Intersection Improvement in Udaipur:
A Demonstration of Passive Junction Design Solutions

Implemented by

ICLEI Local Governments for Sustainability

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Introduction

Udaipur is a rapidly growing city. The city core is an old walled city, surrounded by planned development which is currently sprawling within the natural limits of peripheral hills. The walled part of the city forms the core of the city and is accessed through 10 traditional gates known as 'pols', which today are amongst busiest street junctions. The streets connecting the junction serves as the major commercial streets, especially towards the eastern side. These junctions and streets were functional without hassle when the city had a very few number of motor vehicles.

The current report - Intersection Improvement at Udaipur - A demonstration of Passive Junction Design Solutions, is part of the output reports under the project "Supporting Smart Urban Mobility and Built Environment in Indian Cities" under Grant Ref: G 15 SSEF-140 for the period of October 2015 to January 2017. The main objective and deliverables of the project were to broadly engage with state level officials in two states and have continuous on ground engagements with targeted authorities in cities on urban transport and built environment towards implementing the Smart Cities Mission. This included assessment of existing urban transport scenario in the identified cities for each state providing handholding support to city teams for smooth initiation of Smart city program.

The report presents the summary of design strategy for improvement of intersection/junctions to resolve traffic issues at three major junctions - Suraj Pole, Hathi Pole and Delhi Gate, along with the streets connecting them. The report also intends to capture the various issues encountered during redevelopment of junction, as per revised designs. Based on the response from different stakeholders, the report provides process details which can be replicated for redesign of other junctions in Udaipur.

Context

Presently, these junctions witness considerable traffic demand which results in long queues and traffic jams, especially during peak hours. These areas are also plagued by on-street parking and reducing space for clear movement. To improve the mobility and accessibility to the walled city area, the city desires to resolve traffic issues at three major junctions - Suraj Pole, Hathi Pole and Delhi Gate, along with the streets connecting them. The mentioned junctions selected for redevelopment in Udaipur are similar in character, typology and nature. This is because each of them encloses a heritage structure, is an important activity node and has similar physical as well mobility-related issues.

Approach

Intersection improvement of these junctions is intended to accommodate an infrastructure which will ensure a safe and reserved right of way for pedestrians as well cyclists, and space for accommodating infrastructure (which supports context relevant activities currently observed on the street) such as pedestrian, vending and landscaping space to support shopping and religious activity on the street, along with spaces for parking of Integrated public transit (IPT), bus stops, etc. The junction improvement needs to meet local objectives of reducing traffic queues during peak hour along with reducing delays and improving safety for non-motorized modes. These requirements can be met by Modern Roundabout development at this intersection.

The selected approach offers solutions based on segregating slow moving traffic as well other activities from motorist right of way at the junction. This requires appropriate geometric design of the junction and the public domain around it. Additionally, the design needs to be based on the current (traffic) demand and

existing constraint. Modern roundabouts work best with junction traffic volume of less than 6,000 Passenger Car Unit (PCU), and they ensure minimal conflicts and offer maximum safety as well efficiency. This has led to selection of modern roundabouts as the solution of choice to resolve all woes of the selected junctions (for redesigning) in Udaipur. The current junction traffic volume at any of the selected locations does not exceed more than 6,000 PCU per hour.

Methodology, Principles and Standards

The project aims at guiding the city in moving from the current short-term infrastructure intensive approach (such as grade separated solutions) to long-term mobility and safety centric solutions, to resolve urban traffic issues. Thus, the objective of the project was to demonstrate a rational, quantitative approach (based on principles of sustainable mobility) to resolve traffic junctions, and the effectiveness of low cost passive junction solutions in resolving mobility and safety issues for all modes.

Project Methodology

The methodology to achieve the objectives of the project was finalized based on assessment of the current situation and demand, followed by a study to understand the ground situation, assessment of alternate solutions, leading to analysis and recommendations. The following steps have been followed for the junction re-development exercise.

1. Total station survey of the junction and streets accessing was conducted to generate the existing site plan.
2. Issues at the junction were recorded through activity mapping of the entire junction area, including streets leading to it. This created a real-time activity plan of the junction with informal activities shown on the site plan along with formal/fixed structures and boundaries.
3. Traffic flow data at the junction was collected using sample video recordings during peak hour. Data was collected mode and direction wise, to allow analysis of mode share and directional load.
4. Analysis of the site conditions, activity mapping and traffic data was used to create a complete understanding of all issues at the intersection.
5. Based on the detailed understanding of all issues at the intersection, an ideal solution based on the principles of equity and sustainability was recommended.
6. The recommended solution was replicated on site, using temporary barricading and other means, and the resultant impact on the traffic was recorded.
7. Learnings from the on-site demonstration of the solution have been used to refine/improve the junction design. If required, the revised design can be replicated again on site with step 6 and 7 repeated.
8. Approval from all stakeholders including traffic police was sought on the final working (temporary) solution. Following this, the temporary setting has been left functioning on site for the public to experience the benefits and to provide any suggestions (also for traffic police and other stakeholders to experience it over a longer term).
9. The city then commissioned the preparation of detailed drawings and tender documents for the final solution to a consultant or in house team.
10. The final solution has been implemented on ground and the interventions have been made permanent.

Design Principles

The principles and salient features which are being followed in the junction re-designing exercise are as follows:

1. Pedestrian friendly environment
2. Integrated barrier free infrastructure (mandated by disability act of 1995)

3. Integrated bicycle-friendly infrastructure to support captive use and bicycle sharing efforts
4. Organized traffic circulation, through improved geometric design to improve junction efficiency, minimize congestion
5. Equity in road space allocation, ensuring designed space is integrated for activities such as vending and IPT parking
6. Designated spaces for private vehicle parking (as per current demand), which can be charged as per parking policy
7. Generation of 'city space' treatment through landscaping, lighting, street furniture and signage
8. Enhancement of heritage appeal and attractiveness through better experience, connectivity and access
9. Improved safety and security through active and passive means such traffic calming (speed control) and better lighting

Design Standards

Listed below is a brief list of standards and guidelines which have been followed while re-designing selected junctions (Suraj Pole, Hathi Pole and Delhi Gate):

1. IRC Codes
2. Referred Roundabouts: An Information Guide (U.S Department of transportation)
3. Referred NCHRP Report 572 – Roundabout in the United States
4. Referred ASVV–CROW Record 15 (Recommendations for traffic provisions in built-up areas)
5. Design of Urban Roads: Code of Practice Part-1 – Cross sections. (Ministry of Urban Development, Government of India)
6. Design of Urban Roads: Code of Practice Part-2 – Intersections. (Ministry of Urban Development, Government of India)

Junction Redevelopment

The observed issues on the identified junctions mainly include congestion, interlocking (of traffic) at junctions and on street parking, scattered informal kiosks and encroachment. It has been concluded through observations and data analysis that these issues are a result of undefined available right of way for usage by different modes and functions (vehicular movement, pedestrian movement etc.). Additionally, it is concluded that traffic 'congestion' at these junctions is not a result of capacity constraint but caused by friction between motor vehicles and slow moving traffic (such as pedestrians and cyclists) as well static activities such as street vending, all of which share the right of way with motorized modes. Analysis of primary data collected at these intersection reveals that the current junction traffic volume at any of the locations does not exceed more than 6,000 PCU per hour. Thus, the remodelling of the junctions addresses the issues of traffic flow, road safety, and congestion in Udaipur, through design intervention, demonstration of design solutions and public engagement.

Suraj Pole Junction

Suraj Pole is situated in the heart of the city, just 0.5 km away from the Udaipur city bus depot and 1 km from Udaipur city railway station. It is the focal point for many adjoining markets, namely Bapu Bazar, Nehru Bazaar, Dhaan Mandi, Gulab Bagh, Ziniret Chowk etc. The abutting area has a mixed land use, with elements of residential, commercial and institutional use (refer Figure 1).

Presently, Suraj Pole is a complex junction with two separate intersections spaced less than 100 m away. One intersection acts as a rotary while the other used to function as a signalized junction. After discussions with

Figure 1.: Suraj Pole Junction

all stakeholders, including Udaipur Municipal Corporation and local traffic police, the following design requirements were finalized for Suraj Pole:

1. Efficient traffic movement through the twin intersections with minimal conflicts and delays
2. A safe and comfortable pedestrian and cyclist environment. This shall include wide comfortable and landscaped pedestrian plaza
3. Defined spaces for vending outside the pedestrian and vehicular movement lines
4. Defined space for IPT and private vehicle parking as per existing demand
5. Provision of required pavement marking and signages
6. Provision of lighting
7. Integration of services such as storm water drainage

Based on the methodology discussed in previous sections, data collection including total station survey was conducted for Suraj Pole. The findings from this exercise and the design brief were used to arrive at design recommendations. For example, the traffic data (Left - Figure 2) collected at this junction revealed that the junction presently caters a total of 13,738 PCU's per hour[1]. Similarly, the findings of the activity survey (Right- Figure 2) suggest that the junction presently has around 760 two wheelers, 19 four wheelers, 19 auto rickshaws parked in and around the junction along with a total of 32 hawkers at any given point of time.

Based on these findings, twin modern roundabouts are suggested at this intersection. While one roundabout is an improvement on the current rotary around the historic Suraj Pole structure, the other roundabout has been modified in to an ellipse (to reduce conflicts between high traffic from Town Hall with 3,030 PCU per hour and Airport Link road with 3,316 PCU per hour. Both these roads are perpendicular and have high traffic of heavy vehicles. Additionally, current space limitation restricts overall roundabout diameter, limiting its capacity. Thus, an elliptical roundabout around the central park was tested and the same proved successful.

1. 13738 PCU per hour is total PCU collectively catered by two separate intersections as mentioned in Section 6.1

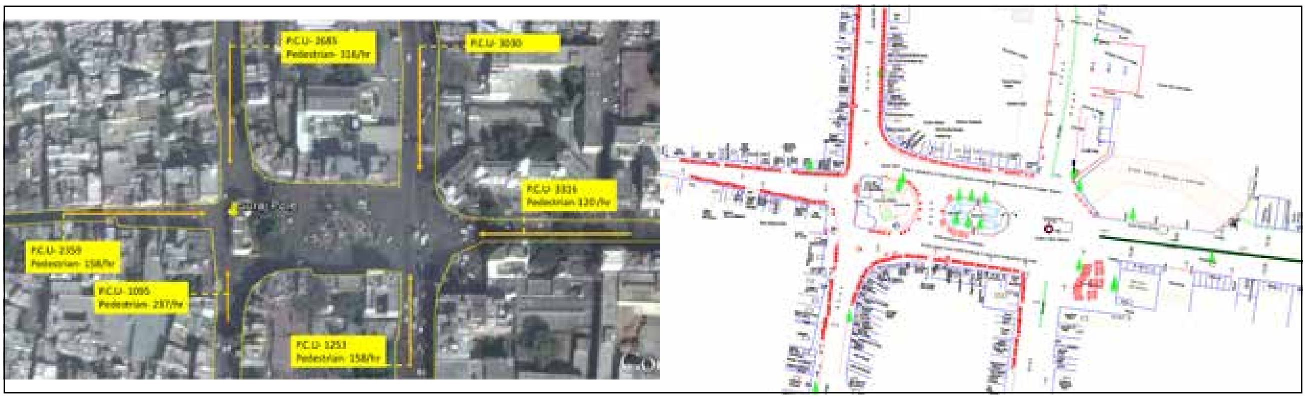

Figure 2.: Traffic Volume Count(Left) and Activity Mapping (Right) at Suraj Pole

The traffic entering the two junctions varies between a low of 1,095 PCU per hour per direction from Bapu Bazar Road and a high of 3,316 PCU per hour per direction from Airport Link Road. Since the peak capacity in urban conditions is suggested as 2,000 PCU per hour per lane, it is evident that two lane carriage-way for each direction traffic on roads feeding the intersection is sufficient to cater to current demand. However, between the two junctions, the available width is more than twice required for a two-lane carriageway (6.7 m). Thus, by proposing a junction geometry in line with the current demand, a demarcation was created on the current 9.8 m wide carriageway between the junction, which leaves near about 13 m width on either side to be developed as landscaped pedestrian realm, parking and vending spaces. The proposed design for Suraj pole intersection is presented in Figure 3.

Figure 3.: Design Proposal – Suraj Pole

The proposed design (Figure 4) was presented to all stakeholders, along with the data and other observations which formed the basis of this design. After approval from the decision makers, plans were drafted for onsite demonstration. This plan was a slightly modified version of the junction design, to allow temporary barricading without the need for any demolition or re-construction. The demonstration with temporary barricades proved two things:

- Traffic circulation improves and delays are reduced with modern roundabout
- A safe and enjoyable pedestrian zone can be created outside vehicular right of way

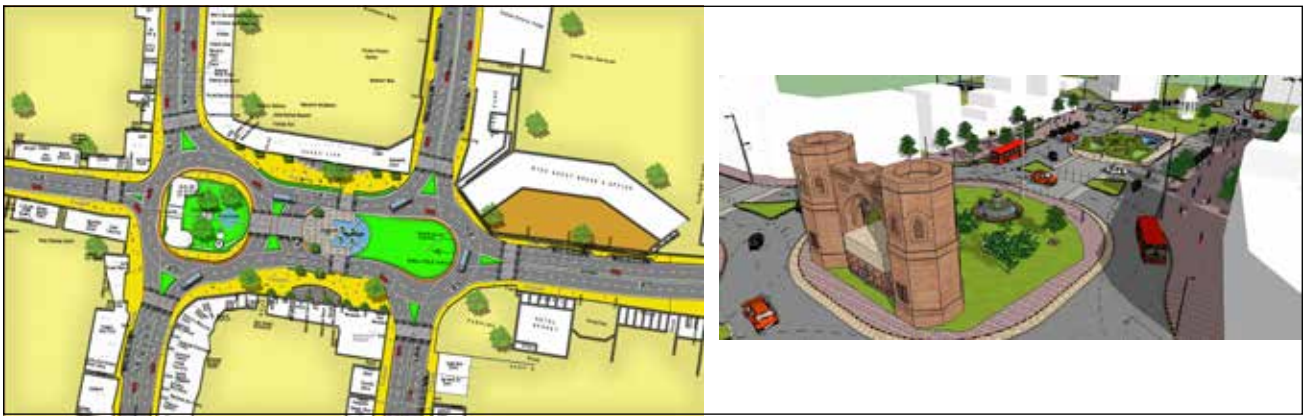

Figure 4.: Design Proposal and View – Suraj Pole

Suraj Pole junction design was modelled practically on ground and has been running successfully for six months, with much appreciation from all walks of society, city, traffic administration and media. People have appreciated the initiative not only by following the planned traffic movement, but have also developed an insight towards traffic improvement ideology. This laid the trust in the design solution of roundabout as a junction improvement. Public now believes in a possibility of larger benefit over long term through classification and segregation of available road space to meet requirement for all modes. Figure 5 below presents some glimpses during the Suraj Pole junction experiment.

Figure 5.: During Experiment at Suraj Pole

The findings from the on-site demonstration exercise have been used to refine the designs, which have now been handed over by the Udaipur Municipal Corporation to the Smart Cities Project Management Consultant for timely implementation on ground. A similar process was followed up for Delhi Gate and Hathi Pole junction.

Delhi Gate Junction

Delhi Gate junction currently acts as a signalized rotary (with a small central island). The streets merging at the junction contribute to the complex nature of the junction. Thus, design brief for Delhi Gate intersection redevelopment was finalized after discussions with all stakeholders such as Traffic Police and Udaipur Municipal Corporation. Data collection, including total station survey and activity mapping was conducted for Delhi Gate junction. The findings from this exercise and the design brief were used to arrive at design recommendations.

As per the design brief and data analysis for Delhi Gate, a large oval roundabout was suggested at this intersection. This roundabout combined the cluster of junctions at this location into one large roundabout. This was proposed along with a revised circulation plan for the surrounding road network – Proposal A (Figure 6). The proposal was later modified to allow experimentation on site using temporary barricades. The proposal constituted improvement of the current rotary around the historic Delhi gate structure along with signal free traffic circulation - Proposal B (Figure 6). This proposal was executed on the site, but did not work well because of a construction on the western edge. Thus, the proposal was reverted to cluster of junction design, with redevelopment of all three junctions to passive controlled intersections using roundabout - Proposal C (Figure 6). Experiment for this proposal was conducted, involving the main junction, which was the most traffic intensive junction of the three (Figure 7).

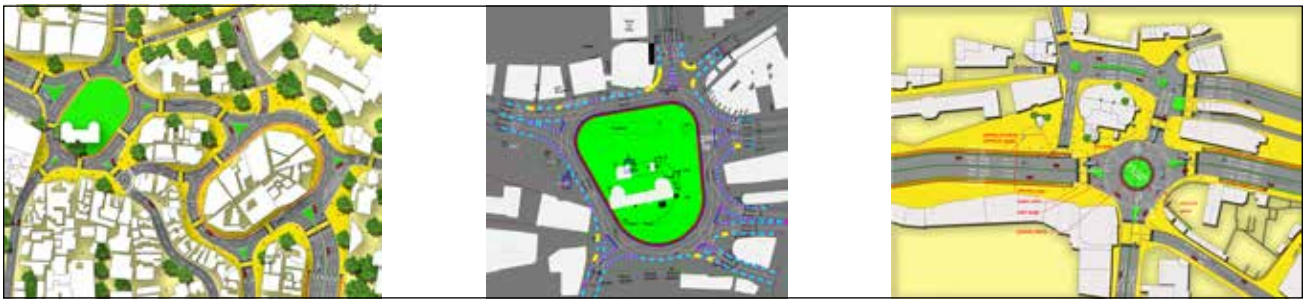

Figure 6.: Design Transition Delhi Gate – A. Initial proposal (Left), B. Modified Proposal (Center) and C. Final proposal (Right)

Figure 7.: Delhi Gate – During Experimentation

The revised design - Proposal C (Figure 6) was presented to the stakeholders and it has been decided that another full experiment will be conducted on site with more permanent nature of the barricades. The final design incorporates through continuous pedestrian movement aided with raised crossing. Dedicated vending zones are proposed to be provided, along with twin parking system in front of Taibiyah School, with a capacity of 50 cars and 31 two wheelers. This arrangement promised organized and calmed movement for all.

Figure 8.: Proposed View – Delhi Gate

Hathi Pole Junction

Hathi Pole is the adjoining pole, next to Delhi Gate. The junction currently acts as an elliptical rotary enclosing the Hathi Pole heritage structure. However, multiple streets comprising of big and small roads are merging at this junction. Being similar in nature and character i.e. enclosed heritage structure, main activity node of the city, currently loaded with unorganized with the activities like informal parking and vendors, the concerns remain almost the same.

Like the redevelopment approach for Suraj Pole and Delhi Gate junctions, Hathi Pole Redevelopment plan followed a process of stakeholder interaction, and an intended-on site demonstration of the plan. Based on multiple meetings and presentations conducted with different stakeholders, including Udaipur Municipal Corporation, Traffic Police and elected representatives, a design brief for Hathi Pole was developed. Activity mapping, data collection, including total station survey and traffic counts was also conducted for the same.

Figure 9.: Hathi Pole – Design Proposal and View

The findings from this exercise and the design brief were used to arrive at design recommendations. Based on the data analysis, traffic load and site characteristics, a modern roundabout (Figure 9) has been designed at the Hathi Pole junction, enclosing the heritage structure. However, the proposal has not yet been finalized for implementation and is pending for demonstration and experimentation on site.

Outcomes and Learnings

It was observed that the decision makers understand the benefit of junction re-design for better traffic flow and increased carrying capacity. Currently, urban mobility has become a topic of discussion for city officials, as well as citizens. This view was endorsed by not only the Udaipur Municipal Corporation (UMC) officials but the Urban Improvement Trust (UIT) officials, traffic police as well as local media has extended support to the initiative.

While steering the experiment, the importance of conducting total station survey before going for any design intervention solution was realized, as it gives an insight into the actual situation on ground. Also, the infrastructure requirements need to be seen beforehand, prior to conducting the experiment, else due inadequate infrastructure provisions the design may not be fully executed on the ground, leading to possibility of the failure of the design.

Another important learning from the exercise was that the officials and the team executing the task need to be well informed and should know every detail of the design. This helps in easy operation of the same when transferred on ground. For this, the designers, should explain the design in detail to the concerned officials – such as those from the municipal corporation and the traffic police -- prior to conducting the experiment. A brief should be provided to the residents and the media so that the unwanted chaos can be avoided and co-operation from these sections of the society can be ensured.

Way Forward

UMC, with active support from ICLEI South Asia and S G Architects, will continue to undertake the implementation of junction development in the city. To contribute to this process, the project team intends to support capacity building of UMC engineers and planners. This shall include knowledge sharing and hand holding support during planning, experimentation and implementation process on three or more of the selected seven other intersections/locations for re-development. Additionally, the team shall also extend their handholding support to the mobility team from project management consultant (PMC) appointed by UMC under the smart city project.

In this endeavour, a workshop for the planners, engineers, PMC officials and traffic police personnel (who shall be working on junction redevelopment projects) is being proposed to be undertaken at the UMC. The workshop will demonstrate the process of junction redevelopment followed so far. Additionally, the principles and design process for junction redevelopment shall also be detailed out. The next phase of development will include junction development exercises for Chetak Circle and Udaya Pole intersections along with demonstration exercise for Hathi Pole.

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