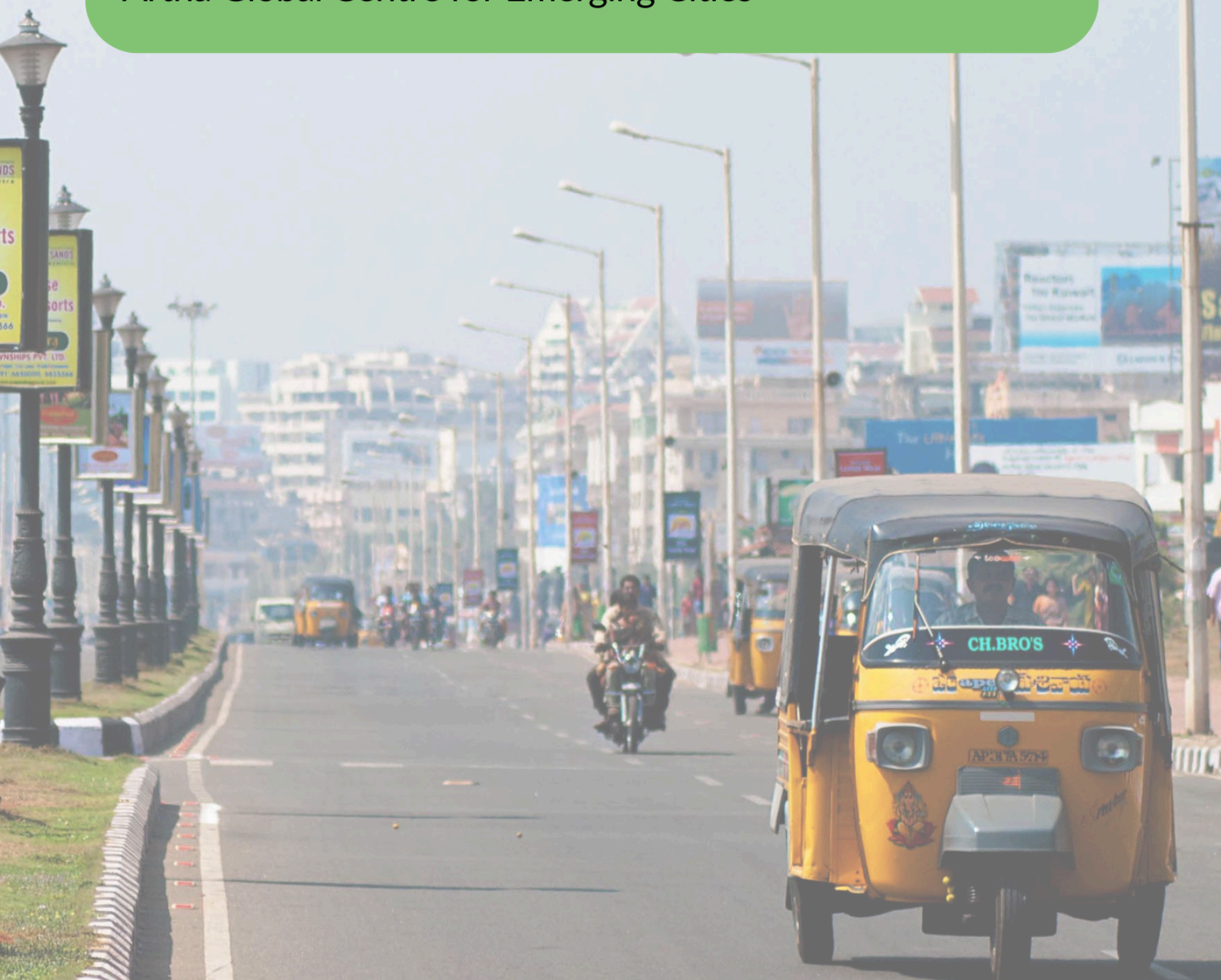


Citizen Perceptions of Clean Air Zone Measures in Visakhapatnam and Vijayawada

Artha Global Centre for Emerging Cities



REPORT

Citizen Perceptions of Clean Air Zone Measures in Visakhapatnam and Vijayawada

Artha Centre for Emerging Cities
February 2026

Team: Anushri Pundit, Sunanda Paturu and Vivek Vaidyanathan

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Executive Summary

Our Clean Air Zones (CAZ) project focuses on two cities in Andhra Pradesh: Visakhapatnam and Vijayawada. These two cities are non-attainment cities under the National Clean Air Programme (NCAP), which means they consistently experience air pollutant concentrations that do not meet the National Ambient Air Quality Standards (NAAQS) for PM 10. Clean Air Zones are a hyper-local approach to air quality improvement through neighbourhood-level, transportation sector interventions, aimed at reducing vehicle emissions in designated areas.

As part of this project, we have undertaken a perception survey study to ensure that citizens are aware and have a say in the implementation of CAZ. In the first two years of the CAZ project, the control measures were narrowed down to three general types: area improvements, public transport enhancements, and parking management strategies. These surveys ask the relevant groups of citizens their opinions on the specificities of these control measures. The results of this survey will be used to prioritise control measures and determine exactly where, within the CAZ, certain interventions are needed.

Key Findings

- In Visakhapatnam, 90% of respondents feel adversely affected by poor air quality, while in Vijayawada only 12% feel affected. Regardless of whether they feel personally affected by air pollution, over 90% of respondents in both cities believe that CAZ measures will improve air quality and public health.
- In both cities, respondents' top priorities for area improvements are improved footpaths, improved pedestrian crossings and increased vehicle compliance with traffic laws. Sixty percent of private 2-wheeler vehicle users in Vijayawada and 85% in Visakhapatnam report being willing to switch to walking or cycling for trips shorter than 2 km if these area improvements are made.
- In both cities, private vehicle users demonstrate a willingness to pay for on-street and off-street parking. Limiting the availability of parking spots and making them paid, emerges as a strategy for regulating demand from private vehicle users.
- In both cities, respondents' top priorities for public transport enhancements are better (cleaner, more accessible) bus stops, increased bus frequency, and increased bus route connectivity. Bus route connectivity may be of particular concern in Vijayawada where over 90% of bus users experience last mile distances greater than 1km.
- Auto rickshaws contribute to a large proportion of PM emissions from vehicles in the CAZ¹ and availability of feasible financing was the most popularly reported condition under which auto rickshaw drivers would switch to e-rickshaws. However, in Vijayawada, half the auto rickshaw drivers surveyed chose that under no circumstances would they switch to e-rickshaws, indicating that further studies may be needed to understand reasons for this and how auto rickshaw emissions could be reduced.

¹Hourly emissions profiles developed in partnership with TERI showed auto rickshaws to be a large contributor to total PM emissions from vehicles across stretches in the CAZ and throughout the day.

Introduction

Our Clean Air Zones (CAZ) project focuses on two cities in Andhra Pradesh: Visakhapatnam and Vijayawada. These two cities are non-attainment cities under the National Clean Air Programme (NCAP), which means they consistently experience air pollutant concentrations that do not meet the National Ambient Air Quality Standards (NAAQS) for PM 10.

Visakhapatnam is an industrial port city, surrounded by mountains on all sides, creating a bowl effect that exacerbates the effects of air pollution. Due to rapid industrialisation and urbanisation, the vehicular population in Visakhapatnam is increasing rapidly with 20,000 new vehicle registrations per year, contributing to the deterioration of air quality². As the most industrialised city in Andhra Pradesh, Visakhapatnam experiences critical levels of pollution, underlining a drastic need for air quality improvement interventions. Vijayawada is a very densely populated city with over 30,000 people per square kilometer.³ With high levels of construction, urbanisation and commercial activity taking place in and around Vijayawada, air pollution has become a significant problem.⁴ Further, a nearby coal-based Thermal Power Plant also contributes significantly to the ambient air pollution.⁵

With a mandate under NCAP for implementing programmes to improve the air quality in these two cities, Artha saw an opportunity to address this need by piloting Clean Air Zones (CAZ). Artha's engagement on the CAZ programme began in late 2022 with conversations with the Andhra Pradesh Pollution Control Board (APPCB), the nodal agency for improving air quality across the state. The focus was on reducing transport sector emissions in non-attainment cities in AP. Over a period of a year, we entered into formal agreements, first with APPCB, and then with the urban local bodies (ULBs) of Vijayawada and Visakhapatnam to socialise and pilot CAZ as a strategy to improve air quality in those cities. In the following two years, we introduced the ULBs to best practices for CAZ implementation, contextualising it to Indian climatic and traffic conditions, built up scientific evidence through primary air quality and transport surveys to understand sources of emissions, and designed bespoke control measures based on detailed stakeholder engagements.

To build on the stakeholder engagements we have been conducting with state- and municipal-level stakeholders to understand local needs, we have taken on this perception survey study to ensure that citizens are aware and have a say in the implementation of CAZs. In the first two years of the CAZ project, the control measures were narrowed down to three

² "Traffic," Visakhapatnam City Police. N.d. <https://vizagcitypolice.gov.in/TrafficScenario.html>.

³ U Sudhakar Reddy, "Vijayawada is third densely packed city; 31,200 people in every square km," *Deccan Chronicle*, August 19, 2016, <https://www.deccanchronicle.com/nation/current-affairs/190816/vijayawada-is-third-densely-packed-city-31200-people-in-every-square-km.html>.

⁴ G. Krishnaveni and K. Kiran Kumar, "Air pollution tolerance index of selected plants in Vijayawada city, Andhra Pradesh," *International Journal of Green Pharmacy*, no. 4 (Oct-Dec 2017). <https://doi.org/10.22377/ijgp.v11i04.1419>.

⁵ The Hindu Bureau, "Residents stage protest against pollution caused by Vijayawada Thermal Power Station," *The Hindu*, November 4, 2024, <https://www.thehindu.com/news/national/andhra-pradesh/residents-stage-protest-against-pollution-caused-by-vijayawada-thermal-power-station/article68828255.ece>.

general types: area improvements, public transport enhancements, and parking management strategies. These perception surveys ask the relevant groups of citizens their opinions on the specificities of these control measures. Citizens are asked about their current transportation habits within the CAZ, which specific interventions they would like to see implemented, where within the CAZ they believe the need for these interventions is greatest and generally, whether they think the proposed control measures will improve air quality and health in the CAZ area. The results of this study will be used to prioritise the CAZ interventions and determine exactly where, within the CAZ, certain interventions are needed. Using the results of this survey, and insights gathered from previous stakeholder engagements, this report will present a recommended implementation agenda for each city.

The recommended interventions are aimed at improving air quality in the CAZ. These measures, specifically designed to address transport emissions, aim to improve traffic flow, promote the use of zero emissions modes like walking and cycling, increase public transit ridership, and reduce the use of polluting vehicles, thereby reducing vehicular emissions and subsequently, residents’ exposure to air pollution.

Survey Framework & Methodology

Surveys were done through in-person on-ground interviews over the course of one week in November 2025, with 1027 respondents, 515 in Visakhapatnam, 512 in Vijayawada. The survey was multiple choice and began with a general questionnaire, asked to every respondent, on perceptions of air quality within the city, mode of transport and trip purpose, preferred pedestrian infrastructure and public transport improvements, and respondent demographics. Pedestrians and cyclists were only asked this general questionnaire. In addition to the general questionnaire, the following groups were asked category-specific multiple choice questions (See Appendix for a full version of the survey questionnaire):

- Bus users
- College/medical students
- Auto rickshaw drivers
- Private vehicle users
- Local business owners

Respondents were selected through purposive sampling to ensure an adequately sized sub-sample from each respondent type. The purposive sampling distribution can be seen in Table 1. Survey enumerators chose respondents by going on ground in the CAZ area and asking potential respondents who fit into each survey category if they were willing to be surveyed, until they satisfied the quotas for each respondent type.

Table 1: Purposive Sampling Distribution for Each City

Respondent Category	Gender Split	Sub-Sample Size
College Students (Vijayawada) / Medical Students (Visakhapatnam)	50% Men 50% Women	100

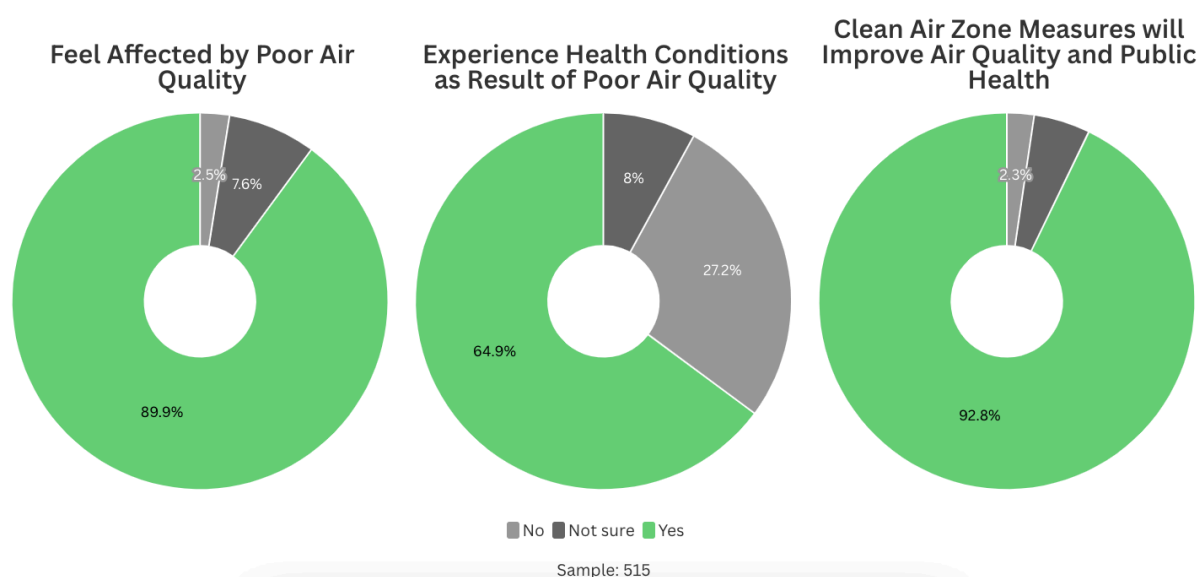
Private 4 Wheeler Vehicle Users	As found in sample	75
Private 2 Wheeler Vehicle Users	As found in sample	75
Auto Rickshaw Drivers	As found in sample	50
Local Business Owners	As found in sample	30
Bus Users	50% Men 50% Women	100
General (Pedestrians / Cyclists)	50% Men 50% Women	70
Total		500

Findings

Visakhapatnam

Perceptions of Air Quality

Figure 1: Visakhapatnam Respondents' Perceptions of Air Quality

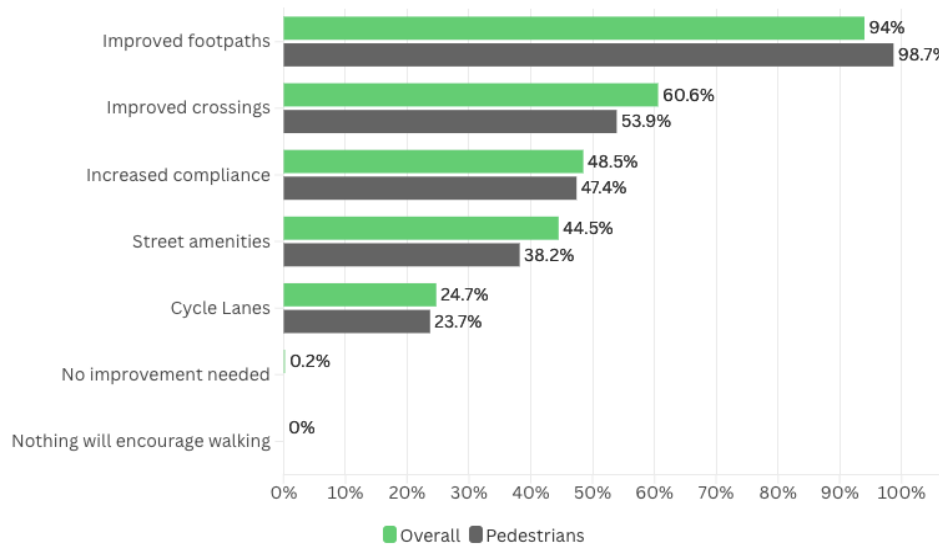


Respondents in Visakhapatnam (n=515) overwhelmingly feel impacted by poor air quality in their city with 90% reporting feeling affected by poor air quality and 65% having themselves or a family member experience health conditions such as respiratory issues or eye irritation as a result of poor air quality. This is in line with the air quality readings captured by the low-cost sensors that have been deployed within the CAZ. The average concentrations of measurements taken every hour over the period of November-December 2025 were 117 $\mu\text{g}/\text{m}^3$ and 130 $\mu\text{g}/\text{m}^3$ for PM2.5 and PM10, respectively. These concentrations exceed the NAAQS standards for 24-hour averages, which are 60 $\mu\text{g}/\text{m}^3$ and 100 $\mu\text{g}/\text{m}^3$ for PM2.5 and PM10, respectively, meaning these pollutants are present in the CAZ at dangerous levels.

Respondents displayed positive perceptions of the CAZ measures, reporting that they believe measures such as area improvements, public transport enhancement and parking solutions will help improve air quality and public health in the neighbourhood. These results do not differ significantly by occupation, age or gender.

Area Improvements

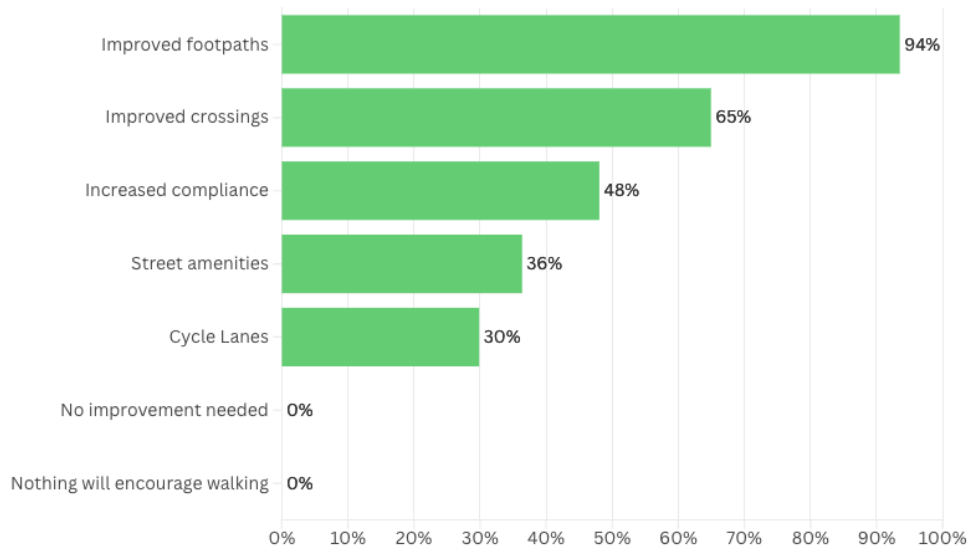
Figure 2: Visakhapatnam Respondents' Priorities for Area Improvements



Each respondent was asked to pick the three area improvements that would best promote walking and cycling. This chart shows the percentage of respondents who selected each option. Because they could choose multiple options, the percentages do not add up to 100%.

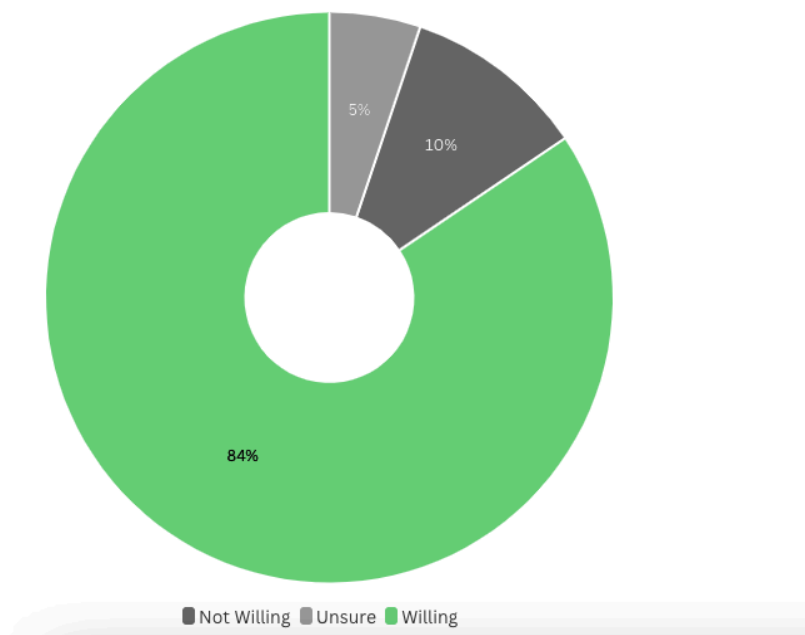
Respondents were shown a list of possible area improvements and asked to choose which three provisions would most encourage them to make more of their trips by active transportation (walking/cycling). The most popular choices among both the overall sample (n=515) and the sub-sample of those who already make most of their trips by walking (n=76), were improved footpaths, improved pedestrian crossings and increased compliance of vehicles with traffic laws.

Figure 3: Visakhapatnam 2-Wheeler Users' Area Improvement Priorities



Each respondent was asked to pick the three area improvements that would best promote walking and cycling. This chart shows the percentage of respondents who selected each option. Because they could choose multiple options, the percentages do not add up to 100%.

Figure 4: Visakhapatnam 2-Wheeler Users' Willingness to Switch to Walking or Cycling for Short Trips with Improvements to Pedestrian Infrastructure



Two-wheeler users in the sample (n=77) were also asked if, given the area improvements they selected were made, they would be willing to make their shorter trips (<2 km) by walking or cycling instead of by two-wheeler. Eighty-four percent of the two-wheeler users said they would be willing to make more trips by active transport and the most popular area improvements that would encourage this mode shift were also improved footpaths, improved pedestrian crossings and increased compliance of vehicles with traffic laws.

Figure 5: Visakhapatnam Respondents' Desired Stretch for Area Improvements



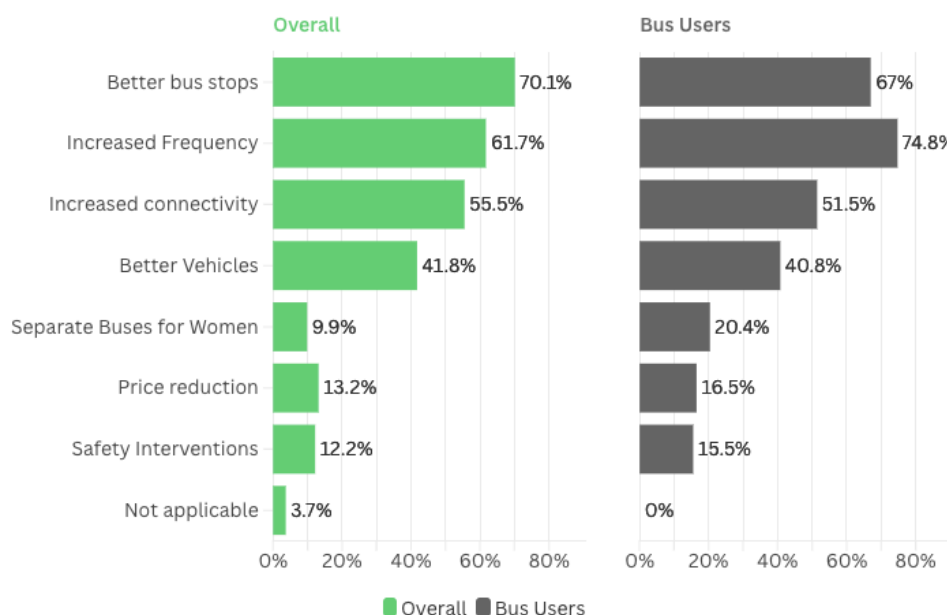
Figure 6: KGH Up Road Stretch



When asked which stretch of the CAZ they most wanted to see their selected improvements implemented on, the most respondents overall (43%) selected the stretch of KGH Up Road starting from Jagadamba Centre to KGH Down Road through Med Plus. For the respondents who selected KGH Up Road, the top three choices for area improvements were still improved footpaths, improved pedestrian crossings and increased compliance.

Public Transport Enhancement

Figure 7: Visakhapatnam Respondents' Priorities for Public Transport Enhancement

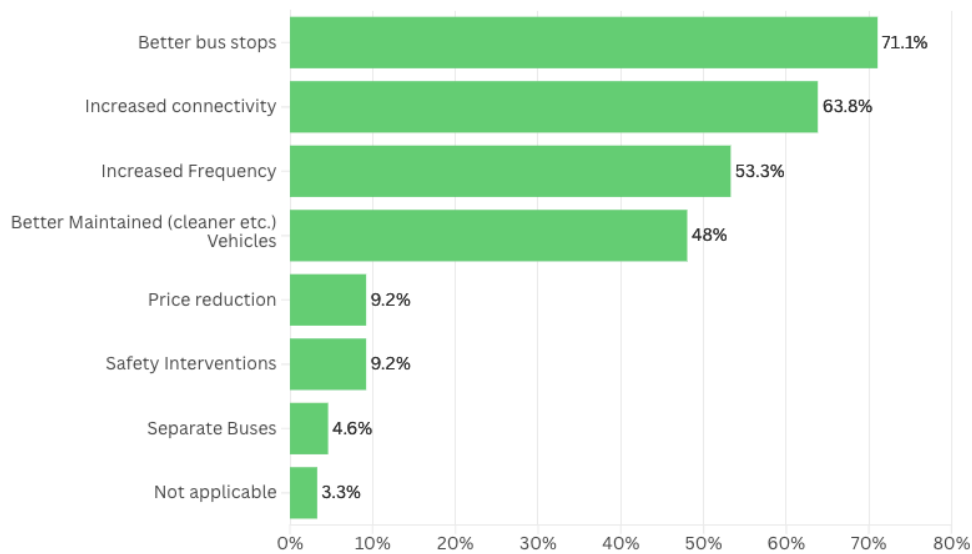


Each respondent was asked to pick the three public transport improvements that are of priority to them. This chart shows the percent of respondents who selected each option. Because they were allowed to select multiple options, the percentages do not add up to 100%.

Respondents were shown a list of possible public transport enhancements and asked to choose which three improvements would most encourage them to make more of their trips by public transport. The most popular choices among both the overall sample (n=515) and the sub-sample of respondents who already use the bus to commute to the CAZ (n=103) (and therefore likely have a more informed idea of what improvements are needed) were better bus stops, meaning bus stops that are cleaner with more shade and seating provided, increased bus frequency and increased connectivity of bus routes. Among the top three priorities, the top priority for bus users was increased bus frequency while in the overall sample it was better bus stops. About half the bus users in the sample typically wait more than 10 minutes for the bus, demonstrating a need for higher bus frequency⁶.

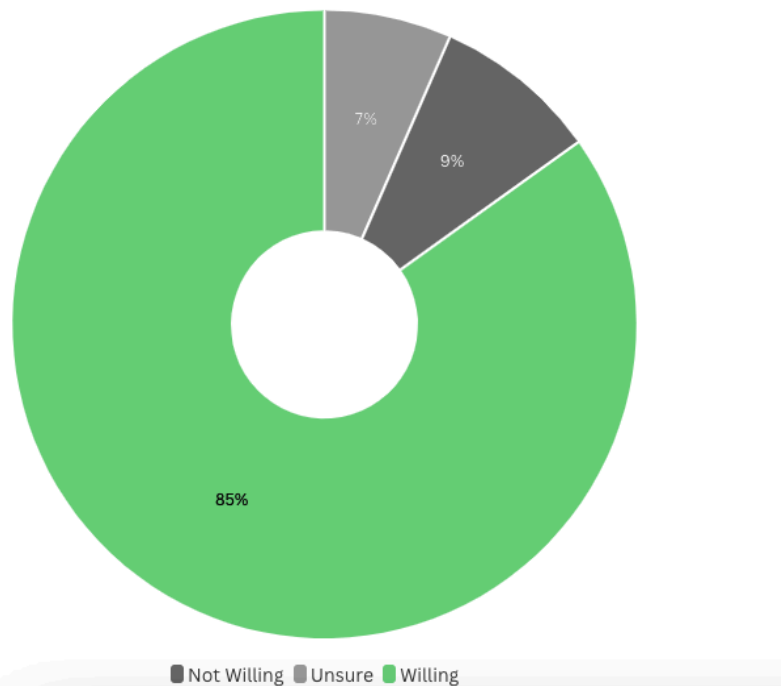
⁶ Here we take 10 minutes as a rough estimate for the wait time beyond which customer satisfaction and willingness to use the bus decreases. This is aligned with the LA metro's goal in their [NextGen Bus Plan](#) to provide more than 80% of current bus riders with a bus headway of 10 minutes or less. Further, in [Arhin et al. \(2019\)](#), it was found that the average maximum acceptable bus wait time is 8 minutes beyond the scheduled arrival time.

Figure 8: Visakhapatnam Private Vehicle Users' Public Transport Enhancement Priorities



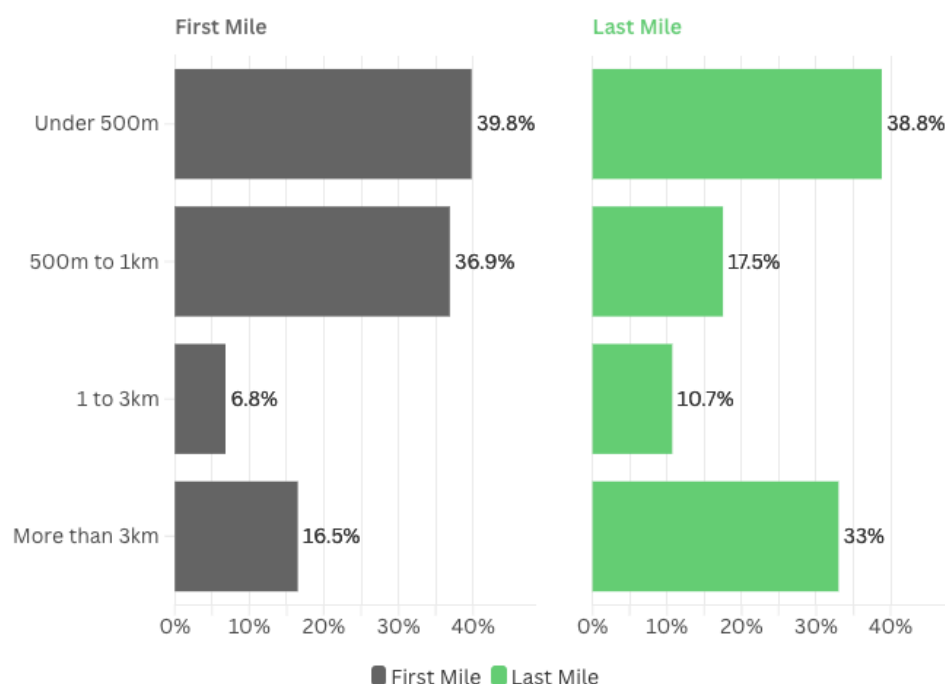
Each respondent was asked to pick the three public transport improvements that are of priority to them. This chart shows the percent of respondents who selected each option. Because they were allowed to select multiple options, the percentages do not add up to 100%.

Figure 9: Visakhapatnam Private Vehicle Users' Willingness to Reduce Private Vehicle Use with Enhanced Public Transport



Respondents who currently use private vehicles to commute to the CAZ (n=152) were asked if, given the public transport enhancements they selected were made, they would be willing to reduce their private vehicle use. Eighty-five percent of private vehicle users said they would be willing to reduce their use of private vehicles if their selected public transport enhancements were made, and the top public transport enhancements among this sub-sample were also better bus stops, increased bus route connectivity and increased bus frequency.

Figure 10: Visakhapatnam Bus Users' First and Last Mile Distance



This chart shows the distance that bus users travel from the bus stop to their destination within the CAZ.

Respondents who currently use the bus as their main mode to commute to the CAZ (n=103) were asked what distances they travel to get from their homes to the bus stop (first mile) and from the bus stop to their destinations (last mile). The majority of respondents had first and last mile distances that are less than 1 km, typically considered walkable distances⁷. However, a third of respondents have last mile distances of over 3 km, indicating there is substantial room for improvement of bus route connectivity. Bus users were also asked what mode they typically use to cover the first and last mile distances. They were allowed to select multiple responses as different modes may be used for the first versus last mile or on different days. The most popular modes were walking, chosen by 56% and auto rickshaws, chosen by 52%.

Further, bus users were asked what stretch their destination within the CAZ is on. The most popular destination was KGH Up Road starting from Jagdamba Centre to KGH Down Road through Med Plus (see Figure 6), chosen by 43%. As shown in Figure 11, there are three bus routes that enter the CAZ and there are three bus stops within the CAZ, one at Jagdamba Centre, at the start of KGH Up Road, and two on KGH Down Road. Many buses service the Jagdamba Centre bus stop, indicating that the CAZ is relatively well connected to other parts of the city. With the most popular stretch for bus users' destinations being on KGH Up Road, bus users getting off at Jagdamba Centre would not have very long last mile distances left to cover.

⁷1km is taken as a walkable distance on the basis of a 15-minute walking threshold used in [Jain's \(2024\)](#) study on walk-to-work accessibility in Visakhapatnam (1km can be covered in approximately 15 minutes of walking). It should be noted, however, that respondents of a Germany study by [Sarker et al. \(2020\)](#) preferred to walk, on average, 7 minutes to catch a bus and that only less than 10% of respondents were willing to walk 15 mins or more.

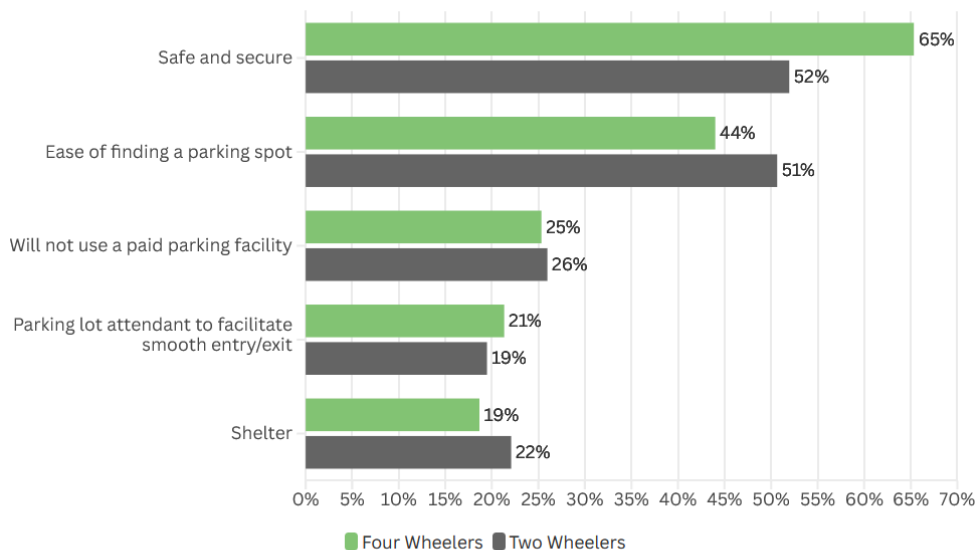
two-wheeler users (n=77) already use paid parking facilities and so are already accustomed to the concept of paying for parking.

Box 1: National CAZ Workshop Key Takeaway - Parking Management as a Tool to Regulate Demand by Private Vehicle Users

Artha Global hosted a National Clean Air Zones Workshop in Delhi in January 2026. One session of this workshop featured a panel on Parking Management Strategies. Panelists from the Raahgiri Foundation and WRI expressed that while parking is not a right, everyone should have the right to walk and cycle safely. For this reason, parking should not be given priority road space. Where road space is dedicated to parking, it should be priced to reflect the valuable space it is taking up. The availability and price of parking should make people think twice about taking their car and incentivise them to take other low- or zero-emission modes. Parking management strategies can be used to regulate demand from private vehicle users.

Further, if parking management strategies are presented in a way that highlights the objective of giving road space back to pedestrians and cyclists and making streets safer and healthier spaces, community buy-in can be fostered. Community members need to feel like even though parking spaces and the convenience of widely available parking is being taken away from them, they are gaining something more valuable in the form of safer, cleaner and healthier neighbourhoods.

Figure 13: Visakhapatnam Private Vehicle Users’ Key Conditions for Using Paid Off-Street Parking Facilities

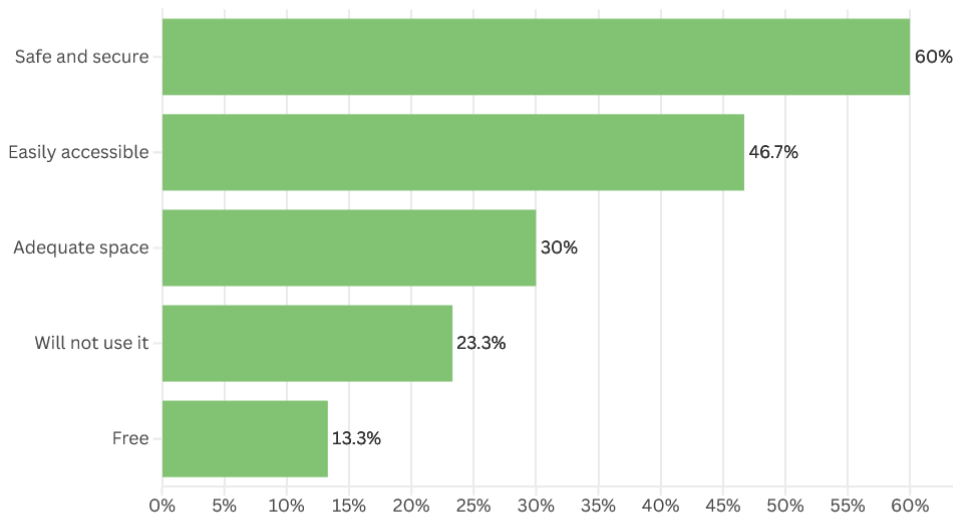


Respondents were asked to choose their top 2 conditions for using paid off-street parking facilities. This chart shows the percentage of respondents who selected each option. Because they were allowed to select multiple responses, percentages will not add up to 100%.

Private vehicle users were also asked to choose what conditions would have to be met for them to use a paid off-street parking facility rather than parking on the street. Out of a list of possible conditions, they were asked to choose their top two. The most popular choices among both four- and two-wheeler private vehicle users were that the off-street parking facility is

safe and secure, and that it is easy to find a parking spot in the facility (there are almost always spots available).

Figure 14: Visakhapatnam Local Business Employees’ Key Conditions for Using Dedicated Off-Street Parking Facilities



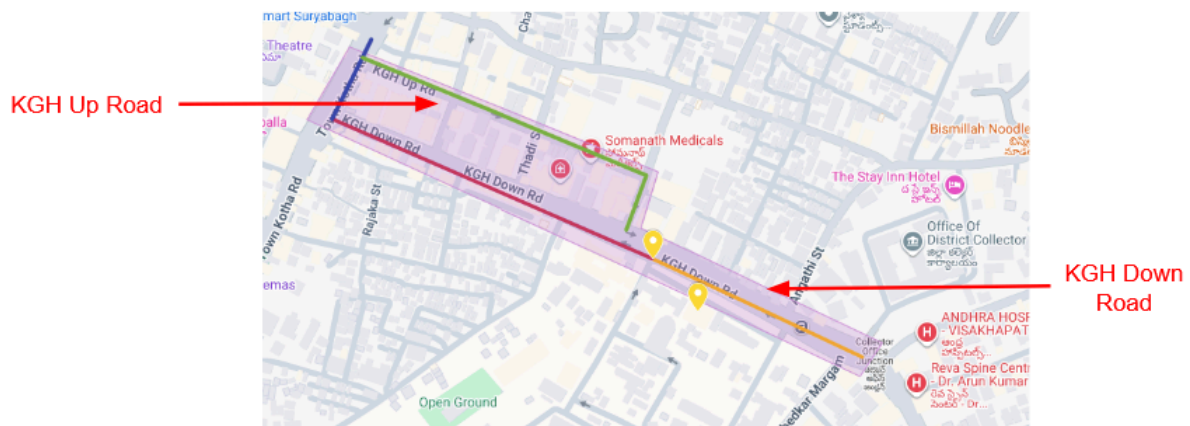
Respondents were asked to choose their top 2 conditions for using off-street parking facilities. This chart shows the percentage of respondents who selected each option. Because they were allowed to select multiple responses, percentages will not add up to 100%.

The thirty local business employees that were surveyed were asked about the conditions under which they would use an off-street parking facility rather than parking on the street. In this scenario, the off-street facility was not necessarily paid, rather just a parking facility, walking distance from the local business, which local business employees could use so their vehicles would not be causing congestion on the streets or footpaths in front of stores. Out of the thirty surveyed, twenty respondents travel to work by personal vehicle. Those who did not travel to work by personal vehicle answered this question on behalf of their colleagues who do use a personal vehicle to commute to work. The most popular conditions were that the facility is safe and secure, and that it is easily accessible from the business. Only a few local business employees said that under no circumstances would they use an off-street parking facility or that the parking facility had to be free for them to use it.

Local business employees were also asked if their business provides parking for the customers and goods vehicles that visit their business. Only 17% of local businesses employees reported that their business provides parking, indicating that there is a need for dedicated parking spots for customers visiting businesses within the CAZ.

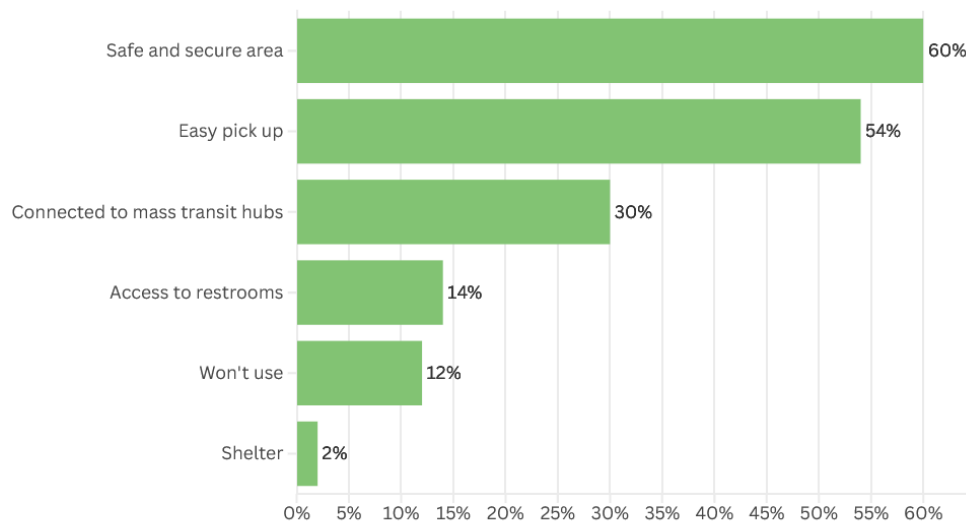
Finally, all private vehicle owners (n=152) were asked where, within the CAZ, they park their vehicles when visiting the area. The most popular destinations were KGH Up Road, chosen by 45%, and the stretch of KGH Down Road from the District Collector’s office junction to KGH OP gate, chosen by 28%. Given these 2 stretches are the most popular stretches for private vehicle users to park on, interventions aimed to organise parking better should focus on these stretches.

Figure 15: Visakhapatnam CAZ Map



Auto Rickshaws

Figure 16: Visakhapatnam Auto Rickshaw Drivers' Key Conditions for Using a Dedicated Customer Pick-Up Area



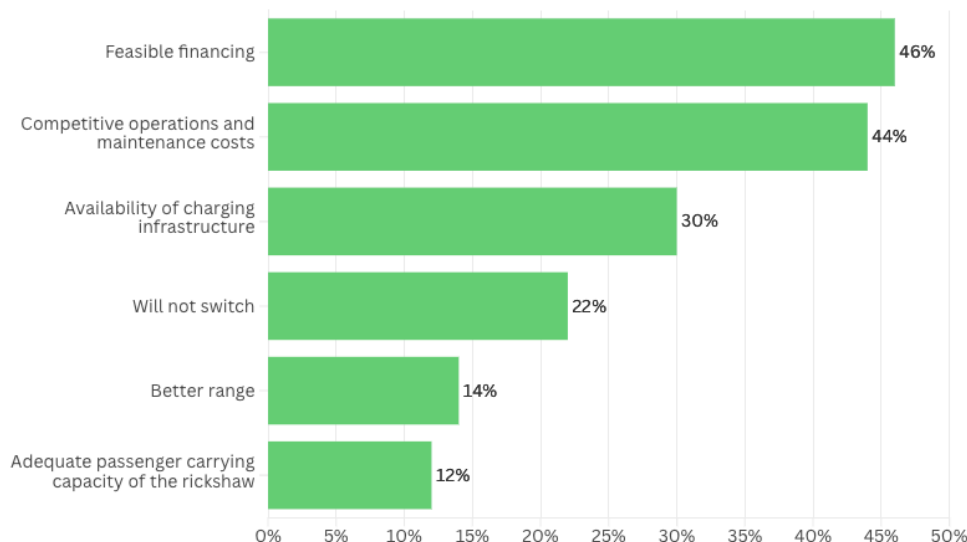
Respondents were asked to choose their top 2 conditions for using a dedicated customer pick-up area. This chart shows the percentage of respondents who selected each option. Because they were allowed to select multiple responses, percentages will not add up to 100%.

Auto rickshaw drivers (n=50) were surveyed in order to find out what provisions could be implemented that could help them pick up customers in a more efficient manner, causing less congestion on roads. They were asked to pick the top two from a list of conditions under which they would use a dedicated customer pick-up area (like an auto stand) rather than stopping at any given point on the street. The most popular conditions were that the customer pick-up area is safe and secure, and that it is easy to pick up customers from this area, implying that it is easy for customers to access from KGH.

Auto rickshaw drivers were also asked where they typically pick-up customers from, and to select all the stretches that apply. The most popular stretches were the stretch of KGH Down Road from the District Collector's office junction to KGH OP gate, chosen by 52% of auto rickshaw drivers, and KGH Up Road, chosen by 50% of auto rickshaw drivers (See Figure 15).

This implies that interventions aiming to streamline auto rickshaw pick-ups and reduce congestion should be focused on these two stretches within the CAZ.

Figure 17: Visakhapatnam Auto Rickshaw Drivers' Key Conditions to Switch to E-Rickshaws



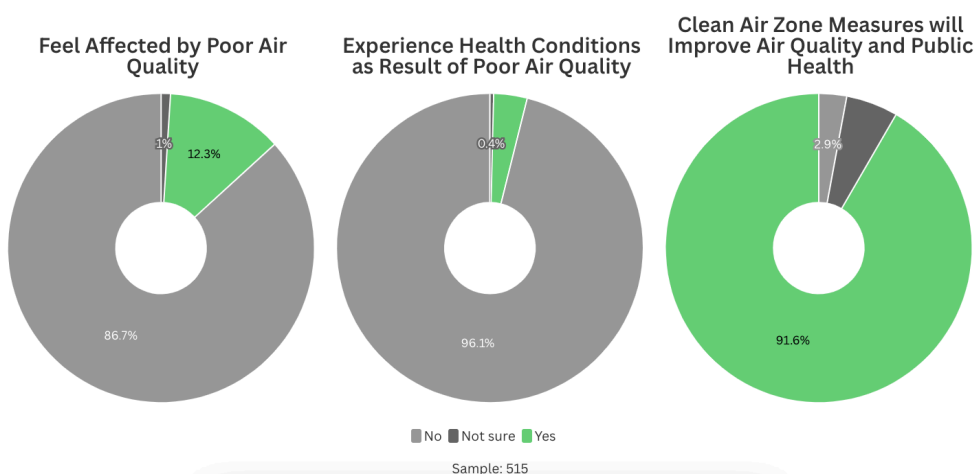
Respondents were asked to choose their top 2 conditions for using an e-rickshaw. This chart shows the percentage of respondents who selected each option. Because they were allowed to select multiple responses, percentages will not add up to 100%.

Finally, auto rickshaw drivers were asked for the top two conditions under which they would consider switching to an electric rickshaw, in order to reduce vehicular emissions from auto rickshaws. The most popular condition was feasible financing, followed by competitive operations and maintenance costs. This indicates that cost is the biggest barrier for auto rickshaw drivers in Visakhapatnam to adopt e-rickshaws.

Vijayawada

Perceptions of Air Quality

Figure 18: Vijayawada Respondents' Perceptions of Air Quality

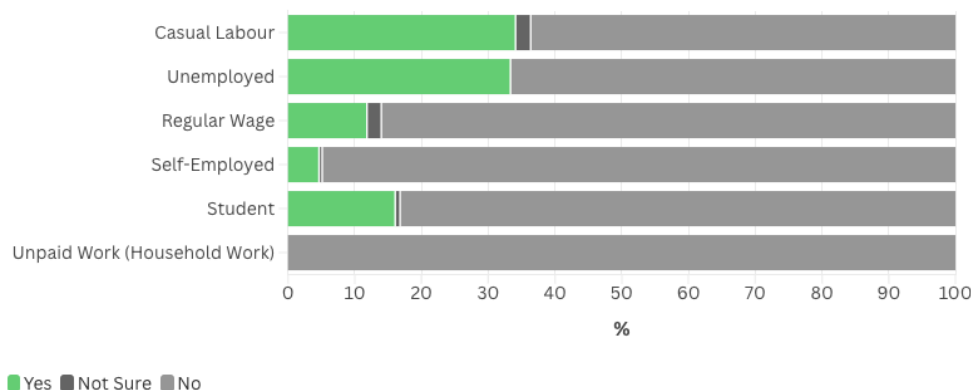


Most respondents in Vijayawada (n=512) do not feel affected by poor air quality, with only 12% reporting feeling affected by poor air quality and 4% having themselves or a family member experience health conditions as a result of poor air quality. Although respondents do not perceive the poor air quality to be a problem, the low-cost air quality sensors that have

been deployed within the CAZ, tell a different story. The average concentrations of pollutant measurements taken every hour over the period of November-December 2025 were 115 $\mu\text{g}/\text{m}^3$ and 127 $\mu\text{g}/\text{m}^3$ for PM2.5 and PM10, respectively. These concentrations exceed the NAAQS standards for 24-hour averages, which are 60 $\mu\text{g}/\text{m}^3$ and 100 $\mu\text{g}/\text{m}^3$ for PM2.5 and PM10, respectively, meaning these pollutants are present in the CAZ at dangerous levels.

In spite of respondents' overarching perception that air pollution does not impact them, over 90% of respondents believe that measures such as area improvements, public transport enhancement and parking solutions will help improve air quality and public health in the neighbourhood. These results do not differ significantly by age or gender.

Figure 19: Vijayawada Respondents' Feeling Affected by Poor Air Quality by Occupation



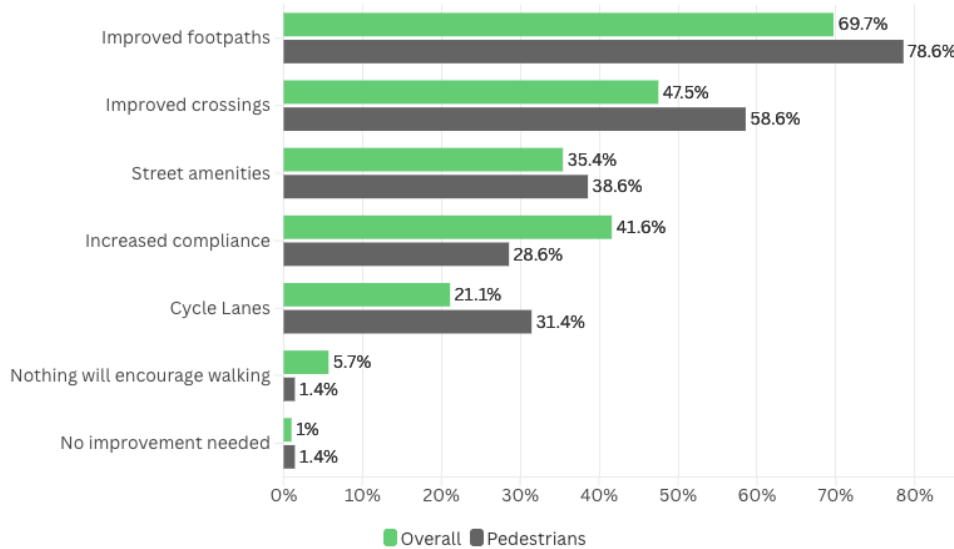
Sample: 512

By occupation, casual labourers (n=44) and unemployed respondents (n=15) report being most affected by poor air quality. If occupation is taken as a proxy for income level, these results highlight that poor air quality is potentially affecting lower income individuals to a greater extent⁸.

⁸ Note: The 'Unpaid Work' category consists of only 8 respondents.

Area Improvements

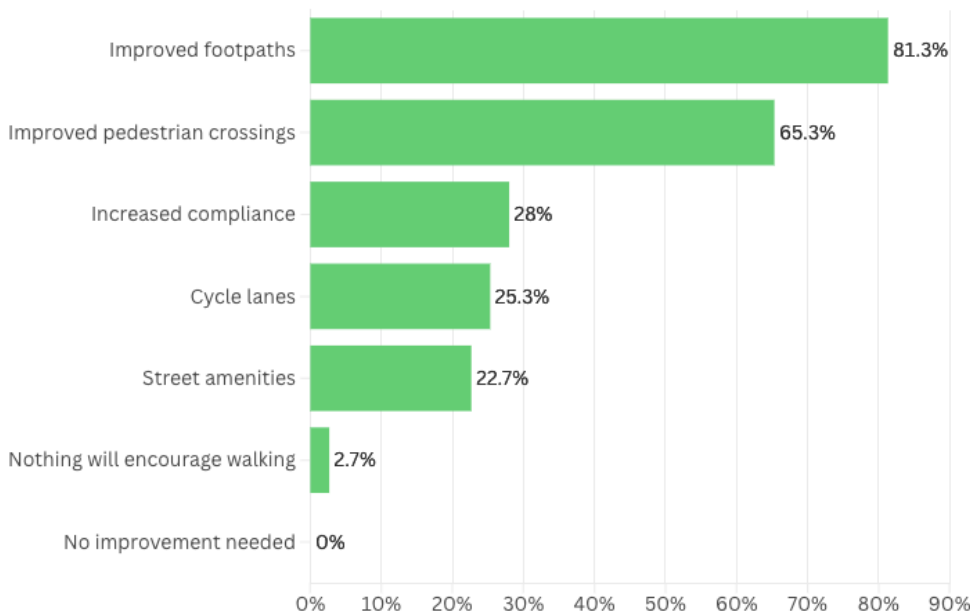
Figure 20: Vijayawada Respondents' Priorities for Area Improvements



Each respondent was asked to pick the three area improvements that would best promote walking and cycling. This chart shows the percentage of respondents who selected each option. Because they could choose multiple options, the percentages do not add up to 100%.

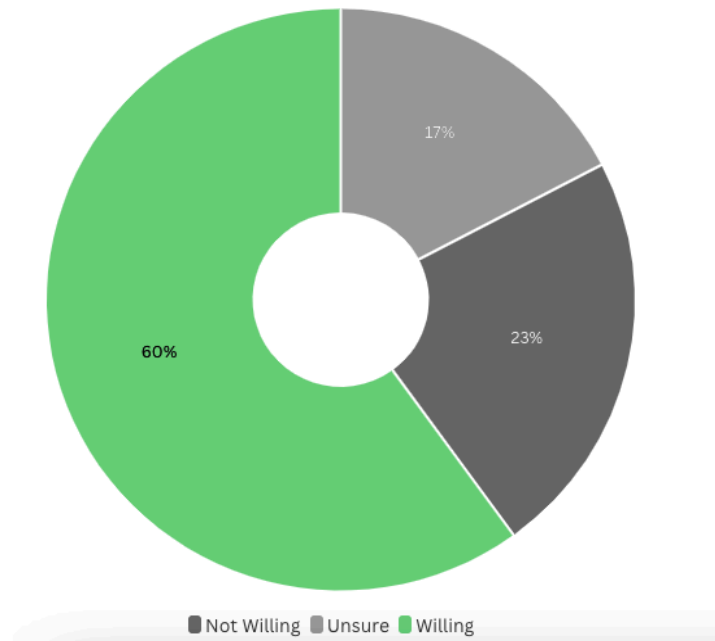
The most popular choices for area improvements among the overall sample (n=512) were improved footpaths, improved pedestrian crossings and increased compliance of vehicles with traffic laws. For those who already make most of their trips by walking (n=70), the addition of street amenities such as benches or water fountains was more popular than increased compliance with traffic laws.

Figure 21: Vijayawada 2-Wheeler Users' Area Improvement Priorities



Each respondent was asked to pick the three area improvements that are of priority to them. This chart shows the percent of respondents who selected each option. Because they were allowed to select multiple options, the percentages do not add up to 100%.

Figure 22: Vijayawada 2-Wheeler Users' Willingness to Switch to Walking or Cycling for Short Trips with Improvements to Pedestrian Infrastructure



Sixty percent of two-wheeler users (n=75) said they would be willing to make more trips by walking or cycling and the most popular area improvements that would encourage this mode shift were also improved footpaths, improved pedestrian crossings and increased compliance of vehicles with traffic laws.

Figure 23: Vijayawada Respondents' Desired Stretch for Area Improvements

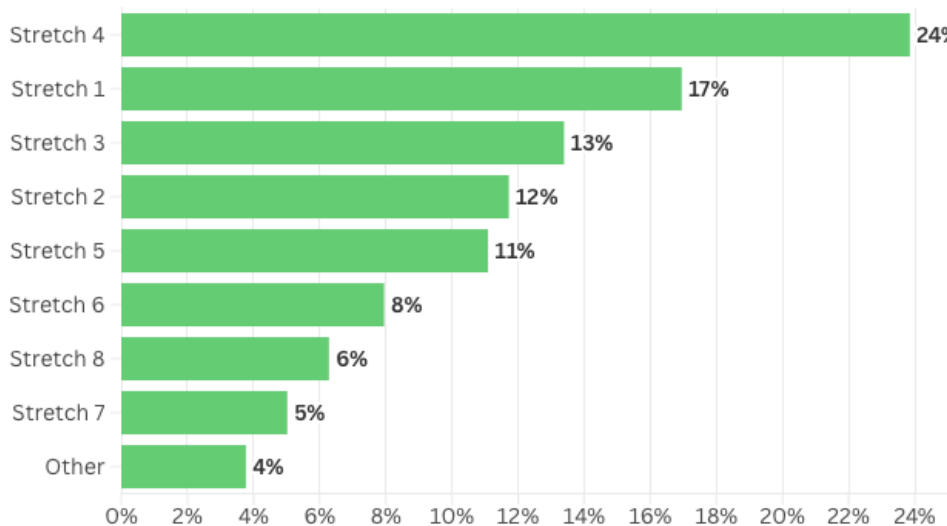


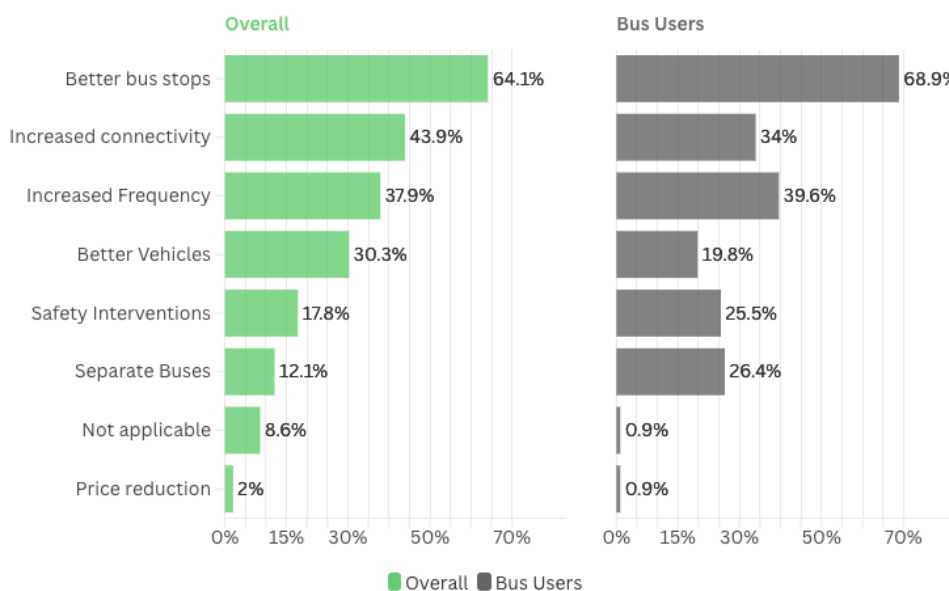
Figure 24: Siddhartha College Road (Stretch 4) and ITI Road from Ramesh Hospital Junction to Loyola College Entrance (Stretch 1)



When asked which stretch of the CAZ they most wanted to see their selected improvements implemented on, the most respondents overall (24%) chose the stretch from Siddhartha College junction to Jammichettu junction (stretch 4). For those who selected this stretch, the top three choices for area improvements were still improved footpaths, improved pedestrian crossings and increased compliance.

Public Transport Enhancement

Figure 25: Vijayawada Respondents' Priorities for Public Transport Enhancement

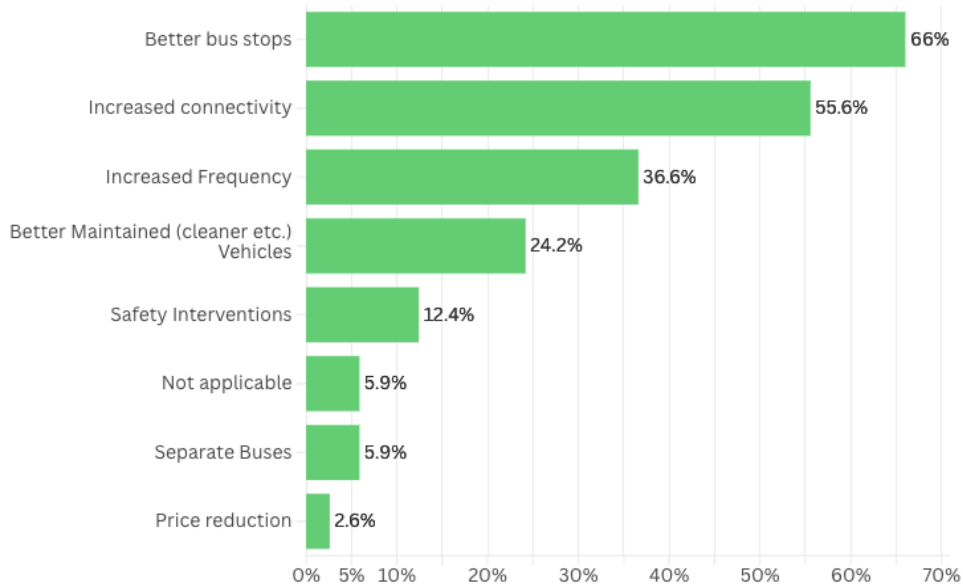


Each respondent was asked to pick the three public transport improvements that are of priority to them. This chart shows the percent of respondents who selected each option. Because they were allowed to select multiple options, the percentages do not add up to 100%.

Out of the public transport enhancements presented to respondents, the most popular choices overall (n=512) were better bus stops, increased bus route connectivity and increased bus frequency. Among the sub-sample of respondents who already use the bus as their main mode to commute to the CAZ (n=106), the most popular choices were the same; however, increased

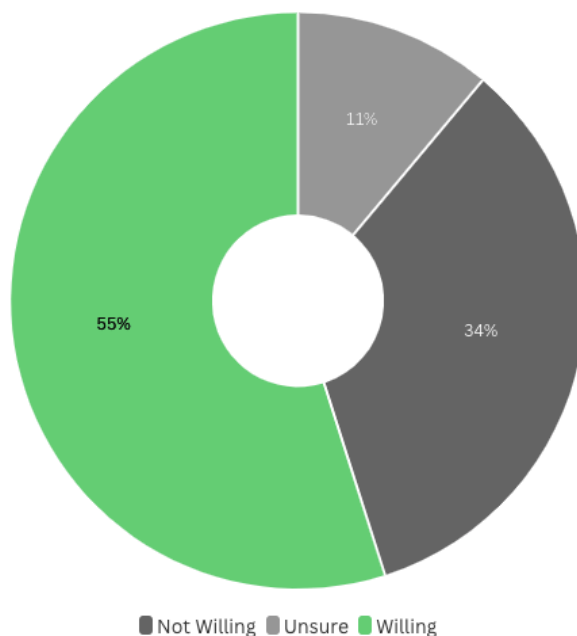
bus frequency was more popular than increased bus route connectivity. Eighty-eight percent of current bus users typically wait for the bus for more than 10 minutes, indicating a need for more frequent buses on routes servicing the CAZ.

Figure 26: Vijayawada Private Vehicle Users' Public Transport Enhancement Priorities



Each respondent was asked to pick the three public transport improvements that are of priority to them. This chart shows the percent of respondents who selected each option. Because they were allowed to select multiple options, the percentages do not add up to 100%.

Figure 27: Vijayawada Private Vehicle Users' Willingness to Reduce Private Vehicle Use with Enhanced Public Transport

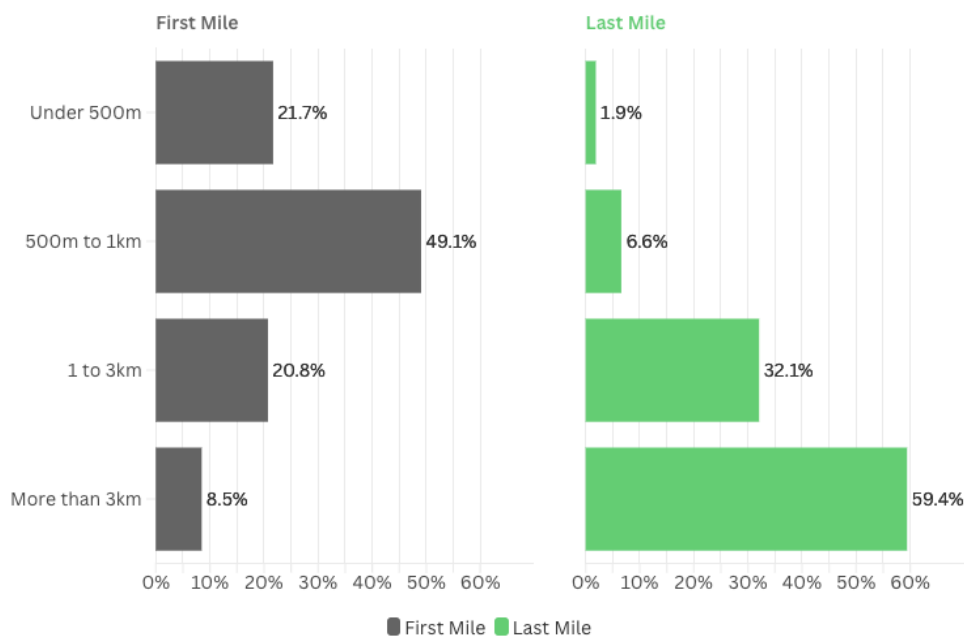


This question was asked to respondents who already use private vehicles as their main mode to access the area.

Of respondents who currently use private vehicles to commute to the CAZ (n=153), 55% said they would be willing to reduce their use of private vehicles if their selected public transport

enhancements were made. The top public transport enhancements among this sub-sample were also better bus stops, increased bus route connectivity and increased bus frequency.

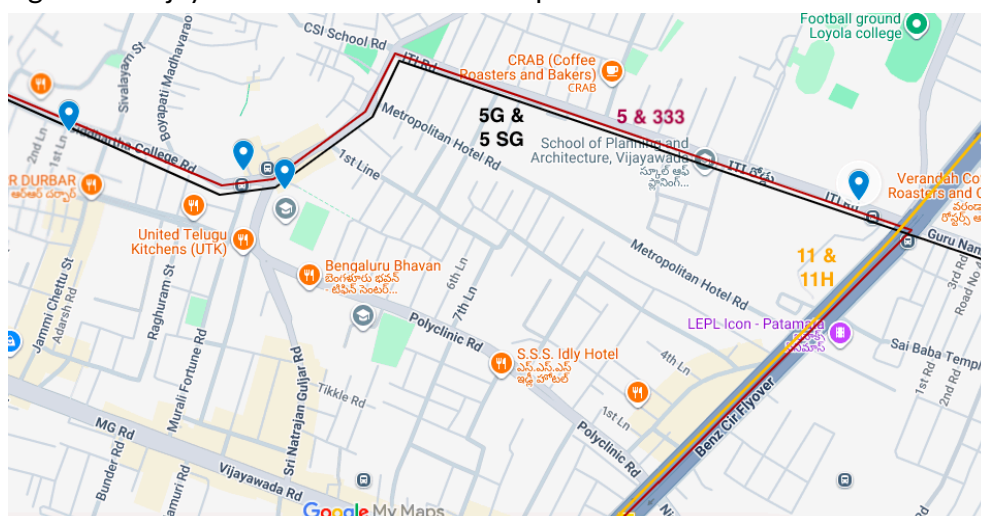
Figure 28: Vijayawada Bus Users' First and Last Mile Distance



This chart shows the distance that bus users travel from the bus stop to their destination within the CAZ.

The majority of respondents had first mile distances that are less than 1 km, typically considered walkable distances. However, most bus users reported long last mile distances, with 59% reporting last mile distances of more than 3 km and more than 90% reporting last mile distances of more than 1 km. This indicates that bus route connectivity to the CAZ is severely lacking as bus users have to travel very far from bus stops to their destinations in the CAZ. The bus routes that service the CAZ are shown in Figure 29, with the different routes tending to follow similar paths, and no routes servicing the south side of the CAZ. Commuters that come from areas of the city not serviced by these bus routes, or those whose destinations are not near the bus stops in the CAZ will experience long last mile distances. Further, 94% of bus users in Vijayawada report only using one bus to complete their trip, telling us that users are not finding it convenient to switch buses to get closer to their destinations, which could also contribute to long last mile distances.

Figure 29: Vijayawada CAZ Bus Route Map



Bus users were also asked what mode they typically use to cover the first and last mile distances. They were allowed to select multiple responses as different modes may be used for the first versus last mile or on different days. The most popular modes were auto rickshaws, chosen by 59% and 2-wheelers, chosen by 53%. With such long last mile distances and poor pedestrian infrastructure, few bus users are able to walk from the bus stop to their destination.

Box 2: National CAZ Workshop Public Transport Takeaways

The Public Transport panel session of the National CAZ Workshop featured panelists from WRI, UITP and Transport for London. The discussion touched on the prevalence of the first/last mile problem in Indian cities, particularly Tier 2 and 3 cities. Often, the first and last mile distances make up too large a proportion of the whole trip distance and for shorter trips, bus wait times make up too large a proportion of the total trip time for public transport to be an attractive mode. Non-motorised transportation (NMT) infrastructure is very poor making it difficult to cover the first/last mile distances.

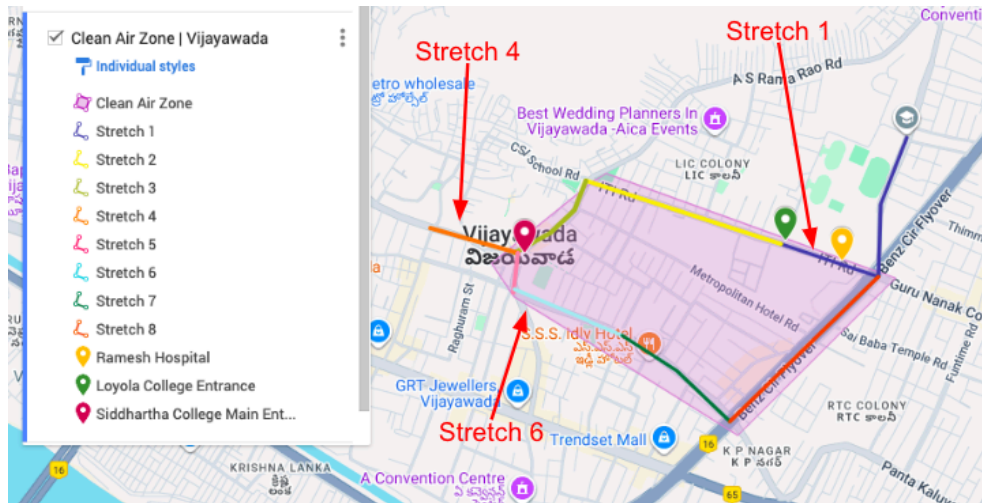
The problem of different modes not being properly integrated was also a key point of discussion. Kochi was cited as a good Indian example where the transport system has efficiently integrated multiple modes. There is good multi-model connectivity between metro, water metro and buses. Bus routes have been planned such that they serve as a feeder system to the metros. Planning and scheduling information, as well as fare payments, are integrated across all three modes so that customers can easily plan trips using multiple modes. Fragmentation across transportation agencies is often a barrier to a well-integrated transportation system. Other cities need to develop apex governance bodies that integrate different transportation agencies and develop holistic, multi-modal transportation systems.

Finally, state transportation utilities should be focused on ways to increase their non-farebox revenue so they can enhance the efficiency of their processes and build capacity.

Further, the most popular destination in the CAZ for bus users was the stretch of Siddhartha College Road from Siddhartha College junction to Jammichettu junction (stretch 4), chosen by

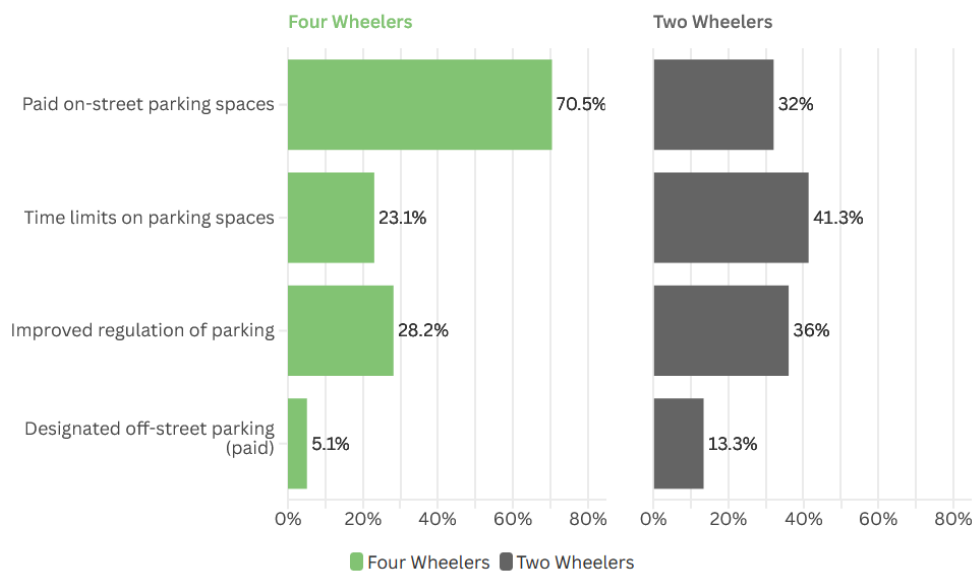
25%. The second most popular was the stretch of Polyclinic Road from Polyclinic Road junction to Lalitha Jewellery (stretch 6) and the third most popular was the stretch of ITI Road from Ramesh Hospital junction to the Loyola College entrance (stretch 1). This should be considered when looking to improve bus route connectivity. More bus routes or bus stops may be needed servicing these stretches.

Figure 30: Siddhartha College Road (Stretch 4), ITI Road from Ramesh Hospital Junction to Loyola College Entrance (Stretch 1) and Polyclinic Road from Polyclinic Road Junction to Lalitha Jewellery (Stretch 6)



Parking Improvement Plans

Figure 31: Vijayawada Respondents' Parking Improvement Priorities

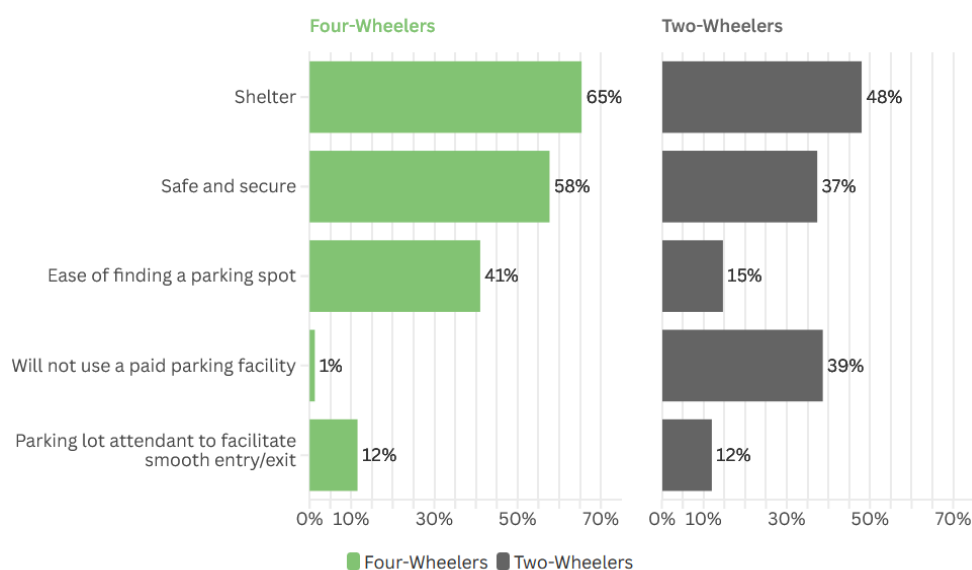


Each respondent was asked to pick the two improvements to parking facilities that are of priority to them. This chart shows the percent of respondents who selected each option. Because they were allowed to select multiple options, the percentages do not add up to 100%.

The most popular improvements among four-wheeler private vehicle users (n=78) were to provide paid on-street parking spaces and to improve regulation of parking. Among two-wheeler private vehicle users (n=75), the most popular improvements were time limits on

parking spaces and improved regulation of parking. Respondents demonstrate a desire for overall more organised and regulated on-street parking. Paid on-street parking being popular among the four-wheeler private vehicle users is backed up by the fact that 74% of four-wheeler users already use paid parking facilities and so are already accustomed to the concept of paying for parking. On the other hand, only 7% of two-wheeler users already use paid parking which may be contributing to their relative reluctance to choose this parking improvement.

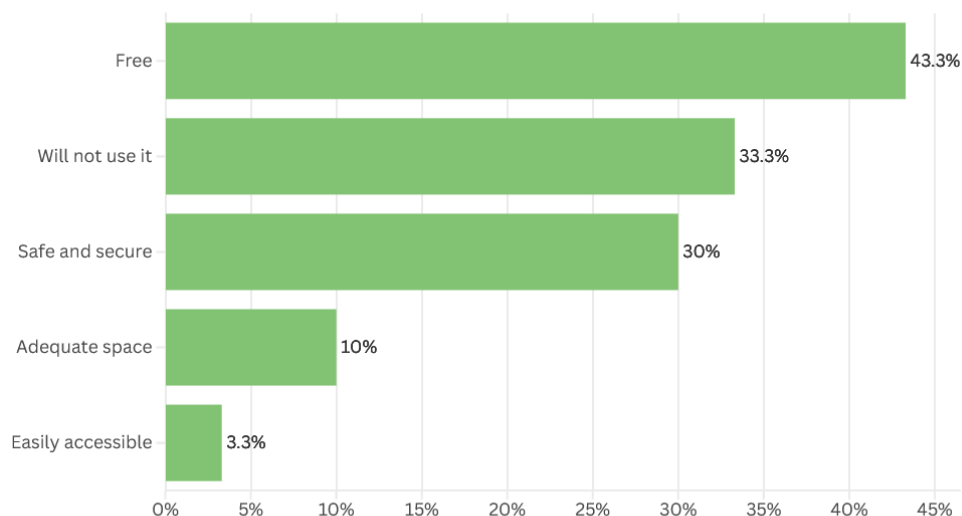
Figure 32: Vijayawada Private Vehicle Users' Key Conditions for Using Paid Off-Street Parking Facilities



Respondents were asked to choose their top 2 conditions for using paid off-street parking facilities. This chart shows the percentage of respondents who selected each option. Because they were allowed to select multiple responses, percentages will not add up to 100%.

Private vehicle users were also asked to choose what conditions would have to be met for them to use a paid off-street parking facility rather than parking on the street. The most popular choices among four-wheeler private vehicle users were that the facility is sheltered (shaded) and that it is safe and secure. For two-wheeler private vehicle users, almost half said that they would use an off-street parking facility under the condition that it is sheltered, however, 39% said that under no conditions will they use a paid parking facility. In contrast, only 1% of four-wheeler private vehicle users reported that under no conditions will they use a paid parking facility. These results tell us that providing an off-street parking facility catered towards four-wheelers alongside regulated, time-limited on-street parking provisions for two-wheelers (and four-wheelers) might be most successful.

Figure 33: Vijayawada Local Business Employees’ Key Conditions for Using Dedicated Off-Street Parking Facilities



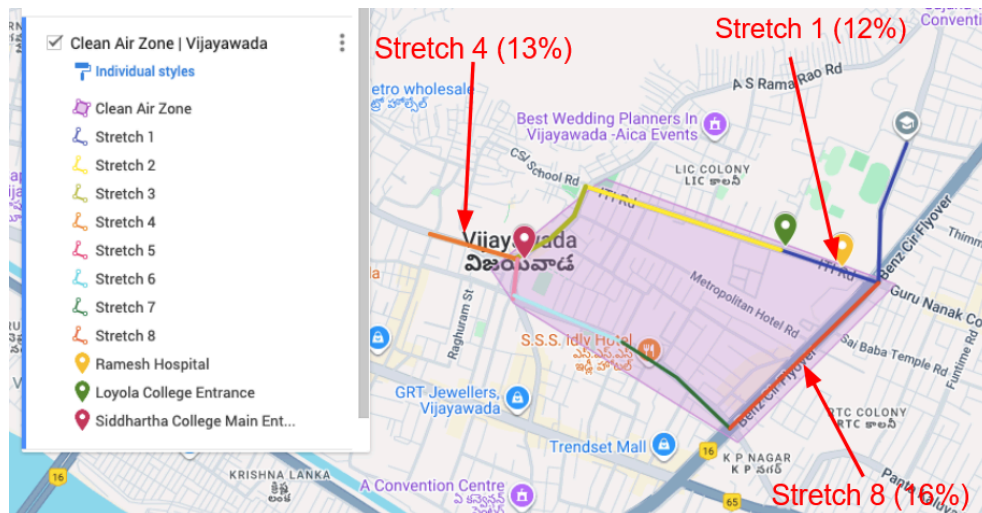
Respondents were asked to choose their top 2 conditions for using off-street parking facilities. This chart shows the percentage of respondents who selected each option. Because they were allowed to select multiple responses, percentages will not add up to 100%.

The thirty local business employees that were surveyed were asked about the conditions under which they would use an off-street parking facility rather than parking on the street. Out of the thirty surveyed, eighteen respondents travel to work by personal vehicle. Those who did not travel to work by personal vehicle answered this question on behalf of their colleagues who do use a personal vehicle to commute to work. The most popular condition was that the facility is free, however, a third of the respondents reported that under no conditions would they use an off-street parking facility. These results imply that asking local business employees to park at an off-street parking facility walking distance from their businesses may not be the most successful method of reducing the number of vehicles parked on streets and footpaths in front of shops and businesses. To do this, it may be more prudent to focus on regulating and organising on-street parking in front of local businesses.

Local business employees were also asked if their business provides parking for the customers and goods vehicles that visit their business. Ninety percent of local businesses employees reported that their business provides parking, however, it should be noted that employees may consider empty space or a footpath in front of their store as parking and the parking may be encroaching on pedestrian infrastructure or the shoulder of the road. This requires further investigation.

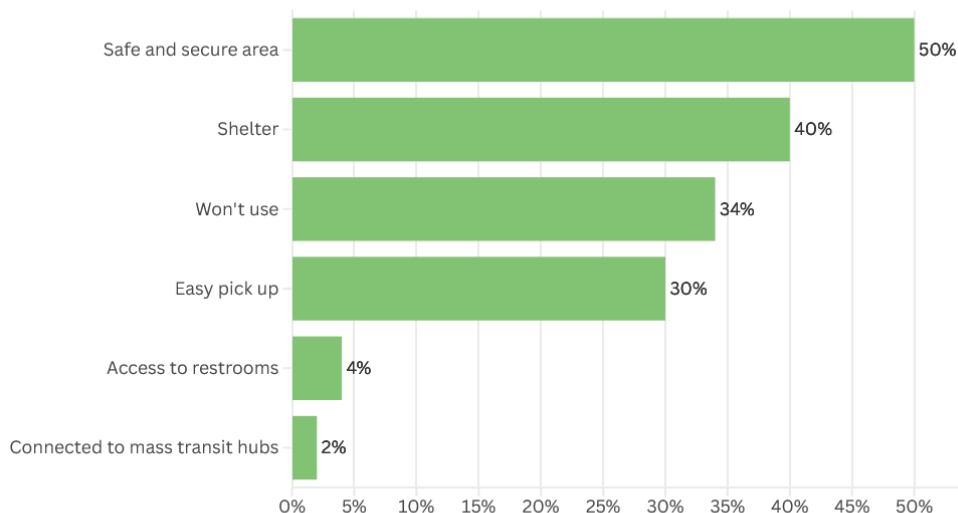
Finally, all private vehicle owners (n=153) were asked where, within the CAZ, they park their vehicles when visiting the area. The most popular destinations were the stretch of Ring Road from Nirmala Convent junction to Ramesh Hospital junction (stretch 8), chosen by 16%, Siddhartha College Road from Siddhartha College junction to Jammichettu junction (stretch 4), chosen by 13%, and ITI Road from Ramesh Hospital junction to Loyola College entrance (stretch 1), chosen by 12%. Given these 3 stretches are the most popular stretches for private vehicle users to park on, interventions aimed to organise parking better should focus on these stretches.

Figure 34: Siddhartha College Road (Stretch 4), Ring Road from Nirmala Convent Junction to Ramesh Hospital Junction (Stretch 8) and ITI Road from Ramesh Hospital Junction to Loyola College Entrance (Stretch 1)



Auto Rickshaws

Figure 35: Vijayawada Auto Rickshaw Drivers' Key Conditions for Using a Dedicated Customer Pick-Up Area



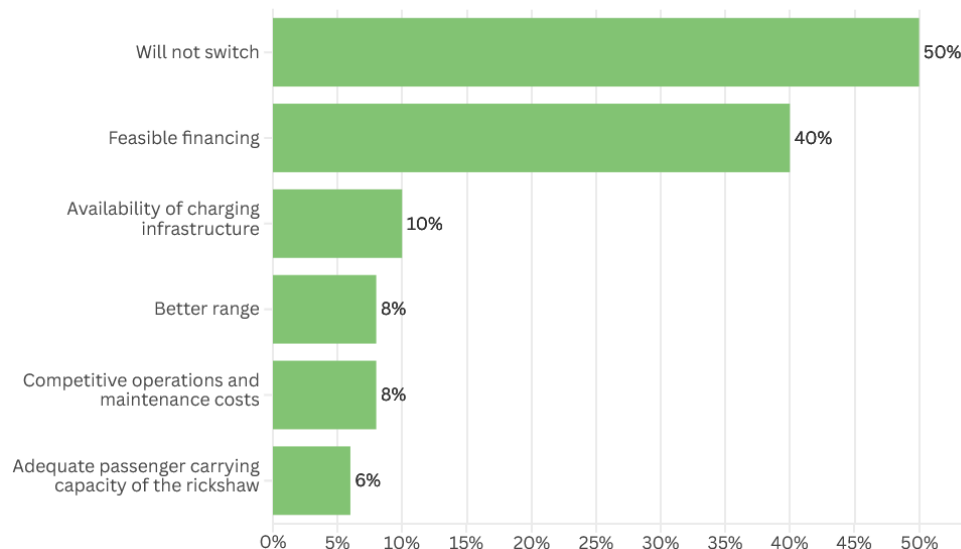
Respondents were asked to choose their top 2 conditions for using a dedicated customer pick-up area. This chart shows the percentage of respondents who selected each option. Because they were allowed to select multiple responses, percentages will not add up to 100%.

Auto rickshaw drivers (n=50) were asked to pick the top two from a list of conditions under which they would use a dedicated customer pick-up area (like an auto stand) rather than stopping at any given point on the street. The most popular conditions were that the customer pick-up area is safe and secure, and sheltered (shaded).

Auto rickshaw drivers typically pick-up customers from Siddhartha College Road between Siddhartha College junction and Jammichettu junction (stretch 4), chosen by 56% of auto rickshaw drivers, and Ring Road between Nirmala Convent junction and Ramesh Hospital junction (stretch 8), chosen by 50% of auto rickshaw drivers. This implies that interventions

aiming to streamline auto rickshaw pick-ups and reduce congestion should be focused on these two stretches within the CAZ.

Figure 36: Vijayawada Auto Rickshaw Drivers' Key Conditions to Switch to E-Rickshaws



Respondents were asked to choose their top 2 conditions for using an e-rickshaw. This chart shows the percentage of respondents who selected each option. Because they were allowed to select multiple responses, percentages will not add up to 100%.

Finally, auto rickshaw drivers were asked for the top two conditions under which they would consider switching to an electric rickshaw, in order to reduce vehicular emissions from auto rickshaws. The most popular response was that they would not, under any conditions, switch to using an electric rickshaw, implying that this is likely not a realistic method for improving air quality within the CAZ. However, because three-wheelers (diesel autos) account for a large percentage of vehicle emissions in the CAZ, further studies should be done to better understand the push-back against electric autos and behavioural change interventions or awareness campaigns could be deployed to increase likelihood of e-rickshaw adoption.

Discussion & Recommendations

Using the results of the previously conducted technical studies, the perception surveys and insights from other stakeholder engagements that have been undertaken with institutional stakeholders within the ULB, control measure implementation plans have been developed. An overview of recommended control measures and their locations in each city are shown in Figures 37 & 38.

Figure 37: Visakhapatnam Control Measure Implementation Plan

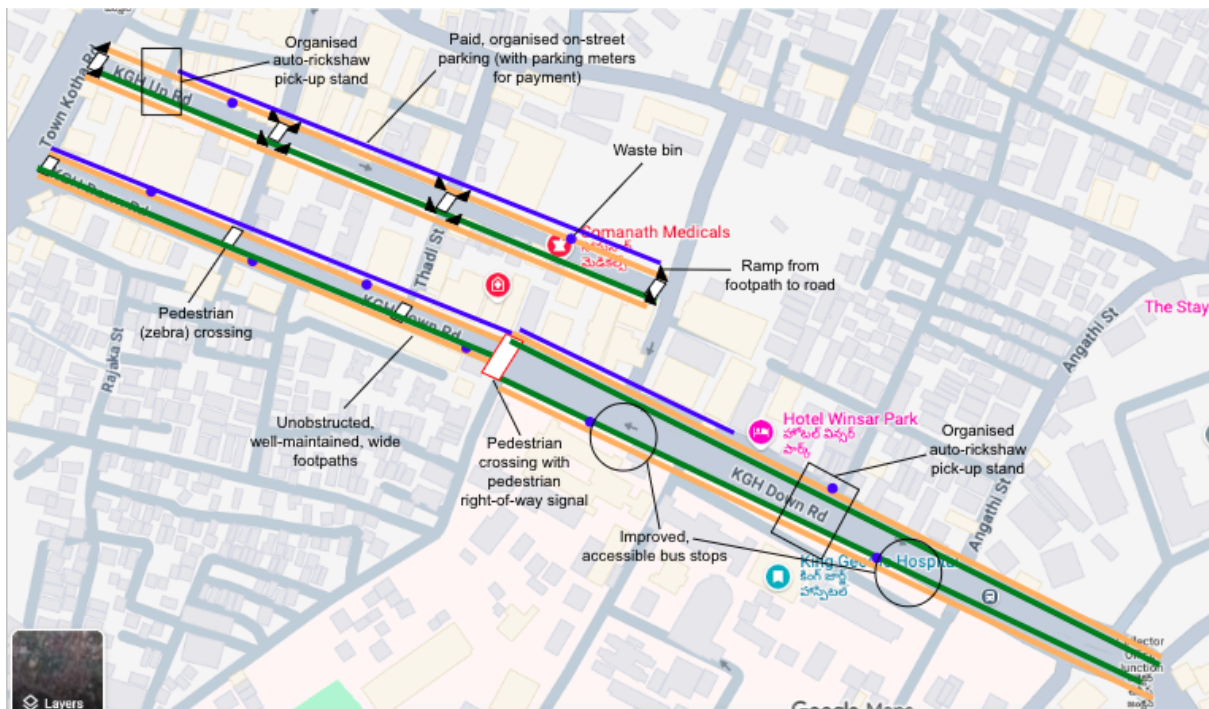


Figure 38: Vijayawada Control Measure Implementation Plan



Visakhapatnam
KGH Up Road

In Visakhapatnam the most popular destination where respondents want to see area improvements is on KGH Up Road. The most desired area improvement here is improved footpaths. While KGH Up Road already has footpaths on both sides of the street for the

majority of the stretch, the footpaths are not of high quality and have many flaws which make it difficult for pedestrians to navigate them. Some of these are:

- The footpaths are too high and in some places lack ramps at property entrances and intersections.
- Footpaths are not continuously usable due to a variety of obstructions or breaks where the footpath has not been maintained.
- Footpaths are not wide enough next to commercial establishments to accommodate for the frontage zone needed in front of these establishments. This causes commercial establishments and vendors to encroach on space where pedestrians would walk.

The next most desired area improvement on this stretch is improved pedestrian crossings. There are no designated pedestrian crossings on this stretch. The third most popular desired area improvement on this stretch is improved traffic compliance. This entails that vehicles obey official traffic regulations such as stopping at pedestrian crossings, abiding to the speed limit, and obeying parking regulations. Overall, 38% and 24% of respondents selected adding street amenities (benches, water fountains, waste bins etc.) and cycle lanes, respectively, as desired area improvements. Wider footpaths could accommodate amenities such as waste bins and greenery. Added cycle lanes on this stretch would increase safety and inclusivity for all modes.

KGH Up Road is also the most popular stretch among bus users for destinations within the CAZ. With a bus stop right at Jagdamba Centre, last mile distances are typically not very long (less than one kilometer for the majority of bus users in the sample). Furthermore, this bus stop is serviced by many buses, meaning the CAZ is relatively well connected to the rest of the city. Accordingly, the most popular public transport enhancement that respondents chose was better bus stops (bus stops that are clean, shaded, seating provided, show updated bus arrival times, CCTV cameras). Among the respondent group who already use the bus to commute to the CAZ, the most popular public transport enhancement was increased bus frequency at the bus stops in the CAZ.

KGH Up Road is also the most popular stretch selected by private vehicle users for parking within the CAZ. According to a local shopkeeper, on this stretch, parallel parking is allowed, free of cost, on one side of the street but most people are not aware of this, resulting in vehicles being parked on both sides of the street. Lack of organisation and enforcement of parking regulations also results in two-wheelers parking on the footpath, obstructing it. Adding paid, regulated parking with time limits on this stretch was desired by the majority of respondents who use private vehicles. These parking management improvements would improve accessibility both for private vehicle owners and users of other modes such as walking and cycling. Further, a couple streets north of this stretch is an off-street paid, multi-level parking facility. Increasing use of this facility and moving some of the cars encroaching on road-space on KGH Up Road to this facility would also reduce congestion and increase inclusivity of all modes on this stretch. Increasing use of this facility would require greater enforcement of parking regulations by traffic police - they could ensure that instead of parking vehicles illegally on streets, private vehicle users are directed to the off-street parking facility.

Fifty percent of auto drivers reported picking up passengers on KGH Up Road, implying that there may be a demand for an auto rickshaw stand on this stretch. Organising auto rickshaw

passenger pick-ups would smoothen traffic flow by reducing congestion due to stopped auto rickshaws. The addition of a designated auto rickshaw stand on KGH Up Road near the intersection with Kota Road could help smoothen traffic on KGH Up Road. Thirty-percent of auto rickshaw drivers chose 'connectivity to mass transit hubs' as a condition for them using an auto-rickshaw passenger pick-up stand. The auto rickshaw stand should be adjacent to the bus stop to help with first/last mile connectivity, encouraging auto rickshaws to take on the role as feeders to the bus system. To help reduce the emissions from diesel autos, auto rickshaw drivers should be encouraged to switch to using e-rickshaws. With feasible financing and competitive operations and maintenance costs as the top conditions under which drivers would begin using e-rickshaws, subsidised purchasing or leasing programs for auto rickshaw drivers could help encourage the switch to lower-emissions modes.

KGH Down Road

Many respondents also wanted to see area improvements on KGH Down Road. Footpaths are practically non-existent for the majority of the stretch between Collector's office junction and Kotha Road. On both sides of the road between Collector's office junction and KGH OP gate, footpaths are completely obstructed by parked vehicles. In front of KGH, particularly, they are obstructed by parked ambulances and autos waiting to pick up passengers. On the stretch from KGH OP gate to Kotha Road, footpaths are obstructed by parked two wheelers and other obstructions like hawkers, gates, signs and electrical boxes. Pedestrian crossings are also practically non-existent on this stretch. For much of the stretch, there is a grade difference between the two ways of traffic, so for this stretch it is not possible to have a pedestrian crossing. However, this highlights the need for a safe pedestrian crossing before the grade difference begins and at regular intervals between that point and Kotha Road. As on KGH Up Road, this stretch would also benefit from increased traffic compliance, particularly stopping at pedestrian crossings, and from street amenities such as benches and waste bins, and from cycle lanes.

KGH Down Road, between KGH OP Gate and Collector's Office Junction, is the second most popular destination within the CAZ for bus users. There are two bus stops on this stretch. These bus stops are served by two bus routes which stop right in front of KGH, likely the destination for most bus users getting off at these stops, indicating short last mile distances. Again, the most popular public transport enhancement that respondents chose was better bus stops. The bus stops on KGH Down Road are not clean and are often not easily accessible by footpath because of the obstructions around them. Further, buses are not able to stop right next to the bus stop due to parked vehicles, standing autos and hawkers on the road, making bus users stand on the road while waiting to board the bus. This makes the bus stop less safe and less accessible. In addition, providing real-time bus arrival times and having CCTV cameras at the bus stops would make them more usable and safer.

This stretch of KGH Down Road was also the second most popular stretch selected by private vehicle users for parking within the CAZ. On this stretch, parking is disorganised and many parked vehicles encroach on the footpath and on the road. Because vehicles are able to drop-off and pick-up within the KGH gate, on-street parking may be less important in front of the hospital. The extra road space should be dedicated to buses pulling up and stopping at bus

stops, footpaths and cycle lanes, and an auto rickshaw stand so they no longer encroach on the footpath while waiting for passengers. This would further encourage people to take less-polluting modes when accessing KGH. Between KGH OP Gate and Kotha Road, there are many commercial establishments, making it a more natural placement for paid on-street parking. On this stretch, the street is quite wide and if parking was regulated a lot of space could be freed up for other modes.

The most popular spot for auto rickshaw drivers to pick up passengers within the CAZ was on KGH Down Road (between KGH OP Gate and Collector’s Office Junction). Many auto rickshaws stop in front of the KGH Gate and park on the footpath when waiting for passengers or taking a break, obstructing the footpath. They also encroach on the road space in front of the bus stops to wait for passengers. A dedicated auto rickshaw stand here would help smoothen traffic flow and make the area more walkable by freeing up the footpath. Proximity to the bus stop in front of KGH Hospital would also help the auto rickshaws cover first/last mile distances and act as feeders to the bus system. The stand should be directly in front of the hospital gate, making it easy for drivers to pick up passengers, a key condition that auto rickshaw drivers reported to ensure that they use the pick-up stand.

Recommendations

Given the current state of pedestrian infrastructure, parking management and public transport service in the Visakhapatnam CAZ area, as well as the stated desired improvements by surveyed respondents, the following interventions are recommended⁹ (in order of perceived feasibility):

1. Addition of conspicuous signs that designate where street parking is legal and where it is not on KGH UP Road.
2. Addition of both north-south and east-west pedestrian zebra crossings at each intersection on KGH UP Road and periodically on KGH Down Road (before the grade difference).
Ideally, in the longer term the pedestrian crossings would be raised and at grade with the footpath, ensuring that cars must slow down when approaching it and increasing likelihood of them properly stopping for pedestrians.
3. Increased traffic regulation enforcement by officers, including tickets for fast driving, not providing pedestrians right-of-way at pedestrian crossings, and illegal parking.
4. Improve all bus stops within the CAZ
 - a. Ensure bus stops are clearly indicated and sheltered
 - b. Clear obstructions on the footpath around the bus stops so pedestrians can easily access it from all directions
 - c. Clear obstructions from the road around the bus stops so buses can stop right next to the curb and bus users do not have to stand on the road while waiting to board
 - d. Add electronic message boards with updated bus arrival times
 - e. Add waste bins and CCTV cameras to the bus stops

⁹ Note that for more detail on best practice standards for road, footpath, pedestrian crossing, bus stop and public transport system design, refer to Jana Urban Space’s [Tender S.U.R.E Volume 1](#), ITDP’s [Footpath Design Handbook](#) (2013), and the Indian Roads Congress (IRC) Standard codes.

5. Increased frequency along bus routes serving the CAZ.
6. Establish safe and sheltered auto rickshaw stands adjacent to the bus stops on KGH Up Road and KGH Down Road (in front of the KGH gate) to smooth traffic and eliminate encroachment of stopped auto rickshaws on roads and footpaths.
7. Implement financing programs to help auto rickshaw drivers lease or buy e-rickshaws.
8. Add ramps from footpaths onto streets at intersections (especially important given the current height of the footpath) on KGH Up Road.
9. Ensure pedestrians can cross at grade and there are ramps for vehicles to enter at property entrances throughout the CAZ.
10. Addition of parking payment meters instituting paid, time-limited parking on the north side of KGH Up Road and on both sides of KGH Down Road from Kotha Road to the beginning of the grade difference
11. Add a signalised pedestrian crossing on KGH Down Road before the grade difference begins
12. Lower the height of footpaths (IRC standards specify a maximum height of 150mm)
13. Increase the width of the footpath, particularly on the north side of the KGH Up Road where there are more commercial establishments, so that the pedestrian zone is unobstructed and all obstructions are part of the furniture zone and obstructions related to shops and vendors are in the frontage zone.¹⁰
 - a. This would allow for the addition of street amenities such as waste bins, benches and greenery without obstructing pedestrians' path.

Using Google's Gemini tool we developed visualisations of what the CAZ could look like with some of the above interventions implemented.

Figure 39: Organisation of street parking to paid, regulated on-street parking on KGH Up Road

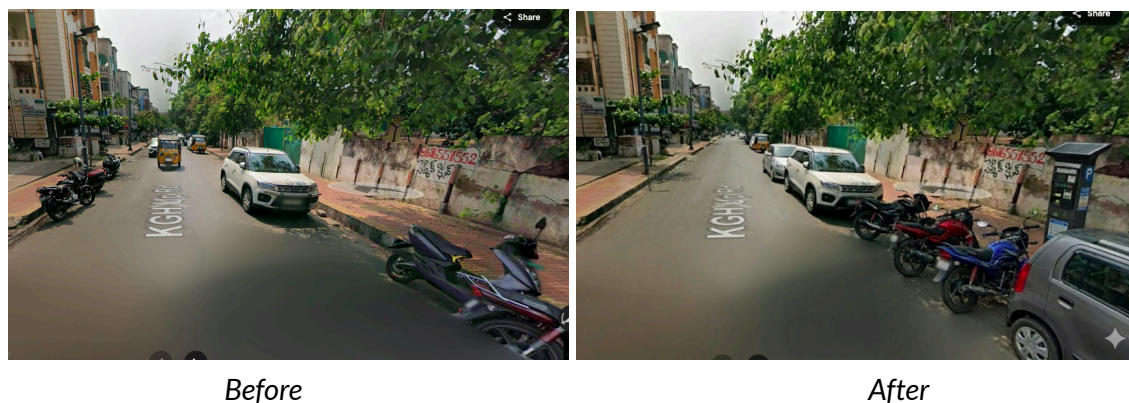


Figure 40: Improved footpaths and organised parking on KGH Up Road

¹⁰ As per the IRC's Guidelines for Pedestrian Facilities, footpaths are divided into three zones. First, the frontage zone which is the segment of the footpath right in front of a compound wall or in front of shops in a commercial area. The frontage zone can vary from a minimum width of 0.5 m along a compound wall to 1.0 m in commercial areas. Next, the pedestrian zone is a space for pedestrians to walk that is continuously clear of obstructions, it must be a minimum of 1.8m in width. Finally, the furniture zone contains elements such as electric boxes and trees so that they are not obstructing the pedestrians' direct line of travel.

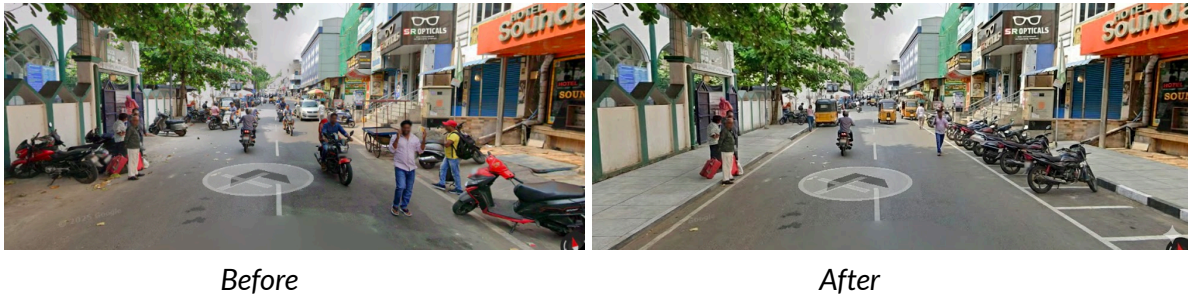


Figure 41: Improved footpath and bus stop cleanliness, addition of real-time information at bus stop on KGH Down Road

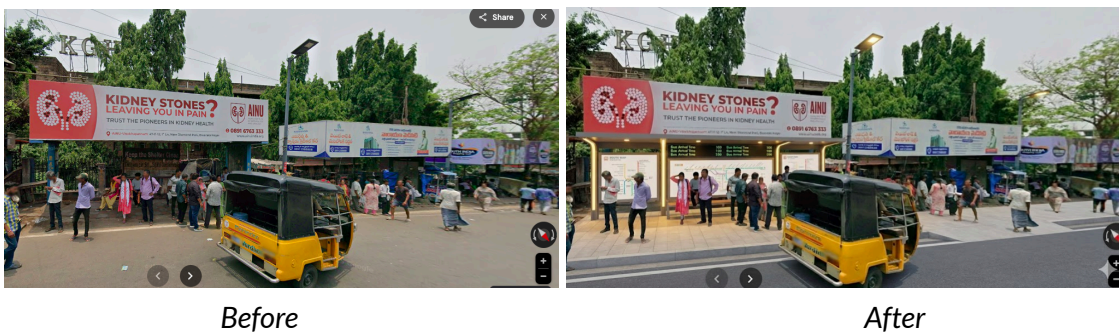


Figure 42: Addition of a signalised pedestrian crossing on KGH Down Road



Vijayawada

Siddhartha College Road

In Vijayawada, respondents most wanted to see area improvements made on Siddhartha College Road between Siddhartha College junction and Jammichettu junction. Just as in Visakhapatnam, the most popular area improvements were improved footpaths, improved pedestrian crossings, and increased vehicle compliance with traffic laws. For most of this stretch, the north side of the road has no footpath and the south side has a covered drain which is meant to serve as a footpath, however the surface is on an angle, is too narrow to properly act as a footpath and has obstructions or parked vehicle encroachments periodically along the stretch. This stretch has only one dedicated pedestrian crossing. Throughout the rest of the stretch there is a median separating the two directions of traffic and the road is wide, with high traffic volumes, making it unsafe and difficult for pedestrians to cross throughout. Due to the road being wide and vehicles travelling at relatively higher speeds, the addition of speed bumps as vehicles approach pedestrian crossings could also increase their compliance with the pedestrian right-of-way and make the crossings safer. This stretch is full of commercial

establishments which could be made much more accessible with wider, better maintained footpaths - this stretch could become an enjoyable and interesting place to walk and cycle. To make this stretch more pedestrian friendly, increased vehicle compliance would be necessary. Vehicles should obey speed limits, stop at pedestrian crossings, and abide by parking regulations.

Likely due to its abundance of commercial establishments and the presence of Siddhartha College, this stretch is also the most popular destination for bus users accessing the CAZ. With only a few bus routes passing through the CAZ and only three bus stops in the CAZ, the stretch is inaccessible to many commuters who may not have origins near these bus routes or to commuters whose destinations within the CAZ are more than a 5-10 minute walk from one of the bus stops. This is reflected in the long last mile distances reported by over 90% of bus users in Vijayawada. Adding bus routes that come from different areas of the city, could increase connectivity and reduce last mile distances. Respondents also expressed the need for improved bus stops. While bus stops on this stretch are relatively clean, are sheltered and have seating, improvements such as enhancing the walkability of the footpaths around the bus stops, the addition of waste bins, and a screen with updated arrival times could be made. Respondents have also expressed the need for increased bus frequency. This could partially be served by the addition of bus routes to serve the CAZ, as well as increasing the frequency of the bus routes that currently serve it.

The Siddhartha College Road stretch is also the second most popular stretch for private vehicle users to park their vehicles. Currently, vehicles park on either side of the road, encroaching on either road or footpath space. Respondents expressed interest in the implementation of paid, regulated parking with time limits on this stretch, which would free up space for footpaths, and free up road space, leading to better traffic flow.

Siddhartha College Road is the most popular stretch for auto rickshaw drivers to pick up passengers. A sheltered and safe auto rickshaw pick up stand near Siddhartha College junction would allow auto rickshaws to serve as the first/last mile mode for bus users and an auto rickshaw pick up stand in front of Siddhartha College buildings would also allow for ease of auto rickshaw drivers in picking up college students as passengers. Establishing auto rickshaw stands would ease traffic flow as it would reduce the encroachment of standing autos on the road.

Overall, improvements to pedestrian and cycling infrastructure and traffic smoothening on this stretch would not only connect users of these modes to destinations on the stretch, but would also make the last mile for many bus users easier and safer. Paid and regulated parking would make the stretch more accessible to users of all modes. All of these interventions would make the commercial establishments on this stretch more accessible, potentially increasing their footfall and bringing increased revenue, as well as making the stretch a more safe and enjoyable space for the community.

ITI Road (Ramesh Hospital)

Many respondents also wanted to see area improvements on ITI Road, particularly the stretch in front of Ramesh Hospital, from Ramesh Hospital junction to the entrance of Loyola College (Institute of Engineering and Technology). This stretch lacks proper footpaths on both sides of the road, and even the road shoulder with a covered drain is completely encroached on by parked vehicles. The stretch has a lot of greenery, which could potentially make it a pleasant place to walk and cycle if the infrastructure was available. The stretch only has one pedestrian crossing in front of the hospital and this crossing could benefit from a bigger pedestrian refuge area in the middle of the road to make it safer and more accessible to cross. For the remainder of the stretch, there are no pedestrian crossings and a high median between the two ways of traffic makes it almost impossible for pedestrians to cross. In alignment with survey responses, this stretch could also benefit from increased vehicle compliance with traffic laws and the addition of street amenities like waste bins, benches and water fountains.

This stretch was a popular destination for bus users. As with the Siddhartha College Road stretch, few bus routes pass through this stretch and adding bus routes that come from different areas of the city could increase connectivity and reduce last mile distances. Currently there are accessibility issues with the bus stops next to Ramesh Hospital. The footpaths leading up to them are broken and/or obstructed making them difficult to access by foot, and there is a significant gap between the bus and the curb when they stop, meaning bus users have to stand on the road while waiting to board. Improved bus stops in this area would include better maintained footpaths, improved cleanliness of the bus stop, displays with real-time bus information and ensure that buses stop close enough to the curb that passengers can step directly onto the bus.

This stretch was also popular for private vehicle users to park their vehicles, which is aligned with the visible situation on ground with parked vehicles lining both sides of the road. Regulating parking on this stretch would remove illegally parked vehicles, freeing up road space for wide footpaths and cycle lanes. Demand for parking on this stretch is high because Ramesh Hospital does not have its own dedicated parking area. However, an empty lot across the street from Ramesh Hospital could provide a solution to this. This lot could be used as a sheltered, safe and secure off-street parking facility for those visiting Ramesh Hospital. Street parking on at least one side of the road could be outlawed. One side of the street could potentially still have a limited amount of paid, regulated parking spots with time limits, encouraging those visiting the hospital to use the dedicated lot, rather than encroaching on the street.

Thirty-six percent of auto rickshaw drivers reported picking up passengers on ITI Road between the Loyola College entrance and Ramesh Hospital Junction. A dedicated auto rickshaw pick up stand in front of Ramesh Hospital would reduce the amount of autos stopping and encroaching on the road and footpath in that area, smoothing traffic flow and increasing walkability. Further, an auto rickshaw stand in front of Ramesh Hospital would be next to the bus stop that is also there, allowing auto rickshaws to more easily act as a first/last mile mode for bus users whose destinations are elsewhere in the stretch.

Improvements to pedestrian and cycling infrastructure, along with improved parking management and improvements to the bus stops would make this stretch a safe and enjoyable area for people to walk and cycle and improve the air quality and general health impacts around the hospital.

Recommendations

Given the current state of pedestrian infrastructure, parking management and public transport service in the Vijayawada CAZ area, as well as the stated desired improvements by surveyed respondents, the following interventions are recommended (in order of perceived feasibility & importance):

1. Add frequent north-south pedestrian crossings with gaps in the median and pedestrian refuges throughout Siddhartha College Road and ITI Road
2. Increased traffic regulation enforcement by officers, including tickets for fast driving, not providing pedestrians right-of-way at pedestrian crossings and illegal parking.
3. Conduct further studies into the push-back against switching to electric auto rickshaws.
 - a. Develop financing options, incentivising the switch to e-rickshaws
 - b. Work towards more accessible charging infrastructure for e-rickshaws to increase their usability
4. Improve all bus stops within the CAZ
 - a. Ensure bus stops are clearly indicated and sheltered
 - b. Clear obstructions on the footpath around the bus stops so pedestrians can easily access it from all directions
 - c. Clear obstructions from the road around the bus stops so buses can stop right next to the curb
 - d. Add electronic message boards with updated bus arrival times
 - e. Add waste bins and CCTV cameras to the bus stops
5. Create a safe, secure and sheltered off-street parking lot in the empty space across from Ramesh Hospital
6. Addition of parking payment meters instituting paid, time-limited parking on one side of Siddhartha College Road and one side of ITI Road
7. Add wide, well maintained, unobstructed footpaths to both sides (or at least to the south side) of Siddhartha College Road and both sides of ITI Road
8. Add street amenities such as waste bins, benches and greenery to the footpaths on Siddhartha College Road and ITI Road
9. Establish safe and sheltered auto rickshaw stands adjacent to the bus stops on KGH Up Road and KGH Down Road to smooth traffic and eliminate encroachment of stopped auto rickshaws on roads and footpaths.
10. Addition of speed bumps on the approach to each pedestrian crossing
11. Add a dedicated cycle lane with bollards separating it from cars on Siddhartha College Road and ITI Road. Ensure the cycle lanes are connected and continuous between the two stretches.
12. Increased bus frequency for routes servicing the CAZ
13. Increased bus routes coming from various areas of the city servicing the CAZ

Using AI we developed visualisations of what the CAZ could look like with some of the above interventions implemented.

Figure 43: Addition of footpath and pedestrian crossing on Siddhartha College Road



Figure 44: Improved footpath and regulated, paid parking on Siddhartha College Road

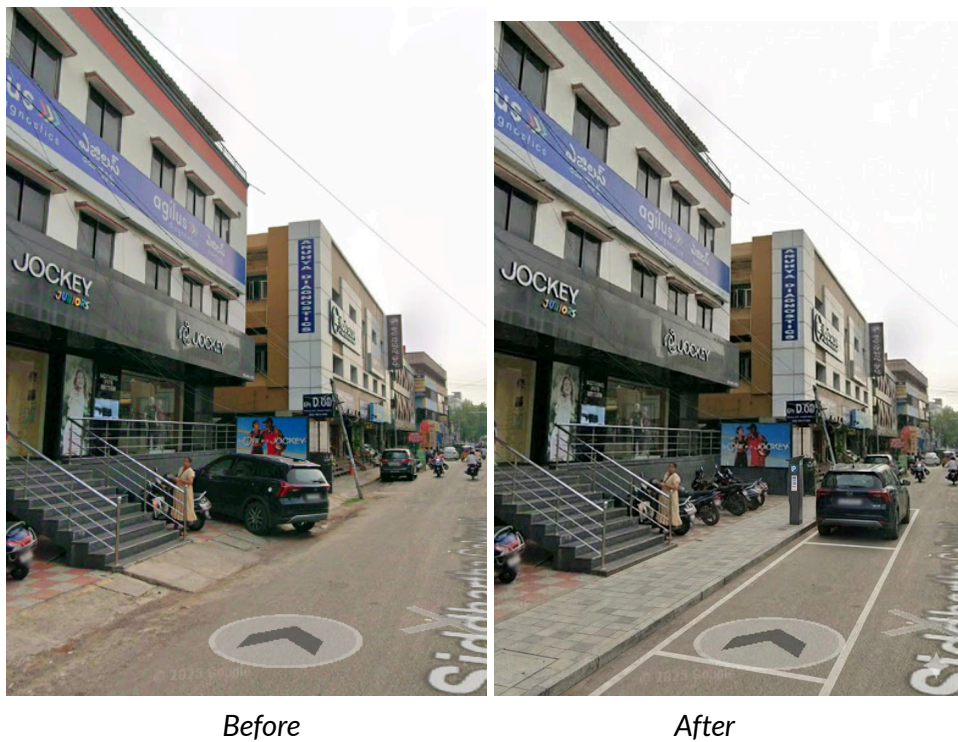


Figure 45: Addition of an auto stand on Siddhartha College Road



Before

After

Figure 46: Addition of footpaths and pedestrian crossing on ITI Road



Before

After

Figure 47: Addition of footpaths and pedestrian crossing on ITI Road



Before

After

Figure 48: Development of hospital parking lot in the space across from Ramesh Hospital



Box 3: Nature-Based Solutions

Nature-based solutions are another type of air pollution control measure that can contribute to reductions of pollutant concentrations, locally. Examples of Nature-based solutions are:

- Vertical gardens on street poles and walls: Effectively lower concentrations of airborne pollutants such as O₃, NO₂, SO₂, PM_{2.5} and PM₁₀.
- Miyawaki Forests at junctions: Dense, native plant forests created using the Miyawaki method can absorb CO₂ and filter airborne pollutants.
- Trees and pergolas: Create cool, shaded areas, increasing walkability.

Our technical partners, TERI, are working on plans for implementing Nature-based solutions in the CAZs in Visakhapatnam and Vijayawada.

Box 4: Financing Clean Air Zones - National CAZ Workshop Takeaways

A key aspect of being able to implement the recommended control measures within Clean Air Zones is having the available funds. One session of our National CAZ Workshop was dedicated to Financing Clean Air Zones and more generally, Climate Finance. While the capital costs of CAZ are not very high, they generally still exceed city budgets. Further, there is not a lot of funding available from development finance institutions for air quality improvement projects because they don't produce direct revenue. As well, for ULBs to raise loans, they need to obtain a particular rating. Many ULBs are not even rated and many have low ratings because of a lack of financial discipline to repay corporate loans or green debts in a timely manner. Some key takeaways for ULBs to consider are:

- Cities should consider innovative financing mechanisms to direct funds towards clean air. Holistic, systems-level projects with many co-benefits, one of which being clean air, could be a good strategy.
- Cities can augment their own revenue through property taxes. To do this, they need to better use data that is available to them, like discom data, to determine who needs to pay more. Cities should take a holistic view on increasing revenue collection and utilization of revenue.

- Municipal capacity needs to be built for better fund utilization. Under NCAP, fund utilization was low in initial years because cities did not know what to use the money for since the scheme was new.
- Cities need to uncomplicate governance structures. Time is lost in every added layer of fund allocation. Money can be pooled at the department level and then disbursed to municipalities.

Conclusion

This report explores the results of perception surveys conducted on citizens in Visakhapatnam and Vijayawada, as well as insights gathered from other stakeholder engagements such as the National CAZ Workshop, to distill targeted, hyper-local recommendations for control measures to improve air quality within the CAZ. The purpose of this study was to ensure that citizens and key stakeholders have their voices heard and their feedback integrated into the final CAZ implementation plan so that CAZ measures can best serve the local communities.

The key findings of the surveys were that the majority of private 2-wheeler vehicle users reported that they would be willing to switch to using zero-emissions modes like walking and cycling for short trips if area improvements, such as improvements to pedestrian crossings and footpaths, are made. Private vehicle users are willing to pay for on-street and off-street parking, and pricing and availability of parking spaces can be used to regulate demand from private vehicle users. Finally, there is a need for improved bus stops and in Vijayawada, particularly, improved bus frequency and connectivity. The improvement of walking and cycling infrastructure can help solve the first/last mile problem.

Next steps for this work involve ULBs creating financing plans for CAZ implementation and then starting to implement recommendations in a phased, organised manner.

Appendix

Sample Questionnaire - Visakhapatnam

General Questions

1. Where do you live? (Short answer)
2. How often do you visit this area?
 - a. Never
 - b. Occasionally/rarely
 - c. Frequently (at least weekly)

If never or rarely is chosen, do not continue with the rest of the survey
3. For what purpose do you primarily visit this area?
 - a. Recreation
 - b. Work
 - c. School
 - d. Place of residence
 - e. Other: _____
4. What is your main mode of travel to access this area?
 - a. Public bus
 - b. Auto rickshaw
 - c. Company/university/school bus
 - d. Taxi
 - e. Car (passenger with driver)
 - f. Car (passenger in carpool)
 - g. Motorcycle / Scooty
 - h. Bicycle
 - i. Walk
 - j. Other: _____
5. Do you feel you are affected by poor air quality?
 - a. Yes
 - b. No
 - c. Not sure
6. Have you or your family members experienced any health conditions related to air quality (e.g., respiratory issues, eye irritation)?
 - a. Yes
 - b. No
 - c. Not sure
7. The city plans to introduce measures such as Transport enhancement, Parking solutions, Area improvement (addition of pedestrian crossing, increased green-cover etc.) to develop this stretch as a Clean Air Zone. In your opinion, will this help improve air quality and public health?
 - a. Yes
 - b. No
 - c. Not sure

Public transport questions

8. In order for you to use public transport more, what improvements need to be made to the public transportation within the CAZ? (Select top 3 choices)

- a. Increased frequency
- b. Increased connectivity (reduction of last mile distances)
- c. Price reduction
- d. More accessible bus stops (clean, shade provided, seating etc.)
- e. Better maintained vehicles (i.e. increased cleanliness)
- f. Implementation of interventions to increase safety for women and gender minorities
- g. Not applicable - I will not use public transit
- h. Other: _____

Area improvement questions

9. What provisions would encourage you to make more of your trips by active transportation (walking / cycling) to/from or within the CAZ? (Choose up to 3)
 - a. Improved footpaths (more shade, fewer obstructions, better lighting, wider, better maintenance, more footpaths)
 - b. Improved pedestrian crossings (more crossings, safer crossings, more time to cross, higher frequency of crossing opportunities)
 - c. Provision of cycle lanes (safe and connected cycle lanes)
 - d. Increased compliance of vehicles to traffic and parking rules
 - e. Street amenities (benches, water fountains, waste bins, public toilets, guardrails, planters etc.)
 - f. No improvement needed
 - g. Nothing would encourage me to walk more often
 - h. Other: _____
10. Is there any specific area of the road that you would most like to see improved pedestrian infrastructure? (Select top choice)
 - a. **Stretch 1:** KGH Up road- Jagadamba center to KGH Down road through Med Plus
 - b. **Stretch 2:** KGH Down road - Collector's office junction to KGH OP gate
 - c. **Stretch 3:** KGH Down road - KGH OP gate to Lepakshi store
 - d. **Stretch 4:** Kotha road - Lepakshi store to Jagadamba center
 - e. Other: _____

Demographic questions

11. What is your sex?
 - a. Male
 - b. Female
 - c. Other
 - d. Prefer not to say
12. What is your age group?
 - a. 18-30 years
 - b. 31-45 years
 - c. 46-60 years
 - d. Above 60 years
13. What is your occupation?
 - a. Regular wage/salary earner
 - b. Self-employed (in agriculture or non-agriculture)

- c. Casual labor (agriculture or non-agriculture)
 - d. Unpaid work (agriculture or non-agriculture)
 - e. Student
 - f. I do not work outside the home
 - g. Other (please specify): _____
14. Which of the following does your household own? (select all that apply)
- a. Television
 - b. Electric Fan
 - c. Air Conditioner
 - d. Bicycle
 - e. Motorised Two-wheeler
 - f. Washing Machine
 - g. Laptop/Computer
 - h. Car/Four-wheeler/Six or Eight wheeler
15. Would you be willing to be contacted in the future to participate in a more in-depth interview or focus group discussion on these topics?
- a. Yes
 - b. No
16. If yes, what is your contact information?

Questionnaire for Medical Students

1. How do you travel to and from the hospital?
- a. Walking
 - b. Public transportation
 - c. Dedicated student bus
 - d. Auto rickshaw
 - e. Private 2-wheeler
 - f. Private 4-wheeler
 - g. Carpool
 - h. Rideshare service (i.e. Uber, Ola)
 - i. Cycle
 - j. Other: _____

If you use a private vehicle to commute to college/school:

2. Where do you park your vehicle?
- a. **Stretch 1:** KGH Up road- Jagadamba center to KGH Down road through Med Plus
 - b. **Stretch 2:** KGH Down road - Collector's office junction to KGH OP gate
 - c. **Stretch 3:** KGH Down road - KGH OP gate to Lepakshi store
 - d. **Stretch 4:** Kotha road - Lepakshi store to Jagadamba center
 - e. Designated area inside the hospital campus
 - f. Multi-level car park facility
 - g. Other: _____

If you use a private vehicle, auto rickshaw or rideshare to commute to college/school:

3. In order for you to use public transport more (including the dedicated student bus), what improvements need to be made to the public transportation within the CAZ? (Select top 3 choices)
 - a. Increased frequency
 - b. Increased connectivity (reduction of last mile distances)
 - c. Price reduction
 - d. More accessible bus stops (clean, shade provided, seating etc.)
 - e. Better maintained vehicles (i.e. increased cleanliness)
 - f. Implementation of interventions to increase safety for women and gender minorities
 - g. Not applicable - I will not use public transit
 - h. Other: _____
4. If we enhance public transportation to your college, how likely are you to use it?
 - a. Very unlikely
 - b. Unlikely
 - c. Likely
 - d. Very Likely
 - e. Not sure
5. If unlikely, what are the reasons for not using public transport? (select all that apply)
 - a. Cost
 - b. Other modes are more comfortable
 - c. Poor last mile connectivity
 - d. Driving is faster
 - e. Long wait times
 - f. Other: _____

Questionnaire for Private Vehicle Users

Questions for respondents who access the CAZ by private vehicle (not including students who use private vehicles to commute to college)

1. Where do you park your private vehicle when you come to this area?
 - a. **Stretch 1:** KGH Up road- Jagadamba center to KGH Down road through Med Plus
 - b. **Stretch 2:** KGH Down road - Collector's office junction to KGH OP gate
 - c. **Stretch 3:** KGH Down road - KGH OP gate to Lepakshi store
 - d. **Stretch 4:** Kotha road - Lepakshi store to Jagadamba center
 - e. Other: _____
2. What recommendations do you have for how to improve parking facilities in this neighbourhood? (Rank these options in order of priority)
 - a. Paid on-street parking spaces available
 - b. Time limits on parking spaces
 - c. Improved regulation of parking
 - d. Designated off-street parking (paid)
 - e. Other: _____
3. Do you currently use any paid parking services in this area?
 - a. Yes

- b. No
- 4. Under what conditions would you use a paid off-street parking facility? (choose top 2)
 - a. Area is safe and secure
 - b. You are easily able to find a parking spot
 - c. There is a parking lot attendant to facilitate smooth entry/exit of parking spots
 - d. Area has shelter/shade
 - e. I would not use a paid parking facility
 - f. Other: _____
- 5. Do you feel you would reduce your usage of private vehicles to access this area if the recommended improvements (q. 8 of general survey) to public transportation provisions in the area were made?
 - a. Yes
 - b. No
 - c. Not sure

If the private vehicle is a two-wheeler:

- 6. What is the origin of your trip being made by two-wheeler? (*Ask respondent to give an area name and confirm area on a map*)
- 7. What is the destination of your trip being made by two-wheeler? (*Ask respondent to give an area name and confirm area on a map*)
- 8. If the city were to implement the recommendations to active transportation (walking/cycling) provisions you gave above (q. 9 of the general survey) would you be willing to make your shorter trips (<2 km) by active transport instead of by two-wheeler?

Questionnaire for Auto Rickshaw Drivers

- 1. What specific area do you use to park your auto within the CAZ?
 - a. **Stretch 1:** KGH Up road- Jagadamba center to KGH Down road through Med Plus
 - b. **Stretch 2:** KGH Down road - Collector's office junction to KGH OP gate
 - c. **Stretch 3:** KGH Down road - KGH OP gate to Lepakshi store
 - d. **Stretch 4:** Kotha road - Lepakshi store to Jagadamba center
 - e. Other: _____
 - f. None
- 2. On which stretches do you usually the pick-up customers? (select all that apply)
 - a. **Stretch 1:** KGH Up road- Jagadamba center to KGH Down road through Med Plus
 - b. **Stretch 2:** KGH Down road - Collector's office junction to KGH OP gate
 - c. **Stretch 3:** KGH Down road - KGH OP gate to Lepakshi store
 - d. **Stretch 4:** Kotha road - Lepakshi store to Jagadamba center
 - e. Other: _____
- 3. Under what conditions would you use a dedicated customer pick-up area (auto bay) for autos? (choose top 2)
 - a. Area is safe and secure
 - b. You are easily able to pick up customers from this location (i.e. easily accessible from KGH)
 - c. Area is near mass transit hubs (i.e. bus stops)
 - d. Area has access to restroom / hygiene facilities

- e. Area has shelter/shade
 - f. I would not use a dedicated customer pick-up area
 - g. Other: _____
4. Under what circumstances would you be willing to switch to an e-rickshaw? (Choose top two)
- a. Feasible financing of purchasing the rickshaw
 - b. Operations and maintenance costs that are competitive with regular rickshaws
 - c. Availability of charging infrastructure
 - d. Adequate passenger carrying capacity of the rickshaw
 - e. [Added “better range” to the instrument]
 - f. I would not switch to an e-rickshaw under any of these circumstances
 - g. Other: _____

Questionnaire for Local Business Owners

Including medical college students who take public transportation to the hospital.

1. Where do your customers currently park their vehicles to visit your business? (short answer)
2. What type of goods vehicles visit your business for loading and unloading of materials/ stock etc?
 - a. Light Commercial Vehicles (LCV) (Eg:Tata Ace)
 - b. Medium Commercial Vehicles (MCV) (Eg: Vans like Mahindra Bolero Pik-up)
 - c. Heavy Commercial Vehicles (HCV) (Eg; Trucks)
 - d. None
3. When, in the day, do the goods vehicles visit your business?
 - a. Morning (6am - 10am)
 - b. Mid-day (10am - 2pm)
 - c. Afternoon (2pm - 6pm)
 - d. Evening (6pm - 10 pm)
4. Where do these goods vehicles park during loading and unloading of materials? (short answer)
5. Do you provide parking facilities for your customers and commercial vehicles?
 - a. Yes
 - b. No
6. If you or your employees travel to work by private vehicle, what parking facilities do you use? (short answer)
7. Under what circumstances would you use dedicated parking facilities that are walking distance away from your business? (Choose top two)
 - a. Vehicles are safe and secure in that area
 - b. The area is easily accessible from my business
 - c. There is adequate parking space available there
 - d. It is free
 - e. I would not use dedicated parking facilities
 - f. Other: _____

Questionnaire for Current Bus Users

(For those who chose one of the bus options as their primary mode of travel to the CAZ)

1. What is the area where your trip originates? (short answer)
2. What is your destination within the CAZ?
 - a. **Stretch 1:** KGH Up road- Jagadamba center to KGH Down road through Med Plus
 - b. **Stretch 2:** KGH Down road - Collector's office junction to KGH OP gate
 - c. **Stretch 3:** KGH Down road - KGH OP gate to Lepakshi store
 - d. **Stretch 4:** Kotha road - Lepakshi store to Jagadamba center
 - e. Other: _____
3. How many buses do you have to take to complete your trip to your destination in the CAZ?
4. What is the distance from your home to the bus stop (first mile)?
 - a. Less than 500m
 - b. 500m - 1km
 - c. 1km - 3 km
 - d. More than 3 km
5. What is the distance from the bus stop to your destination in the CAZ (last mile)?
 - a. Less than 500m
 - b. 500m - 1km
 - c. 1km - 3 km
 - d. More than 3 km
6. What modes of transportation do you use to travel to/from the bus stop to your destination/home? (select all that apply)
 - a. Auto rickshaw
 - b. Taxi
 - c. Car (passenger with driver)
 - d. Car (passenger in carpool)
 - e. Motorcycle / Scooty
 - f. Bicycle
 - g. Walk
 - h. Other: _____
7. On average, how long do you have to wait to catch the bus?
 - a. Less than 5 mins
 - b. 5-10 minutes
 - c. 10-20 minutes
 - d. 20-30 minutes
 - e. Over 30 minutes