Steps to Sustainability

THE IMPACTS OF NEW FOOTPATHS ON MODE CHOICE IN CHENNAI, INDIA

ITDP

EXECUTIVE SUMMARY

The best solutions are often the simplest. This study presents evidence that improved footpaths are a highly cost-effective means to mitigate greenhouse gas emissions (GHGs), improving public health, saving money for residents, and improving public safety in cities in lower- and middle-income countries (LMICs). To our knowledge, this is the first study to demonstrate this connection empirically. Using data collected in Chennai, India, in 2019, we found that between 9% and 29% of people walking on improved footpaths would have used a private motorized mode if the footpaths had not been improved. As a result, we estimate that between 4,200 tonnes and 12,000 tonnes of CO_2-equivalent greenhouse gas emissions are prevented annually thanks to the footpath improvements. This is equivalent to taking about 1,000 to 2,900 cars off the road for one year.

Since 2013, Chennai has dedicated significant resources to improving its streets for pedestrians. In 2014, the city became the first in India to adopt a nonmotorized transport (NMT) policy committing to allocate over half of its transport budget to pedestrian and bicycle infrastructure. Between 2013 and 2019, the city designed and built footpaths on more than 100 km of streets. To our knowledge, no previous studies have looked at the quantitative impacts of such footpath projects in LMICs. This study makes an important contribution to the literature by demonstrating the significant modal shift, climate, air quality, and other impacts of footpath infrastructure in LMICs.

From user intercept surveys, we found that many pedestrians shifted their trips to walking as a result of the new walking infrastructure—between 3% and 11% of footpath users would have used a private motor vehicle if the footpaths had not been built. By counting samples of the volume of pedestrians and extrapolating the results, we estimate that between 4,200 tonnes and 12,000 tonnes of GHG emissions are prevented annually because of the footpath improvements. Additionally, the footpaths reduce between 2.6 tonnes and 7.6 tonnes of GHGs per INR crore spent (22 to 63 tonnes per USD million spent). That makes the footpath improvements more cost-effective for reducing GHG emissions than metro projects.

The footpaths had many other benefits beyond their climate impact. By shifting away from motor vehicles, footpath users reduce between 150 kg and 680 kg of particulate matter less than 2.5 micrometers in diameter (PM2.5) annually, and their increased walking activity prevents about 340 deaths each year from noncommunicable diseases. Additionally, 95% of survey respondents reported feeling safer on the improved streets.

It is clear that investments in walking infrastructure have significant and tangible benefits in lower- or middle-income countries. These benefits accrue not only to pedestrians but to society at large. Constructing well-designed footpaths is an efficient way to shift city residents out of polluting vehicles, reduce thousands of tonnes of GHGs per year, and improve residents' and cities' well-being.

SUMMARY OF RESULTS IN IMPACT AREAS

AREA OF IMPACT	ESTIMATED VALUE FOR COMPLETED CHENNAI FOOTPATHS
CLIMATE Reduction in greenhouse gas emissions.	Between 4,200 and 12,000 tonnes of CO_2-equivalent emissions are prevented annually (equivalent to taking about 1,000 to 2,900 cars off the road for one year).
EQUITY The extent to which the benefits of the system are shared with marginalized members of society. This indicator is measured both individually and as a component of other indicators.	86% of trips that would not have been made without the improvements were made by lower-income and nonearning people. 6% of women would not have taken their trip if the footpaths had not been improved, compared to only 1% of men.
ACCESS Number of people within a walkable distance of mobility improvements.	1.2 million Chennaiites live within a 300 m walkable network distance of the improved footpaths (11% of the population).
SAFETY Perception of safety improvement.	95% of respondents believe that the streets are safer overall, in terms of both personal security and road safety. 78% said that the streets are now safer for children, and 81% said that the streets are now safer after 10 pm since the improvements.
HEALTH Health benefits from improved air quality and increased physical activity.	Reduced vehicle activity results in a reduction of PM2.5 emissions of between 150 and 680 kg annually. Increased physical activity prevented 340 premature deaths in 2019.
ECONOMY The cost savings enjoyed by footpath users.	Chennaiites who shift to walking from another mode save a total of 2.9 INR billion (~290 crore) each year (35 USD million).[1]

All results listed in this section have been rounded to two significant figures after calculation.

1 Monetary values throughout have been adjusted for inflation to 2024 values.

ACKNOWLEDGMENTS

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COVER PHOTO:
Photo at Pedestrian Plaza, Chennai.
SOURCE: Elements Creative for Smart Cities Mission and ITDP India

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STEPS TO SUSTAINABILITY THE IMPACTS OF NEW FOOTPATHS ON MODE CHOICE IN CHENNAI, INDIA 2024

FOREWORD BY WALK21 CEO BROWNEN THORNTON

Walking is everywhere and for everyone. If it wasn't, our communities and our transport system would literally grind to a halt. But that doesn't automatically ensure there is a budget line to invest in enabling people to walk.

The case for investing in infrastructure for walking is clear, especially when the goals include reductions in road injuries and deaths, mortality from non-communicable diseases, air pollution and congestion. More positively, investment in walking is also shown to deliver improvements in gender equity and social, economic and political inclusion and makes the whole transport system more affordable and sustainable.

This study in Chennai makes the connections between these benefits at a local level and demonstrates how a comprehensive approach to assessing the impact of walking infrastructure can provide a practical foundation for better decision making and broader investment priorities. It is an important step forward, and I hope from this local foundation, we can scale for more consistent recognition of the return on investment in walking and bring changes to our appraisal systems overall.

The report includes the results of talking directly to people on foot, combined with a robust evaluation of the externalities that both impact and are impacted by their decision to walk. The hard numbers calculated for climate, air quality, and safety impacts make a compelling case for further investment.

I urge you to consider how this evaluation can be applied to other neighbourhoods across Asia and around the globe. I hope that you will be inspired to consider its potential wherever you live or work, to do more for people walking. They are everywhere, but they need your help to be visible and valued in the setting of transport priorities and investment decisions.

WALK21

Bronwen Thornton
CEO
Walk21 Foundation

INTRODUCTORY MESSAGE FROM ASWATHY DILIP

It gives me immense pride and satisfaction to present this comprehensive report on the impact of pedestrian transformation projects in Chennai. This report underscores the significant strides made by the city of Chennai in enhancing urban mobility, fostering environmental sustainability, and improving the quality of life for our citizens through well-designed pedestrian infrastructure.

In an era where cities around the globe grapple with the twin challenges of urbanization and climate change, the solutions often lie in the simplest of interventions. This study provides compelling evidence that improved footpaths are a remarkably cost-effective measure for mitigating greenhouse gas emissions, enhancing public health, saving money for residents, and bolstering public safety.

This report is a testament to the power of strategic urban planning and the importance of investing in non-motorized transport infrastructure. The footpath improvements not only provide a safe and convenient means for pedestrians but also contribute significantly to the broader goals of environmental sustainability and public health. Our experience in Chennai serves as a valuable case study for other cities in LMICs, demonstrating that with the right policies and investments, urban environments can be transformed to support healthier, safer, and more sustainable lifestyles.

I extend my heartfelt gratitude to all the stakeholders, partners, and team members whose unwavering support and dedication have been pivotal in realizing these projects in Chennai and inspired other cities in the country. As we move forward, we remain committed to continuing our efforts in transforming Chennai into a model city for sustainable urban mobility and environmental stewardship.

Aswathy Dilip
Managing Director
ITDP India

INTRODUCTION

This report evaluates the impacts of over 120 km of pedestrian infrastructure in Chennai that was designed and built between 2013 and 2019. It is based on insights from pedestrian surveys and pedestrian counts conducted in 2019, as well as geospatial analysis. It quantitatively measures the benefits that this sustainable transportation infrastructure has had for the environment, the health and safety of residents, the city's economy, residents' access to mobility, and social equity. It is, to our knowledge, the first research that quantitatively measures how improved footpaths can cause people to shift away from private motorized modes of transport, and subsequently reduce greenhouse gas emissions, in a city in a low-income country.

ITDP PROJECT EVALUATIONS

The Institute for Transportation and Development Policy (ITDP) works with cities worldwide to create healthy and livable communities through high-quality public transport, including e-mobility, safe spaces for walking and cycling, traffic-reduction mechanisms, and people-centered policies. Evidence shows that shifting from single-occupancy private cars to high-capacity public transport and zero-carbon modes such as walking and cycling would drastically cut emissions, reduce traffic congestion, and better connect low-income communities to the opportunities and resources they need.[2]

In 2019, ITDP conducted an in-depth evaluation of the footpath project in Chennai. We intend these results to guide the design of future footpath projects, and we plan to incorporate the results into our development of tools to predict the impacts of footpath projects around the world.

The data was collected in 2019 and originally planned for publication in 2020. However, publication was delayed by the COVID-19 pandemic, because these findings seemed less relevant to policymaking during the pandemic lockdowns. Since the pandemic has subsided, ITDP India has conducted several studies evaluating the quality of footpaths, including a forthcoming situational analysis of Chennai's streets.[3] However, these studies have not attempted to identify a quantitative link with modal shift. These more recent studies illustrate that pedestrian activity in Indian cities has generally returned to a status comparable to that before the pandemic, meriting the publication of the present findings.

SOURCE: ITDP India and Elements Creative for Smart Cities Mission

2 Fulton and Reich, *The Compact City Scenario: Electrified* (2021), https://itdp.org/wp-content/uploads/2021/12/EN_Compact-Cities-REPORT_SINGLEPAGE-1.pdf.

3 ITDP India, *Pune's Walk & Cycle Analysis* (2022), https://itdp.in/wp-content/uploads/2022/12/Pune-IA-report_final_Ped-day.pdf; ITDP India, *Pune's Sustainable Transport Journey* (2021), https://itdp.in/wp-content/uploads/2021/02/Punes-Sustainable-Transport-Journey.pdf.


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Veeraswamy
RESTAURANT

CHENNAI'S STREETS FOR PEOPLE JOURNEY

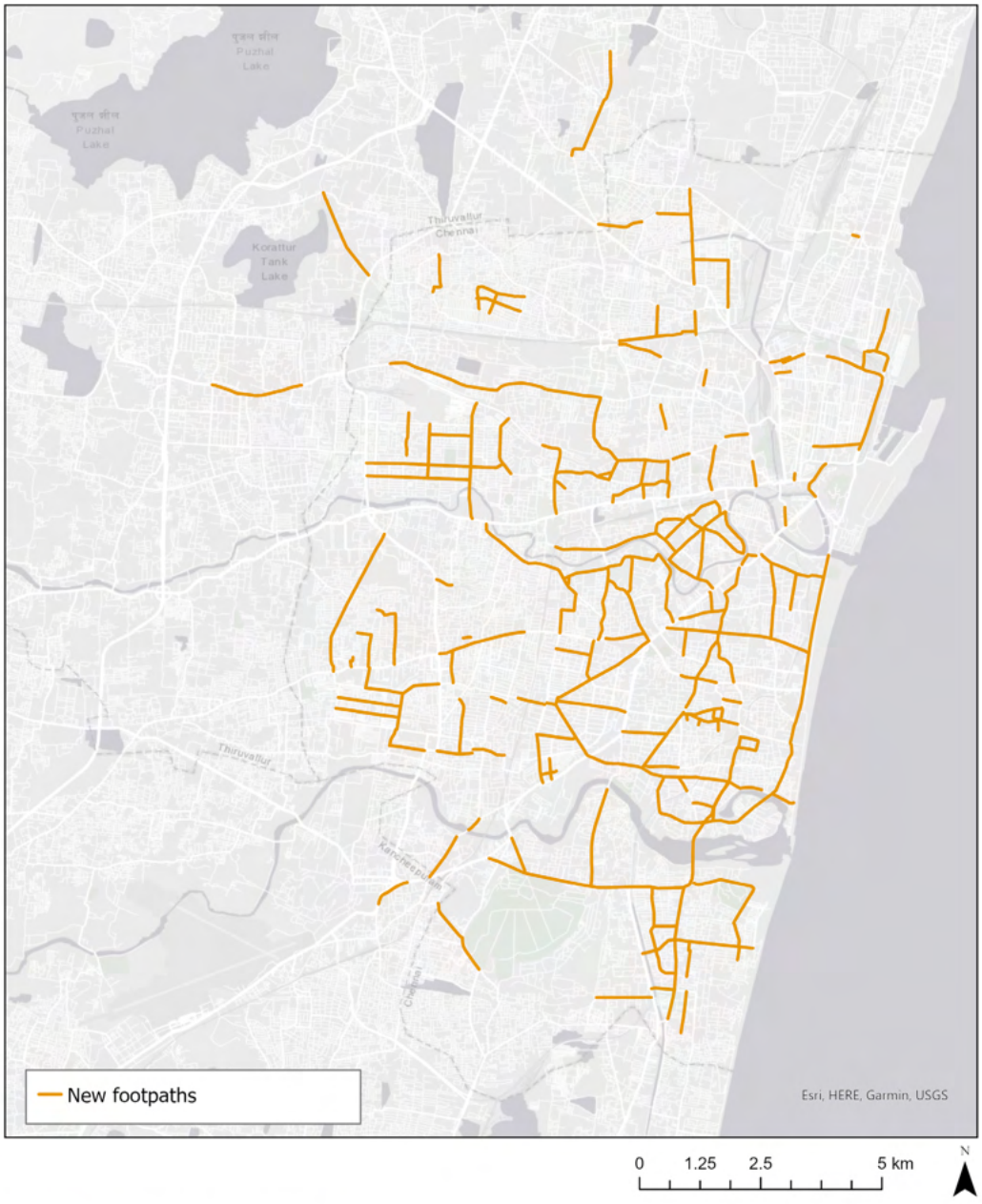
Since 2013, Chennai has been transforming its streets for the safety, comfort, and inclusivity of its users. Previously, footpaths were largely nonexistent except for a few locations with very poor-quality footpaths. In 2014, the city adopted the Non-Motorised Transport (NMT) Policy to dedicate 60 percent of its transportation budget towards NMT.[4] Chennai was the first Indian city to adopt a policy of this kind. Since then, with the support of the ITDP India program, the city has:

- Transformed over 100 km of the city's streets for more accessible and equitable mobility. The project has improved access to roughly 300 bus stops and more than 60 schools.
- Inaugurated the Pondy Bazaar Pedestrian Plaza as a model "people-friendly" public space, incorporating underground utilities and abundant seating.[5]
- Initiated the scale-up of the street transformation works across six neighborhoods.
- Built the capacity of municipal engineers through study tours, workshops, and formal training programs.
- Adopted the Complete Street Guidelines to inform all future street design projects.[6]
- Launched the Car-Free Sundays/Happy Streets program to promote the idea of celebrating streets as public spaces.7
- Engaged the public in a participatory planning process through several tactical urbanism initiatives and stakeholder consultations.

This research analyzes the impacts of the footpath transformations that were completed until mid-2019, with the goal of understanding the possible impacts of improving and expanding footpath networks in Chennai and other Indian cities.

4 Corporation of Chennai, *Non-Motorised Transport Policy* (2014), https://itdp.in/wp-content/uploads/2014/10/NMT-Policy.pdf.
5 Aishwarya Soni, "Making Places for People: The Launch of the Pondy Bazaar Pedestrian Plaza" (2019), https://www.itdp.in/making-places-for-people-the-launch-of-the-pondy-bazaar-pedestrian-plaza/.
6 Greater Chennai Corporation, *Complete Street Design Guidelines* (2021), https://cscl.co.in/publication.
7 ITDP India, "Carefree on Car-free Sundays: Citizens take to city streets for fun and revelry" (2018), https://itdp.in/carefree-on-car-free-sundays-citizens-take-to-city-streets-for-fun-and-revelry/.

NEW FOOTPATHS IN CHENNAI, 2013-2019



Source:
Infrastructure Works
(December 2019)

WHY EVALUATE FOOTPATHS?

Walking, which includes the use of wheelchairs and mobility aids, strollers, and prams, is the fundamental mode of sustainable transportation: It is free, zero-carbon, and efficient (if properly invested in), and it requires no extra equipment. In dense, mixed-use cities, walking provides an alternative to car use for short trips to attend to daily needs.

Researchers and urban planners have asserted that a safe, comfortable walking environment is an effective way to prevent the expansion of car ownership and car use, and thereby to reduce the environmental impacts of transportation.[9] The literature also demonstrates that pedestrian infrastructure catalyzes improvements in public transit by making it easier for people to access transit.[10] However, the impacts of adding or improving walking infrastructure have not been studied comprehensively in the Global South. While almost all footpath evaluations are based in developed cities in the Global North, cities in the Global South often already have higher levels of walking for transportation (as opposed to recreation) and greater potential for preventing the growth of widespread car ownership.[11]

Most footpath impact evaluations focus on changes in time spent walking and the resulting health impacts.[12] Less research exists on other benefits, such as reductions in GHGs and improvements in air quality and safety. In 2019, UN Environment estimated the climate impacts of nonmotorized transport projects and policies in Nairobi and Cape Town; however, the estimations were based on predictions of impacts on travel activity rather than on-the-ground data.[13] A 2018 study in New Zealand estimated that improvements to 60 km of walking and cycling infrastructure in two cities reduced GHG emissions by 1,150 tonnes CO_2-equivalent per year, but this included both walking and cycling impacts.[14] The impacts that are the least researched and reported are typically qualitative, such as equity impacts.

In this study, we aim to identify the presence or absence of an empirical relationship between footpath improvements and reduced travel by personal motorized modes. We also include footpath impacts that are rarely evaluated at a project level, such as equity and access. However, the primary purpose of this evaluation is to contribute to the field of research by providing quantitative data about footpath infrastructure's impacts on travel behavior in a city in the Global South.

By evaluating the impacts of footpaths in Chennai, we hope not only to provide knowledge on the benefits of improved walking infrastructure in the city but also to support evaluation of footpath improvements in other major cities in low- and middle-income countries. We hope that this knowledge will demonstrate the benefits of walking infrastructure for the climate, but also for the economy, public health, safety, social inclusion, equity, and improved mobility.

Pedestrians enjoy a concert in Pedestrian Plaza, Chennai. Source: Elements Creative for Smart Cities Mission and ITDP India

8 Quoted in J. Speck, "Walkable City" (2012).
9 Eva Heinen et. al, "Changes in mode of travel to work: a natural experimental study of new transport infrastructure" (Int J Behav Nutr Phys Act, vol. 12, no. 81, 2015), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4496849/
10 ITDP and the World Bank, *The Path Less Travelled: Scaling Up Active Mobility to Capture Economic and Climate Benefits* (2023), https://itdp.org/wp-content/uploads/2023/11/10036-Critical-Report-for-COP28_V3.pdf.
11 Anna Goodman, Shannon Sahlqvist, David Ogilvie, on behalf of the iConnect Consortium "New Walking and Cycling Routes and Increased Physical Activity: One- and 2-Year Findings From the UK iConnect Study", American Journal of Public Health 104, no. 9 (September 1, 2014): pp. E38-e46, https://doi.org/10.2105/AJPH.2014.302059; Chapman et al., "A Cost Benefit Analysis of an Active Travel Intervention with Health and Carbon Emission Reduction Benefits," *International Journal of Environmental Research and Public Health* 15, no. 962 (2018): pp. 1-10, doi:10.3390/ijerph15050962.; Sean Cooke, Carly Koinange and Mark Zuidgeest, "Calculating the potential climate value of Non-Motorised Transport projects in African Cities" (UN Environment, 2019), https://www.sustmob.org/PDFs/ClimateValue_NMT.pdf
12 Goodman, Sahlqvist, and Ogilvie 2014.
13 Cooke, Koinange and Zuidgeest 2019.
14 Chapman et. al 2018.

Pondy Bazaar before (left) and after adding new footpaths
Source: ITDP India

Pantheon Road before (left) and after adding new footpaths. Pantheon Road was not a case study street in the current evaluation.
Source: ITDP India

Second Avenue Besant Nagar before (left) and after adding new footpaths. Second Avenue Besant Nagar was not a case study street in the current evaluation.
Source: ITDP India

PROJECT EVALUATION METHODOLOGY

We evaluated the completed street transformation across six areas of impact: climate, equity, access, safety, health, and economy. We used user surveys, user counts, and geospatial analysis to provide both qualitative and quantitative information about the impacts of the new paths. The user surveys provided us with in-depth information about the demographics, perceptions, and travel behaviors of a sample of pedestrians on the footpaths. The user counts provided a basis for estimating the total daily number of pedestrians using the footpaths and demographic information, while the geospatial data let us calculate the number of people living within a given radius of the footpaths. By presenting both qualitative and quantitative information, we hope to present a complete picture of how Chennaiites have benefited from these improvements in their city.

STUDY LOCATIONS

Four streets with distinct street typologies were chosen for the user surveys and pedestrian counts:
1. Pondy Bazaar Pedestrian Plaza
2. Anna Nagar 2nd Avenue
3. CSIR Road
4. Harrington Road

TABLE 1. STUDY LOCATION CHARACTERISTICS

Street Name	Length (m)	Neighborhood	Character	Cost of Improvements
Pondy Bazaar Pedestrian Plaza—Sir Thyagaraya Road	1,450	T. Nagar	Commercial, institutional	51 INR Cr (6.1 USD million)
Harrington Road	800	Chetpet	Residential, institutional	8–10 INR Cr (0.96 USD million–1.2 USD million)
CSIR Road	1,350	Tharamani	Institutional	3.5–8.6 INR Cr (0.41 USD million–1.0 USD million), estimated
Anna Nagar 2nd Avenue	1,230	Anna Nagar	Residential, commercial	3.1–13 INR Cr (0.38 USD million–1.5 USD million), estimated

USER SURVEYS

The survey of pedestrians using the footpaths was the foundation of our evaluation to analyze the project's impacts. It was the most intensive element of data collection, and it allowed pedestrians to share their perspectives on the footpath improvements.

Delivery of the survey took place from November 20 to November 29, 2019, using the *KoBoToolbox* smartphone application. In total, 424 footpath users responded to the survey. Surveyors intentionally tried to speak with a sample of roughly half women and half men. This is, therefore, not a representative sample of all footpath users, but it provides important perspectives from a large number of users of each gender. In the future, the study could be improved by using a larger sample size; an estimated 14,700 pedestrians used the footpaths studied each day, meaning that the sample size of 424 was limited.

SOURCE: ITDP India and Elements Creative for Smart Cities Mission


PICK - UP AND DROP - OFF ONLY
NO PARKING
10

The survey consisted of 21 questions, of which 9 dealt with travel behavior, 6 with user perception, and 6 with user demographics. The questions about travel behavior asked the user to describe their trip, including the mode they used (Stated Preference) and the time and expense required. It also asked about the mode they would use as an alternative if the footpaths were not available. The survey form can be found in Appendix C.

A limitation of the methodology is that users were not asked to provide a detailed, leg-by-leg itinerary of their real or hypothetical substitute trip. Because of this, some of the original survey responses may state that the trip mode was only walking, when it was actually a combination of walking and a different mode. For this reason, we also made a conservative estimate of the number of footpath users shifting from a different mode to walking as a result of the improved footpaths. In this scenario, we assumed that a respondent only represented an actual modal shift from a different mode to walking when they: 1) reported a modal shift, and 2) either reported a current trip cost of zero or a current trip cost of less than half of the hypothetical trip cost.

When calculating climate and air pollution impacts, both this conservative modal shift estimate and the originally reported values are used to present a range of results. For all other impact categories, only the originally reported values are used. For more information on the calculation of mode shift, see Appendix A, *Calculation of Vehicle-Kilometers Traveled*.

TABLE 2. DEMOGRAPHICS OF SURVEY RESPONDENTS

		Number of Respondents	Percent of Respondents
Location Where Intercepted	Pondy Bazaar	100	24
	Harrington Road	121	29
	CSIR Road	103	24
	Anna Nagar 2nd Avenue	100	24
	Total	424	100
Gender	Women	205	48
	Men	218	51
	No response	1	0
	Total	424	100
Age	10 to 25	112	26
	26 to 50	227	54
	51 to 80	82	19
	> 80	1	0
	No response	2	0
	Total	424	100
Ability	Has a disability	7	2
	Does not have a disability	414	98
	No response	3	1
	Total	424	100

Monthly Income	Non-earning	134	32
	INR 0 to 1,900 (USD $0 to $23)	16	4
	INR 1,900 to 6,400 (USD $23 to $77)	17	4
	INR 6,400 to 12,800 (USD $77 to to $153)	29	7
	INR 12,800 to 25,500 (USD $153 to $304)	63	15
	INR 25,500 to 38,200 (USD $304 to $455)	47	11
	INR 38,200 to 63,800 (USD $455 to $760)	41	10
	> INR 63,800 (> USD $760)	48	11
	No response	29	7
	Total	424	100
Profession	Business	24	6
	Daily wage worker	25	6
	Domestic help	25	6
	Homemaker	42	10
	Not employed	14	3
	Other	3	1
	Retired	20	5
	Salaried employee	196	46
	Student	72	17
	No response	3	1
	Total	424	100
Private Vehicle Ownership	Family does not own a private car or two-wheeler	121	29
	Family owns a private car or two-wheeler	296	70
	No response	7	2
	Total	424	100

USER COUNTS

Pedestrian counts were recorded for one hour during morning and evening peak periods at the four survey locations. For Pondy Bazaar Pedestrian Plaza, surveys and counts were taken at the weekend; the other three streets were surveyed on weekdays.

GEOSPATIAL ANALYSIS

We used the NetworkX (version 3.2) and OSMNX (version 1.7.0) packages in Python (version 3.10.9) to map the areas within a 300 m walking distance of the footpaths.[15] This calculation of walking distance is made along public roads and paths, using a walkable network buffer.

We then used the European Commission's 2020 Global Human Settlement Layer to estimate the average population density within these areas.[16] The population density was multiplied by the total buffer area to find the number of people near the footpaths.

15 People near footpaths are defined by a radius of 300 m, using pedestrian network walking distance. The radius was agreed upon by ITDP's Walking and Cycling Community of Practice.

16 Schiavina M., Freire S., Carioli A., MacManus K., *GHS-POP R2023A - GHS population grid multitemporal (1975-2030)* (European Commission, Joint Research Centre (JRC), 2023), doi:10.2905/2FF68A52-5B5B-4A22-8F40-C41DA8332CFE.

RESULTS OF THE STUDY

CLIMATE

When people travel by walking rather than motorized modes, they produce fewer carbon emissions. Our user counts and intercept surveys allowed us to calculate the number of trips on the footpaths that had shifted from different modes of transportation and therefore the annual greenhouse gas emissions prevented. The average volume of pedestrians across all of the streets was 14,670 trips per day (see Table 3). Notably, Pondy Bazaar Pedestrian Plaza had more than twice the number of trips per hour and per day than the other locations, suggesting that the significant investment and improvements in this site increased its use by pedestrians.

TABLE 3. USER COUNTS BY LOCATION

Street Name	Neighborhood	Character	Cost of Improvements	Trips/Hour (Mapped for a Peak Hour)	Estimated Trips/Day
Pondy Bazaar Pedestrian Plaza—Sir Thyagaraya Road	T. Nagar	Commercial, institutional	51 INR Cr (6.1 USD million)	2,960	29,600
Harrington Road	Chetpet	Residential, institutional	8–10 INR Cr (0.96 USD million–1.2 USD million)	1,024	10,240
CSIR Road	Tharamani	Institutional	3.5–8.6 INR Cr (0.41 USD million–1.0 USD million)	1,008	10,080
Anna Nagar 2nd Avenue	Anna Nagar	Residential, commercial	3.1–13 INR Cr (0.38 USD million–1.5 USD million)	876	8,760
Average				1,467	14,670
Average (without Pondy Bazaar)				969	9,690

In stated preference surveys, respondents reported the mode of transport that they would have used to make their trip if the roads were not improved or were nonexistent. We found that between 9% and 29% of respondents shifted their trip from a motorized mode, including 3% to 11% who shifted from private cars or two-wheelers (see Tables 4–5). These results are comparable to the modal shifts previously measured from protected bicycle lane projects in middle-income countries. In Bogotá and Guangzhou, 1.6% and 14.8% of protected bicycle lanes users surveyed, respectively, had shifted from private motor vehicles.[17] This suggests that well-designed footpaths, like protected bicycle lanes, are effective at getting people out of private vehicles to use other modes of transportation.

Based on the number of people who shifted their trips from motorized modes to walking, we estimate that Chennai's investment in footpaths reduced the city's greenhouse gas emissions by a minimum of 4,200 tonnes and a maximum of 12,000 tonnes of CO_2-equivalent annually. This is comparable to taking about 1,000 to 2,900 cars off the road for one year.[18]

Many footpath users had the option of moving around the city in a private car or two-wheeler but did not—indeed, 70% of respondents have access to a private motorized vehicle in their households. This suggests that high-quality pedestrian infrastructure makes walking attractive, even to those who can choose to drive, resulting in significant climate benefits.

SOURCE: ITDP India and Elements Creative for Smart Cities

17 D. Taylor Reich, *Protected Bicycle Lanes Protect the Climate* (ITDP, 2021), https://itdp.org/wp-content/uploads/2022/10/ITDP_Protected_Bicycle_Lanes_Protect_the_Climate.pdf.
18 Environmental Protection Agency, Greenhouse Gas Equivalencies Calculator (2024), https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.


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TABLE 4. ESTIMATED GREENHOUSE GAS EMISSIONS REDUCTIONS FROM MINIMUM MODAL SHIFT TO FOOTPATHS

Mode	Percentage of non-new trips that would have used this mode if not for footpath improvements	Change in annual vehicle-kilometers traveled	Well-to-wheel CO_2-equivalent emissions (grams/vehicle kilometer traveled)	Change in CO_2-equivalent emissions per year (tonnes)
Walk (no modal shift)	85.0%	0	0	0
Auto-rickshaw	4.7%	-21,000,000	136	-2,900
Bicycle	2.6%	-17,000,000	0	0
Motorized two-wheeler	1.9%	-9,500,000	41	-400
Private car	1.2%	-2,900,000	195	-600
Taxi	0.2%	-800,000	195	-200
City bus	0.9%	-200,000	816	-200
Train	0.0%	0		0
Would not have taken trip	3.5%	23,000,000	N / A	0
TOTAL	100.0%			-4,200

Change in annual vehicle-kilometers traveled and change in CO_2-equivalent emissions per year have been rounded to two significant figures after calculation. Due to rounding, values may not sum exactly.

TABLE 5. ESTIMATED GREENHOUSE GAS EMISSIONS REDUCTIONS FROM MAXIMUM MODAL SHIFT TO FOOTPATHS

Mode	Percentage of non-new trips that would have used this mode if not for footpath improvements	Change in annual vehicle-kilometers traveled	Well-to-wheel CO_2-equivalent emissions (grams/vehicle kilometer traveled)	Change in CO_2-equivalent emissions per year (tonnes)
Walk (no modal shift)	63.9%	0	0	0
Auto-rickshaw	9.9%	-45,000,000	136	-6,100
Bicycle	3.1%	-20,000,000	0	0
Motorized two-wheeler	6.8%	-34,000,000	41	-1,400
Private car	5.9%	-11,000,000	195	-2,200
Taxi	1.2%	-9,100,000	195	-1,800
City bus	5.2%	-900,000	816	-700
Train	0.5%	0	N / A	0
Would not have taken trip	3.5%	23,000,000	N / A	0
TOTAL	100%			-12,000

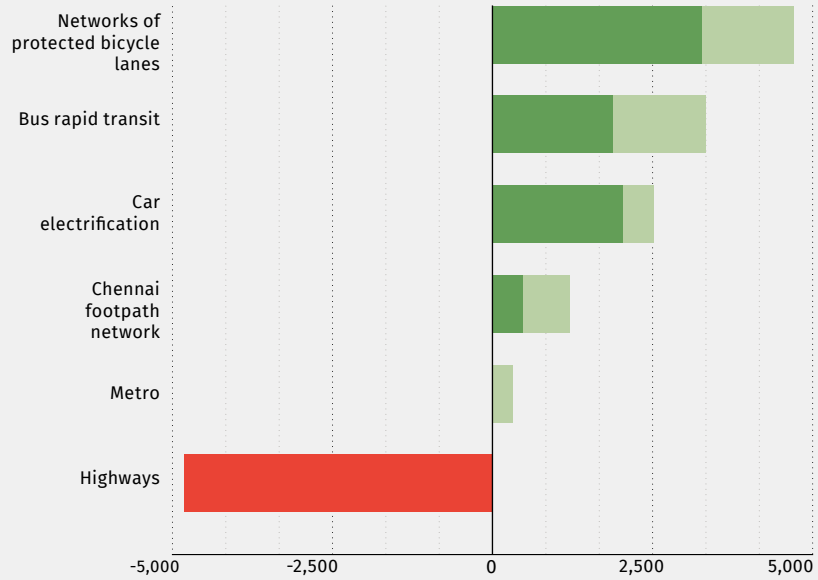
Change in annual vehicle-kilometers traveled and change in CO_2-equivalent emissions per year have been rounded to two significant figures after calculation. Due to rounding, values may not sum exactly.

Calculating the emissions reduced for a specific cost allows us to compare the footpaths' cost-effectiveness at preventing GHGs to other sustainable transportation interventions. The cost per kilometer for improving each of the streets studied ranged from 2.6 INR crore to 34 INR crore (0.38 USD million to 6.1 USD million), depending on the length of the street and the number of elements added (see Graphic 1). Pondy Bazaar Pedestrian Plaza cost significantly more than the other streets; however, we included it in the average because it also had higher pedestrian volumes (and therefore prevented more emissions), balancing out the increased cost.

Based on the average costs, the footpaths prevent between 2.6 tonnes and 7.6 tonnes of GHGs per INR crore spent (22 to 63 tonnes per USD million spent). That means that footpath improvements may not be as cost-effective for preventing GHG emissions as BRT, bicycle lane, or car electrification projects in LMICs; however, they are more cost-effective than metro projects because of the low cost of building footpaths.

GRAPHIC 1. CARBON REDUCTION COST-EFFECTIVENESS IN MIDDLE-INCOME COUNTRIES

Tonnes of CO_2-equivalent emissions prevented per million USD spent on infrastructure (20-year horizon)



EQUITY

Equity is a crucial part of urban mobility. A transportation system that only benefits the privileged does not fully serve the prosperity and sustainability of its city. In this study, we looked at equity in terms of gender, income, and ability.

Gender

As the survey was conducted, surveyors intentionally tried to speak with a sample of roughly half women and half men. This means that we have large samples of each of these genders, and thus a strong basis from which to infer differences between them. Of the 424 pedestrians surveyed, all but one provided their gender: 218 identified as men and 205 as women. No other gender identities were reported during surveying, and the survey did not ask about cisgender or transgender identity.

TABLE 6. SURVEY RESPONSES BY GENDER

	All Men	All Women
Purpose of Trip:		
Work	53%	44%
Shopping	18%	23%
Errands	13%	18%
Study	14%	13%
Recreation	2%	1%
Respondent Perspectives:		
Walk more overall since footpath improvements	87%	90%

Spend quality time on improved footpaths	51%	34%
Footpaths are safer overall since improvements	93%	96%
Footpaths are safe during evening/night	83%	79%
Footpaths are safe for children	80%	76%
Has a Disability:	3%	1%
Profession:		
Salaried employee	57%	35%
Student	15%	19%
Homemaker	0%	20%
Domestic help	1%	11%
Daily wage worker	7%	5%
Businessperson	8%	3%
Other profession	1%	0%
Retired	6%	3%
Not employed	3%	3%
Monthly Income per Person:		
No income (homemaker, retired, or student)	22%	42%
INR 0 to 1,900 (USD $0 to $23)	4%	3%
INR 1,900 to 6,400 (USD $23 to $77)	0%	8%
INR 6,400 to 12,800 (USD $77 to $153)	7%	7%
NR 12,800 to 25,500 (USD $153 to $304)	20%	10%
INR 25,500 to 38,200 (USD $304 to $455)	12%	10%
INR 38,200 to 63,800 (USD $455 to $760)	13%	6%
> INR 63,800 (> USD $760)	13%	9%
No response	8%	5%
Shifted From Which Mode Because of Improvements:		
Still walk	68%	60%
Auto-rickshaw	8%	12%
City bus	4%	6%
Would not have taken trip	1%	6%
Private car	3%	6%
Bicycle	2%	4%
Private motorized two-wheeler	10%	4%
Taxi	3%	2%
Train	1%	0%

Due to rounding, responses may not add up to 100%.

For more on modal shift, see Appendix A, *Calculation of Vehicle-Kilometers Traveled*.

A breakdown of certain attributes of respondents by gender shows us gendered patterns in behavior on and attitudes toward the footpaths. Women may have particular needs from their city's mobility network, and often especially rely on walking infrastructure, as described in ITDP's publications on *Women and Transport in Indian Cities* and *Access for All*.[19]

Some 6% of women who responded to the survey would not have taken their trip if the footpaths had not been improved, compared to only 1% of men. This suggests that the footpaths are creating new opportunities for women to move around the city. Furthermore, women tended to have lower incomes, which also suggests that they may have fewer choices of mode. Women who responded

19 *Access for All: Access and Gender*, https://itdp.org/publication/women-transport-indian-cities/; *Women and Transport in Indian Cities*, https://www.itdp.org/publication/access-for-all-gender/.

to the survey were 20% more likely to have no income (all homemakers who responded were women). Among pedestrians who earned incomes, women's tended to be lower than men's; women were 14% less likely than men to have a monthly income higher than 25,500 INR (305 USD). We conclude that the new footpaths brought a greater benefit to the mobility of lower-income or non-earning women than for higher-earning men.

In general, few other major differences between men and women were revealed in the study. Men were 9% more likely to use the footpaths to commute, 4% more likely to be older than 50, and 6% more likely to have walked if the improvements had not been made. Women were 5% more likely to be walking for shopping and for errands (trip purposes that often involve trip-chaining). More information on gendered perceptions of safety can be found in the "Safety" section below.

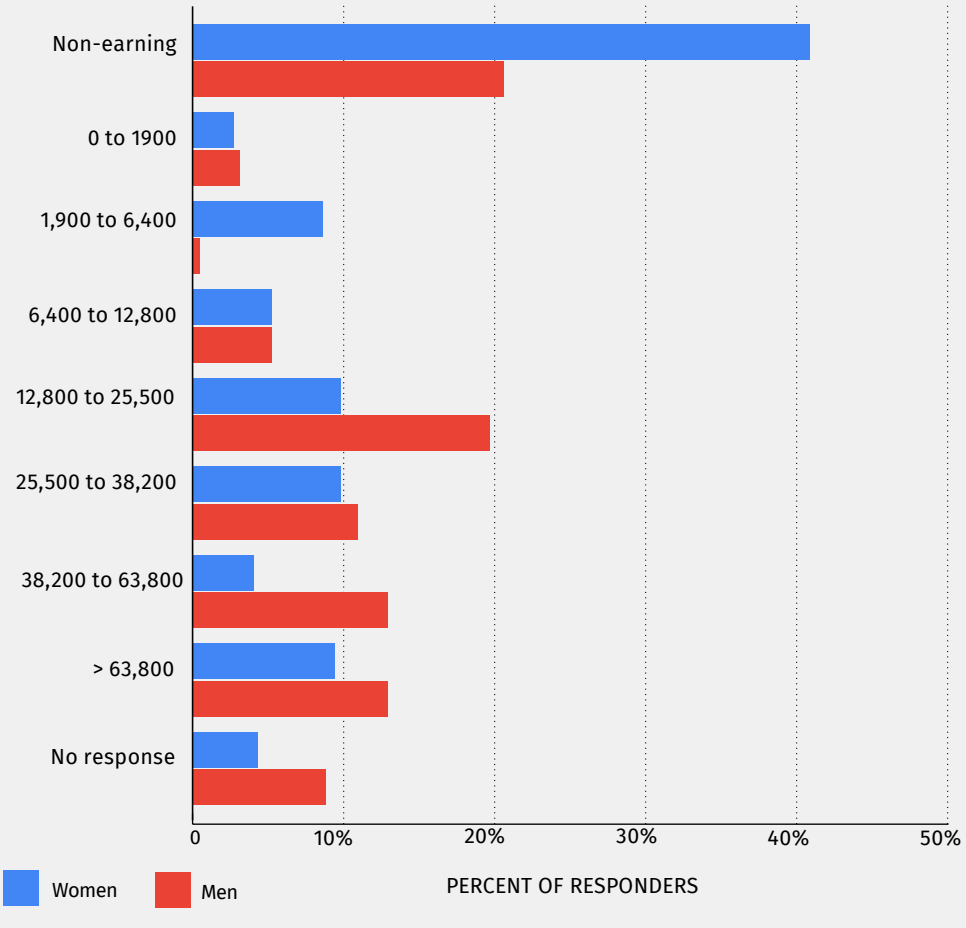
Because the surveyors did not randomly sample the pedestrians, but instead tried to choose a roughly equal split between men and women, we cannot estimate the total percentage of footpath users who are women. Future studies could improve on this methodology by using a gender-disaggregated pedestrian volume count along with surveys.

Income

A total of 50% of the survey respondents had an income below 63,800 INR a month (760 USD), 11% had an income above that threshold, and 32% were students, homemakers, or retired people and therefore not seeking employment. The remaining 7% did not respond when asked about income. Improved walkability offers a benefit to people at all income levels, but most of all for low-income pedestrians who have the fewest options available for mobility[20]

It is interesting to note that about 3.5% of all trips made on the footpaths would not have been made at all, by any mode, if the footpaths had not been improved. This shows that the pedestrian infrastructure is offering new access to chances for recreation, shopping, and possibly even employment for residents. A total of 86% of those new trips were made by lower-income people and those without incomes, which suggests that the footpaths are literally creating opportunities for those who need them the most.

GRAPHIC 2. SURVEY RESPONDENT INCOME LEVELS (RUPEES PER MONTH)



20 Dorina Pojani and Dominic Stead, "Sustainable Urban Transport in the Developing World: Beyond Megacities" (Sustainability, no. 7, 2015), http://dx.doi.org/10.3390/su7067784.

TABLE 7. SURVEY RESPONSES BY MONTHLY INCOME (INR)

		All	63,800 or Above	Less Than 63,800	No Income
Disability:					
	Does not have a disability	98%	100%	96%	99%
	Has a disability	2%	0%	4%	1%
Gender:					
	Men	52%	60%	58%	35%
	Women	48%	40%	42%	65%
Profession:					
	Salaried employee	47%	83%	67%	0%
	Student	17%	0%	0%	54%
	Homemaker	10%	0%	0%	31%
	Daily wage worker	6%	0%	10%	0%
	Domestic help	6%	0%	11%	0%
	Businessperson	6%	17%	5%	0%
	Retired	5%	0%	0%	15%
	Not employed	3%	0%	7%	0%
	Other	1%	0%	0%	0%
Purpose of Trip:					
	Work	49%	67%	69%	6%
	Shopping	21%	23%	17%	25%
	Errands	16%	10%	12%	25%
	Study	13%	0%	0%	43%
	Recreation	2%	0%	2%	1%
	Other	0%	0%	0%	1%
Shift From Which Mode Because of Improvements:					
	Walk (no modal shift)	64%	54%	64%	63%
	Auto-rickshaw	10%	8%	12%	9%
	Motorized two-wheeler	7%	10%	8%	4%
	City bus	5%	2%	6%	7%
	Private car	4%	13%	4%	3%
	Would not have taken trip	4%	4%	3%	5%
	Bicycle	3%	0%	1%	7%
	Taxi	3%	8%	2%	1%
	Train	0%	0%	1%	0%
Private Vehicle Ownership:					
	Family owns a private car or two-wheeler	71%	98%	61%	77%
	Family does not own a private car or two-wheeler	29%	2%	39%	23%

Respondent Perspectives:					
	Walk more overall since footpath improvements	89%	85%	90%	93%
	Spend quality time on improved footpaths	44%	48%	42%	43%
	Footpaths are safer overall since improvements	95%	94%	93%	99%
	Footpaths are safe during evening/ night	82%	81%	89%	75%
	Footpaths are safe for children	78%	69%	83%	78%

Disability

Seven respondents (1.5%) reported a sensory or physical disability. Of those with a disability, more than half used crutches. Footpath users with disabilities felt less safe on the footpaths than other footpath users did—81% of all pedestrians felt that the footpaths are safe at night, but only three of the seven pedestrians with disabilities agreed. This illustrates that pedestrians with disabilities are more vulnerable to the factors that could make a street unsafe. However, almost all pedestrians, including those with disabilities, agreed that the improved footpaths were safer than they had been before.

ACCESS

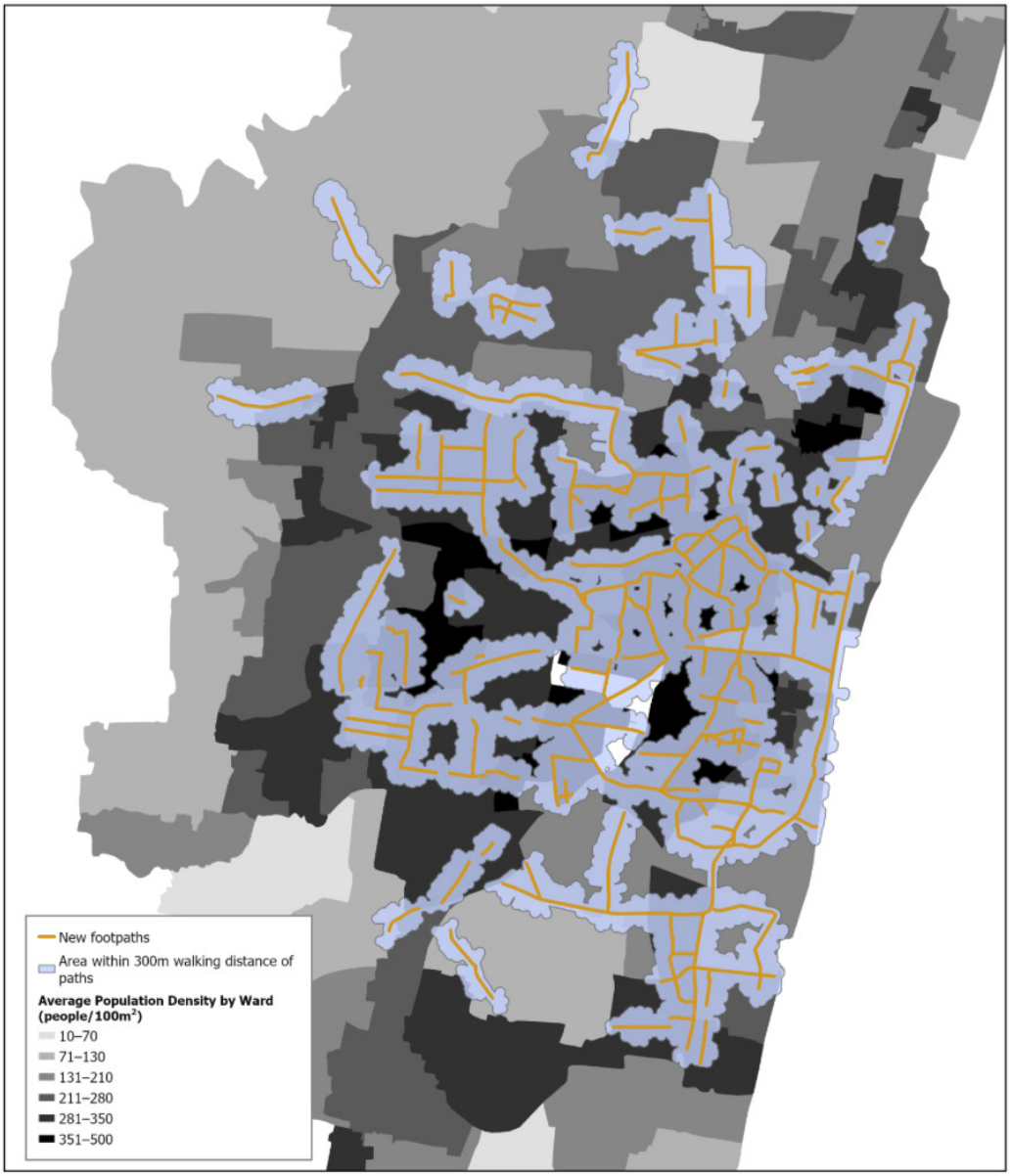
Changes to a city's transportation system impact people in many ways, but the most direct is by changing people's ability to access destinations by moving through the city. When transportation infrastructure is built near where people live, it benefits them more directly than when it is built far away. This is especially true for walking infrastructure, because most walking trips are relatively short.

The new footpaths have been built in both high- and low-density neighborhoods of the city. Overall, in 2020, the completed footpaths provided access to approximately 1.24 million Chennaiites living within 300m of the completed improvements. Assuming that Chennai's population was about 11 million in 2020, this means that the completed footpaths benefit about 11% of the population of Chennai.[21]

The project also improved access to roughly 300 bus stops. While we do not have quantitative data on the ridership of these bus lines before and after the project, the footpaths likely expand Chennaiites' ease of access to public transit and contribute to higher ridership on these bus lines by increasing first- and last-mile connectivity.[22]

21 World Population Review, "Chennai Population 2024," https://worldpopulationreview.com/world-cities/chennai-population.
22 Todd Litman, "Evaluating Active and Micromode Emission Reduction Potentials" (Victoria Transport Policy Institute, 2024), https://www.vtpi.org/amerp.pdf.

ACCESS TO NEW FOOTPATHS IN CHENNAI, 2020



Sources: Infrastructure Works (December 2019), European Commission (2023), Spatial Data of Municipalities (Maps) Project by DataMeet (2008)

SAFETY

The improved footpaths benefit public safety in two ways. First, there may be benefits in safety from crime, as the improved footpaths encourage more active street life and promote “eyes on the street” that discourage criminal behavior. Also, the footpaths may aid in reducing injuries and fatalities from traffic crashes. It is safer to walk on improved footpaths because they provide greater separation between pedestrians and motor vehicles. Improved footpaths may also result in modal shift away from cars, auto-rickshaws, and two-wheelers. This, in turn, reduces the number of motor vehicles on the road and may increase overall traffic safety in the city.

Our understanding of safety improvements is based on perceptions of street safety among survey respondents. During the survey, we asked three general questions about the safety of the streets. We found a nearly unanimous consensus that the improvements to the footpaths made the streets safer than they had been. Most respondents also felt that the streets were safe after 10 pm and were safe for children. However, respondents on Anna Nagar 2nd Avenue generally had the lowest perceptions of safety, and fewer than half of respondents on that street found it safe for children. This may be due to the high traffic volume and speed on that street, which passes through a school zone.

Men's and women's perceptions of safety were very similar. However, women were 4% less likely than men to find the streets safe after 10 pm and 5% less likely to find the streets safe for children. This speaks to the unique gendered experiences of safety on footpaths and implies that street improvements may need to be better tailored to women's experiences for them to feel safe.

TABLE 8. PERCEPTIONS OF SAFETY BY GENDER AMONG SURVEY RESPONDENTS

		The Street Is Safer Overall Than Before Improvements	The Street Is Safe After 10 pm	The Street Is Safe for Children
All Streets	**All**	95%	81%	78%
	Men	93%	83%	80%
	Women	96%	79%	75%
Harrington Road	**All**	92%	80%	94%
	Men	92%	83%	93%
	Women	92%	78%	94%
Pondy Bazaar	**All**	100%	95%	100%
	Men	100%	96%	100%
	Women	100%	93%	100%
CSIR Road	**All**	97%	70%	69%
	Men	96%	70%	68%
	Women	97%	69%	69%
Anna Nagar 2nd Avenue	**All**	92%	81%	45%
	Men	85%	87%	47%
	Women	96%	76%	43%

Legend:

< 50%	50%–69%	70%–84%	85%–100%

Of the 26 respondents who reported feeling unsafe at night on the improved footpaths, 20 responded to a follow-up question about their reasons for feeling unsafe. The most common response was the lack of other people. This supports the "eyes-on-the-street" theory: that more walkable and well-used areas are safer because of the informal surveillance created by larger numbers of pedestrians.[23] This "mix" principle (meaning a mix of land uses and types of people using the space) is one of the foundations of transit-oriented development.[24] This response could also explain why CSIR Road had the lowest perceptions of safety at nighttime among all streets (Table 9); it is an institutional neighborhood that likely has fewer pedestrians at night.

Other common reasons for feeling unsafe were poor lighting (55% of responses) and obstruction of the footpath by parked vehicles (45%). Lack of police was not a major factor for people's feelings of unsafety, suggesting that Chennaiites find formal police presence to be less effective in making their streets safer than the presence of other people, adequate lighting, and the absence of parked vehicles in the path. To make these streets even safer in the future, continued interventions should include adequate lighting and parking enforcement and aim to attract pedestrians at all times of day and night.

23 Jane Jacobs, *The Death and Life of Great American Cities* (1961).
24 ITDP Global, *The TOD Standard* (2017), https://www.itdp.org/publication/tod-standard/.

TABLE 9. RESPONDENT REASONS FOR FEELING UNSAFE IN THE EVENING

	Reason for Feeling Unsafe:	Poor Lighting	Lack of People	Men Dominating Street	Lack of Police	Anti-Social Activity	Parking (Obstruction by Parked Vehicles)	Dangerous Vehicles
All Streets	**All**	55% (11/20)	90% (18/20)	20% (4/20)	10% (2/20)	15% (3/20)	45% (9/20)	20% (4/20)
	Men	50% (4/8)	100% (8/8)	0% (0/8)	0% (0/8)	0% (0/8)	62% (5/8)	25% (2/8)
	Women	58% (7/12)	83% (10/12)	33% (4/12)	16% (2/12)	25% (3/12)	33% (4/12)	16% (2/12)
Harrington Road	**All**	0% (0/4)	100% (4/4)	25% (1/4)	0% (0/4)	25% (1/4)	25% (1/4)	0% (0/4)
	Men	0% (0/2)	100% (2/2)	0% (0/2)	0% (0/2)	0% (0/2)	50% (1/2)	0% (0/2)
	Women	0% (0/2)	100% (2/2)	50% (1/2)	0% (0/2)	50% (1/2)	0% (0/2)	0% (0/2)
Pondy Bazaar	**All**	None	None	None	None	None	None	None
	Men	None	None	None	None	None	None	None
	Women	None	None	None	None	None	None	None
CSIR Road	**All**	50% (4/8)	100% (8/8)	37% (3/8)	0% (0/8)	25% (2/8)	25% (2/8)	37% (3/8)
	Men	50% (2/4)	100% (4/4)	0% (0/4)	0% (0/4)	0% (0/4)	50% (2/4)	50% (2/4)
	Women	50% (2/4)	100% (4/4)	75% (3/4)	0% (0/4)	50% (2/4)	0% (0/4)	25% (1/4)
Anna Nagar 2nd Avenue	**All**	87% (7/8)	75% (6/8)	0% (0/8)	25% (2/8)	0% (0/8)	75% (6/8)	12% (1/8)
	Men	100% (2/2)	100% (2/2)	0% (0/2)	0% (0/2)	0% (0/2)	100% (2/2)	0% (0/2)
	Women	83% (5/6)	66% (4/6)	0% (0/6)	33% (2/6)	0% (0/6)	66% (4/6)	16% (1/6)

The contents of each cell are given as the ratio of the number of respondents who expressed that reason for feeling unsafe to the number of respondents who expressed feelings of unsafety at all, given as both a percentage and a fraction. "Abandoned buildings" and "Other" were also provided as options, but they were not selected by any respondents and so were omitted from this table. No respondents at Pondy Bazaar reported feeling unsafe at night.

Legend:

< 25%	25%–49%	50%–74%	75%–100%

Our final technique for understanding safety on these footpaths was through the occurrence of injuries to pedestrians. We asked survey respondents whether they had ever been injured on these streets, whether the injuries had taken place before or after the improvements to the footpaths, and what the cause of the injuries had been.

Harrington Road and Anna Nagar 2nd Avenue were the most common locations for post-improvement injuries, while no post-improvement injuries took place at Pondy Bazaar.

The improvements appear to have been successful in preventing injuries because of high-speed vehicles, high footpath height, and other causes. However, they have been less successful in preventing injuries because of poor footpath surface or open manhole covers, both of which were reported more frequently after the improvements than before them.

Because street-level pedestrian–vehicle collision data were not available from the Chennai government, we were unable to measure overall changes in the number of collisions due to the street transformation. We are also unable to account for improved safety from crime.

TABLE 10. REPORTED INJURIES AMONG RESPONDENTS BY CAUSE

Cause of Injury	Incidents Before Improvements	Incidents After Improvements	Streets Where Incidents Took Place After Improvements (Number of Incidents After Improvements)
All injuries	20*	18*	Harrington Road (10) Anna Nagar 2nd Avenue (6) CSIR Road (2)
High Speed of Vehicles	12	2	Harrington Road (1) CSIR Road (1)
Poor Footpath Surface	7	15	Harrington Road (10) Anna Nagar 2nd Avenue (5)
Open Manhole Cover	3	5	Anna Nagar 2nd Avenue (5)
Wrong-Side Driving	3	2	Anna Nagar 2nd Avenue (1) CSIR Road (1)
High Footpath Height	4	1	Harrington Road (1)
Other	12	6	Harrington Road (4) Anna Nagar 2nd Avenue (2)

**Injuries often had more than one cause. That is why the numbers of individual causes do not sum to the number of all injuries.*

HEALTH

The health impacts of the Chennai footpaths take two forms. First, there is a benefit to the health of residents around the city due to the reduction in harmful pollutants as travelers shift from polluting motorized modes to walking. Second, there is a benefit to people who now travel by walking instead of riding in motorized vehicles, as the physical activity results in improved bodily health. Although it is difficult to estimate the contribution of reduced emissions to public health, we find that the impact of increased physical activity prevents about 340 premature deaths per year.

Emission Reductions Resulting From Improved Footpaths

Motor vehicles produce emissions that include PM2.5, or particulate matter with a radius of less than 2.5 microns. Long-term exposure to PM2.5 can increase people's risk of developing heart disease, respiratory diseases, and lung cancer, among other health problems. The risks are especially high for children, pregnant people, and the elderly.[25]

The improvements to the footpaths caused people to shift from cars, taxis, buses, and auto-rickshaws to walking, resulting in a decrease of 150 kg to 680 kg of PM2.5 released into the local atmosphere annually.

25 Health Effects Institute, "Health Effects of Air Pollution" (State of Global Air, 2020), https://www.stateofglobalair.org/sites/default/files/documents/2020-10/soga-health-effects-factsheet_0.pdf.

TABLE 11. ESTIMATED PM2.5 EMISSIONS REDUCTIONS FROM MINIMUM MODAL SHIFT TO FOOTPATHS

Mode	Percentage of non-new trips that would have used this mode if not for footpath improvements	Change in annual vehicle-kilometers traveled	Tank-to-wheel PM2.5 emissions (grams/vehicle-kilometer traveled)	Change in PM2.5 emissions per year (kilograms)
Walk (no modal shift)	85.0%	0	0	0
Auto-rickshaw	4.7%	-15,000,000	0.0018	-28
Bicycle	2.6%	-17,000,000	0	0
Motorized two-wheeler	1.9%	-9,500,000	0.0018	-17
Private car	1.2%	-2,900,000	0.0222	-64
Taxi	0.2%	-600,000	0.0222	-13
City bus	0.9%	-200,000	0.1546	-31
Train	0.0%	0	N / A	0
Would not have taken trip	3.5%	+23,000,000	N / A	0
TOTAL	100.0%			-150

PM2.5 emissions factors from the ICCT, Roadmap v2.2, 2024. Change in annual vehicle-kilometers traveled and change in PM2.5 emissions per year have been rounded to two significant figures after calculation. Due to rounding, values may not sum exactly.

TABLE 12. ESTIMATED PM2.5 EMISSIONS REDUCTIONS FROM MAXIMUM MODAL SHIFT TO FOOTPATHS

Mode	Percentage of non-new trips that would have used this mode if not for footpath improvements	Change in annual vehicle-kilometers traveled	Tank-to-wheel PM2.5 emissions (grams/vehicle-kilometer traveled)	Change in PM2.5 emissions per year (kilograms)
Walk (no modal shift)	63.9%	0	0	0
Auto-rickshaw	9.9%	-32,000,000	0.0018	-58
Bicycle	3.1%	-20,000,000	0	0
Motorized two-wheeler	6.8%	-34,000,000	0.0018	-62
Private car	5.9%	-15,000,000	0.0222	-330
Taxi	1.2%	-4,100,000	0.0222	-91
City bus	5.2%	-900,000	0.1546	-140
Train	0.5%	0	N / A	0
Would not have taken trip	3.5%	+23,000,000	N / A	0
TOTAL	100.0%			-680

PM2.5 emissions factors from the ICCT, Roadmap v2.2, 2024. Change in annual vehicle-kilometers traveled and change in PM2.5 emissions per year have been rounded to two significant figures after calculation. Due to rounding, values may not sum exactly.

These calculations are conservative because they only include direct PM2.5 emissions. They do not account for secondary PM2.5 formation in the atmosphere from vehicle emissions or for other harmful effects of non-PM2.5 pollutants, and they do not include the contributions of dust kicked up by vehicle movement or by tire erosion.

Health Impacts of Increased Physical Activity

Walking is good for both physical and mental health. When people can walk for transportation in their daily lives, they can be more physically active, moving their body throughout the day without having to intentionally exercise. This is beneficial for the heart, lungs, bones, and muscles, and it reduces both body fat and the risk of disease.[26] It's also good for the mind: Walking can reduce depression, anxiety, stress, and loneliness.[27]

From the user count data, we estimate that approximately 3.6 million walking trips are made per day on the improved footpaths. Of these, a minimum of 444,000 are trips that would have been made by a motorized mode or would not have been at all if the footpaths had not been improved. Survey respondents reported that an average walking trip after the interventions was about 28 minutes long. However, we do not have preintervention data, so we cannot compare this with the length of walking trips before the footpath improvements.

To calculate the health impacts of physical activity, we used a model from the World Health Organization's Health Economic Assessment Tool for Walking and Cycling (version 5.2.0) to estimate the health benefits of increased active transportation for populations.[28] The Health Economic Assessment Tool indicates that by enabling 444,000 people to walk and thereby improving physical health, the completed Chennai footpaths prevented 340 premature deaths in 2019.[29]
The model assumes a moderate baseline level of physical activity and is intended to estimate impacts on people whose daily work does not involve physical activity—which may not be true for the Chennaiites traveling on the footpaths. For those reasons, this estimation of health impacts may be an overestimation—but even so, the prevention of 340 premature deaths every year is a major benefit of this project.

ECONOMY

Walking is free and does not require any additional equipment. When people are able to walk instead of using other modes of travel, they can save money that might have been spent on transit fare or their vehicle's upkeep or fuel. In this way, Chennai's investment in walking infrastructure is an economic investment that benefits people who are now able to walk on the improved footpaths.

A minimum of 12% of trips on the improved footpaths, or 444,000 trips per day, would have been made by a different mode if the footpaths had not been improved. On average, the people making these trips each saved 18 INR (0.22 USD) per trip as a result of the modal shift made possible by the footpath improvement. At 18 INR per trip and 444,000 trips per day for 365 days per year, these improved footpaths save the Chennaiites who use them a total of INR 2.9 INR billion (~290 crore) each year, or about USD $35 million.

It would also be possible for us to estimate the time savings of improved footpaths, but we have chosen not to make these estimates in part because a significant benefit of the improved footpaths is that many users of the footpaths may intentionally choose to spend more time in these public spaces after their improvement: In fact, 43% of respondents say they spend more quality time on footpaths now than they did before.

Equity of Economic Impacts

Although 12% of footpath users benefit economically from modal shifts enabled by the footpath improvements, the cost savings benefits accrued by lower-income pedestrians were found to be less than the mobility and safety improvements that they experienced. Many low-income residents either did not shift modes or shifted from bicycling or public transit, meaning that they saw less in the way of cost savings after the improvements, especially compared to wealthier residents, who may have shifted from more expensive modes.

Pedestrians making more than 63,800 INR a month (764 USD) saw a much greater financial benefit than lower-income pedestrians: They saved 19 INR (0.23 USD) per trip, compared to 6 INR (0.07 USD) saved by lower-income pedestrians and 1 INR (0.01 USD) saved by non-earning pedestrians. This is probably because higher-income pedestrians were more likely to have used more expensive modes of travel before the footpath improvements.[30] The economic benefits also varied by gender: On average, women saved 1 INR (0.01 USD) per trip compared to men, who saved 11 INR (0.13 USD) on average. This may be because women were less likely than men to shift from more expensive modes and more likely to have walked even if the paths were not improved.

26 Kelly, P., Murphy, M., & Mutrie, N., "The Health Benefits of Walking" *(Transport and Sustainability* 2017, *61–79),* doi:10.1108/s2044-994120170000009004
27 Kekäläinen, T., Freund, A.M., Sipilä, S. et al., "Cross-Sectional and Longitudinal Associations between Leisure Time Physical Activity, Mental Well-Being and Subjective Health in Middle Adulthood", *Applied Research Quality Life* 15, 1099–1116 (2020), https://doi.org/10.1007/s11482-019-09721-4
28 World Health Organization, Health Economic Assessment Tool (2023), https://www.heatwalkingcycling.org/#homepage.
29 We made the following inputs: Hypothetical one-case scenario, physical activity and air pollution; 99% for transport; 100% "in traffic"; 28 minutes of walking per day among a population of 444,000; No temporal and spatial adjustment; default mortality rate of 640 deaths/100,000 inhabitants; PM2.5 concentration of 49ug/m^3; 5.0 km/hr walking speed.
30 These figures all include pedestrians who did as well as those who did not shift modes.

Despite the disparity in these cost savings, many of those who saved less on transportation in this time period may have been able to increase their spending in other areas, such as food, education, or health care, because they already used a lower-cost mode.

TABLE 13. COST SAVINGS BY DEMOGRAPHIC

		Average Cost Savings (Rs)
Gender	Women	1
	Men	11
Profession	Businessperson	15
	Daily wage worker	1
	Domestic help	3
	Homemaker	-7
	Not employed	-1
	Other	0
	Retired	14
	Salaried employee	10
	Student	1
Income Level	Monthly income above 63,800 INR	19
	Monthly income below 63,800 INR	6
	Non-earning	1
Shift From Which Mode Because of Improvements	Auto-rickshaw	36
	City bus	3
	Bicycle	-7
	Private car	74
	Private motorized two-wheeler	38
	Still walk	-1
	Taxi	84
	Train	-16

OTHER LESSONS LEARNED

The survey asked a number of questions that were not specifically required for calculating qualitative impacts but that nonetheless help us understand the improved footpaths, how people are using them, and how improvements could be even more effective.

These results were based on questions about the specific trip that a pedestrian was taking. Additional questions were more general, dealing with the respondent's overall attitude toward the improved footpaths.

Increased Walking in General

A total of 88% of pedestrians replied that the improved footpaths led them to walk more in general. This result did not vary significantly across demographics: People of all incomes, genders, and occupations showed similar rates of increased walking.

Specific footpath improvement projects varied in terms of how much they encouraged additional walking. Pondy Bazaar was the most effective at encouraging walking, which may be as a result of the extensive investment in the Pondy Bazaar Pedestrian Plaza. Additionally, the initial conditions varied from street to street. The population density of the projects' surrounding neighborhoods may also be a factor.

TABLE 14. WALKING BEHAVIOR AND PERCEPTIONS OF STREET SAFETY

		Walk More Often?	Spend More Quality Time?	How Much Quality Time per Day (min.)	Is the Street Safer Overall?	Is the Street Safe After 10pm?	Is the Street Safe for Children?
All Streets	**All**	89%	43%	10 min	95%	81%	78%
	Men	87%	51%	12 min	93%	83%	80%
	Women	91%	34%	8 min	96%	79%	75%
Harrington Road	**All**	85%	44%	7 min	92%	80%	94%
	Men	82%	51%	8 min	92%	83%	93%
	Women	89%	35%	6 min	92%	78%	94%
Pondy Bazaar	**All**	99%	76%	23 min	100%	95%	100%
	Men	98%	79%	25 min	100%	96%	100%
	Women	100%	71%	19 min	100%	93%	100%
CSIR Road	**All**	82%	33%	6 min	97%	70%	69%
	Men	82%	43%	7 min	96%	70%	68%
	Women	80%	19%	4 min	97%	69%	69%
Anna Nagar 2nd Avenue	**All**	92%	21%	6 min	92%	81%	45%
	Men	90%	27%	8 min	85%	87%	47%
	Women	93%	16%	5 min	96%	76%	43%

Legend:

< 50%	50%–69%	70%–84%	85%–100%
0–6 min	7–13 min	14–20 min	> 20 min

Leisure Time Spent on Footpaths

Improved footpaths are more than transportation infrastructure. The streets of any city are part of the public sphere: They are sites of socialization, economic exchange, cultural production, play, and relaxation. Streets are an essential part of the urban fabric as a shared space for everyday life, especially in cities with limited public access to parks. By making the streets more comfortable for people on foot, these footpath improvements made Chennai's communal urban space more enjoyable and valuable for all.

A total of 43% of Chennaiites reported spending more leisure time (phrased as "quality time" in the survey) on the footpaths after the improvement, spending an average of 10 minutes per day on activities like sitting, socializing, exercising, playing, or eating.

Men spent more leisure time on the footpaths than women did—12 minutes per day, compared to 8 minutes per day—with 51% of men reported spending more leisure time after the improvements were completed, compared to only 33% of women. This may be because women were slightly less likely to be making recreational trips (see Table 6).

People with higher incomes also spent more leisure time on footpaths. People making more than 63,800 INR (760 USD) monthly spent an average of 15 minutes per day relaxing on the footpaths, which is more time than people of any other income group.

Pedestrians reported using this leisure time in various ways, with socializing being the most common:

TABLE 15. PURPOSE OF LEISURE TIME ON FOOTPATHS, BY GENDER

Activity	Percentage of all respondents using the footpaths in this way	Percentage of all men using the footpaths in this way	Percentage of all women using the footpaths in this way
Sitting	22%	22%	21%
Socializing	38%	38%	37%
Exercise	12%	15%	10%
Playing	4%	6%	3%
Eating	18%	19%	17%

The amount of relaxing on the footpaths varied significantly by street, with Chennaiites spending four times as much quality time on Pondy Bazaar as on CSIR Road or Anna Nagar 2nd Avenue. This may be due in part to the surrounding land uses—nearby commercial uses like vendors and restaurants encourage greater use of walking paths for leisure time and more foot traffic overall. The quality of the walking path itself also plays a large role: The Pondy Bazaar improvements created a wider footpath with more benches, which was much more amenable to comfortable leisure and enjoyment.

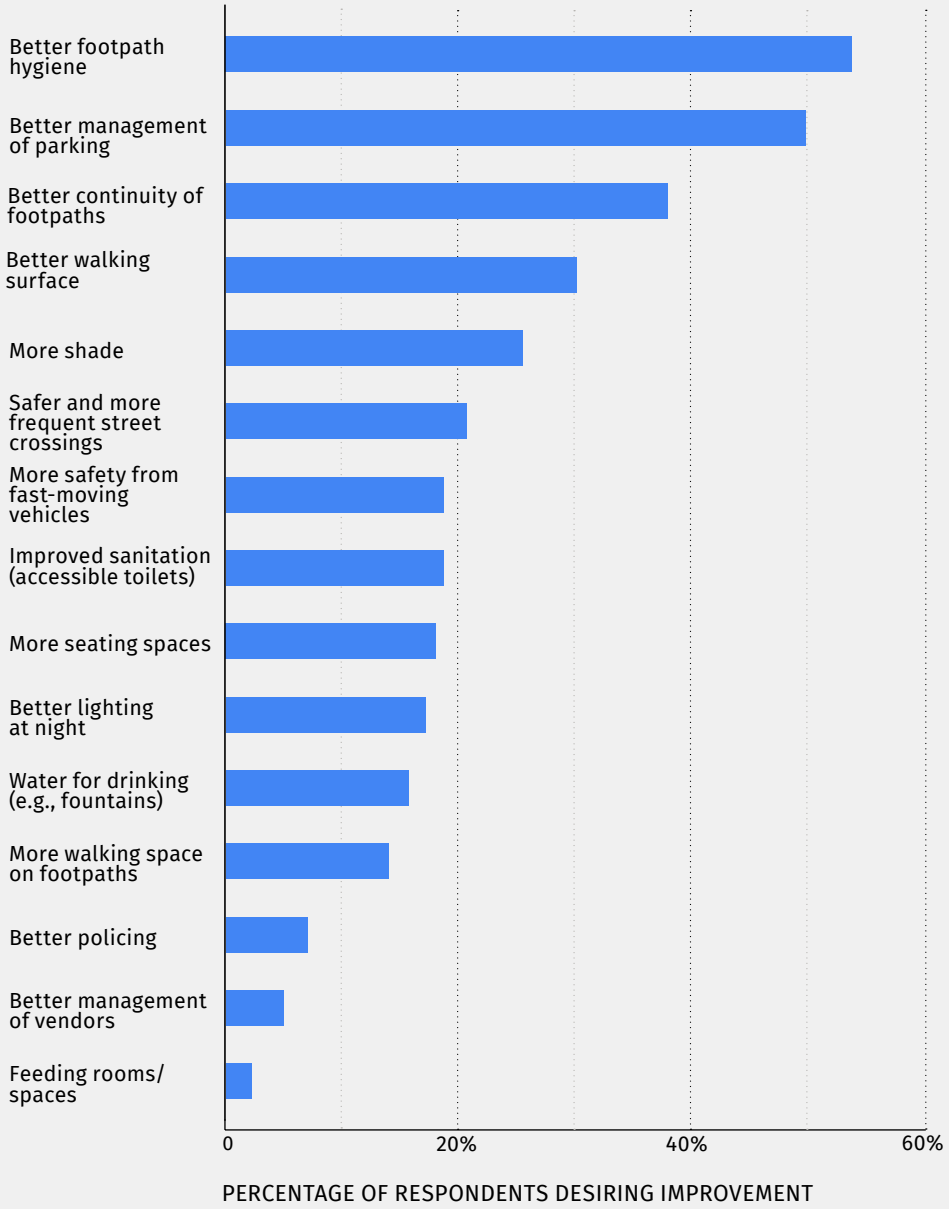
Photo at Pedestrian Plaza, Chennai. Source: Elements Creative for Smart Cities Mission and ITDP India

Desired Improvements

The survey asked respondents to share their perspectives on which further improvements they would like to see to the already improved streets. Respondents could select as many improvements as they wanted or none.

The majority of the pedestrians wanted improved footpath hygiene, reflecting the need for operations and maintenance. Parking management (because of vehicles parking on the sidewalk) and footpath continuity were also in high demand.

GRAPHIC 3. DESIRED IMPROVEMENTS IN CHENNAI FOOTPATHS



CONCLUSIONS

The Greater Chennai Corporation launched the Chennai Mega Streets Programme in 2020 to create a citywide network of streets with a lifespan of at least 30 years, prioritizing liveability, mobility, and utility. The success of the street transformation works and the Mega Streets launch was reflected in the Tamil Nadu budget announcement in February 2020, with the allocation of funds for the preparation of detailed project reports and commencement of work. Insights from the users on the desired improvements will be valuable for the city to address as it works toward scaling up the transformation across the city.

Globally, it has been observed that walking and cycling have significant economic benefits—for individuals, cities, and society—and function as a low-cost, high-yield, scalable solution to climate and equity issues.[31] However, walking is rarely considered as a viable, scalable tool for transport decarbonization. It is important to thoroughly evaluate projects as pioneering cities like Chennai around the world begin to scale up street transformations and sustainable mobility infrastructure. By measuring shifts from other modes, rigorous impact studies can make a data-driven case for increasing investments in active mobility, especially walking, as a step toward sustainability.

SOURCE: ITDP India and Elements Creative for Smart Cities Mission

31 Dana Yanocha and Mawdsley, Sarah, *Making the Economic Case for Cycling* (2022), https://www.itdp.org/wp-content/uploads/2022/06/Making-the-Economic-Case-for-Cycling_6-13-22.pdf.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APPENDIXES

APPENDIX A: CALCULATION OF VEHICLE-KILOMETERS TRAVELED

The effect of the Chennai footpaths on vehicle-kilometers traveled (VKT) by various modes was the basis for most of the calculations used to estimate the impact of the new footpaths. To estimate those impacts, we used the following process:

Based on the surveys of footpath users, we estimated the average distance covered in a walking trip on the footpaths (about 500 m).

We calculated the average number of passersby per peak hour using the pedestrian count data. We assume that each peak hour has about twice as much activity as an off-peak hour. Assuming that there are four peak hours in a day (8 am to 10 am, 4 pm to 6 pm) and 12 off-peak hours (and assuming that there are no passersby at night), one peak hour has about 10% of the daily activity. The three locations included had an average of 1,467 passersby per hour at peak hour (see Table 3); therefore, we estimated that the average location along the footpaths experiences about 14,670 passersby per day.

To estimate the average number of trips taken on the footpaths per day, we multiplied the number of people counted walking on the footpaths at each location in a day by the total length of the improved footpath network (122 km) and divided by the average distance of a walking trip on the new footpaths (500 m), with a result of about 3.6 million daily trips along the new footpaths.

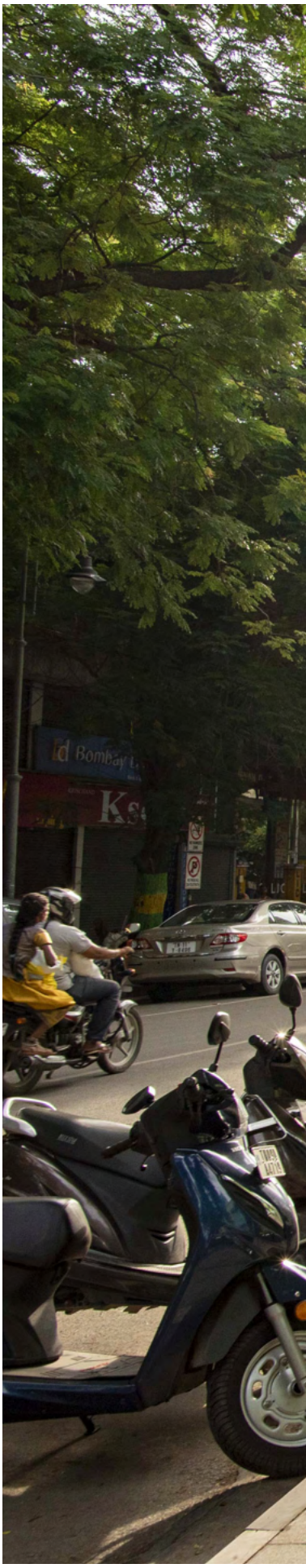
The surveys revealed that the average pedestrian's trip is about 1 km long. We assume that half of that trip took place on the improved footpaths, with the other half on unimproved streets. This assumption is necessary because we did not ask respondents what fraction of their trip took place on the improved footpaths. It is meant to be conservative, resulting in lower estimates of impact than if we assumed that the entirety of a walking trip took place on improved footpaths. This means that the average trip segment on the improved footpaths is about 500 m.

We assume that this average holds for all days and not only workdays. Although commuting travel is lower on weekends and holidays, other trips still take place, and social and recreational trips are often more common on weekends.

Based on the surveys, we identified what proportion of trips on the Chennai footpaths would have been made by other modes of travel if the footpaths had not been improved.

When we conducted the survey, we did not ask for the detailed, leg-by-leg itinerary of the real or the hypothetical trip. We only asked what alternate mode would have been used. So, for example, if a respondent reported that with unimproved footpaths they would have ridden a bus instead of walking, we had no way of knowing how much they would have walked to or from the bus stop. Similarly, we did not identify which respondents were using the improved footpaths to access a different mode of travel.

For this reason, we also made a conservative estimate of the number of footpath users shifting from a different mode to walking as a result of the improved footpaths. In this scenario, we assumed that a respondent only represented an actual modal shift from a different mode to walking when they: 1) reported a modal shift and 2) reported either a current trip cost of zero or one that is less than half of the hypothetical trip cost. Both this conservative modal shift estimate and the originally reported values are presented as a range.



SOURCE: ITDP India and Elements Creative for Smart Cities

We compare these proportions to the estimated average number of trips taken on the footpaths per day in order to estimate how many trips would have been taken by each alternative mode each day (or each year) if the footpaths had not been improved. We then converted the number of trips to the number of person-kilometers traveled (PKT) using the average length of a pedestrian trip (about 1km).

The default trip length for taxis and ride-hail cars includes a "deadheading" factor. As stated in the *Compact City Scenario: Electrified* documentation report, deadheading refers to "the empty vehicle travel in shared vehicles necessary to provide passenger transport services." Trip lengths for taxis and ride-hail cars are increased by 39%, based on research from the California Area Research Board.[32]

Using average vehicle occupancies in India from ITDP's *Compact Cities Electrified: India* report, we converted person-kilometers traveled numbers into vehicle-kilometers traveled (VKT). VKT was not calculated for train trips, as we assume that the number of trains running and their resulting VKT would not change.

By following this procedure, we calculated the annual reductions in VKT by various modes (car, auto-rickshaw, bus, etc.) that were caused by the improved footpaths. Those reductions in VKT can be used to estimate the improved footpaths' impacts on the various themes as described in the sections above.

TABLE 16. ESTIMATED CHANGES IN PASSENGER- AND VEHICLE-KILOMETERS TRAVELED BY VARIOUS MODES DUE TO COMPLETED IMPROVEMENTS OF CHENNAI FOOTPATHS: MINIMUM MODE SHIFT

Mode	Number of trips that would have used this mode if not for footpath improvements	Percentage of non-new trips that would have used this mode if not for footpath improvements	Change in number of daily trips	Change in annual passenger-kilometers traveled	Number of passengers per vehicle	Change in annual vehicle-kilometers traveled (rounded)
Walk (no modal shift)	360	85.0%	0	0	1	0
Auto-rick-shaw	20	4.7%	-168,236	-30,702,990	2	-15,000,000
Bicycle	11	2.6%	-93,066	-16,984,633	1	-17,000,000
Motorized two-wheel-er	8	1.9%	-68,010	-12,411,847	1.3	-9,500,000
Private car	5	1.2%	-41,844	-7,636,552	2.6	-2,900,000
Taxi	1	0.2%	-8,269	-1,509,019	2.6	-600,000
City bus	4	0.9%	-32,215	-5,879,296	36.5	-200,000
Train	0	0.0%	0	0	120	0
Would not have taken trip	15	3.5%	+125,282	+22,863,929	1	+23,000,000

32 Lew Fulton, Maha Ahmad, and Taylor Reich, "Compact City Scenario: Electrified High Shift Model and Scenario Documentation Report" (unpublished), UC Davis and ITDP. Contact taylor.reich@itdp.org to receive a copy of the documentation report.

TABLE 17. ESTIMATED CHANGES IN PASSENGER- AND VEHICLE-KILOMETERS TRAVELED BY VARIOUS MODES AS RESULT OF COMPLETED IMPROVEMENTS OF CHENNAI FOOTPATHS: MAXIMUM MODE SHIFT

Mode	Number of trips that would have used this mode if not for footpath improvements	Percentage of non-new trips that would have used this mode if not for footpath improvements	Change in number of daily trips	Change in annual passenger-kilometers traveled	Number of passengers per vehicle	Change in annual vehicle-kilometers traveled (rounded)
Walk (no modal shift)	271	63.9%	0	0	1	0
Auto-rick-shaw	42	9.9%	-354,571	-64,709,232	2	-32,000,000
Bicycle	13	3.1%	-109,748	-20,029,048	1	-20,000,000
Motorized two-wheeler	29	6.8%	-244,823	-44,680,184	1.3	-34,000,000
Private car	25	5.9%	-211,476	-38,594,435	2.6	-15,000,000
Taxi	5	1.2%	-41,789	-10,600,759	2.6	-4,100,000
City bus	22	5.2%	-185,728	-33,895,312	36.5	-900,000
Train	2	0.5%	-16,884	-3,081,392	120	0
Would not have taken trip	15	3.5%	+126,633	+23,110,440	1	+23,000,000

APPENDIX B: BREAKDOWN OF SURVEY RESPONSES

The following table shows the patterns that can be identified from the responses to the survey. The left-hand column identifies a particular demographic, the next column counts the total respondents in that demographic, and the remaining columns show the percentages of respondents in that demographic who meet a certain criterion or show the average value of a measurement for people in that demographic.

TABLE 18. BREAKDOWN OF SURVEY RESPONDENTS

		Number of Respondents	Percent of Respondents
Location Where Intercepted	**Pondy Bazaar**	100	24
	Harrington Road	121	29
	CSIR Road	103	24
	Anna Nagar 2nd Avenue	100	24
	Total	424	100
Gender	**Women**	205	48
	Men	218	51
	No response	1	0
	Total	424	100
Age	**10 to 25**	112	26
	26 to 50	227	54
	51 to 80	82	19
	> 80	1	0
	No response	2	0
	Total	424	100

		Number of Respondents	Percent of Respondents
Ability	**Has a disability**	7	2
	Does not have a disability	414	98
	No response	3	1
	Total	424	100
Monthly Income	**Non-earning**	134	32
	0 to 1,900 INR	16	4
	1,900 to 6,400 INR	17	4
	6,400 to 12,800 INR	29	7
	12,800 to 25,500 INR	63	15
	25,500 to 38,200 INR	47	11
	38,200 to 63,800 INR	41	10
	> 63,800 INR	48	11
	No response	29	7
	Total	424	100
Profession	**Businessperson**	24	6
	Daily wage worker	25	6
	Domestic help	25	6
	Homemaker	42	10
	No response	3	1
	Not employed	14	3
	Other	3	1
	Retired	20	5
	Salaried employee	196	46
	Student	72	17
	Total	424	100
New or Non-New Trip	**New**	15	4
	Non-new	409	96
	Total	424	100
Shift From Which Mode Because of Improvements	**Auto-rickshaw**	42	10
	City bus	22	5
	Cycle	13	3
	Private car	19	4
	Private motorized two-wheeler	29	7
	Still walk	271	64
	Taxi	11	3
	Train	2	0
	Would not have taken trip	15	4
	Total	424	100
Car Ownership	**No**	121	29
	No response	7	2
	Yes	296	70
	Total	424	100

APPENDIX C: SURVEY DOCUMENT

Chennai Footpaths Monitoring and Evaluation Survey

Name of road

Did you use ABC Road before it was changed?
☐ Yes
☐ No

Purpose of current trip
☐ Work
☐ Study
☐ Errands (includes visiting market, convenience store, clinic, and other day-to-day tasks)
☐ Shopping (includes going to mall, movie)
☐ Recreation (includes exercise, marathon running)

How much money does the trip cost now (one-way, including connecting transit and parking) (Rs)? How long does the trip take in total (minutes)?

If there was no footpath or a poor-quality footpath on ABC Road (compare to nearby road if necessary), would you still have chosen to walk for your current trip? Would you have taken some other form of travel? Or would you not have taken the trip at all?
☐ Still walk
☐ Cycle
☐ City bus
☐ Private motorized two-wheeler
☐ Private car
☐ Taxi
☐ Auto-rickshaw
☐ Train
☐ Would not have taken trip
☐ Other

Specify other mode of travel

How much money would the complete one-way trip have cost using X mode (Rs)?

How long would the complete one-way trip have taken using X mode (even if still walking) (minutes)?

Do you walk more often than you did before the footpaths were improved?
☐ Yes
☐ No

Do you spend quality time on footpaths now (for example, sitting, relaxing, talking to others, drinking tea)?
☐ Yes
☐ No

How much time do you spend (minutes)?

OPTIONAL qualitative questions

Do you think the footpath is safer overall now than it was before, considering both crime and the risk of crashes?
☐ Yes — safer than before
☐ No — less safe than before
☐ No — same as before

Do you feel safe walking on ABC Road during the evening or at nighttime?
☐ Yes
☐ No
☐ Cannot say

Why do you think ABC Road is unsafe in the evening (may select more than one)?
☐Poor lighting
☐Presence of few people
☐Men dominated street
☐Lack of police patrolling
☐Abandoned buildings
☐Occurrence of antisocial activities
☐Parking
☐Dangerous vehicles
☐Other

What is the other reason(s)?
Have you experienced any injury or accident while walking on ABC Road?
☐Yes
☐No

Was the injury before or after the footpath improvement?
☐Before
☐After

Specify reason(s) for injury.
☐High speed of vehicles
☐Wrong-side driving
☐Poor footpath surface
☐High footpath height
☐Open manhole covers
☐Negligent driver behavior
☐Other

Do you think ABC Road is safe for children (8 years to 12 years) to cross on their own? ("Children" does not include infants and toddlers.)
☐Yes
☐No

ºWhat activities do you use the ABC Road footpath for other than commuting?
☐Sitting by myself
☐Socializing with close ones
☐Exercise (includes physical exercise, running, brisk walking)
☐Playing
☐Eating
☐Celebrating festivals

What improvements would you like, to make your walking experience more comfortable and safe?
☐Enough walking space on footpath
☐Continuity in walking
☐Shade
☐Better walking surface
☐Safety from fast-moving vehicles
☐Safe and frequent pedestrian crossings
☐Management of on-street parking
☐Management of on-street vendors
☐Hygiene of the footpaths
☐Policing
☐Adequate lighting at night
☐Seating spaces
☐Policing
☐Sanitation facilities — toilets (accessible)
☐Feeding rooms/spaces
☐Drinking-water points
☐Demographic questions

Age

Gender
☐Male
☐Female
☐Other

Disability
☐Wheelchair
☐Crutches
☐Vision
☐Hearing
☐Other
☐None

Profession
☐Student
☐Homemaker
☐Retired
☐Business
☐Domestic help
☐Daily wage worker
☐Salaried employee
☐Not employed
☐Other

Do you have a private vehicle (car or two-wheeler) in your family?
☐Yes
☐No

Income level (per month)
☐Up to 1500 INR
☐1,500 to 5,000 INR
☐5,000 to 10K INR
☐10K to 20K INR
☐20K to 30K INR
☐30K to 50K INR
☐50K+ INR

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