of one publication on the walled city (Raman, 2012) it was imperative in this case to create the topologically accurate spatial model of the city. This was done using the road centreline map based on volunteered geographic information (VGI) from Open Street Maps (OSM) downloaded through Geofabrik (Geofabrik GmbH and openstreetmap contributors, 2018). The road centreline map thus obtained is used in order to create a segment map of the current structure of the city of Ahmedabad, centring the focus on the river, which is also the geographic centre of the greater urban agglomeration itself. In creating this model from a road centreline model it has been edited manually and using some experimental plugins in QGIS. Some of the processes include reducing the redundant parallel lines, simplifying excess segmentation, removing short line stubs etc. (Krenz, 2017). Angular

turns of less than 10degrees have been eliminated by using the *rcl-topology-cleaner plugin* for QGIS. The model has detailed pedestrian movement paths of the riverfront area and topologically sound single lines for the rest of the city, except in the case of roads with BRTS (Bus rapid transportation system) infrastructure wherein the two sides of the road are kept as separate segments in order to represent the actual condition of two distinct roads. A segment map of the city before the riverfront project is also constructed in order to examine in comparison. An angular segment analysis is run for both the models ('before' and 'after') using PST (Place Syntax Toolkit).

The angular segment analysis (ASA) of the model is run at Radii: 800m, 1.2kms, 5kms and global (Radius n) for closeness centrality and between-ness centrality[3]. The radii are selected to represent the walking distances (800metres and 1.2kms), cycling distance as well as larger zones and inter-ward relationships (5000metres) and the global (Radius n) for understanding vehicular movement and the city-wide structure.

The ward-level population data is from the previous (2011) census of India acquired from the Ahmedabad Municipal corporation website (AMC, 2019). The population density is calculated by dividing the population by the area of the polygons in QGIS and expressed in population per square kilometre.

A manual mapping of the points of interest is carried out using Google maps, where the author has identified 415 places of worship, 180 retail activities, 195 restaurants and cafes[4].

A network catchment analysis is done to ascertain the extent of catchment from the bus stops closest to the river. For this the public transportation network is intersected with the street network. Bands of catchment are shown as 0-200metres, 200-400 metres and 400-700 metres to describe the pedestrian accessibility after arriving at the nearest bus stop to the riverfront.

4.3 Investigating people's activities: an observational study

To add an understanding of the patterns of prevalent usage of the riverfront, movement counts have been done at select locations. The observed usage of the riverfront promenade was documented at select locations. In the selection of location, there was an attempt to get a fair representation of the different conditions of the stretch of the riverfront on east and west

[3] All reported values are normalised.
[4] These points constitute neither an exhaustive list nor are they based on any published listing but are rather based on the authors own selection.

banks between the four central bridges. The observations were done at peak hours of usage for outdoor recreational facilities in hot dry climates, which are weekend evenings. An imaginary gate is assumed at each selected location. The two phenomena being observed are the numbers of people moving through the gate in spans of 5 minutes and the likelihood of belonging to a minority religious group based on the observed attire. The five minute long movement counts are extrapolated to give an estimate for 1 hour movement counts. The observers attempt to cause minimum possible obstruction to the normal activity of the space and users being observed. Further details of the instructions given to the volunteers who have collected the data can be found in the Appendix.

5 An assessment of the riverfront's impact

Having established the methods, this chapter contains the core spatial analysis on which the argument of the study hinges and the findings thereof. It is an effort in answering research question-A by uncovering, geo-locating and interpreting the impact of the riverfront development on the urban spatial structure.

5.1 Description of the spatial structure of Ahmedabad before the SRFD

To understand how the city was restructured by the riverfront project this section begins with a description of the structure of the city as it was before the intervention followed by the changes made by the project.

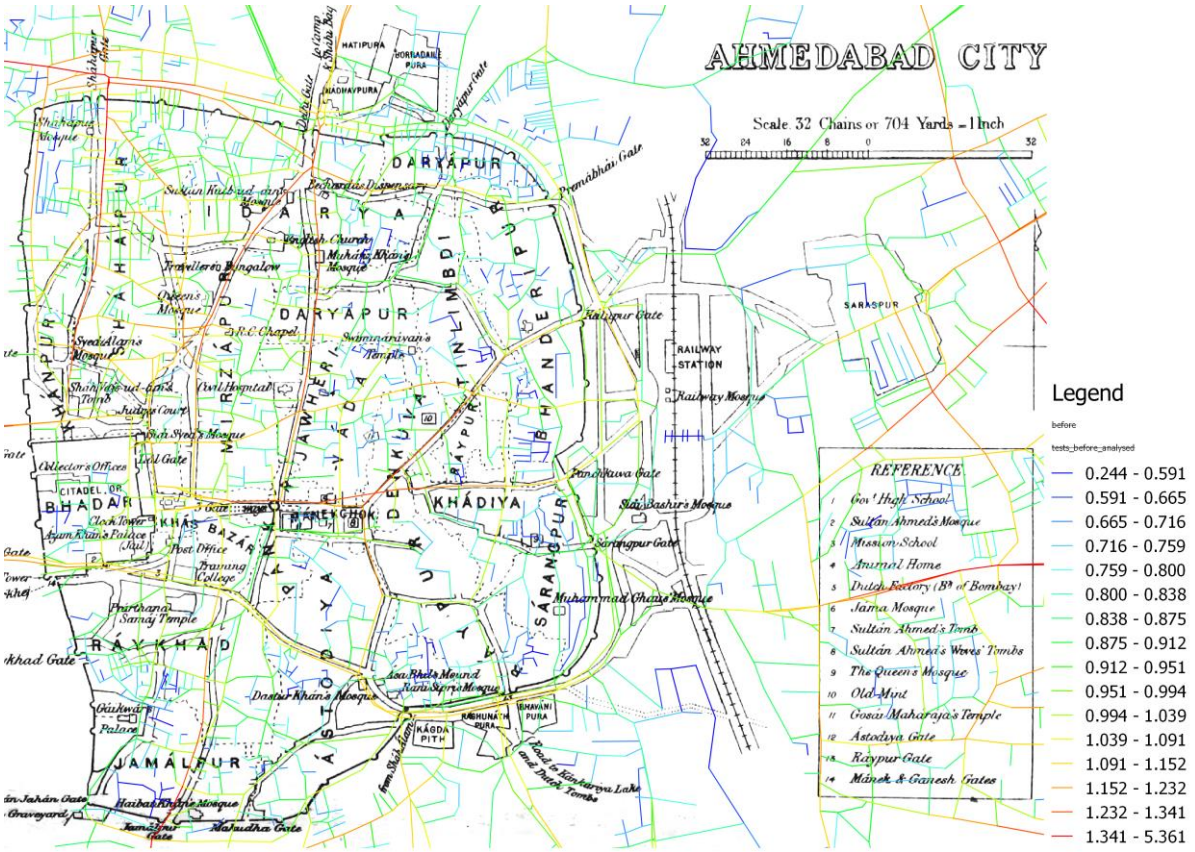


Figure 12: Map from Gazetteer of the Bombay Presidency. (1896) by James M. Campbell with an overlay of the current model NAIN (Radius 1.2kms).

The historic core (the walled old city) of Ahmedabad (See **Figure 12**) had a prominent Symbolic East-West axis (Gandhi road) starting at the Bhadra Square extending towards the East. This axis from the time of the Establishment of the old city meets the Bhadra fort perpendicular to its front thus reinforcing the symbolic importance of the fort, but also functioning instrumentally to support the everyday activities of the historic markets along the Teen darwaza area and its surroundings, also being adjacent to but not incident on the main

mosque as well as the two monuments of historic significance- The kings and Queen's tombs. As is seen in the current model analysed at various radii the significance of this axis in the larger system has been persistent.

Figure 13: ASA Before SRFD showing NAIN (Radius n)

The NACH (radius n) (See **Figure 17**) shows the arterial road network of the city, highlighting the structure of the highest choice values shown in white. Four rings and fourteen radials can be identified as constituting the foreground (segments with top 10-20% values) of NACH. The fourth bridge (counting from south to north) Nehru Bridge does not feature in the NACH foreground, which is a peculiarity, as bridges by their very nature, are important thoroughfares for through-movement.

The foreground of the integration network at the global scale corresponds closely with the arterial roads, highways and the BRTS corridors. These are primarily vehicular and unfriendly for pedestrians and also lack the micro-morphological characteristics for becoming centres of urban activity. In spite of their potential by virtue of their configurational centrality these roads do not act as urban public centres due to their non-pedestrian-friendly morphological attributes, heavy vehicular traffic amongst other reasons. This is evidenced by the example of the Narol- Naroda road (On outer ring to the East seen in **Figure 13**) which is

high in terms of global integration but as is visible in **Figure 14** the nature of the road does not support the possibility of being an active urban centre. This is also seen in the case of Sarkhej-Gandhinagar highway(high-integration north-south link on the west **Figure 13**), the 132 foot ring road and the 120 feet ring road. This means that the areas with potential for acting as urban centres are being designated as vehicular arteries instead with the exception of cases such as CG road and Ashram where the predominance of retail functions coupled with high integration creates a vibrant public space. When seen in conjunction with the NACH (radius n), we see that the instances with highest integration and highest choice are coinciding. This reinforces the vehicular instrumentality of these centres. Overall, at the global scale, as is seen in **Figure 13 the integration cores are formed by vehicular arteries and are largely linear in their form. Therefore city of Ahmedabad lacks convex centres (clusters of connected and highly integrated streets) conducive to being used as urban public space.**

Figure 14: Naroda- Narol road, location near Rabari Colony

Considering the NAIN at radius 800m as to-movement potential at the scale of local and pedestrian activity, it is noted through **Figure 15** and **Figure 16** that the places which are convex centres at radius 800metres are not as prominent when analysed for their global centrality. This confirms that the use of these two radii is able to bring out readings of relevance for different scales of operation in the city of Ahmedabad. The further analysis therefore explores the same measures at different radii: 800metres, 1.2kms, 5kms and globally (Radius n).

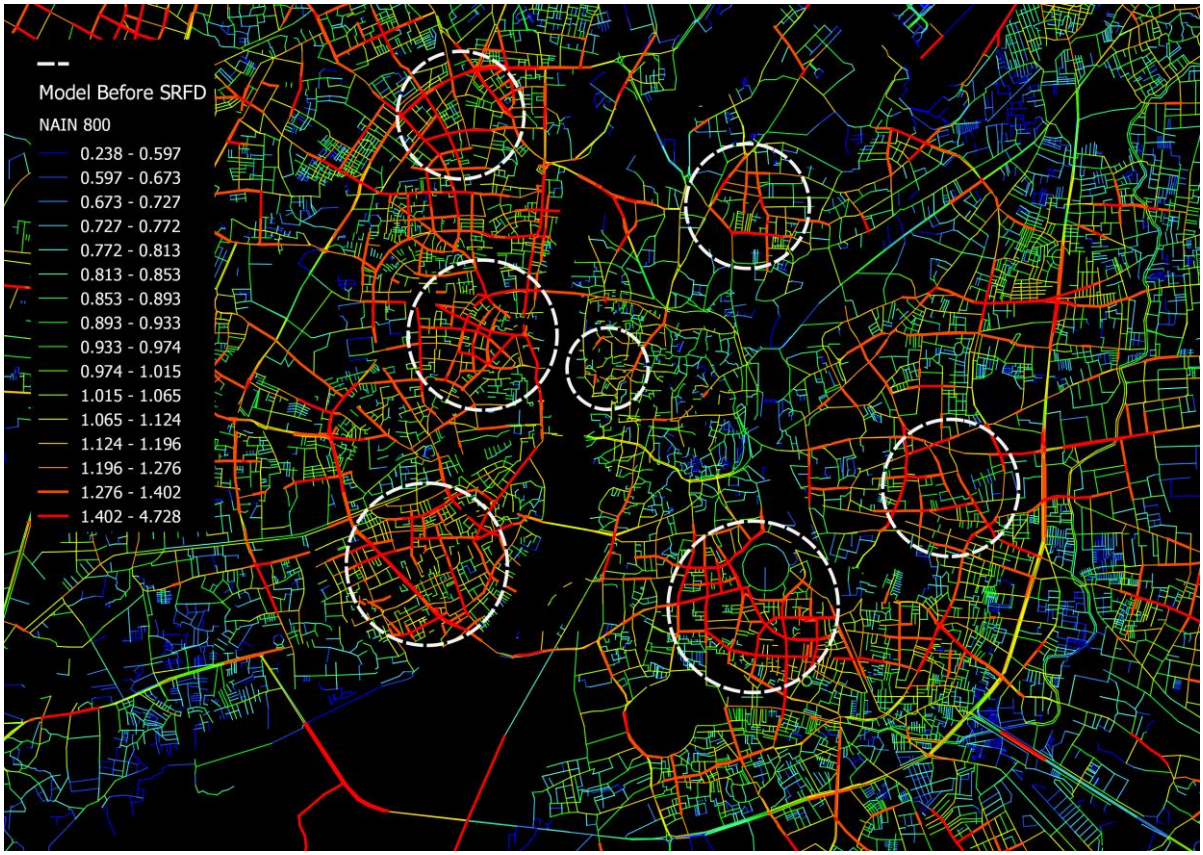


Figure 15: ASA Before SRFD showing NAIN (radius 800 metres), Local Centres identified and highlighted

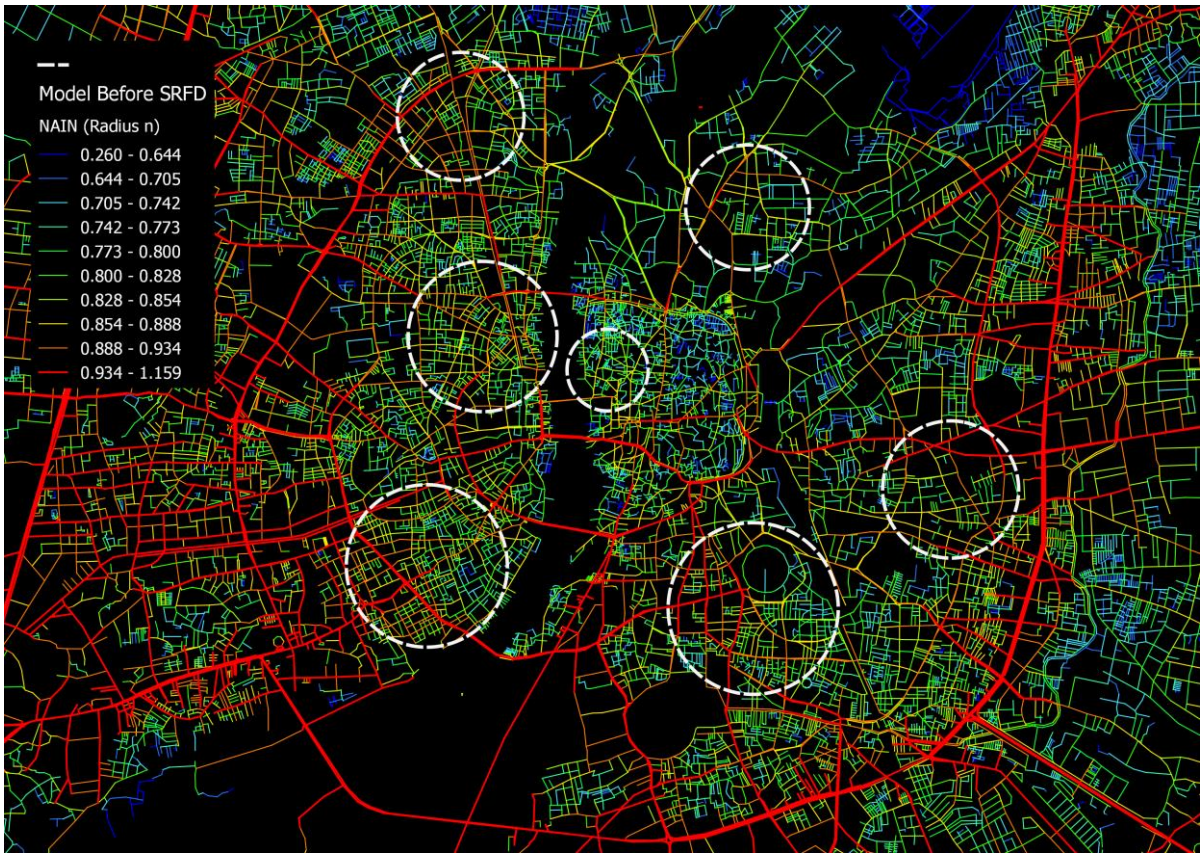


Figure 16: ASA Before SRFD showing NAIN (Radius n) comparing with the centres identified at 800metres

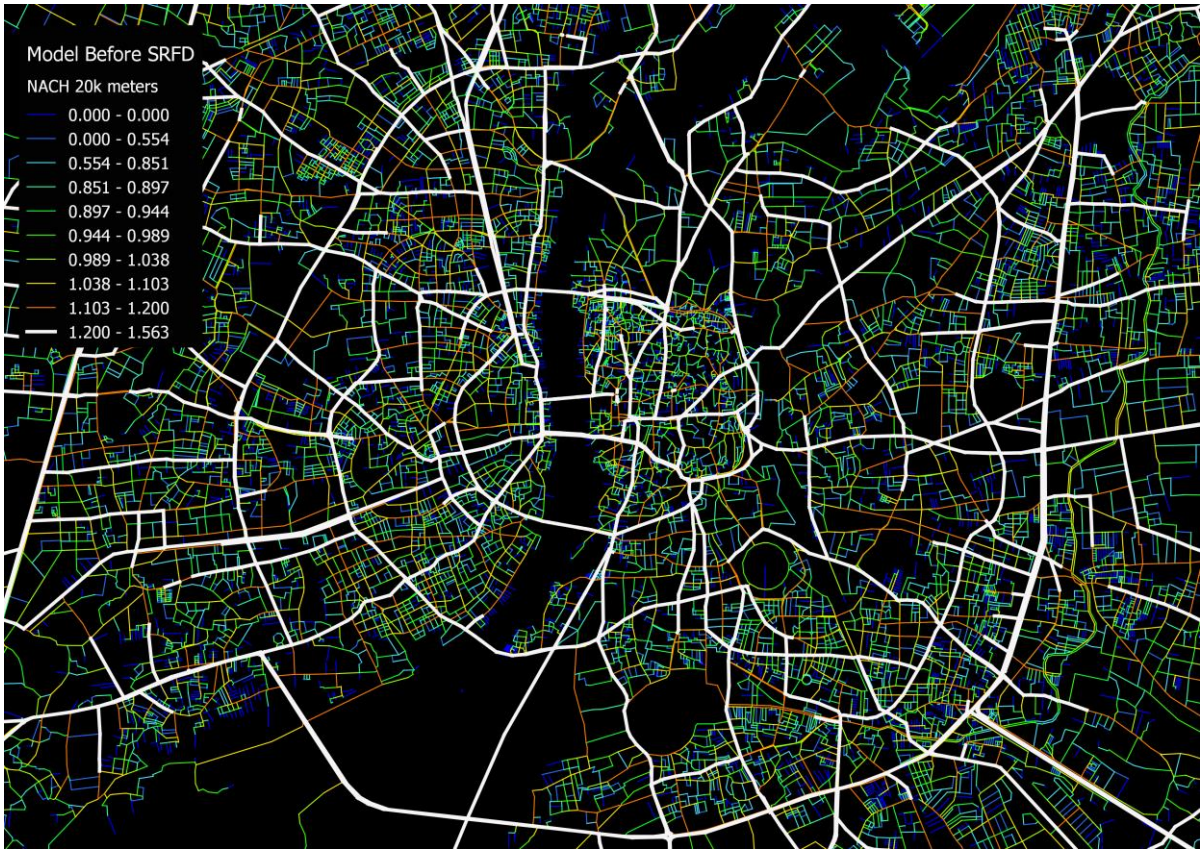


Figure 17: NACH (Radius n) of the model before SRFD

Figure 18: NACH (Radius n) of the model after SRFD.

5.2 Change from Before to After the SRFD project

The ASA of the models before and after the project are used to calculate the extent of change of centrality values of each segment. This allows us to address the sub question- 'Which are the parts of the spatial structure which are most effected by this project and how?' What has been visualized in Figure 19 is the percentage change in the NAIN (Radius n) value of each segment from before to after the project. The change ranges between -10% to +19%. However the largest number of changed segments experienced a change in the range of 0-1%. This implies that the project is affecting almost every segment in the system, however most segments have seen a very small change in value (See **Figure 19**). The colour range shows segments which increased tending towards red and those which decreased tending towards blue and the newly built segments as grey. It is seen that the maximum change in integration values (radius n) of individual segments is seen adjacent to the river up to a range of 0-3.5 kms .

As a general pattern, NAIN (Rn) and NAIN (Radius 5kms) have increased for the areas adjacent to the riverfront. In the case on NAIN (Radius 5kms), this effect reduces consistently with distance from the riverfront, until a point where there is a negative change in value (See **Figure 20**). This tipping point is roughly at the 132 foot ring road on the west and a ring at a similar radial distance on the east. **This indicates that closeness centrality at both scales shifted from the larger rings towards the centre of the city.** It can also be seen that though equidistant from the riverfront, within the old city, the north east is less affected than the south east. In the whole model, the bridges and the roads in continuation with them have experienced the highest increase in integration values. The addition of the riverfront road increased the centrality values of not only the centre but also areas further north (such as slums near Khanpur) and south (Juhapura) which have been severely segregated and marginalized until recent years. This therefore hints at possibilities of positive impact on areas which have so far been marginalised owing to socio-economic and communally reasons.

Figure 15 identified the city's local (radius 800 metres) centres as they were before the riverfront. For six centres near the SRFD (See **Figure 20**) there is an increase in average NAIN (radius 5kms) values of the segments constituting these centres. This suggests that the riverfront project strengthened the performance of these existing centres. However the NAIN (Radius 5k) values of the centre to the East (Rakhial) is seen to have been weakened (Mean change % = -0.46).

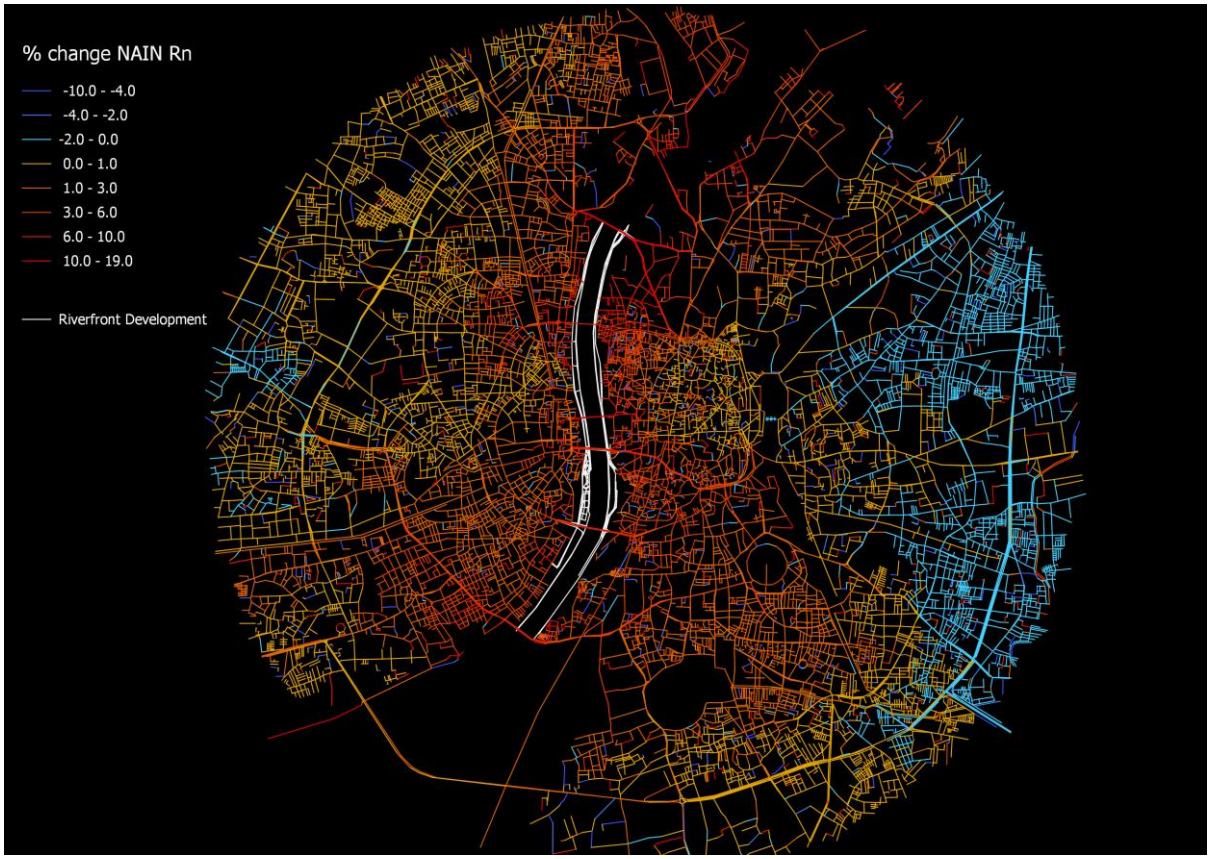


Figure 19: Percentage change in NAIN (Radius n) from before to After SRFD

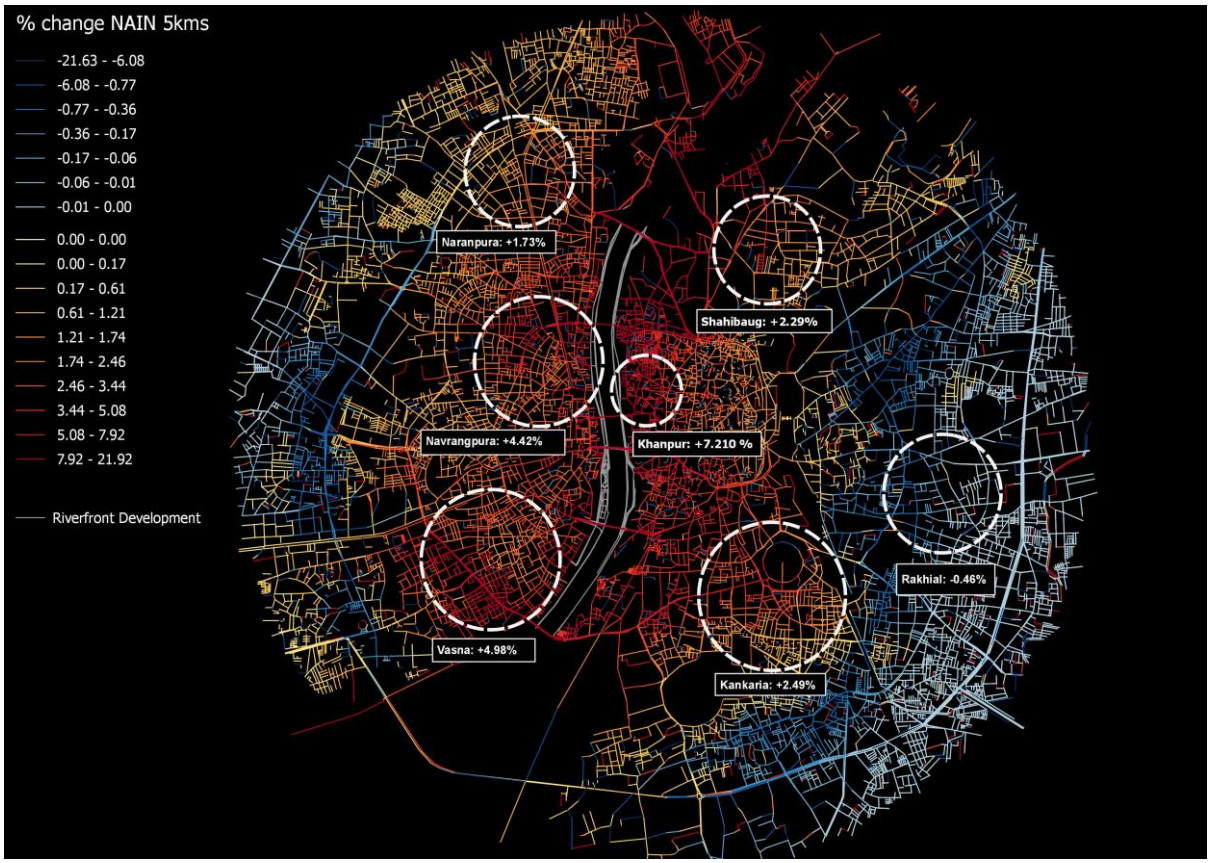


Figure 20: Percentage Change in NAIN (Radius 5kms) showing Mean of % change in NAIN (Radius 5kms) for identified Centres.

5.3 The change in the city-river relationship

We now return to the question of how the SRFD altered the city's relationship with its river by altering the spatial structure of the city itself.

As noted earlier about the linear centres, the riverfront road has a similar potential as other linear centres but less likelihood of actualization due to its primarily vehicular intent and hence design. The riverfront project has been seen to increase the integration values of the major east west connections and the bridges, thus increasing their to-movement potential. However the pedestrian connection between the riverfront itself and the bridges is tenuous/ circuitous thus undermining positive impacts of one on the other. This is being addressed by the addition of a pedestrian bridge as a well-integrated connector, explored further in the Epilogue.

As can be read from the % change in integration values (See Figure 19 and Figure 20) as well the choice (Radius n) before and after (See Figure 17 and **Figure 18**), there has been a clear shift of the centrality (both closeness and between-ness) from the inner parts of the city towards the river. Thus demonstrating unambiguously that the importance of the river to the city has been heightened in terms of it centrality. However the shift in NACH (Radius n) means a potential shift in vehicular traffic. The main change observed between Figure 17 and Figure 18 is the newly created riverfront road which has the highest NACH (Radius n) therefore potential for high vehicular traffic. Bringing this traffic between the fabric of the city and the river is a severance to the local connectivity with the river, literal as well as perceptual (See Figure 31).

Before the SRFD the relationship with the river was an intimate one where the inner parts of the background network terminated loosely into the river bed. This was in sync with the functions as a space for informal laundry services, markets etc. by the communities settled on the river banks. This was also problematic in that it disallowed global integration and hence accessibility of the river to the city. The newly created condition is seemingly a reversal of it, as it integrates the river at the global scale (Radius n) (See Figure 21) but does so almost at the cost of the local integration (1.2kms, 800 metres) seen in Figure 23 Figure 24.

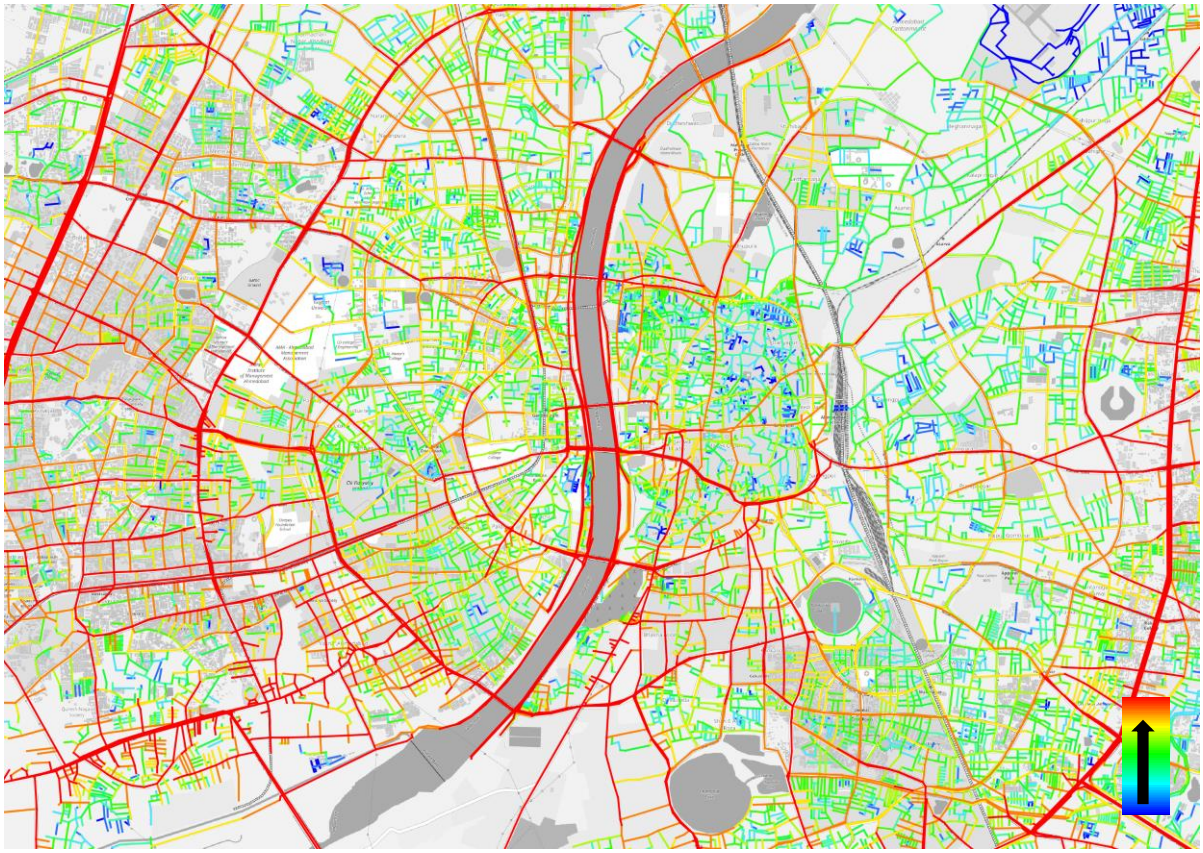


Figure 21: ASA showing NAIN (Radius n) after the SRFD

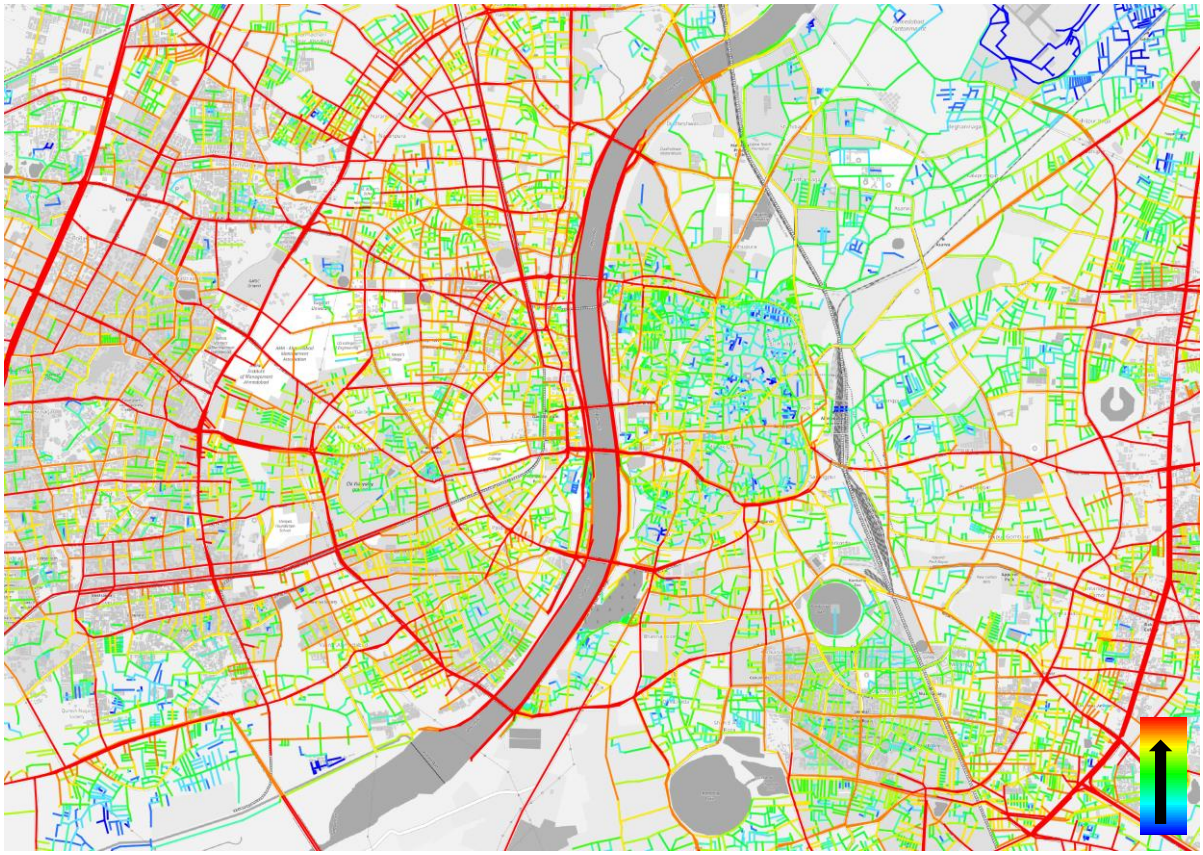


Figure 22: ASA showing NAIN (Radius 5kms) after the SRFD

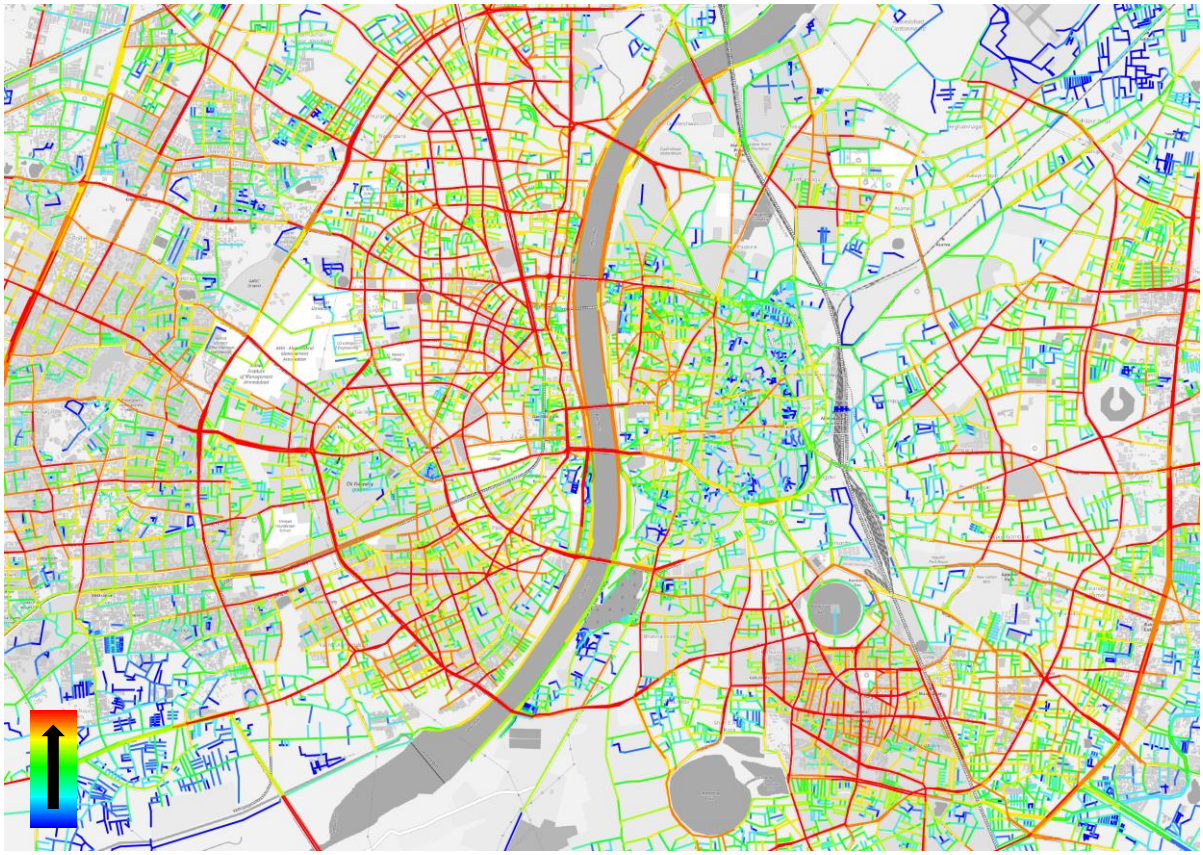


Figure 23: ASA showing NAIN (Radius 1.2kms) after the SRFD.

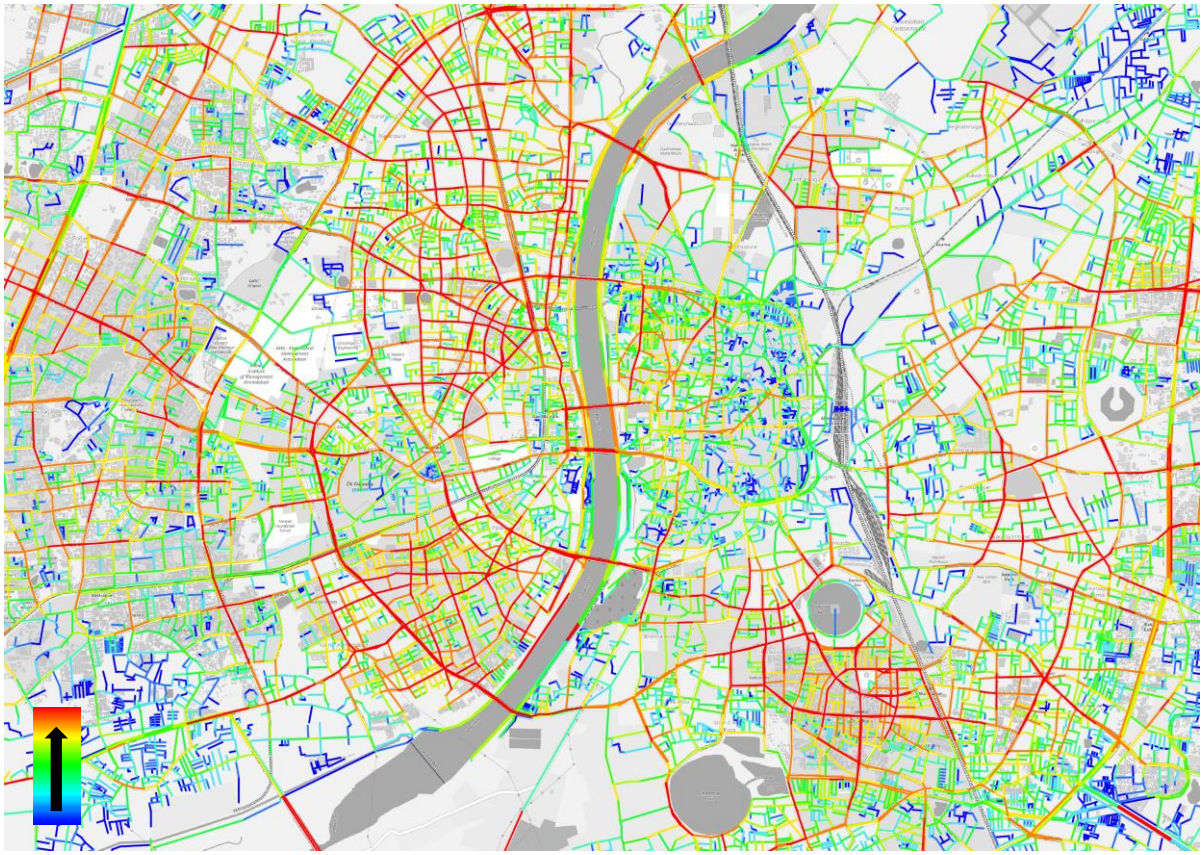


Figure 24: ASA showing NAIN (Radius 800 metres) after the SRFD.

6 Examining the riverfront as a public space

Having assessed the SRFD's impact on the city's structure and its relationship with the river, this section (addressing Question-B), evaluates its potential as well as realised performance as an inclusive public space. It uses spatial network centrality values, public transportation networks and other data as descriptors of the user groups and observed usage patterns.

6.1 Potentials of Usage based on accessibility

Considering accessibility as a basic requirement of an urban public space, we examine how well the spatial network is facilitating it. As has been noted earlier the high integration values (Mean NAIN (R n) = **0.96)** of the segments along the riverfront (**Figure 39**) show that the riverfront is well integrated at the global scale. However the patterns of centrality at local scales (1.2kms, 800 metres) demonstrate that the riverfront road and promenade are much less accessible locally (See Figure 23 and Figure 24). This explains the core of the accessibility issue in configurational terms. **The types of movement seen more locally, which are required for micro scale socio-economic phenomena are much less prioritized than the macro scale (vehicular access) performance of the project.** This undermines the efficacy of the measures such as providing wide pavements and footpaths which as per the designers are supposed to improve and encourage pedestrian access to the river.

For reasons stated in the methodology chapter, accessibility here is examined using not only the spatial network but also the public transportation network.

To read how the riverfront is positioned in terms of accessibility through the public transportation network it is examined using a catchment analysis. For this purpose the regular bus (AMTS) and the bus rapid transport system (BRTS) are considered here. The main focus is on the AMTS bus system as it is the most well distributed formal system which is more affordable than the BRTS and the upcoming metro rail system. The bus stops nearest to the riverfront are highlighted and a network catchment is run. This shows **the road network segments which can be reached within** [5] 200, 400 and 700 metres walking distance. It is observed that a very small portion (segments coloured red in **Figure 26**) of the riverfront is

[5] It must be noted here that this is different from a purely metric catchment. For instance the areas shown in dark red are not all within 200 metres from the bus stop, they constitute segments which start within 200 metres of the stop. If any point of the segment is accessible within 200 metres walk then the whole length of the segment is shown dark red.

accessible within 400 metres walking distance from the bus stops. Imagined as a major urban centre this can be considered a high lack of accessibility through public transportation.

As is seen in Figure 25, the wards of the walled city have the highest population densities amongst those adjacent to the riverfront. As a general trend, around the centre of the city, the wards to the east have a higher population density than those to the west of the river. Wards like Jamalpur and Dariapur are adjacent to the river with a population density of around 30,000 - 50,000 people per square kilometre making them areas most in need of public open space. Added to this is the fact that the average income of the population to the central west is significantly higher than that of those to the east (**Figure 2**). This further emphasizes the need for access to public open space for people from the central eastern part of the city (the walled old city) who do not have private gardens. However what has been seen from the catchment analysis is that these parts are not well connected to the riverfront making the riverfront less accessible to those parts of the population who possibly need it the most. The catchment analysis therefore shows that the riverfront is not well accessed by the bus systems and has room for much improvement in this regard.

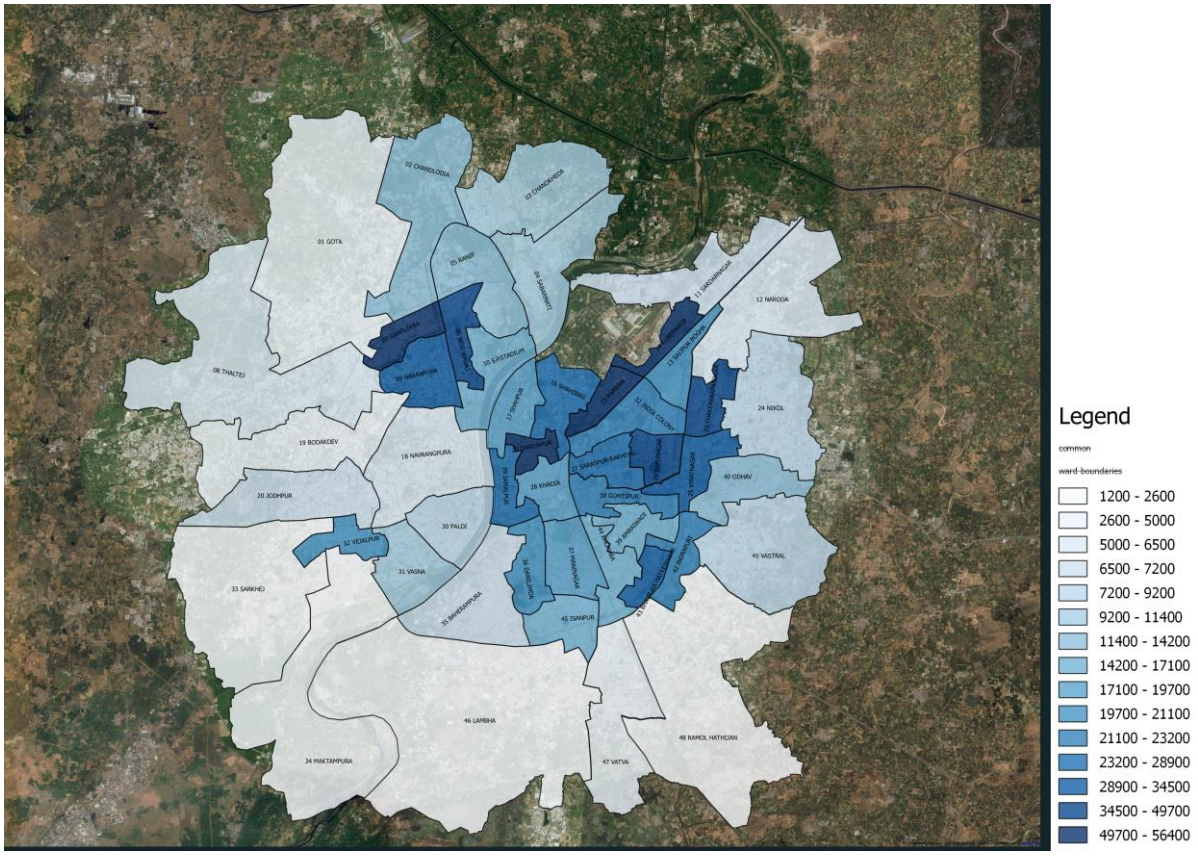


Figure 25: Ward wise Population Density. Residents per square kilometre based on 2011 census data

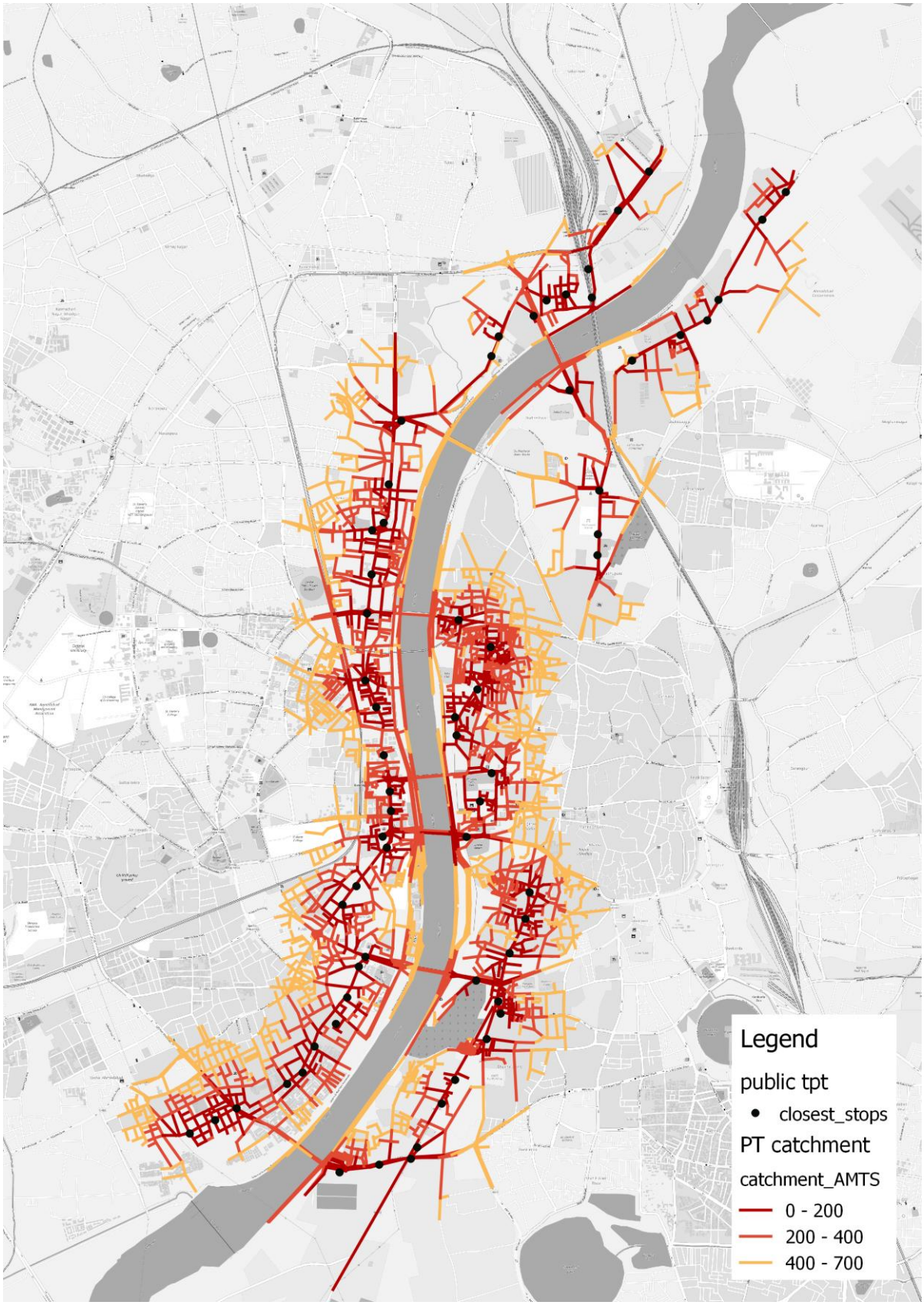


Figure 26: Catchment from nearest AMTS Bus stops to Riverfront

6.2 Observed usage of Space as an indicator of the projects performance

Having seen the potential of accessibility we now look at the actual state of use of how the riverfront is accessed. There are various entrances and approaches to the riverfront's promenade and other public spaces. Noting observed behaviour we see (**Figure 27**) the numbers of people preferring/ frequenting a particular entrance to the riverfront. The highest and lowest movement counts are 960 (near riverfront garden on the west) and 24 people per hour at an entrance on the central east. This demonstrates that there is a wide variation in the usage of the riverfront depending on which part of the city it is connected to.

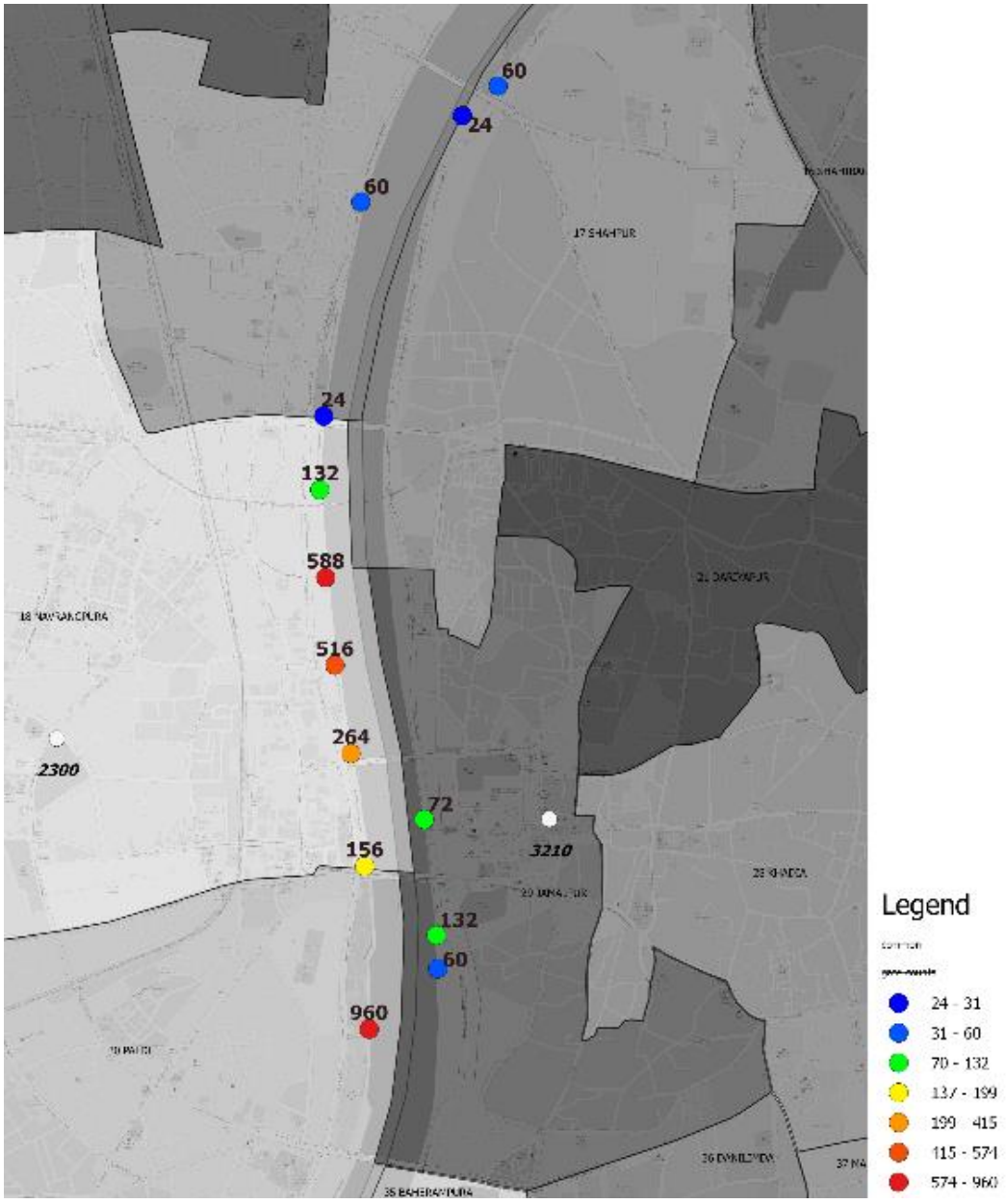


Figure 27: Movement Counts on weekend evenings representing number of people passing per hour.

A stark contrast is seen when these movement counts are compared with the counts at two public spaces- Law Garden (West): 2300 people per hour and Bhadra plaza (East): 3210 people per hour. It can therefore be noted that the highest count of riverfront usage on a regular day is less than half or one third of what is observed in the successful public spaces (a historic centre and a public garden). In simpler terms it may be said that though the river front offers much more open space than these two places it draws much fewer people.

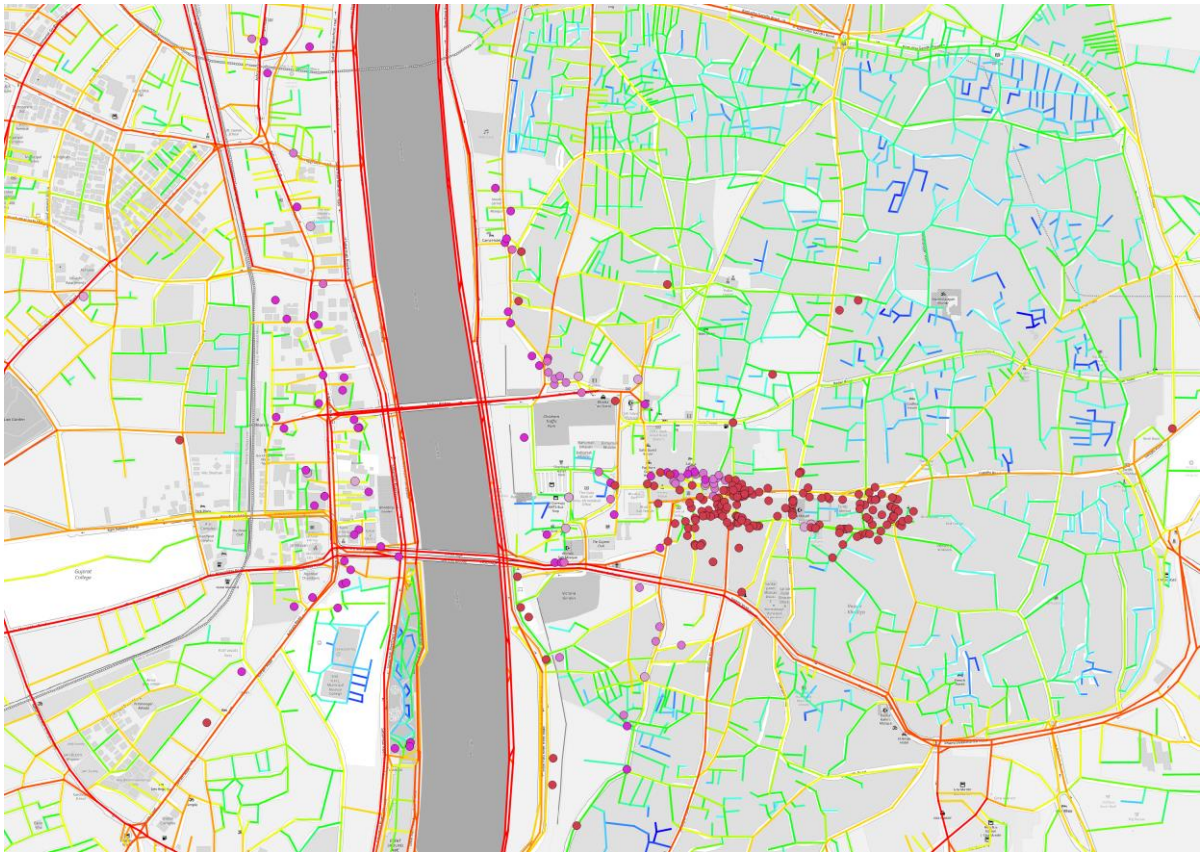


Figure 28: Clustering of Points of Interest –Created using Google my maps and QGIS

As flows of people are related to the presence of attractor functions, the clustering of functions such as markets, shops and restaurants has been mapped using point of interest data. The points do not constitute an exhaustive list, but rather have been selectively marked in order to show the locations of food joints (in pink) closest to the riverfront and small scale retail (markets, shops etc.) around the Bhadra plaza in red. The clusters of markets, shops and food joints around Bhadra plaza is a part of the explanation of why it works as a vibrant public space. Figure 28 shows that the even the closest food joins to the riverfront are too far to create a similar level of attraction.

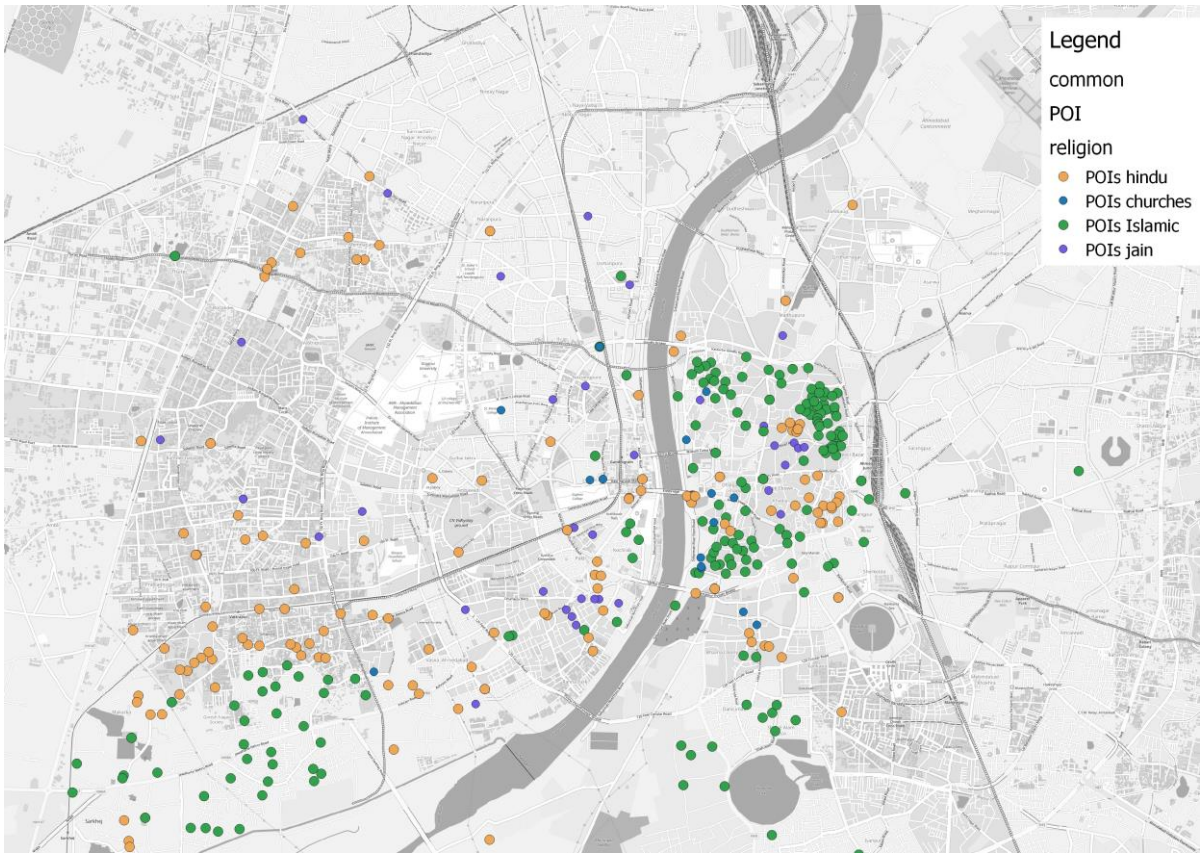


Figure 29: Places of Worship showing segregation based on religion – Created with *Google My Maps* and *QGIS*

Another aspect of the inclusivity of the riverfront is how it performs on the goal of unifying the highly segregated city. The segregation of the city and extreme differences between east and west are worsened by the religious segregation as emphasized through the literature review. This is corroborated by a very selective mapping of the places of worship as seen in Figure 29. It is observed that the two major religious groups (Hindus and Muslims) are spatially separated. The Muslim populations are restricted to the walled city and the area of Juhapura a Muslim ghetto formed after the mass killings of 2002. The most affluent central western areas have not only lesser places of worship in general, but a complete absence of Islamic places of worship.

Since the riverfront project has been seen to have altered the structure of the city, it becomes imperative to see how it has mediated the relationship between the east and the west sides of the river. As the walled city is one of the only two areas in the city with a significant Muslim population the riverfront also acts as a symbolic and functional bridge between the wealthier Hindu majority population on the west and the lower income Muslim minority to the east. In the observations it is noted (based on clothing) the garden to the East of the river has a predominantly Muslim presence, whereas the western garden has no such discernable pattern. The predominance of Muslim users observed on the garden to the east of

the river suggests that in the existing segregation persists in spite of the newly added common facilities. This suggests that the newly created facilities are not able to reduce this prevalent communal separation. It is only fair to acknowledge here that the park's proximity to a certain residential demographic inevitably reinforces this divide. A socio-economic segregation can be seen in the demographic of the North Eastern riverfront park near Subash bridge, due to the fact that it has an entrance fee. Charging a fee for entrance to a public facility brings back the earlier discussions of the city where the poor are not to be seen.

Figure 30: An image showing how the riverfront road is visualised. Source: sabarmatiriverfront.com

The imagination of the project when seen in comparison with the observed functioning shows certain gaps. The image in **Figure 30** depicts a vibrant and actively used street. However the situation observed on ground shows some reasons why it is not performing the way it is imagined in the image. The image shows a bus, however in spite of being the closest access to the river this road doesn't allow public transportation vehicles or have any bus stops.

Figure 31: The Riverfront Road. Source: Google Street Views

These riverfront roads have high speed vehicular traffic and act as long distance connectors for the traffic, making the road unsafe for pedestrians to cross (**Figure 31**). For most part of the project there is no functional barrier free access including the pedestrian crossings which have curbing and level differences. All these factors pose major questions regarding accessibility.

Summing up the findings on the performance of riverfront as an inclusive public space it is seen that the project creates large amounts of open space with various designated functions, however they are severely underutilised in comparison to other public spaces in the city. The reasons identified for this are a lack of access through public transport and a lack of integration at the local, walk-able scales. This means that the riverfront is conveniently accessible only to those sections of the population who own private vehicles. The absence of retail activity further reduces the ability of this space to attract movement. The existing communal and socio-economic segregation persists in spite of the new facilities intending to unite the two sides of the city.

7 Conclusions

The study thus far, builds a clear picture of how the riverfront intervention affects the city's structure and its relationship to the river. It also describes how it performs as a public space. The findings on these fronts are summarised here, briefly touching upon future possibilities of research and design.

It has been demonstrated that the project, which has an impact far beyond its area of intervention has re-structured the city and has configurationally centred the river. It has increased vehicular accessibility to the river but has not integrated the riverfront spaces into their immediate local context well. Described briefly earlier, the fact that the river front project increases the global accessibility of the river at the cost of local accessibility, reasserts the idea that it is intended for projecting an image globally to a larger audience rather than creating a public space which is well integrated within the local context and serves the people of the city.

The monothematic use of the riverfront as a place full of high end real estate development and high-culture recreational facilities such as museums and parks, disallows a more natural adaptation of the newly created spaces into the micro-economic functioning of the city of Ahmedabad. This is largely also a consequence of how it is configured as the spaces (streets) which are highly integrated globally lack the corresponding level of local integration needed for *pervasive centrality* (Hillier B. , 2009). One amongst many similar examples is the waterfront at Thessaloniki (Gospodini A. A., 2001) where the creation of exclusively high-culture spaces resulted in it failing to be a vibrant urban space as it excluded certain groups of people. Another issue faced in both these cases is that that the waterfront, particularly in Ahmedabad is not integrated well with the lively public spaces in the adjoining historical area around the Bhadra square.

Besides the configurational centrality, the existing and proposed land use patterns do not show the potential to create an urban public centre at the riverfront. The lack of movement make the newly created streets and promenades highly unsafe lacking the natural surveillance that would be possible if open markets and street vending were allowed, by first improving the pedestrian movement potential of the area (Mahadevia, 2019). Since open markets and street vending are among the biggest sources of livelihood for the poor in Ahmedabad, depending on a range of skills (Mathur, 2012) it would be ideal to design policy in ways that allows for informality. Besides allowing for a more natural appropriation of the riverfront itself this would

potentially create 'eyes on the street' (Jacobs, 1961) as well as to allow livelihood for the poorest sections of the society.

On the addition of new road linkages it may be observed that indiscriminately increasing integration and connectivity is a process which disrupts the healthy balance in dual grid (foreground and background network). In terms of the change effected in the global integration, it can be seen that the creation of new road linkages to the riverfront is a double edged sword. As one increases the accessibility it can potentially have the effect of gentrification in the areas. Whereas not doing this would perpetuate the segregation and resultant marginalization of some of the lower income areas. Instead the points where the new linkages are added must be strategic in order to minimize the disruption of existing spatial cultures yet increasing accessibility from the area to the riverfront, in an inclusive manner.

The principal architect of the project Dr. Bimal Patel has been quoted as saying the following: "The key objectives have always been to create a public realm along the river, clean the water and rehabilitate those affected by the project. Now a huge public space is available for 7 million people."

The stated intent mentions: '*The project aims to create a thriving, people-centric network of parks, waterside promenades, markets, cultural and recreational facilities in the heart of Ahmedabad, making the city's riverfront a public asset.* (SRFDCL, 2014).

One of the main intentions of this project as stated is to serve as an inclusive public space for the people of the city to come together. In order to achieve this, the project needs to be well integrated into the fabric of the city, accessible for the public, not only by private vehicles but also by public transport and by foot. It needs to be an intelligible and safe environment with the supporting opportunities for micro economic activity which compliments the open public space. Overall, in terms of its accessibility, the riverfront project (which has been treated more as an object than a part of the city), can improve manifold if better stitched in with the urban fabric. Without strengthening the aforementioned aspects, many of which are configurational, the riverfront cannot perform as an inclusive public space befitting to its potential.

Since the SRFD is being seen as a model to base other riverfront development projects across India, this analysis has some guidelines for future projects. Much of the analysis here suggests that in such urban interventions, an in-depth understanding of the specific demographic is required in order to create a space which serves them. This means that

references to other models (if used) need to be adapted to an understanding of the specific user groups of the particular city. The overarching finding here is that the intentions of the project to serve as a public space need to be prioritized so as to prevent the macro-scale urban intervention from becoming primarily an image making exercise. This necessitates a focus on accessibility by integration with public transportation. This also requires the riverfront to be integrated at different radii not only the city wide radius, so as to support walkability. Creation of a network of centres connected to the historic centres and other existing centres can integrate the newly created facility well with the existing. As has been seen in the case of Ahmedabad that though the design of the riverfront focused on the riverfront itself, much of the focus of the future interventions needs to be outside it, on the areas adjacent to the riverfront. This is what the connectivity of the riverfront hinges on, not on the land by the river itself, but on how the city gets linked to the river. This aspect of the linkage or relationship to the city is best understood through a description of the configuration of the spatial structure. This study therefore recommends the use of a spatial network analysis for the design of future riverfront developments for speculative testing of ideas as a process of designing.

Epilogue: Testing strategic design proposals

Building upon the findings of the thesis which examined the impact of the river front on the city-river relationship, as well as its performance as a public space, this section tests a few design strategies to speculate about how they address the problems identified in the functioning of the riverfront.

Pedestrian Bridge

The construction of a pedestrian bridge is underway as on August 2019. The bridge is intended to connect the area near the riverfront garden on the west to the reclaimed land adjacent to the historic Sunday market on the east. This intervention is tested to understand its impact on the immediate context as well as the larger connections it establishes. An analysed model of the spatial network with this link (bridge) added is compared to the one without the bridge. In the model where the bridge is added there are also streets which are created to show pedestrian access through the sites of future development in order to test the effect of the heightened connectivity, further links are added from the riverfront road to the inner parts of the walled city Figure 33. The added links are shown in **Figure 33**. The conditions before and after the links are shown in **Figure 32** and **Figure 34** respectively. Not only are the added street links highly integrated but they also increase the integration values of many of the surrounding segments. It may also be noted that the streets in the inner parts of the walled city which were earlier a part of the background network and purely residential in function would become syntactically shallower/ more integrated.

In the test analysis of adding the pedestrian bridge with multiple other links the riverfront is stitched with the city. As a result the earlier gradual transition of integration values from the main streets up to the innermost streets, changes now, making the internal residential streets shallower to the whole system. Thus the relationship of the dual network (foreground and background) is altered. The local social impact of this might be that the internal communal areas functioning as extensions of domestic space, as safe play-spaces for children, are likely to become retail thoroughfares overtime bringing in traffic and strangers from the city. These drastic changes to the socio-spatial setting can disrupt the existing smooth functioning systems which have evolved over 600 years.

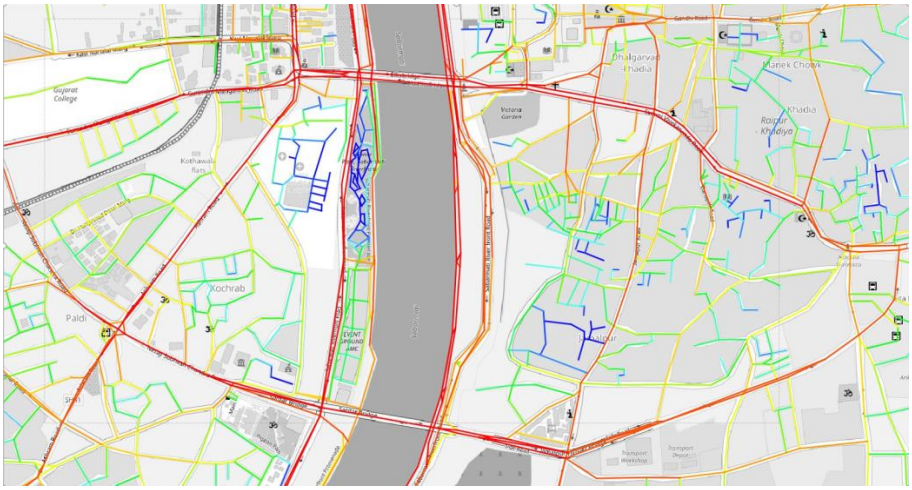


Figure 32: ASA showing NAIN (Radius 5kms) without pedestrian bridge addition

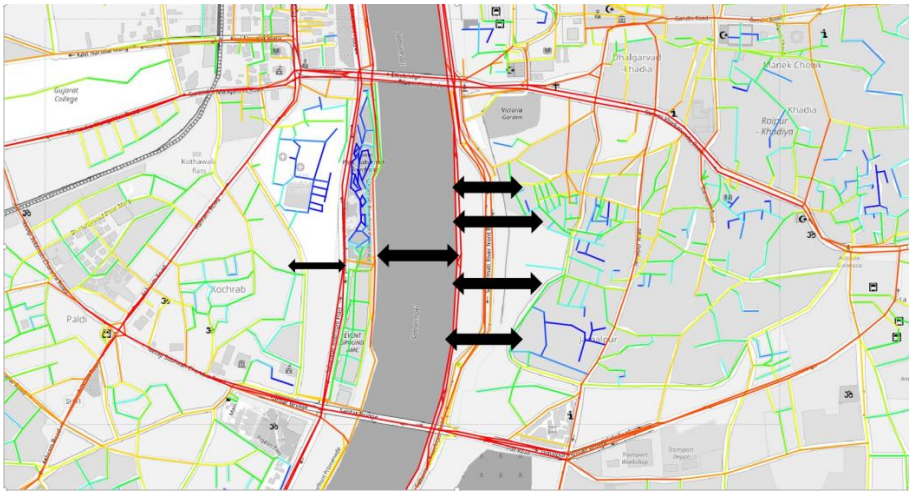


Figure 33: Adding pedestrian bridge and other links

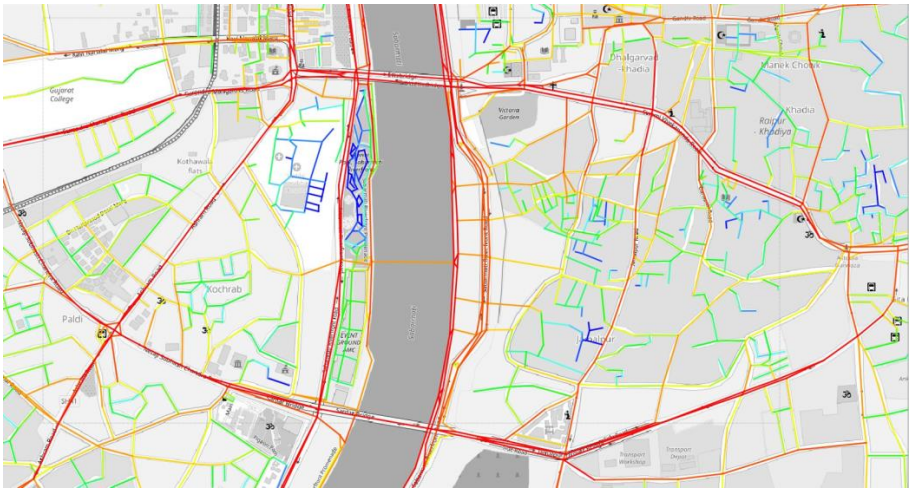


Figure 34: ASA showing NAIN (Radius 5kms) after adding pedestrian bridge and other links

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Appendices

Appendix 1 (to chapter 3)

(In continuation with 3.1)

Institutions in the city:

Some of the institutions which have been pivotal in the city's history include- The Gandhi Ashram, the Ahmedabad textile mill owners Association and the educational institutions such as the Indian Institute of Management, National Institute of Design and Centre for Environmental Planning and technology.

On the traffic problem:

'The privately owned motorised two and four wheelers are increasing with sustained annual growth rates of 12-13 per cent and 7-8 per cent respectively. There are more than 100,000 vehicles being added in the city every year. By 2012, a total of 2.85 million vehicles were registered in Ahmedabad district including 0.42 million four-wheelers and 2.02 million two-wheelers' (Joshi, 2014) The sustained increase of privately owned vehicles in the city as well as the percentage of the city's population which cannot afford even the cheapest forms of public transport, both hint towards alarming trends for the city's future (Joshi, 2014).

Type of motorised vehicles / years	2009-2010	Annual growth rate 09-11 (%)	2010-2011	Annual growth rate 11-12 (%)	2011-2012
Private 4Ws	339055	13.13	383588	12.02	429688
Private 2Ws	1728522	8.51	1875658	7.82	2022424
Auto Rickshaw	115699	10.84	128240	8.85	139587

(Joshi, 2014)

(In continuation with 3.2)

On the Sabarmati Riverfront Development

Chronology and administration:

There have been different proposals for the development of the areas along the river Sabarmati passing through Ahmedabad city. The first such proposal was by a French architect Bernard Kohn in 1964 suggesting a mix of commercial and residential development along the banks from Gandhi to Sardar Bridge. The following events in the timeline are described in Table 1. In 1997, the Ahmedabad Municipal Corporation (AMC) set up the Sabarmati Riverfront Development Corporation Limited (SRFDCL) to oversee the development and execution of the project. Soon after, a feasibility report was developed by the Environmental Planning Collaborative (EPC) under the leadership of Dr. Bimal Patel, post which the SRFDCL appointed HCP Design, Planning and Management—of which Dr. Patel is currently director—to 'lead the architectural, structural and urban design aspects of the project'.

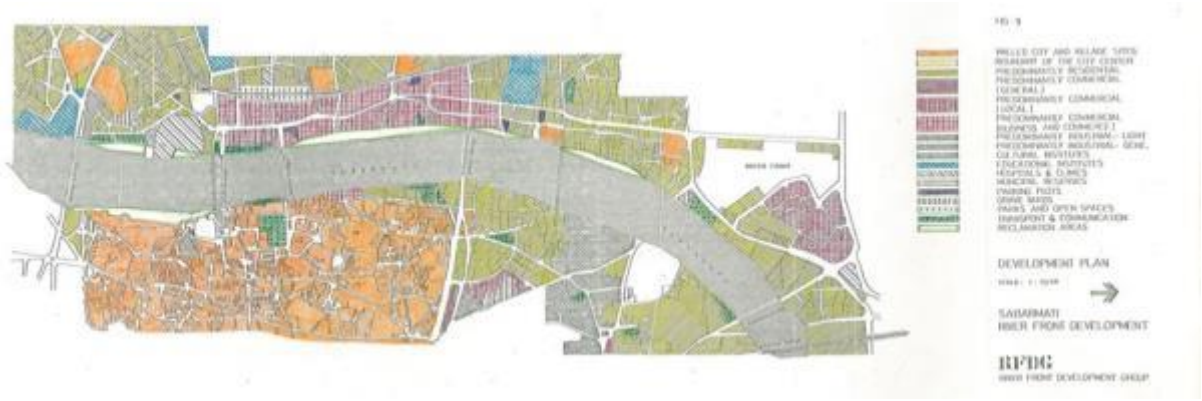

Figure 35: Bernard Kohn's proposal for the riverfront in 1960s

Table 1: Timeline of Sabarmati development proposals

1964	Bernard Kohn, French architect residing in Ahmedabad creates a proposal for Integrated Planning & Development of Sabarmati Riverfront, calling for reclamation of 30 hectares of land.
1966	Kohn's proposal is claimed technically feasible by Government of Gujarat after technical studies are completed.
1976	Riverfront Development Group proposes an incremental approach to reduce the need for initial capital investment.
1992	National River Conservation Plan proposes construction of sewers and pumping stations at the periphery of the city as well as upgrading of existing sewage treatment plants.
1997	Ahmedabad Municipal Corporation (AMC) sets up a Special Purpose Vehicle - Sabarmati Riverfront Development Corporation Limited (SRFDCL) to manage the construction and development of the project
1997	Environmental Planning Collaborative, under the leadership of Dr. Bimal Patel (EPC) prepares the feasibility report for the project, and subsequently, SRFDCL appoints HCP Design and Project Management Pvt. Ltd. to lead the architectural, structural and urban design aspects of the project.

Perceptions, debates and discussions surrounding the project:

As is seen in innumerable records of the imagery used around the project, an example in **Figure 1** shows how Narendra Modi was seen as the face of the project and was credited with its successful execution. This is further evidenced in one of many statements by the then municipal commissioner of Ahmedabad, I P Gautam '*The major credit for the project should go to the Chief Minister Narendra Modi'* (Banerji, 2011, p. 63)-interviewed December 2010. According to Surendra Patel a prominent BJP leader, the two main purposes of the riverfront project were beautification and flood control. He believed that the creation of infrastructural and public recreational facilities was imperative to achieve the goals of raising land values, contributing to real estate potential as has been done by world-class cities of China through riverfront developments. All this suggests that the governments focus besides flood protection was to enhance Ahmedabad's potential for inviting business and investment. (Mathur, 2012)

However the publically stated intentions are always reflecting a very different focus such as '*The project replaces a largely private riverfront with an expansive public realm'* (SRFDCL, 2014) One study highlights the possibility that the impetus on this project was in part due to the need for rebranding the tarnished image of the city after the mass killings of Muslims in 2002 (Desai, 2010).

Renu Desai describes the politics of inclusion in the Sabarmati Riverfront Development project to be one of 'flexible governing', which 'allowed state authorities to negotiate grass-roots opposition and mobilisation, modify the project to gentrify the riverfront further, and even officially represent the project as inclusive although questions of social justice have been profoundly disregarded over the past decade and continue to be insufficiently addressed' From contentions of disregarding the ecology of non perennial river systems (Rao 2012), to the recent report by GPCB stating that the level of industrial effluents contaminating the river have reached unprecedented and unsafe levels (GPCB 2019), the criticism in terms of ecological impact of the project are significantly articulated in the scholarly work regarding this project. Much of the research which was done after the project implementation began, has raised concerns regarding displacement of vast numbers of informal settlements along the riverbed.The project displaced around 4400 families and several researchers have contested the appropriateness of the schedule and process of rehabilitation. (Dmonte, 2011) (Desai, 2010) (Mathur, 2012)Another debate which has been raised regarding the project surround the architectural design of the project and the appropriateness of the image it projects (Rao 2012) (S. Banerji 2011) (Desai, 2010) (Desai, 2012) (Pessina 2018) as the project takes inspiration from several aspects of the Thames waterfront particularly the Southbank area and the riverfront of the Sienne in Paris.

Figure 36: Visualisations of the project and the skyline Source: sabarmatiriverfront.com Retrieved 08.09.2019.

Appendix 2 (to chapter 4)

Instructions for volunteers

Mode of observation:

There are 15 locations for the observations. Each location must be observed once on a weekday and once on a Sunday. Total duration of observation required is 5 minutes at each instance. These five minute can be anytime between 5:30 PM and 6:30 PM. The video should at the least be able to show how many people are passing through that particular gate(imaginary) . Any more detail that can be captured will be helpful but not essential, this means that the camera should stay stationary for the entire 5 minutes.

Confidentiality and data protection:

On each of the 15 locations a total of two videos will be recorded. Each video is of 5 minutes duration and may be recorded on a phone after disabling any automatic cloud sync settings in order to have the video only on the phone's internal memory storage until it is shared. The videos must be shared directly with the researcher and deleted after sharing. The preferred mode of sharing is whatsapp as there is end to end encryption of data. The researcher Freyaan Anklesaria will delete all the videos once she has viewed them and noted down observations, so as to avoid any further circulation of the videos.

Non intrusive Observation:

Observers are requested to occupy a position where they do not obstruct peoples movement. Attempt as far as possible to not offend people. The manner of recording the video should neither over expose people's faces nor attempt to be covert/hidden in anyway. Exercise intuitive discretion based on your awareness of the cultural context with particular attention to gender related sensitivities. Using a tripod may make it a lot more comfortable for the passer-by than if the observer is clearly observing in real time from behind a lens.

Ethical concerns and how to mitigate any risk of infringement of personal information:

(Note to volunteers):

- If asked about the purpose of observation please mention is it your volunteered help with a friend's academic research as part of architectural studies.
- Please be highly attentive to any likelihood of people from the public taking offense to your presence or videography.
- In case of any discomfort whether stated explicitly or sensed by you please abandon the taking of videos completely.

Appendix 3 (to chapter 5):

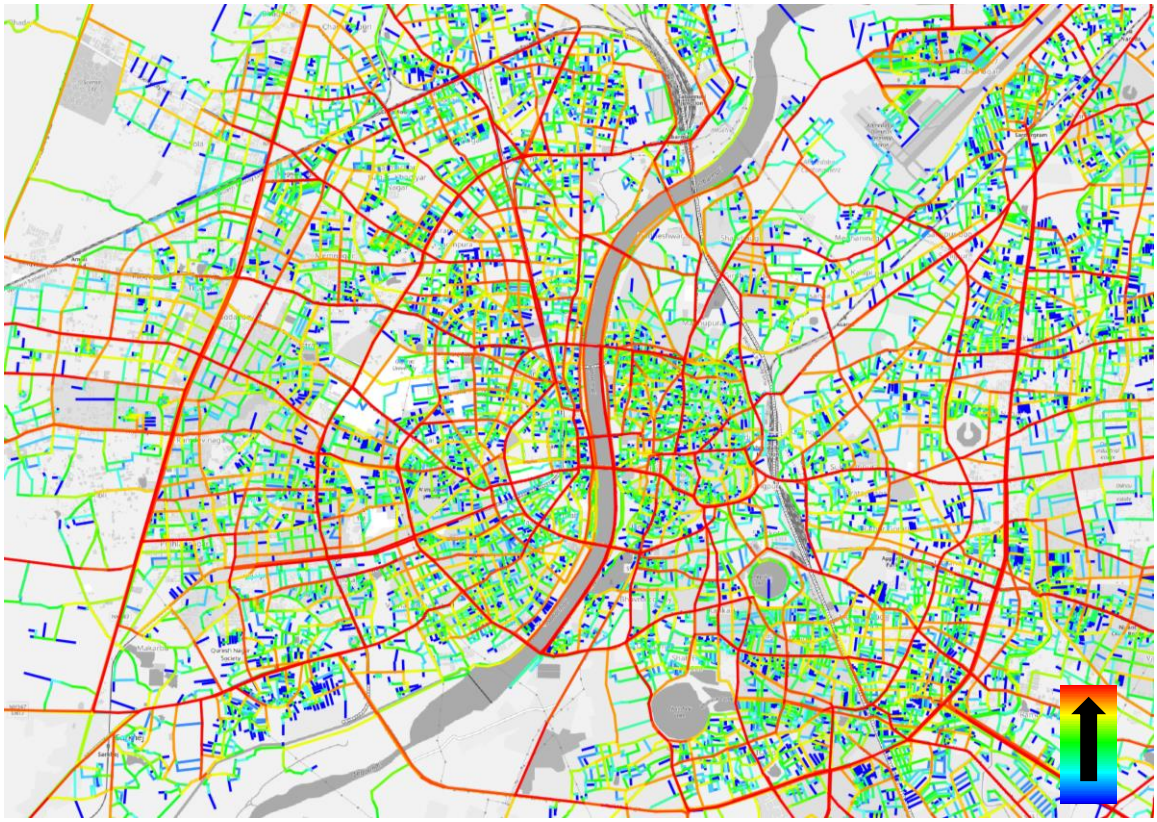

Figure 37: ASA showing NACH (Radius 5kms) After the SRFD

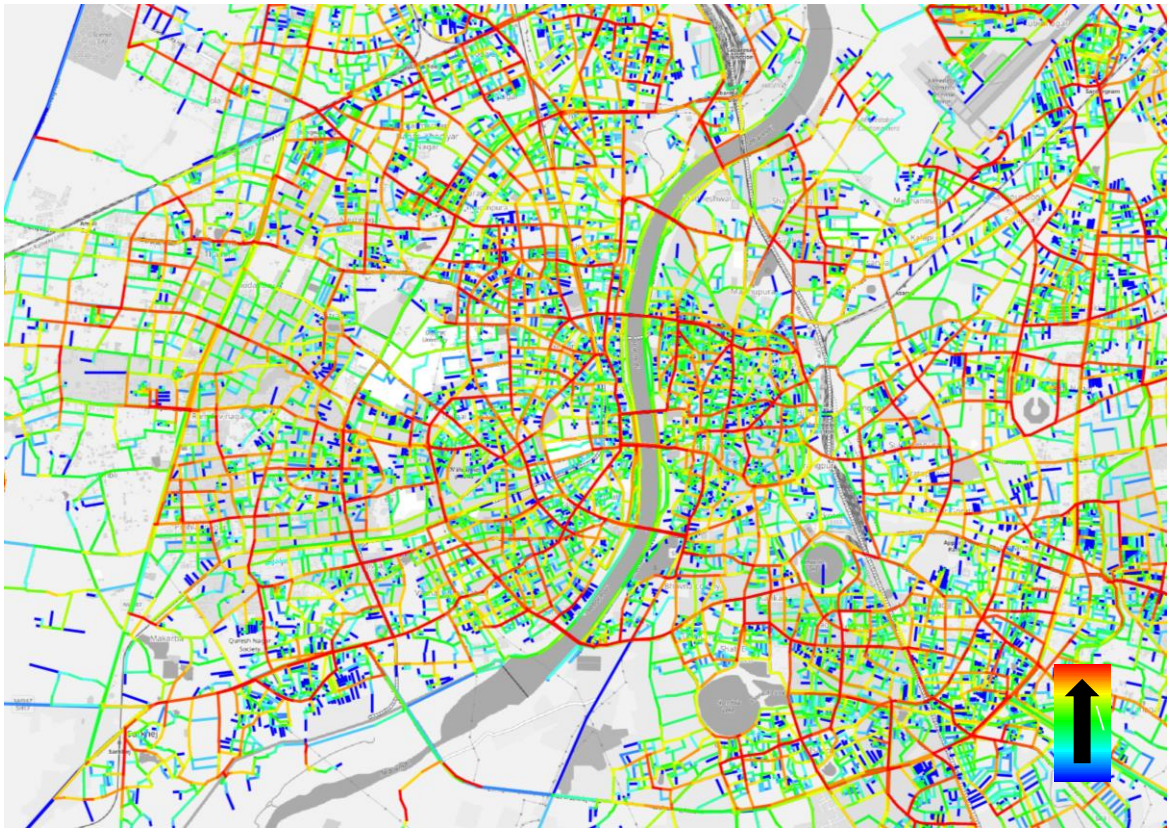

Figure 38: ASA showing NACH (Radius 1.2kms) After the SRFD

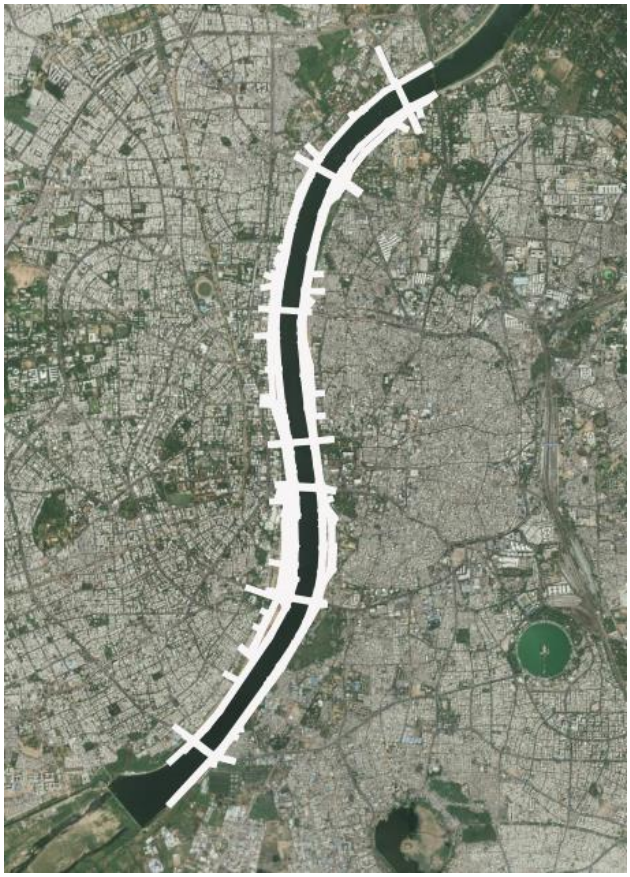

Figure 39: Segments along riverfront highlighted

Figure 40: Image of a retail street at Ratan Pol showing the usual level of activity within the old city. Source https://commons.wikimedia.org/wiki/File:Ratan_Pole,_Ahmedabad.jpg Accessed 08.09.2019