REDESIGN AND OPTIMIZATION OF FOUR-LEGGED URBAN INTERSECTIONS: A CASE STUDYOF HOODI K. R. PURAM REGION OF BENGALURU TRAFFIC ANALYSIS

Project Reference No.: *49S_BE_7079*

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Keywords:
Urban Intersection Design, Four-Legged Intersection, Traffic Flow Optimization, Signal Timing Optimization, Traffic Congestion, Intersection Capacity, Level of Service (LOS), Intelligent Transportation Systems (ITS), Road Safety Engineering, Accident Analysis, Traffic Volume Analysis, Delay Analysis, Geometric Design, Lane Configuration, Turning Radius, Channelization, Roundabout Design, Traffic Control Device, Peak Hour Traffic, Sustainable Urban Mobility and Smart Traffic Management

Introduction:

A four-legged urban intersection is a junction where two roads cross, forming four approaches. These intersections often face challenges such as congestion, long delays, high crash rates and poor pedestrian or cyclist safety due to the complexity of vehicle and human movements. In many growing cities, these intersections are outdated and unable to meet current traffic demand

Objectives:

1. To analyse the existing traffic conditions at the Hoodi- K.R. Puram four intersection, including volumes, movement patterns and delays
2. To identify key operational and safety issues, such as congestion points, conflict areas, pedestrian risks and geometric deficiencies.
3. To optimise signal timings using standard traffic engineering methods to reduce delays and improve the Level of service (LOS)
4. To estimate the overall improvement in the traffic flow, travel time and safety after applying the proposed redesign and optimisation measures. case studies by BMRCL and CDP research teams

Methodology:

1. **Site selection:**
   The **Hoodi – K.R. Puram intersection** was selected as the study site based on its strategic importance, high traffic demand, and recurring operational challenges along Bengaluru's eastern mobility corridor. This four-legged urban intersection lies on the ITPL–Whitefield Road, connecting major residential, commercial, and industrial hubs.
   The junction experiences heavy peak-hour traffic from Hoodi, Mahadevapura, Whitefield, and K.R. Puram, making it a critical point in the regional transportation network.
2. **Data Collection:**
   Data collection is a crucial step in understanding the existing traffic and geometric conditions at the Hoodi – K.R. Puram four-legged intersection. Accurate and comprehensive data ensures that the problems are correctly identified and that the proposed redesign and optimisation measures are effective.
3. **Traffic Analysis:**
   Traffic analysis included a 7-day traffic volume count (TVC), assessment of intersection dimensions and observation of traffic behaviour. This helped in understanding congestion patterns and peak hour flow.
4. **Re-design and optimization:**
   The redesign and optimisation phase included signal cycle timing design, geometric layout improvements and approach-wise lane recommendations. Test and optimise those alternatives using HCM methods, microsimulation, signal optimisation algorithms.
5. **Conclusion and Recommendations:**
   The study on the re-designand optimization of the four-legged urban intersection at Hoodi, KR Puram, reveals that the existing intersection is operating under highly congested conditions with significant delays, long queues, and low Level of Service (LOS). The combination of poor geometric design, inadequate lane channelisation, uncoordinated signal timings,and mixed traffic without lane discipline contributes to inefficient traffic operations and increased conflict points. It is recommended to implement the signal plan, road markings, lane designs and infrastructure upgrades for long-term efficiency and safety.

Result and Discussion:

1. Results

1. Existing traffic conditions at the Hoodi – K.R. Puram four-legged intersection showed high delays, long queues, poor level of service (LOS E–F), and frequent conflicts due to mixed traffic and unregulated movements.
2. Traffic volume analysis confirmed that the intersection was operating beyond its designed capacity, especially during peak hours.
3. After applying redesign and optimization measures—including geometric improvements, signal redesign, channelization, pedestrian facilities, and traffic management strategies—the intersection performance improved significantly.
4. The proposed design resulted in:

    ○ Reduced delay time ○ Improved Level of Service (LOS C–D) o better lane discipline o Fewer conflict points o Safer pedestrian movement
5. Simulation/analytical models (if included) showed that the redesigned intersection can accommodate future traffic growth more efficiently.

2. Discussion:

Existing Site and Traffic Conditions (Before Redesign)
A 7-day traffic survey was conducted at HOODI K.R. PURAM.

Detailed vehicle turning movement counts, volume counts, and peak hour traffic data were extracted.

The site assessment revealed:

- Signal Timing: The existing signal had a cycle time of 180 seconds, with no fixed pedestrian phase and inefficient phasing.
- Pedestrian Facilities: No pedestrian signals were provided.
- Zebra crossings: were either faded or missing.
- Free Lefts: Not present in three directions, leading to unnecessary delays and congestion.
- Obstructions: The intersection had various obstructions like CCTV poles, electrical poles, and unauthorised barriers, creating visibilityand movementissues.
- Lane Allocation: Lanes were not properly marked, and there were no designated turn lanes, resulting in weaving and lane indiscipline.
- Road Markings and Signage: Most road markingshad faded and were ineffective. Only four “No Parking” signswere found, with a complete lack of directional arrows or STOP lines.
- Public TransportProvisions: Auto stands were very close (within 5 m), and the bus stop was located 500 m away with no dedicated bay.

Proposed Redesign and Updated Conditions (After Redesign)

After analysing the data manually and in accordance with IRC, the intersection was redesignedas follows:

- Signal Timing: Using Webster's Method, the signal cycle time was optimised to 150 seconds, reducing delays and idle time. Phase plans were restructured to allow smoother vehicle movement and introduce pedestrian clearance intervals.
- Pedestrian Signals:A dedicated 10-second pedestrian phase was added for each approach, promoting safe crossing.
- Free Left Turn: Free left turns were added in all four directions, with a provision of 25 seconds, improving vehicular discharge efficiency.
- Geometric Improvements: New lane configurations were recommended based on PCU analysis:
    1. Approaches were restructured with2 through lanes and additional turning lanes as per demand.
    2. Bus bays were designed75 m away from the stop line as per IRC:86 & 103, preventing blockage of moving lanes.
- U-Turn Facility: Designed at a safe distance (100 m from stop line), maintaining a minimum 13.8 m turning radius, suitable for heavy vehicles.
- Median and Markings: 1-meter-widemedians were retained/extended for pedestrian refuge and traffic guidance. Completemarkings,including STOP lines, directional arrows, and zebra crossings, were proposed.
- Obstruction Management: Suggestedrelocation or removal of obstructive elements such as poles and railings.
- Signage: A complete signageaudit was conducted, and new signs were recommended, including regulatory, warning, and informational boards.

The redesign of the 4-legged intersection at HOODI K.R.PURAM was based on a detailed survey conducted over 7 days. The extracted data revealed severe inefficiencies in the existing intersection setup, including outdated signal timings, a lack of pedestrian infrastructure, missing free left turns, poor signage, and visible road obstructions. Using IRC a complete manual redesign was undertaken. The new design incorporates optimised signal timing (reducing cycle time by over 2 minutes), dedicated pedestrian signals, free left turns, channelisation, and improved geometric layouts with designated bus bays and U-turns. Approach-wise Lane allocation was revised using PCU-based estimations, and a full signage and road marking audit guided proposed improvements. This redesigned intersection significantly improves safety, reduces delays, and enhances traffic flow, providing a replicable, low-cost solution suitable for urban settings with limited resources.

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Future Scope:

The scope of this project focuses on analysing, redesigning, and improving the operational efficiency and safety of a four-legged urban intersection located at Hoodi in K.R. Puram, within Bengaluru. *VISSIM User Manual* (Software Documentation)