CENTRE for LiveableCities SINGAPORE

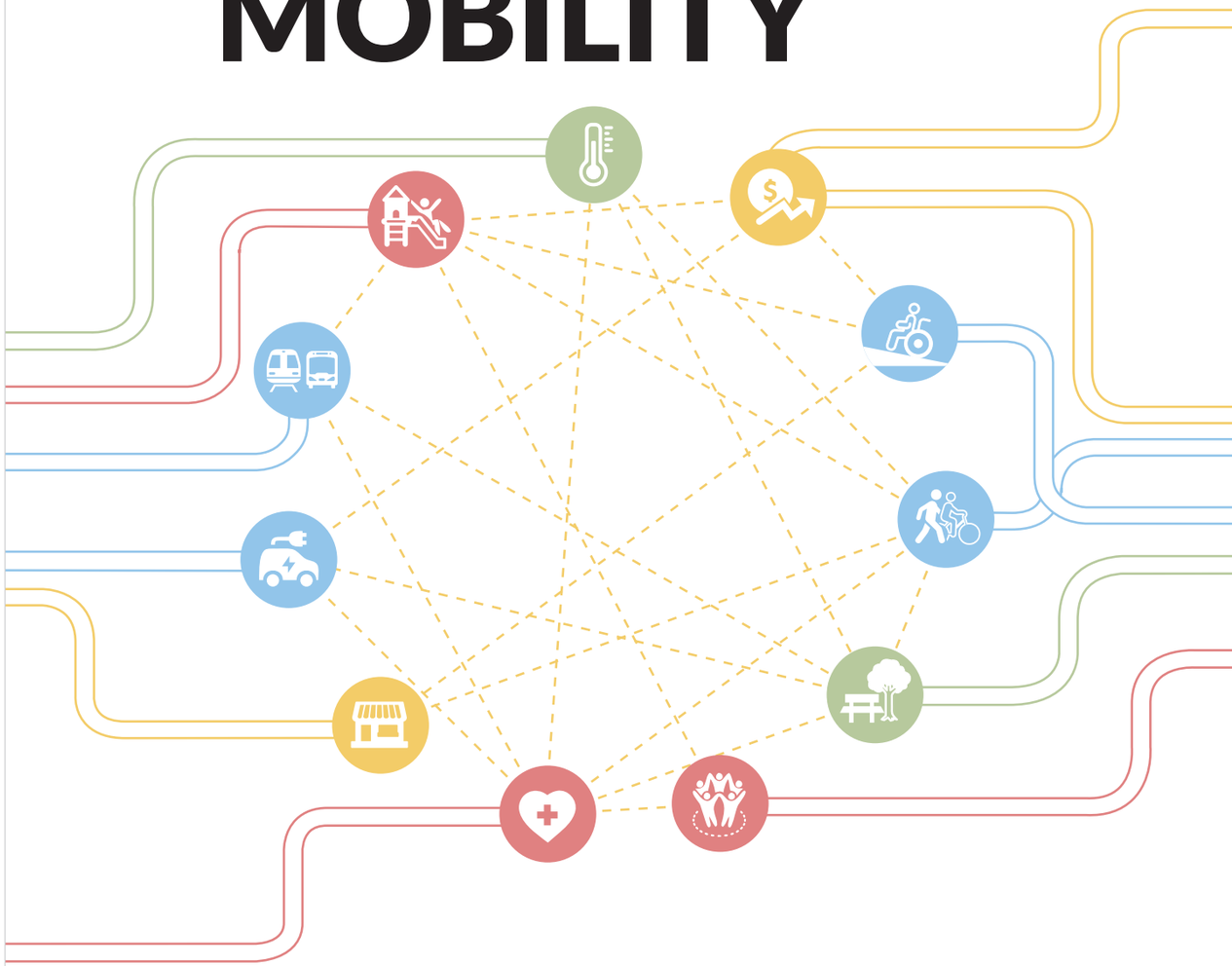
cenit Science for Transport
An Innovation Unit of CIMNE

9 789819 440085

CREATING LIVEABLE CITIES: A CROSS-DOMAIN APPROACH TO SUSTAINABLE MOBILITY

CREATING LIVEABLE CITIES

# A CROSS-DOMAIN APPROACH TO **SUSTAINABLE MOBILITY**



**Project Team**

| | | |
|---|---|---|
| Writers | : | Harini Ravichandran, Zhiyi Teo |
| Research Supervisors | : | Limin Hee, Shawn Tan |
| Research Collaborators | : | Sergi Saurí Marchán, Francesc Gasparín Casajust, Samra Sarwar, Alex Mumbrú Camprubí, Mulia Andreas Pasaribu |
| Editor | : | Ada Davis |
| Design and Production | : | Redbean De Pte Ltd |



CENTRE for LiveableCities SINGAPORE

CLC is a division of MND SINGAPORE

Set up in 2008 by the Ministry of National Development and the then Ministry of the Environment and Water Resources, the Centre for Liveable Cities (CLC) has as its mission "to distil, create and share knowledge on liveable and sustainable cities". The CLC's work spans four main areas—Research, Capability Development, Knowledge Platforms, and Advisory. Through these activities, the CLC hopes to provide urban leaders and practitioners with the knowledge and support needed to make our cities better. For more information, please visit www.clc.gov.sg.

**For enquiries, please contact:**
CLC Publications
5 Maxwell Road
#18-00, Tower Block
MND Complex
Singapore 069110
E: mnd_clc_publications@mnd.gov.sg

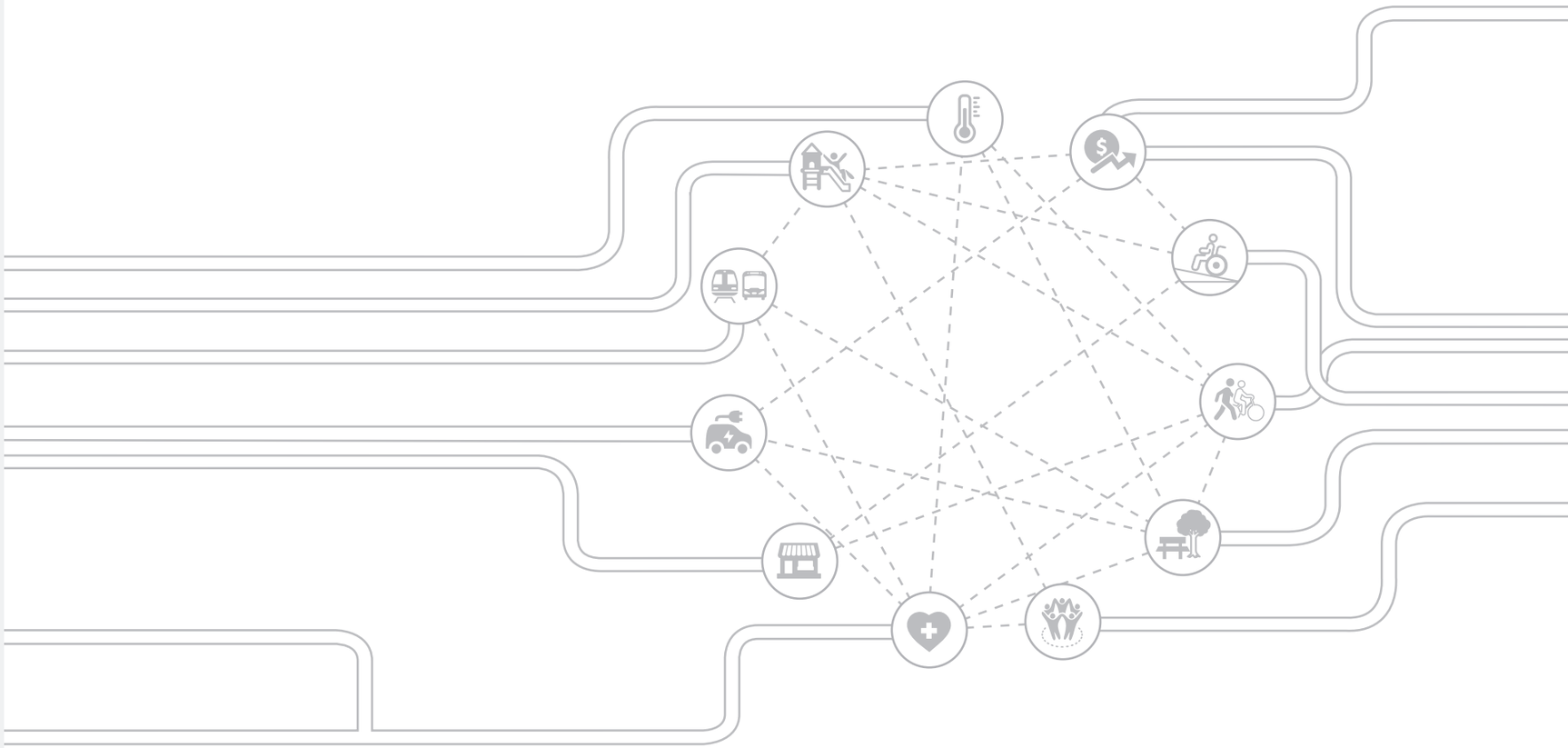
**ISBN 978-981-94-6233-9 (printed)**
**ISBN 978-981-94-4008-5 (e-version)**



Printed on Enviro Wove, a paper made from 100% pre-consumer recycled pulp.

CREATING LIVEABLE CITIES

# A CROSS-DOMAIN APPROACH TO **SUSTAINABLE MOBILITY**



# Contents

# Foreword

## Hugh Lim
Executive Director,
Centre for Liveable Cities

*Sustainable mobility needs to be recognised as a key strategy for creating more liveable communities. With land transport responsible for over 70% of global transport emissions, reimagining how we get around can drive profound changes in our cities.*

Cities in the 21st century will see a transformation in how we move, as more people live in urban areas. At the same time, momentum to decarbonise will continue to grow, along with a greater expectation by urban residents to have access to nature, and opportunities to enhance their health and well-being. Sustainable mobility needs to be recognised as a key strategy for creating more liveable communities. With land transport responsible for over 70% of global transport emissions, reimagining how we get around can drive profound changes in our cities.

The Liveability Framework developed by the Centre for Liveable Cities (CLC) serves as a useful reference for cities to examine the impact of sustainable mobility on the liveability outcomes of a competitive economy, sustainable environment and high quality of life. As a concept, sustainable mobility goes beyond reducing carbon emissions. It embodies a holistic approach to urban planning which, if done well, can foster economic vibrancy, create more equitable and inclusive cities, and bring about a higher quality of life for all.

We need to embrace a more systems-driven understanding of mobility strategies and their externalities. In this regard, applying a cross-domain approach and having a framework that can holistically evaluate the benefits and costs of sustainable mobility interventions can accelerate these transitions.

The CLC and Center for Innovation in Transport in Barcelona have jointly developed a cross-domain framework to help capture, quantify and communicate the holistic benefits of sustainable mobility projects. In doing so, we hope to facilitate integrated decision-making processes and provide a platform for stakeholder engagement. This publication presents our research findings and examines how cities such as Singapore, Barcelona and London have taken a cross-domain approach in their mobility interventions. From enhancing public transportation and reclaiming roads for active mobility, to integrating green infrastructure and adopting data-backed solutions, these cities' experiences provide valuable insights for policymakers and urban planners who are charting pathways ahead.

As cities confront intertwined urban challenges and shifting mobility needs, this framework offers a timely and structured way to ask more informed questions, uncover unexpected impacts, and help balance competing priorities. We hope that the framework will serve as a practical reference for city leaders, planners and researchers seeking to drive mobility strategies that are not only sustainable but meaningfully aligned with the kind of cities we aspire to build. I wish you an enjoyable read.

# Foreword

## Sergi Saurí Marchán

Director,
Center for Innovation in Transport

*As we face pressing global issues such as public health crises, climate change and social inequities, the need for evidence-based and holistic approaches to urban development has never been greater.*

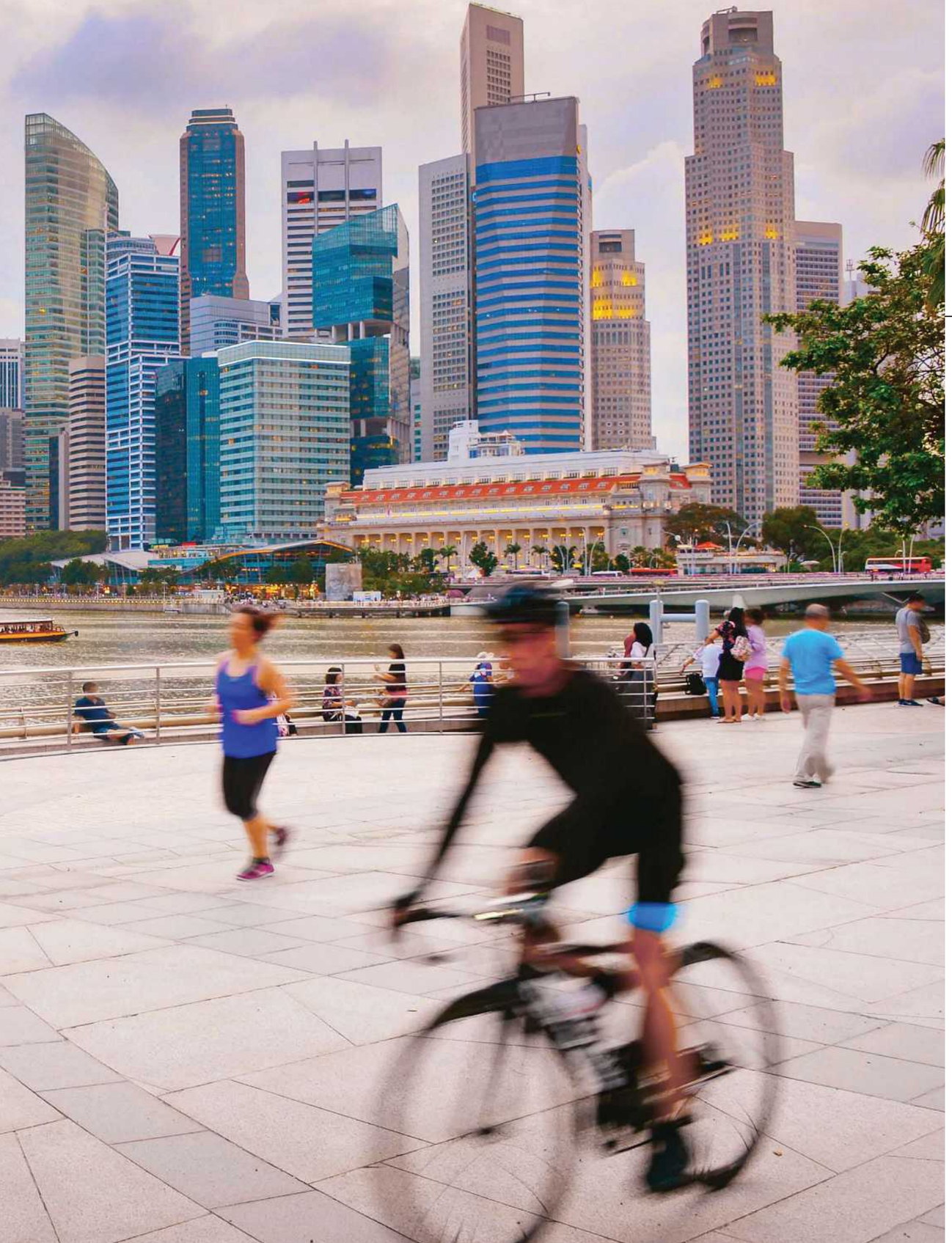
When researchers from the Centre for Liveable Cities and Center for Innovation in Transport set out on this project, they aimed to answer a crucial question: How can we evaluate sustainable mobility initiatives in ways that better inform policy and investment decisions, and in turn, drive more decisive and lasting shifts in travel behaviour? This publication marks the culmination of that journey—but it is also only the beginning. The experiences of the cities featured illustrate the power of cross-domain thinking in action, and how such thinking can reveal benefits, trade-offs and opportunities to drive meaningful change. They show that when mobility is treated as a lever for wider urban transformation, cities can achieve outcomes that are greater than the sum of their parts.

At its core, this publication introduces a multi-criteria analysis framework that considers and quantifies intangible indicators, as well as a set of methodologies that can be used together to holistically assess sustainable mobility initiatives. While this approach is useful in evaluating complex urban mobility interventions, its real value lies in its translatability.

Despite the focus of this publication on sustainable mobility, the framework can in fact be applied in other urban planning and policy domains. Whether assessing green infrastructure implementation, or evaluating urban rejuvenation projects and climate resilience strategies, the ability of the framework to account for economic, social, environmental and health dimensions provides a robust approach for holistic planning and stakeholder engagement. As this framework is applied across diverse areas, it can also uncover new insights to help drive more integrated and effective urban development.

Our work underscores the importance of understanding local conditions to develop context-specific solutions. We must also value interdisciplinary collaborations and be deliberate in bringing together experts from various fields to tackle cross-domain issues through partnerships. We encourage you to explore applying this framework to an emerging challenge in your field, then test and adapt it towards solutioning.

As we face pressing global issues such as public health crises, climate change and social inequities, the need for evidence-based and holistic approaches to urban development has never been greater. The framework presented here represents a step forward to reshape not only how we move, but how we live, work and thrive in our cities. Let us move forth with curiosity, rigour and in partnership with one another.



# 01

## Rethinking Mobility **for Liveable Cities**

Mobility is often seen through a transport lens, yet its impact is broader—shaping health, environmental quality and everyday urban life. Viewing mobility through this wider lens begins to shift how its role in creating liveable cities is understood.

# Introduction

*How can cities better measure and communicate the full range of benefits delivered by sustainable mobility interventions—beyond standard transport metrics?*

Cities today face a growing set of interconnected and complex challenges that call for holistic urban solutions. Climate change, air pollution, evolving public health needs and demographic shifts such as ageing populations are shaping urban policy agendas across the world. Their causes and consequences often span multiple sectors of city governance, reinforcing the need for more integrated approaches to urban development.

Transport systems sit at the centre of many of these challenges. The ways in which people move through cities influence environmental performance, public health outcomes, economic productivity and access to opportunities. Decisions about road space, infrastructure investment and mobility services therefore have implications that extend far beyond the transport sector.

Historically, however, transport planning has often been treated as a relatively discrete policy domain, with planning frameworks focusing on improving traffic efficiency, reducing congestion and expanding network capacity. While these objectives remain relevant, they capture only part of the role that mobility systems now play in shaping urban life.

In recent years, the concept of sustainable mobility has emerged as a priority for cities seeking to address wider challenges. Sustainable mobility refers to transport systems that enable people to move efficiently, safely and inclusively while minimising negative environmental and social impacts. It emphasises accessibility rather than vehicle movement alone and recognises that mobility policies can contribute to broader goals such as climate mitigation, healthier lifestyles and more equitable access to urban opportunities.

Achieving this vision often requires a shift away from car-centric planning towards more people-oriented street design and integrated transport networks. Cities are increasingly investing in public transport improvements, expanding cycling infrastructure and creating pedestrian-friendly environments. These interventions aim not only to improve mobility, but also to enhance the overall quality of urban life.

The significance of these changes lies in their ability to address multiple challenges simultaneously. For instance, expanding cycling networks, improving pedestrian environments or prioritising public transport can help reduce congestion and emissions while also encouraging physical activity and strengthening neighbourhood vitality. Well-designed mobility systems can therefore contribute to cleaner air, safer streets and more vibrant public spaces.

While the impacts of sustainable mobility projects therefore extend across multiple domains—including health, environmental quality, economic activity and social well-being—their outcomes, however, are not consistently captured within existing assessment tools, limiting how their full value is understood and communicated.

An important question thus emerges: *How can cities better measure and communicate the full range of benefits delivered by sustainable mobility interventions—beyond standard transport metrics?*

To address this central research question, the Centre for Liveable Cities (CLC), in collaboration with the Center for Innovation in Transport (CENIT*), explored how cities could move towards a more integrated, cross-domain approach to evaluation, aligned with the systems perspective of the Liveability Framework (LF) developed by CLC. The team undertook a structured research process combining literature reviews of international frameworks, insights from best practices and stakeholder consultations.

First, a review of international frameworks and tools was conducted to understand how cities are currently assessing the broader impacts of mobility interventions. This included approaches that incorporate health, environment, economic and social outcomes, and identifying key gaps and opportunities.

Second, insights from practice were gathered through multi-stakeholder workshops and roundtables involving more than 40 practitioners from the transport, health, urban planning, environment and economic sectors. These discussions highlighted common challenges, including institutional silos, competing priorities, and the difficulty of measuring qualitative or long-term outcomes such as well-being, safety and community cohesion.

Third, the findings were synthesised to inform the development of a structured cross-domain framework, underpinned by a multi-criteria approach. From this synthesis, several guiding considerations emerged. These included the need for tools that are practical, flexible and complementary to existing frameworks already used by cities. Such tools must also help articulate co-benefits and trade-offs, build a shared language across sectors, and support clearer communication with policymakers and the public.

The resulting framework takes an integrated approach to evaluating mobility interventions, aiming to help cities better understand, assess and communicate their broader and longer-term impacts—and the role these play in shaping more liveable urban environments.

*CENIT is an innovation unit in transport under CIMNE (International Centre for Numerical Methods in Engineering), Barcelona.

# The Expanding Role of Mobility

Mobility policies and interventions are no longer viewed solely as mechanisms for moving people and goods efficiently. They are recognised as shaping broader dimensions of urban liveability, including environmental sustainability, public health, economic vitality and social inclusion.

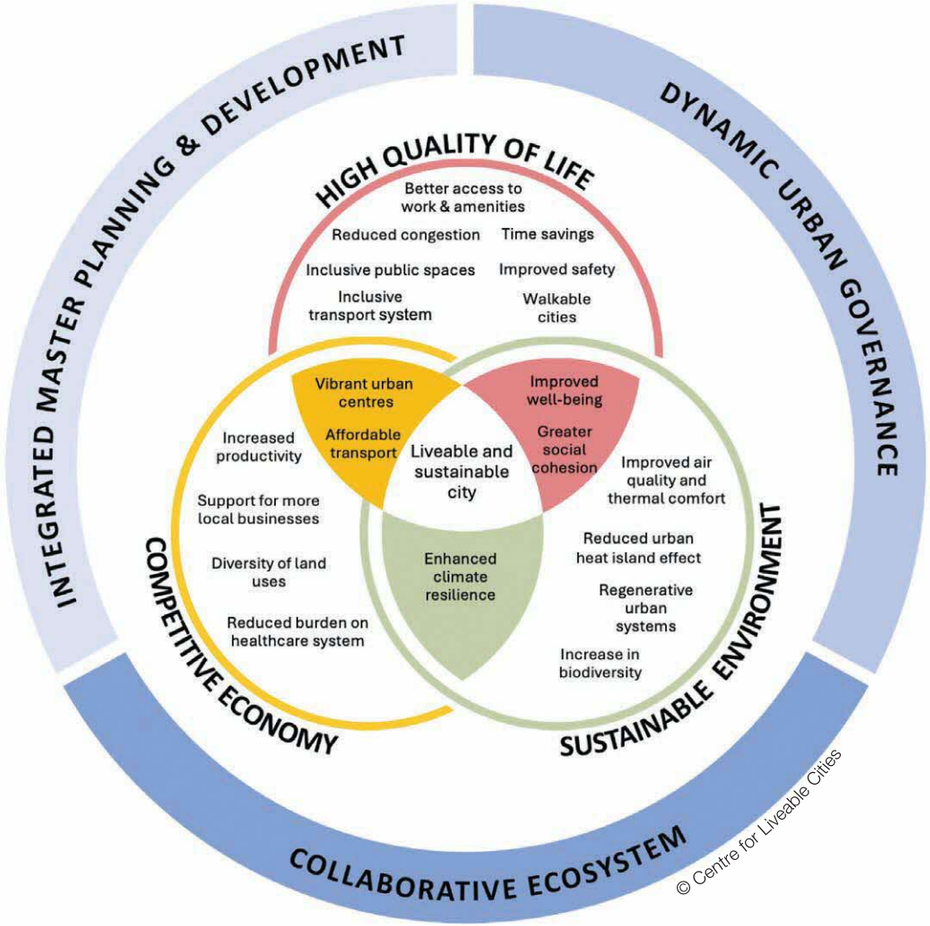
This expanded role is often most visible in the way cities are rethinking the design of their mobility networks. For instance, streets are no longer treated merely as corridors for vehicle movement, but as multi-functional civic spaces that influence how people interact with their environment and with one another.

Street design affects how people access jobs, services and public spaces, and shapes the character of neighbourhoods and the vitality of local economies. As a result, mobility interventions increasingly have implications that extend beyond the transport sector.

As cities increasingly rely on mobility interventions to deliver wider outcomes, expanding our understanding of their impacts becomes increasingly important. Decisions about street design, transport infrastructure and mobility services can have cascading effects across multiple domains of city life, making it necessary for policymakers to consider how mobility contributes to broader urban objectives.

The way these impacts are evaluated plays a critical role in how cities understand and respond to them. It determines which projects receive funding, which initiatives are expanded and how trade-offs are communicated across agencies and to the public. Measurement therefore does not simply describe outcomes—it helps shape decision-making.

The LF developed by CLC offers a useful lens to understand the interdependencies of sustainable mobility outcomes across multiple domains. For instance, it allows us to consider how mobility systems are embedded within broader urban systems, and how transport performance is closely linked to wider liveability outcomes such as environmental sustainability, economic vitality and quality of life. It also underscores that delivering these outcomes requires coordinated governance, integrated planning and collaboration across multiple stakeholders.




Applying the Liveability Framework to visualise the cross-domain benefits of sustainable mobility.

Understanding mobility as part of a wider liveability system highlights the importance of how cities plan, coordinate and evaluate their policies. Aligning planning systems, institutional structures and evaluation approaches therefore becomes increasingly critical in shaping the transition towards sustainable mobility.


# Navigating the Transition to Sustainable Mobility

While many cities recognise the broader role that mobility can play in shaping liveability outcomes, translating this ambition into practice can be challenging. Planning processes and governance structures are typically developed within sector-specific frameworks, with institutional coordination, funding mechanisms and data systems reflecting these boundaries. As a result, integrating environmental, social and economic considerations into mobility decision-making often requires navigating a range of structural and institutional constraints.

Delivering sustainable mobility strategies can therefore involve coordination across separate agencies that are responsible for transport, urban planning, the environment, public health and economic development. Strengthening coordination mechanisms and fostering collaboration across agencies can help cities better align mobility policies with wider urban goals.

Data availability can also vary across domains. This can complicate the recognition of clear relationships between mobility policies and their wider outcomes. Developing more integrated evidence bases across sectors can help cities better understand these impacts and support more informed decision-making.

Existing transport appraisal tools are valuable in shaping investment decisions and defining success for large-scale infrastructure projects which prioritise metrics such as travel-time efficiency, network capacity and cost savings. However, as cities increasingly pursue goals related to climate resilience, public health and equity, a gap can emerge between what mobility policies aim to achieve and what these current evaluation approaches are able to capture.

These constraints present an opportunity to rethink how mobility systems are planned, evaluated and governed. More integrated governance, stronger cross-sector collaboration and outcomes-based evaluation approaches can support more coherent decision-making. Together, these shifts can help cities better align mobility strategies with broader liveability outcomes and navigate the transition towards more resilient, inclusive and people-centred mobility systems.

# How Can Cities Navigate the Transition to Sustainable Mobility?

## Aligning Multi-Level Governance

Sustainable mobility policies often intersect with multiple sectors. Yet responsibilities for these domains are frequently distributed across different agencies and levels of government, each with its own mandates, priorities and decision-making processes.

Strengthening coordination across agencies and levels of governance can help align mobility strategies with broader urban priorities. Integrated planning approaches and clearer institutional roles can also enable more holistic decision-making, ensuring that mobility interventions contribute to environmental, social and economic goals simultaneously.

## Building a Shared Evidence Base

Transport agencies often have well-established datasets related to traffic volumes, travel times and network performance. However, the co-benefits associated with sustainable mobility may be captured by different agencies or not captured in ways that clearly reflect the holistic impacts of mobility interventions.

Expanding data collection and integrating evidence across sectors can help cities build a more comprehensive understanding of mobility outcomes. Developing shared indicators and monitoring approaches enables policymakers to assess progress more holistically, and provides a stronger foundation for evidence-based decision-making for future projects.

## Balancing Stakeholder Priorities

Sustainable mobility interventions affect a wide range of stakeholders, yet they may not always understand the rationale behind mobility policies. Whether this is due to unclear communication with the public, or a lack of civic participation within the community, it may lead to resistance to interventions.

Fostering civic participation and improving public communication can help build trust and shared understanding around mobility initiatives. Additionally, clear evidence and transparent processes can enable cities to explain trade-offs more effectively and support more informed public discourse on the broader impacts of sustainable mobility.

## Planning in Dynamic Environments

Cities are constantly evolving in response to demographic shifts, technological changes and emerging mobility behaviours. Without understanding these dynamics amid local conditions, mobility policies may struggle to achieve intended outcomes or lose relevance over time.

Adopting flexible, context-sensitive approaches that address both physical infrastructure (“hardware”) and travel behaviours (“software”) can help cities adapt to changing conditions. This can be facilitated by combining data with lived experience, and testing and refining interventions over time.

OPINION

# Start with the Street

## Dan Hill

Director,
Melbourne School of Design,
University of Melbourne

*The street is typically a city's largest public space, and certainly its most meaningful, generative and enriching. We must balance its utilitarian functions—milk being delivered to a coffee shop at 5 a.m.; street-cleaning robots sweeping up glass; security guards cycling home; stormwater seeping into bioswales; trees quietly acting as health workers—with its wider cultural and civic purposes. For streets are places where the city plays out, where value is generated, and values are revealed.*

Palla moped, Shanghai street, late September 2024.

Watch any old film of a city street a hundred years ago, and you discover a rich, diverse and fluid set of interactions and relationships unfolding, weaving across and within the street. Instantly, we understand that the street was, for centuries, a truly public space, full of possibility and promise, capable of adapting and flexing in real time, where ideas and cultures collided. We see children playing, people chatting, other animals, trees, commerce and exchange, theatre and music, cooking and eating, intrigue, excitement, solitude, attraction, reflection, experimentation, logistics, maintenance, idleness, invention, energy … the practices of everyday life. Decades later, the dynamic of the street was captured in Jane Jacobs's famous phrase, reflecting on the improvised and emergent choreography outside her window: 'the ballet of the street'.

That all changed, in decisions made quickly and carelessly during the 1930s, driven by the new technology of the motor car. City planners ignored the architect Cedric Price's artful dictum from 1965: 'Technology is the answer. But what was the question?' Rather than asking how particular cities should best move around—and thus what they are about, for whom, why, and who decides?—streets became mere corralled avenues for motor traffic, as if the city's primary role was to 'induce demand' for the automobile industry. The loss of *true* value was immense, though rarely considered next to the blunt metrics of car sales, vehicle miles travelled and commute times.

Now that we are nearing the end of that cycle of domination by the motor car, that most 20th century of technologies, we can ask these questions again, for the 21st century. How should a city best move around? How might a *particular place* move around? How to recapture the dynamic of street as public space, but by moving forward rather than reversing into the ghostly cul-de-sacs of the near past?

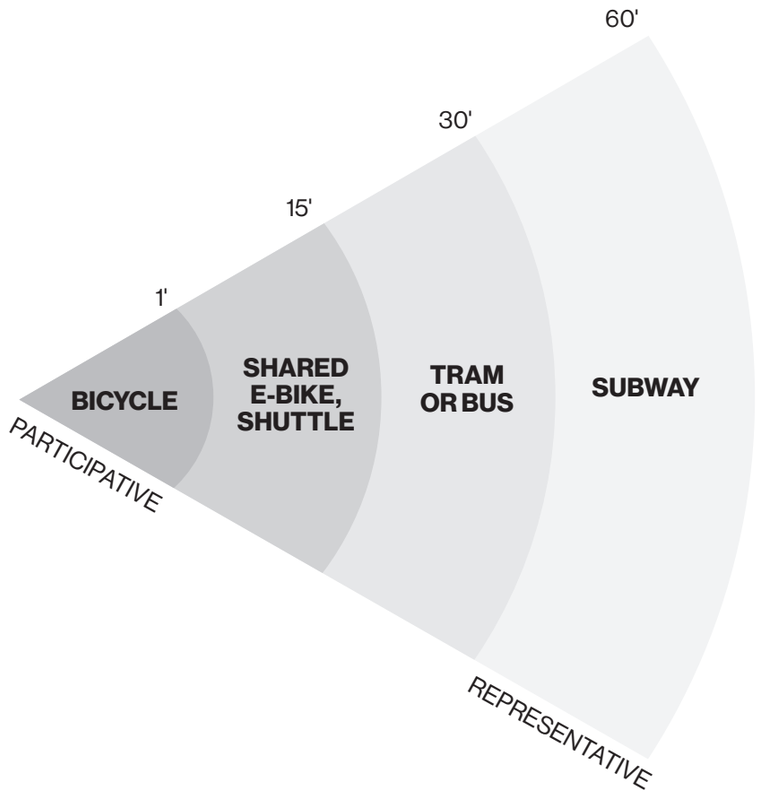
## ERRANDS AND EPIPHANIES

A few key principles may help. Focus on the street first. Use its sense of possibility to reframe mobility technologies. Finally, address the complex questions that emerge around the outcomes of shared value and values.

The street is typically a city's largest public space, and certainly its most meaningful, generative and enriching. We must balance its utilitarian functions—milk being delivered to a coffee shop at 5 a.m.; street-cleaning robots sweeping up glass; security guards cycling home; stormwater seeping into bioswales; trees quietly acting as health workers—with its wider cultural and civic purposes. For streets are places where the city plays out, where value is generated, and values are revealed. As the writer Rebecca Solnit suggests, *"The magic of the street is the mingling of the errand and the epiphany"*.[1] Within that complexity are multiple kinds of value, contained in those 'errands', the jobs that make the city spin, and 'epiphanies', the highly qualitative and intimate reasons why people value city life.

While working at Vinnova, the Swedish Government's innovation agency, we created a 'mission'[2] to retrofit all the streets in the country such that they are 'healthy, sustainable, and full of life', aware that, as the street tangles all systems together, this would mean, in turn, rethinking essentially everything about how cities work. Focusing on the street can connect up our positions and dispositions: we can use the street to forge a joined-up, care-based and upstream approach, allowing us to invest in health-producing—meaning 'health' in a broad sense, for people, place, nature—rather than health-diminishing environments.

The project's 'theory of change' balanced tactical urbanism techniques with strategic design, drawing together all levels of government across multiple agencies, disciplines and functions with large companies like Volvo Cars and startups like Voi, universities, community groups and citizens.[3] As it was applied across a series of differing streets in almost a dozen cities over two years, its key move was to let the citizens of the street retrofit their own street: *the street designs the street*. After all, these people, whether 8-year-olds or 80-year-olds, are the true experts in their own streets. They possess a quite different form of knowledge—grounded, implicit, ambiguous, alive, relational, embodied—as compared to that of the traffic planner's, which is typically abstracted, distanced, atomistic, explicit, transactional. The work of psychiatrist and neuroscientist Iain McGilchrist suggests that these are two knowledge systems at play, which might benefit from a careful mutual interlocking. Foregrounding citizen expertise is a reversal of the typical power balance, of course, requiring quite different public capabilities and sensibilities—designers, planners and bureaucrats support citizens in a co-creative relationship, but it is citizens that actually own the street, and its questions. They are the street.




Place layers organising mobility and governance cultures across scale and time, in 1–15–30–60-Minute Cities.[4]

We called this citizen-led retrofit programme 'The One Minute City'. The city right outside your front door—your street and surrounds—is something you might have an intimate, participative relationship with, far more than with a '15-Minute City'[5] which, for all its many clear virtues, is largely orchestrated by representative municipal teams on your behalf.[6]

To organise these gradients of governance modes, we devised the concept of 'place layers',[7] adapting the place layers concepts of British architect Frank Duffy and American writer Stewart Brand and laying it over urban space, to suggest an arrangement of these different cultures of decision-making for different scales, conditions and technologies. Place layers allowed us to explore what might be truly owned, designed, maintained and managed locally, via participative cultures and systems at the 1–15-Minute City scale, and what requires representative forms of governance, capital, management and infrastructure at the wider scales: say, the 60-Minute City of subways and watersheds.

Giving citizens an appropriately free hand with the designer's pen, and guided by an imperative to address shared systemic challenges, our work showed that people overwhelmingly chose to remove many cars from streets in favour of making more convivial social spaces and healthier green places that are supported by lightweight, affordable and shareable mobility. Citizen approval rating for redesigns hovered around 75% in favour, with only 3% strongly against, and the activity on the retrofitted streets increased by 400% post-design implementation.[8]

## TECHNOLOGY IS THE QUESTION

So, the presence of vehicles *can* be broadly shaped *by* the street, reversing the dynamic of the last century in which *vehicles* shaped the street. But 'starting with the street' does not mean ignoring technology. Rather, we must pay *greater* attention to particular mobility technologies—whether large cargo bikes or large language models—that can help achieve these shared outcomes. After all, technologies tend to change the city more than any architect or urban planner has done. So, we need a new capability here too, with a sensibility for both mobility technologies and the street, in symbiosis.

The new possibilities in small electric and human-powered vehicles—bikes, e-bikes, shared city bikes, e-scooters, trolleys, three-wheeler and four-wheeler micro-cars, Kei-class vans, occasional pockets of electric cars and buses—allow us to recapture the essence of the street as a fluid and adaptive space tuned to both errand and epiphany. These vehicles are generally cheap, lightweight, interchangeable and accessible. They exemplify the qualities of the '£100 technologies' that economist E.F. Schumacher wrote about in his *Small is Beautiful* (1973),[9] with its key principles of *"energy-efficient, environmentally sustainable, and locally autonomous ... a technology with a human face"*. Such adaptive and convivial vehicles bring human faces back into the street. How do we design with them?

## THE NEW VALUE, AND VALUES, OF THE STREET

In all this new diversity, we might spy a new 'value model' for streets around the corner. We sketched out such a model in the Swedish work, realising we needed a clear statement to capture a richer set of outcomes, framed around the shared goals implied in 'every street is healthy, sustainable and full-of-life'.

We unpacked those high-level mission outcomes to a series of sub-goals—health and well-being, biodiversity, environment, maintenance, physical activity, property, commerce, learning and social fabric—which might be supported by numerous research-backed elements, such as an increase in neighbourhood tree canopy and diversity leading to better overall health, mediated by lower obesity and respiratory illnesses, better social cohesion, reduced urban heat island effect, etc., or greener streets that boost children's immune systems and learning abilities, or a decrease in road traffic noise and corresponding increase in birdsong leading to an increase in mental health, recovery from illness, and life satisfaction, and so on.

*Integrating this research might help shift the ways we understand value, and the values that underpin it, and how we articulate places, design for places.*

We collated hundreds of research articles, supporting around 50 data points, yet barely scratched the surface. Still, such research is rarely brought to bear, creatively and coherently, around shared spaces like streets. But as cities look to transform streets back into more diverse public places—and forward into more *biodiverse* spaces—integrating this research might help shift the ways we understand value, and the values that underpin it, and how we articulate places, design for places.

This subtle shift to outcome-oriented approaches led to the development of a prototype urban design tool called Streetmeter.[10] At this stage, it is no more than a deliberately simple interface that might enable urban designers—whether professional planners or citizen amateurs—to adjust basic street conditions such that they might be tuned around shared outcomes. As with any meaningful prototype, it is not yet the answer—but it is a good question. (We've built a similar digital twin here in Australia, deploying 'proximity-based city' principles for the better planning of housing and neighbourhoods.)


A sketch of the value model from Vinnova's mission-oriented approach mapping how retrofitting streets generates overlapping outcomes across multiple types of value, aligned with the United Nations Sustainable Development Goals.[11]

Prototypes like Streetmeter (or our twin) can usefully weave data into drawings, but they are really tools to support discussion rather than spit out technical plans, because we must be careful with metrics. Obsessing over the quantification of complex urban environments tends towards a functionalist view of cities—and thus to functionalist approaches to planning and governing cities, framing them with the logics of efficiency, control or scientism. Cities are not *about* efficiency. If they are about anything, it is culture, conviviality, community—perspectives largely beyond quantification. Some of the best aspects of city life are distinctly inefficient. Use quant for quant things, but don't overreach. After all, the meaning of a tree is more than the sum of its ecosystem services. We must place great store in context, critique and translation, noting that, as McGilchrist writes, *"things as they exist in practice in the real world … are likely to be intrinsically resistant to precision and clarification"* and that we must inflect our representations with *"tactful recognition of the limits to human understanding"*.[12] Like dough, data is of little value unless it is worked into something more meaningful.

*Cities are not about efficiency. If they are about anything, it is culture, conviviality, community—perspectives largely beyond quantification. Some of the best aspects of city life are distinctly inefficient.*

So, we must also *practise* with different languages, and more embodied forms of understanding, in order to transform our bureaucracies' 'dynamic capabilities'.[13] As opposed to designing and managing streets with crass 20th century metrics—leading to trade-offs akin to *the number of deaths per year versus reduction in travel time*—we might start with questions like: *Can children safely walk to good schools nearby, along clean, green, and enriching streets? Or not?* We have endless amounts of research about why this would be a good outcome to strive for. The research is *done*. We just have to deliver on it, reorienting our silos and structures around the gaps in between them, cultivating practises for more meaningful and participative everyday outcomes.

When working on the UK government's mission-oriented industrial strategy at University College London, we hosted workshops about mobility and transport, bringing together academics, policymakers and industry. In one session, the conversation was meandering along 'business-as-usual' lines—reducing congestion, saving the auto industry, mitigating accidents via vehicle design, roll-outs of charging points, 'intelligent' [sic] transportation systems. It was subconsciously following unspoken assumptions about efficiency logics, an induced demand for outdated ideas.

Fortunately, our group included a 'wildcard', the artist and musician Brian Eno, who hit pause on the discussion with a very polite, but firm, suggestion, along the lines of: *"Instead of all that, perhaps we could imagine a place in which everyone and everything moved around a little less, and a little more slowly …"*

In this careful sentence, and its artful, almost deliberately naive framing, lie some clues to 21st-century mobility. It subtly reverses the dynamic of imported tech-driven innovation, and asks us to engage with places, to explore their quite different values. What richly complex variables are implied in that simple question? What might it unlock? What would it mean *here*, in the context of Asian cities? What possible futures might emerge from open, lightweight and adaptive mobility technologies, subtly flavoured with particular folk memories, with 'human faces'? What 'ballet of the street' is this? And with these streets, and their values in mind, how might we get there?

Later, working with Eno again on the Swedish street project, I asked him to write some design principles for streets.[14] The first in his endlessly intriguing set is perhaps one of the most generative: *Think like a gardener, not an architect: design beginnings, not endings.*

In that simple allusion to gardens—the opposite of untended hardscape—we find further clues as to planning versus adaptation, culture and nature, participation, care, reimagining what a street is for, its value and its values as well as mode and method. Design beginnings not endings—and begin in the street.


# 02

# A Cross-Domain Framework for **Sustainable Mobility**

What we measure shapes what we value. Existing assessment tools capture some impacts well, while others remain less visible. A cross-domain framework brings together mobility, environmental, social, health and economic outcomes within a single structure, offering a holistic way of understanding mobility and its wider impacts.

# Learning from Outcome-Led Approaches

Many cities increasingly recognise that sustainable mobility interventions can generate a broader set of outcomes across environmental, social and economic domains. Co-benefits such as cleaner air, healthier lifestyles, safer streets and more vibrant communities are now widely acknowledged as part of the value of sustainable mobility initiatives, but they are not always easily measured, compared or communicated.

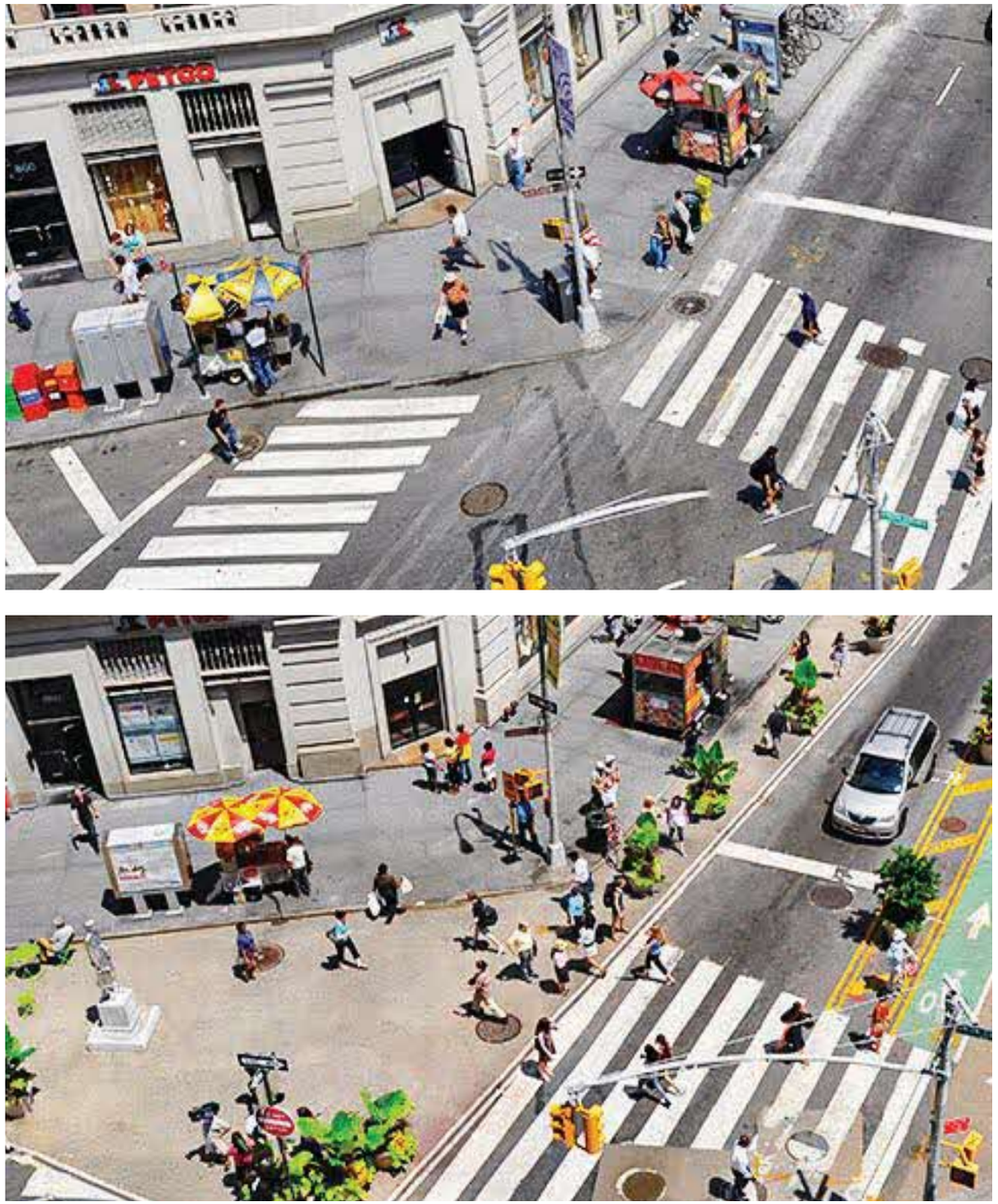
Existing assessment methods such as cost-benefit analysis (CBA) continue to remain valuable and are widely used in transport planning and funding decisions. They provide important insights into efficiency, cost and performance. However, they are usually not designed to capture impacts from multiple dimensions simultaneously. In practice, policy impacts are often assessed within separate domains: transport agencies focus on network performance, health authorities monitor physical activity or disease outcomes, and environmental regulators track emissions and air quality. While each perspective is valuable, this separation can make it difficult to understand how a single intervention may generate multiple, overlapping benefits.

As mobility becomes more closely tied to liveability outcomes, cities will require structured approaches to implement and assess cross-domain impacts coherently. With a need for bringing diverse outcomes into a transparent conversation, cities and practitioners have begun exploring ways to broaden how mobility outcomes are evaluated and communicated. Many of these efforts seek to introduce holistic frameworks, indicators and monitoring approaches that better reflect the wider contributions of mobility interventions to urban liveability.

In several cities, new frameworks have been developed to assess how street environments support public health and everyday urban life. Approaches such as the Healthy Streets framework adopted by Transport for London emphasise indicators including safety, air quality, accessibility, comfort and the ability of streets to support social interaction. These perspectives highlight how the design and management of mobility corridors influence physical activity, well-being and the overall experience of users in public spaces.

Other cities have developed tools for measuring how street interventions affect local economic activity and urban vitality. In New York City, the Department of Transportation's Measuring the Street framework evaluates street redesign projects using a set of indicators that track safety, mobility performance, public space use and economic vitality. These metrics include changes in pedestrian volumes, retail activity, crash rates and user satisfaction. For example, the installation of protected bicycle lanes on Manhattan's 8th and 9th Avenues was associated with a 58% reduction in injuries to all street users and up to a 49% increase in retail sales for locally based businesses along the corridor.[15]

By systematically documenting such changes, these measurement frameworks allow cities to demonstrate the broader value of street redesign. In doing so, they help build the evidence base needed to support sustainable mobility policies and embed such approaches within mainstream transport planning.




Before and after images of New York City's Union Square, where public spaces were introduced to enhance the economic vitality of the neighbourhood.

Another influential shift in mobility evaluation emerged in Sweden, through the adoption of Vision Zero in 1997. At the time, Sweden recorded around 7 road deaths per 100,000 inhabitants annually (a comparatively low rate by international standards),[16] and road fatalities were implicitly treated as an unavoidable by-product of a transport system optimised for speed and efficiency. Conventional appraisal methods often incorporated safety within cost-benefit frameworks, assigning statistical values to fatalities and serious injuries and weighing them against travel-time savings or capacity gains.

Vision Zero challenged this logic by asserting that no loss of life is acceptable within the road transport system. Safety was no longer treated as one objective among many, but as a defining condition of system performance. Reducing fatalities and serious injuries therefore became central indicators shaping infrastructure design, speed management policies and investment priorities. Over time, Sweden's road fatality rate fell to around 2 deaths per 100,000 inhabitants, among the lowest globally, demonstrating how redefining what counts in mobility systems can reshape both measurement practices and policy outcomes.[17]

Advances in urban data and monitoring have also enabled new ways of observing how people use streets and public spaces. Digital tools increasingly track indicators such as pedestrian flows, cycling volumes, dwell time and public space usage. These forms of measurement provide insights into how mobility interventions influence patterns of activity and street life, complementing more conventional transport metrics.

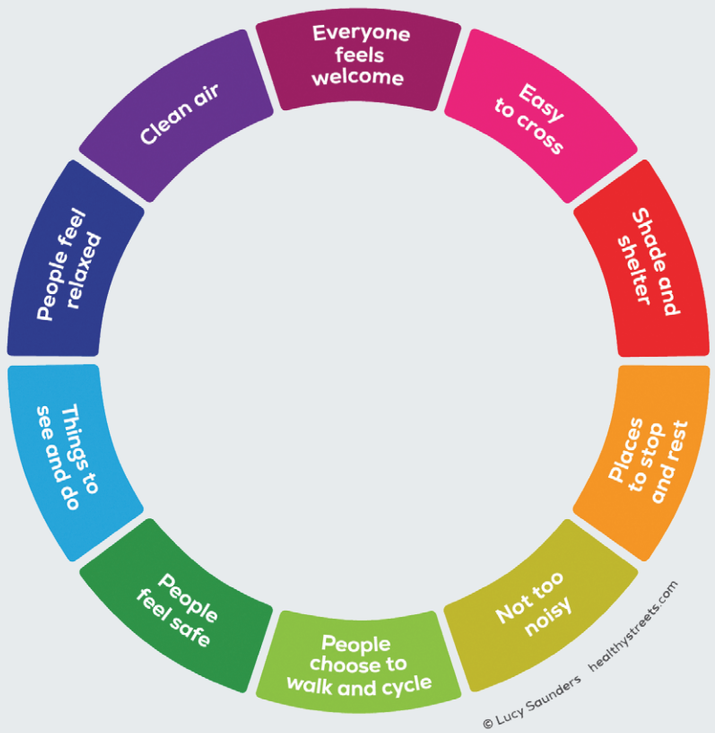
Taken together, these initiatives illustrate a broader shift towards outcome-led approaches to mobility evaluation and reflect a growing global awareness that mobility must be assessed as part of an integrated urban system. While they differ in methodology and focus, they share a common objective: to make visible the wider impacts of mobility interventions on urban liveability. In practice, these approaches begin by identifying specific outcomes and developing indicators to measure progress. This allows cities to demonstrate how mobility interventions influence multiple dimensions of urban life while also strengthening the evidence base for more people-centric design.

OPINION

# How Healthy Is Your Street?

## Lucy Saunders
Director,
Healthy Streets Ltd

*The Healthy Streets Approach offers a comprehensive framework for making decisions on how streets are designed, managed and used. The premise of this approach is very simple—all streets, regardless of their position on the globe or their function in the transport network, must meet the needs of the human beings who inhabit them.*




The 10 Healthy Streets Indicators describe important aspects of the human experience of being on streets that should be considered in the design and evaluation of a project.



While roads are seen primarily as corridors for moving cars, there is a growing understanding that the same is not true of streets, where people also need to walk, cycle and dwell. Spaces that are used by people must meet basic human needs such as being safe from injury, toxic air and harmful noise. This is not just for the protection of public health, but also because walking, cycling and dwelling in cities contributes to making them environmentally sustainable, socially vibrant and economically prosperous.

## THE NEED FOR A COMPREHENSIVE FRAMEWORK

Until now, cities have not had the necessary framing and tools to systematically treat streets differently from roads. Every city has at least a few good examples of public spaces where attention has been paid to the needs of people, but few cities have put in place the means to ensure this is the default approach to all decisions about all streets.

The Healthy Streets Approach offers a comprehensive framework for making decisions on how streets are designed, managed and used. The premise of this approach is very simple—all streets, regardless of their position on the globe or their function in the transport network, must meet the needs of the human beings who inhabit them. The foundation of Healthy Streets is a set of 10 Indicators, each describing a basic human need (e.g., shade and shelter).

Of course, our basic needs change throughout our lives. For example, our need for places to stop and rest may be more urgent when we are very young or very old, pregnant or recovering from an injury. To ensure that everyone's needs are met, all 10 Indicators should be addressed for all streets.

## ROLE IN INFORMING URBAN PLANNING AND POLICY

Practitioners in transport and urban planning know that they play an important role in creating liveable places and supporting people to live healthy lives. However, when they attempt to take a progressive approach for the spaces they design, they often face the institutional barrier of prioritising vehicle throughput. This barrier can be overcome by aligning professional disciplines, party politics and advocacy priorities to deliver a people-centred approach that everyone can accept.

This is what the Healthy Streets Approach offers. It is adaptable, flexible to every situation and easily understandable by all. Globally, the number of people (practitioners, politicians and advocates) who have taken part in Healthy Streets training is increasing, providing a momentum that is leading to delivery at scale.

London's adoption of the Healthy Streets framework in the Mayor's Transport Strategy is a prime example of its successful application. The city's policy shifts towards walking, cycling and public transport are informed by the Healthy Streets Indicators, with a focus on creating safer and more enjoyable streets for all.

A major contributor to the success of this approach is that it is not just an ethos, a set of policies or a way of working. Rather, it offers a range of quantitative tools that can be used to apply Healthy Streets in many different fields. There is a tool for scoring the design of a new neighbourhood, a tool for scoring the layout of a street upgrade, a tool for strategically planning a city, and a tool for gathering the sentiments of the community. This means that all the different processes that shape our experience on streets are quantitatively assessed against the same set of standards—the 10 Healthy Streets Indicators.

Planners aim to provide safe crossing facilities, high quality cycle space, street trees and other landscaping, and wide footpaths. Healthy Streets provides the tools to quantify and demonstrate how all this can be done, even for narrow streets and on low budgets. This holds the potential to add a dollar value to the Healthy Streets score that can be placed alongside the hypothetical disbenefit of reducing the expedience of car movement, which has dominated decision-making for decades.

*The Healthy Streets score can be placed alongside the hypothetical disbenefit of reducing the expedience of car movement, which has dominated decision-making for decades.*

## INTEGRATING COMMUNITY INSIGHTS WITH DATA-DRIVEN SOLUTIONS

The newest Healthy Streets tool may be the most powerful one yet. It can be used by anyone, not just trained professionals. How Healthy Is My Street? is a web-based tool that can be opened on a smartphone and applied to any street in the world to score it both objectively against a set of simple metrics, and also subjectively to give a score of how one feels there. This enables a much wider range of users (the public, businesses, practitioners and politicians) to identify why some streets are not yet meeting their basic needs. This tool also indicates ways to make streets healthier by showing what street features could be incorporated to make the biggest impact in meeting users' needs.

Data collection within the framework combines qualitative and quantitative methods. Local stakeholders provide insights into how streets function, with surveys and street audits used to gather feedback on the experience of walking, cycling and socialising. Additional datasets that measure other elements such as air quality measurements, noise levels and traffic volume can be overlaid to create a more complete picture of street performance. The framework advocates for the use of multiple data sources to ensure a balanced assessment.

So, this is an exciting time. London has established itself as a city that has been successful at implementing the Healthy Streets Approach in its urban spaces through progressive policies. These policies include the rollout of 20-mile-per-hour (roughly 32-km-per-hour) speed limits, as well as restrictions on polluting vehicles, school streets and low traffic neighbourhoods, to mention just some of the city-wide initiatives implemented in the past 5 years. The Healthy Streets Approach is also gaining popularity around the globe and is being applied around the world in projects large and small—from Austria to Australia. The How Healthy Is My Street? app is spreading the conversation and action much further. In the first weeks since this tool was launched, 1,000 surveys were completed globally, showing the potential for this data to produce a Healthy Streets map of the world. As urban planners increasingly recognise the value of prioritising human health and well-being in urban design, the Healthy Streets Approach stands poised to transform our urban landscapes.

OPINION

# Rethinking Transport Infrastructure Investments Through the Lens of Bikenomics

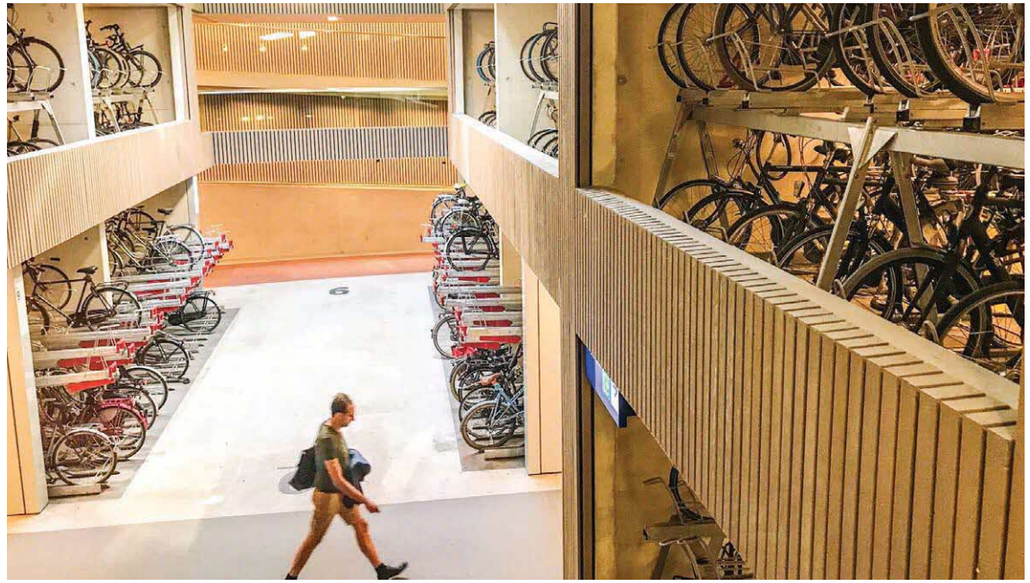
## Chris Bruntlett

International Relations Manager,
Dutch Cycling Embassy

*By quantifying the benefits of getting people out of their cars and onto more active, sustainable and efficient means of travel, they have become a gamechanger when it comes to reallocating public funds from auto-focused infrastructure to ones that induce more walking, cycling and public transport.*

The Stönner-Meijwaardbrug in Oirschot is a walking and cycling bridge providing easy access for pedestrians, mobility scooters, wheelchairs and prams.





The Stationsplein in Utrecht houses the world's largest bike parking facility, with a capacity for 12,500 bicycles.

It's no secret that countries across Europe and around the world are facing a period of economic uncertainty. Sudden demands for defence spending, customs tariffs, and replacement of post-war infrastructure at the end of its lifespan are putting new strains on national budgets and forcing many governments to rethink their priorities in the face of a potential recession. If there is any silver lining to this dark cloud on the horizon, it is that these governments might also rethink their transport infrastructure investments, finally taking into consideration their true cost to society from construction to demolition.

These types of societal cost-benefit analyses are now quite common in the Netherlands, and are legally required by the national government for infrastructure projects of a certain budgetary value. By quantifying the benefits of getting people out of their cars and onto more active, sustainable and efficient means of travel, they have become a gamechanger when it comes to reallocating public funds from auto-focused infrastructure to ones that induce more walking, cycling and public transport. This emerging field has been dubbed "bikenomics" and is responsible for some eye-catching projects in recent years, including parking facilities, rental schemes and superhighways.

For example, when Utrecht cut the ribbon on the world's largest bicycle parking structure, with a total of 12,500 spaces spanning four storeys underneath its central railway station in 2019, critics called the €30-million price tag "crazy".[18] But when the municipality applied a bikenomics lens to the ambitious project, they found the societal benefits far outweighed the costs and easily justified their contentious decision to reallocate much of the budget from a proposed multi-storey car parking structure elsewhere in the city.

To begin, this external analysis put the cost of the parking facility (including amortisation, maintenance and operation) at around one euro per user per day, whereas the cost of providing bus or tram travel was around three euros per user per day. [19] As a result, enabling cycling to the train station saved them millions in public transport subsidies each year. The savings were even more dramatic when compared to accommodating the equivalent amount of car travel to the station. The related negative externalities—such as traffic congestion, air and noise pollution, road safety, and public health—were calculated to cost society tens of millions of euros each year, even in the most optimistic scenarios.


The OV-fiets bike-sharing programme in the Netherlands offers a seamless first- and last-mile connection from train stations.

Furthermore, it is widely known that a great deal of traffic congestion can be relieved by replacing a small proportion of cars with other modes. The provision of cycling and public transport supports this shift, allowing authorities to postpone or even supersede road expansions—such as widenings and flyovers—that would cost them billions of euros. By executing this type of analysis and considering the full economic impact of alternative scenarios—including doing nothing—cities like Utrecht can justify "extravagant" infrastructure investments, because they know it saves taxpayer money year after year.

A similar analysis was done to justify Dutch railways' investment in the OV-fiets (a public transport bicycle) as a last-mile solution for its passengers. With over 22,500 bikes available to rent at 300 train stations across the country, the OV-fiets has been called a "blue and yellow miracle". In a 2011 survey, 54% of OV-fiets users revealed they use the train more often because of its availability. And 8% admitted that, without it, they would drive a car door-to-door instead of using it as part of a bike–train trip.[20] In 2024, researchers at Delft Technical University concluded that every euro invested in the OV-fiets returns up to €2,40 in societal benefits,[21] including improved accessibility, congestion, and health and safety outcomes, all by inducing more train travel, more cycling and less driving.

Looking ahead, the next frontier of bike infrastructure in the Netherlands is the *doorfietsroutes*, continuous cycling routes—enabled by the extended range of the e-bike—designed to cater to trips of 5 to 15 km, which cause the biggest traffic problems because they're too short for the train and too long for the bus or bike. As a result, regions across the country are investing millions to connect residential, commercial and educational hubs with direct and comfortable cycle paths, which often require bridges and tunnels to reduce the amount of stopping.

Early studies have shown that these "cycle highways" create a positive shift in travel behaviour, with a 10% increase in biking probability for adjacent trips.[22] Considering public health, travel times, road safety and maintenance, noise and air pollution, and tourism, each euro invested is found to return €8,90 in societal benefits.[23] In one specific case, officials who were sceptical of a €15-million cycling bridge across the Maas River as part of a 12 km-long doorfietsroute between Heyendaal and Nijmegen commissioned a cost-benefit analysis in 2020. It was predicted to save €114-million over its lifetime.

The amount of money the Dutch spend on cycling often seems extravagant to outsiders, but it happens because they view each penny as an investment—in a healthier and happier population, a low-congestion and low-maintenance road network, and a public realm where people want to spend time and money. This stretches far beyond a few "prestige projects", and means building cohesive networks of high-quality cycling routes, reducing the speed and volume of cars filtering through the city, and combining cycling with public transport to capture the synergy between these two sustainable modes. Then and only then, when we consider the full cost of our mobility choices, will we stop asking whether we can afford to invest in cycling, and start asking whether we can afford not to.

*Then and only then, when we consider the full cost of our mobility choices, will we stop asking whether we can afford to invest in cycling, and start asking whether we can afford not to.*

This article first appeared in Issue 01/2025 of the *Österreichische Zeitschrift für Verkehrswissenschaft* (Austrian Journal for Transportation Science); it is re-published here with slight modifications.

Opened in 2020, the €12-million Maasover bridge is a cross-regional collaboration that connects Cuijk and Mook, and completes a 12-km continuous cycling route to Nijmegen.

The broader impacts of mobility interventions on physical activity, air quality and the overall experience of public spaces raise questions about how urban mobility is evaluated. As cities pursue these wider objectives, to what extent do existing assessment tools adequately reflect contemporary priorities? And if they do not, what structured approaches are needed to bring these dimensions together within a coherent evaluative framework?

These questions highlight the need for more structured and integrated approaches to understand and evaluate sustainable mobility.

# A Cross-Domain Framework for Sustainable Mobility

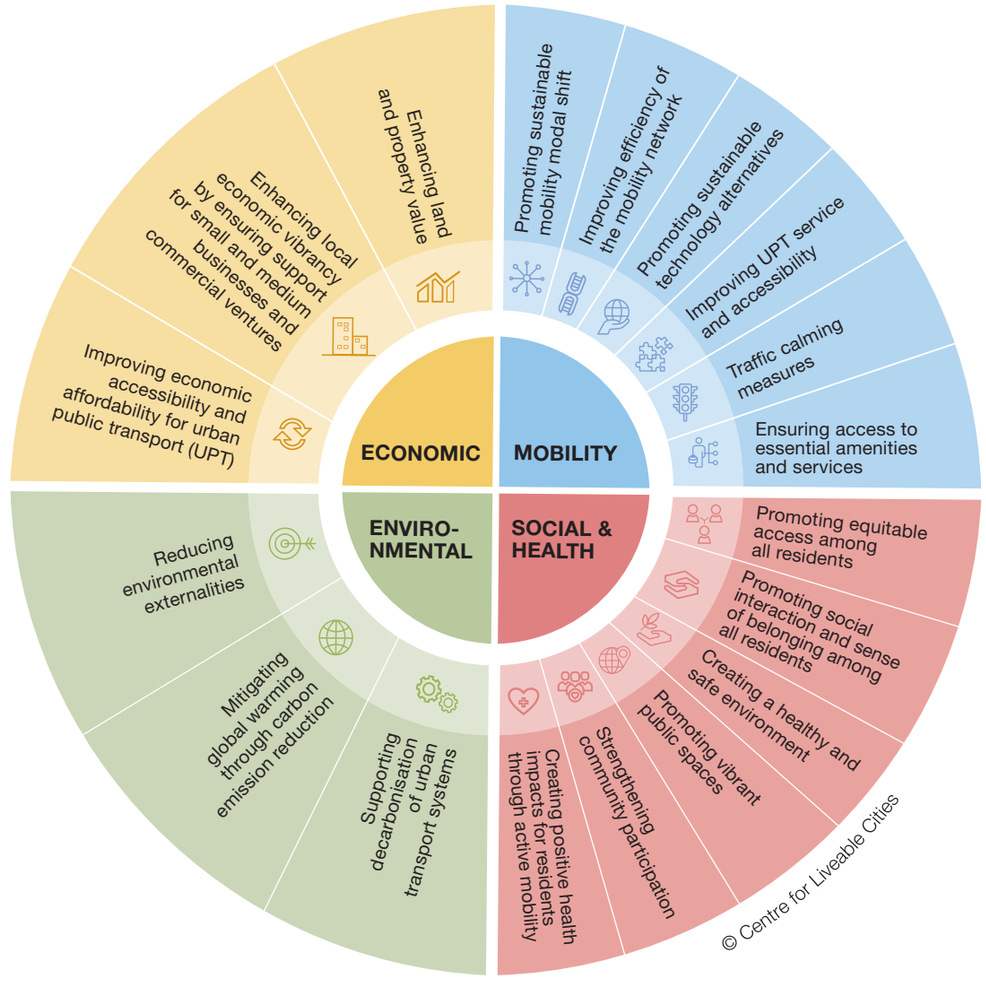
Recognising that mobility systems influence multiple domains, this study proposes a cross-domain approach to assess the holistic impacts of sustainable mobility interventions. This approach builds on the premise that mobility systems are embedded within broader urban systems, and that their impacts should be examined across multiple domains simultaneously rather than in isolation. Examining these domains together enables planners to better understand how mobility interventions contribute to wider urban objectives, while also making potential trade-offs more transparent.

By bringing diverse outcomes into a common evaluative framework, the cross-domain approach enables cities to:

- identify co-benefits that extend beyond transport performance,
- recognise potential trade-offs across domains,
- communicate the broader value of mobility interventions to policymakers and stakeholders, and
- embrace systems thinking to support more integrated decision making that involves all stakeholders.

## OVERVIEW

To operationalise the cross-domain approach, the framework developed in this study organises the assessment of sustainable mobility interventions across four interconnected domains: mobility, environmental, social and health, and economic. These domains reflect key areas through which mobility systems shape urban liveability.




Pillars and sub-pillars representing potential desired outcomes from sustainable mobility initiatives across the four pillars.

## MOBILITY

Mobility outcomes capture how interventions influence the overall functioning of urban transport systems.

They often seek to improve how people move and access opportunities across the city while reducing dependence on private vehicles. This means improving accessibility, safety, travel efficiency, modal share and connectivity—with a strong emphasis on shifting towards more sustainable, active and shared modes of transport.

Indicators in this domain examine travel patterns, network performance and user experience. These may include measures such as modal distribution, levels of accessibility to services and employment, travel times, and the safety and usability of transport infrastructure. Collectively, these indicators help illustrate how mobility interventions influence the effectiveness and inclusiveness of urban transport systems.

## ENVIRONMENTAL

Transport is a major contributor to urban air pollution, greenhouse gas emissions and noise, making mobility policies a critical lever for improving environmental conditions in cities.

According to the International Energy Agency, in 2022, the transport sector accounted for roughly 25% of global carbon dioxide ($CO_2$) emissions,[24] with land transport alone contributing approximately 75% of this total.[25]

Interventions that encourage walking, cycling and public transport can reduce emissions and improve air quality. Indicators in this domain examine factors such as emissions levels, air quality, noise exposure and the environmental efficiency of mobility systems.

## SOCIAL & HEALTH

Mobility systems can shape public health, safety, exposure to environmental externalities and the ability of people to interact in public spaces.

Interventions that prioritise walking and cycling can increase everyday physical activity, reduce long-term health risks and support safer street environments. Physical inactivity associated with sedentary lifestyles is estimated to cost the global economy around US$67 billion annually in healthcare expenditure and lost productivity, highlighting the broader societal implications of mobility systems that discourage active travel.[26]

At the same time, transport systems influence social inclusion and access to opportunities. Street design affects whether children, older adults and people with disabilities can travel independently, while pedestrian-friendly environments can support social interaction and community life. Indicators in this domain examine physical activity levels, traffic safety outcomes, accessibility for different user groups and patterns of public space use.

## ECONOMIC

Mobility systems influence patterns of economic activity and urban productivity by shaping access to employment, supporting commercial activity and enabling the functioning of urban economies.

Evidence from street redesign projects suggests that environments which support walking and cycling can also strengthen neighbourhood economic activity. Evaluations in cities such as New York City and London have recorded increases in pedestrian volumes and improvements in retail performance following street enhancements that prioritise active travel.[27,28]

Indicators in this domain examine aspects such as local economic activity, retail performance and broader economic value associated with mobility.

The following sections introduce the structure and application of the framework. A more detailed explanation can be found in the Practitioner's Guide.

## STRUCTURE

Evaluating cross-domain impacts requires not only selecting relevant metrics but also determining how different outcomes are prioritised and assessed. While the four domains provide a structured way to organise outcomes, their value depends on how they are translated into measurable indicators and applied in practice.

To capture the cross-domain benefits of sustainable mobility, the framework adopts a multi-criteria analysis (MCA) approach to evaluate a wide range of cross-domain criteria, especially for aspects that are difficult to quantify but are important considerations for liveability. This approach enables urban planners and policymakers to evaluate complex decisions by systematically comparing multiple policies against identified policy objectives.[29]

Within this approach, weights are derived using a structured method based on pairwise comparison, commonly implemented through the Analytical Hierarchy Process (AHP).[30] This allows stakeholder priorities to be incorporated systematically into the evaluation, ensuring that both measured impacts and policy preferences are reflected in the assessment.

The framework is organised as a hierarchical structure that links broad domain objectives to measurable outcomes by breaking them down into the following criteria:

- **pillars** that define the four core domains of impact—*mobility, environmental, social and health, and economic;*
- **sub-pillars** that represent key goals or intended outcomes within each pillar;
- **indicators** that are qualitative or quantitative measures used to assess progress towards these outcomes; and
- **metrics** that define how each indicator is assessed, providing specific units of measurement.

| Pillars | MOBILITY | ENVIRONMENTAL | SOCIAL & HEALTH | ECONOMIC |
|---|---|---|---|---|
| **Sub-Pillars** | Key goals or intended outcomes within each pillar; for example, promoting vibrant and socially active public spaces. | | | |
| **Indicators** | Qualitative or quantitative measures used to assess progress towards the outcomes at the sub-pillar level; for example, spaces that promote outdoor usage and active lifestyles. | | | |
| **Metrics** | Specific units of measurement that define how each indicator is assessed; for example, average dwell time, provision of sufficient public seating, percentage of public space dedicated to play areas. | | | |

Hierarchy of criteria with examples.

| PILLARS | | Which of the two pillars is more aligned with the goals of the project? | How much more important is it? (1-9) |
|---|---|---|---|
| A | B | | |
| Economic | Environmental | B | 7 |
| | Social and Health | B | 8 |
| | Mobility | B | 7 |

Example of a pairwise comparison of pillars using the Prioritisation Tool.

## TOOLS SUPPORTING THE FRAMEWORK

The framework is supported by a set of tools that support different stages of application—a Prioritisation Tool to establish priorities, a Self-Assessment Tool to evaluate performance, and a Reference Manual to interpret results.

### Prioritisation Tool

The Prioritisation Tool is used to establish project priorities by determining the relative importance of different outcomes at an early stage.

With urban outcomes increasingly shaped by diverse stakeholder priorities, local contexts and value systems, this tool provides a structured way to translate stakeholder preferences and policy objectives into weightings across pillars and sub-pillars.

This process is implemented using the AHP, which provides a structured method for deriving weightings from pairwise comparisons.[31] Rather than evaluating all criteria at once, the method compares them in pairs. Decision makers are asked to consider which of two outcomes is more important (e.g., whether environmental outcomes should be prioritised over mobility performance) and by how much.

These comparisons can be conducted through surveys, focus group discussions or stakeholder consultations and then be used to derive a set of weights that reflect collective priorities. The approach can be used in participatory and non-participatory contexts to assess complex problems and to complement existing tools like cost-benefit analysis.

### Self-Assessment Tool

The Self-Assessment Tool provides a structured method for evaluating how a mobility intervention performs across selected criteria, and allows cities to assess both direct and indirect impacts of the intervention. Using the tool, each metric is scored and assessed against defined benchmarks or thresholds. The weightings derived from the prioritisation process are then applied to the scores to generate domain-level and overall performance profiles.

One key feature of the tool is its ability to account for the cross-domain influence of an indicator or metric. Because an individual indicator or metric may contribute to multiple domains, the tool allows users to score them accordingly, as well as identify synergies and trade-offs to understand how outcomes interact. For example, a mobility metric such as the number of registered private motorised vehicles in an area can also affect environmental outcomes that measure air quality and noise pollution. The tool helps to highlight such relationships, allowing users to examine how pillars, indicators and metrics interact so they can better assess the full value of sustainable mobility initiatives.

### Reference Manual

The Reference Manual provides guidance on the selection, definition and interpretation of indicators, metrics and scoring.

The manual sets out the:

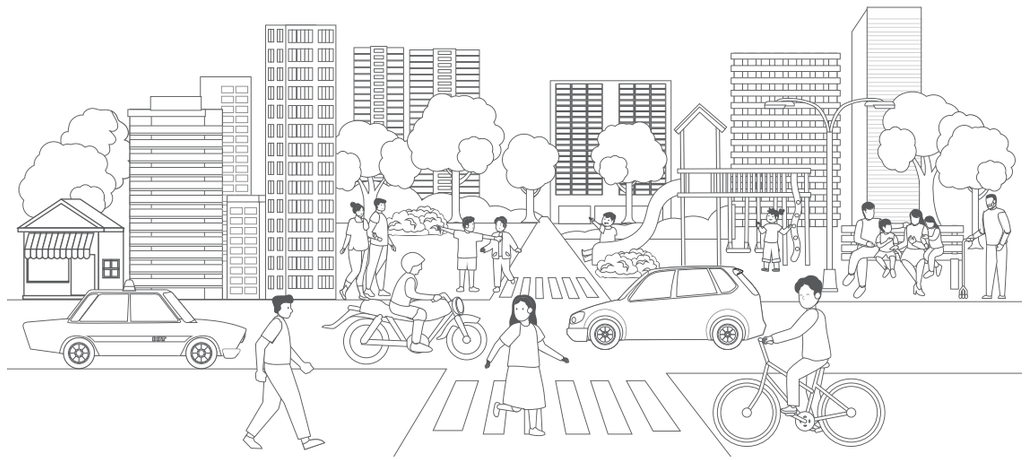
- definition and rationale behind each indicator and metric,
- corresponding scoring scales, and
- points for consideration in interpreting the results.

As data availability and policy priorities vary across cities, the reference manual is intended as an evolving resource rather than a prescriptive checklist. It enables cities to tailor the framework to local conditions while maintaining a consistent structure for cross-domain evaluation.

It is important to note that the list of indicators and metrics is not exhaustive but is intended to serve as a reference for key outcomes to be measured. The final list used for assessment must reflect the priorities and objectives set out for the project.

# Indicators, Metrics and Cross-Domain Mapping

The indicators and metrics are distilled to support the cross-domain evaluation of sustainable mobility initiatives by mapping them across the pillars.



| MOBILITY | | | | | | |
|---|---|---|---|---|---|---|
| **Indicator** | **Metric** | **Outcome Mapping** | | | | |
| | | ● | ● | ● | ● | |
| Walkability | Proportion of pedestrian zones that are barrier- and obstacle-free | ● | ● | | ● | |
| | Proportion of pedestrian lanes over total road network | | ● | ● | ● | |
| | Proportion of covered sidewalks (tree canopies or overhanging roofs) | | ● | ● | ● | |
| | Average width of sidewalk | | ● | | ● | |
| | Ease of crossing (presence of safe and direct crossing or pedestrian right-of-way) | | ● | | ● | |
| Modal share of active mobility modes and shared transport | Active mobility modal share | ● | ● | ● | ● | |
| | Shared transport modal share | | ● | ● | | |
| Modal share of public transport | Public transport modal share | ● | ● | ● | ● | |
| | Number of private motorised vehicles per 1,000 residents registered within the area | ● | ● | ● | | |
| Provision of mobility hubs | Number of transport modes within a mobility hub | ● | ● | ● | ● | |
| | Number of transport-related amenities and services within a transport hub | ● | ● | ● | ● | |
| | Number of non-transport related amenities and services within a transport hub | ● | ● | ● | ● | |
| Ease of intermodal integration | Average transfer time between modes | ● | ● | | ● | |
| Bicycle priority | Proportion of bicycle lanes within the total road network | | ● | ● | ● | |
| Bus priority | Proportion of bus priority lanes within the total road network | | ● | ● | | |
| Efficiency of PT buses | Average speed of urban buses | | ● | | | |
| Level of congestion | Average congestion hours on/near the area per day | ● | ● | ● | ● | |
| Public charging points for electric vehicles (EVs) | Ratio of public charging points (PCPs) per EV | | ● | ● | | |
| | Proportion of residential areas with access to EV recharging points within a radius of 700 m (15-min walk) | | ● | ● | | |
| Urban public transport (UPT) accessibility/ level of service | Population living within a 500-m distance of a 5-minute headway to a UPT stop or station | | ● | | ● | |
| | Average waiting time at UPT stops or stations | | ● | | | |
| | Average walking distance to the closest UPT stop or station | | ● | | | |
| Speed regulation | Average maximum vehicle speed allowed in the area | | ● | | ● | |
| Parking regulation and policy | Area dedicated to parking spaces of private motorised vehicles | | ● | ● | ● | |
| | Number of bicycle parking spots per resident | | ● | | ● | |

## ENVIRONMENTAL

| Indicator | Metric | Outcome Mapping |
|---|---|---|
| Urban heat island (UHI) effect | Total area covered by permeable surfaces | |
| | UHI values | |
| Green space | Total area covered by green space | |
| Blue space | Total area covered by blue space | |
| Air pollution | Annual average air quality index (combination of pollutants) | |
| Noise pollution | Annual average level of noise per day | |
| Share of renewable energy in transport | PT buses on clean energy | |
| | Taxis on clean energy | |
| | EVs in total vehicle fleet | |

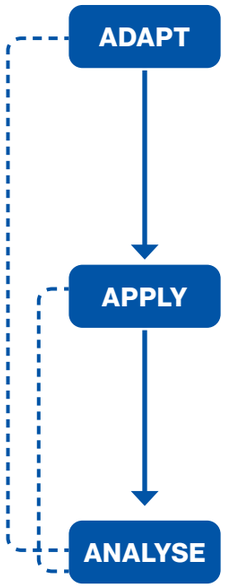
## SOCIAL & HEALTH

| Indicator | Metric | Outcome Mapping |
|---|---|---|
| Spaces that promote outdoor usage and active lifestyle | Average dwell time in the area | |
| | Provision of sufficient public seating infrastructure | |
| | Proportion of public space dedicated to play areas | |
| User profile mix | Diversity of genders and ages of users in the area | |
| | Diversity of household incomes in the area | |
| | Diversity of household types in the area | |
| Accessibility to urban public space | Area of urban public space per resident within a radius of 700 m (15-min walk) of their residence | |
| Placemaking/vibrancy of public spaces | Diversity of users observed in public spaces | |
| | Diversity of uses in public spaces | |
| | Average number of cultural, social and recreational events in public spaces per month | |
| Community engagement/ participatory planning | Number of public consultations for feedback sessions | |
| Public perception of sustainable mobility initiatives | Level of participation | |
| Commuter satisfaction scores | Efficiency and comfort of public transport | |
| Perceived safety of streets | Perceived safety of streets by pedestrians | |

## ECONOMIC

| Indicator | Metric | Outcome Mapping |
|---|---|---|
| Economic activity generated | Number of events in the area that require purchase of an entry ticket | |
| | Change in revenue generated by retail/commercial activity in the area | |
| | Change in number of small and medium-sized enterprises (SMEs) | |
| | Change in commercial space vacancy rates relative to city median | |
| Property value | Average purchasing value of property in the area | |
| Public transport (PT) affordability | Proportion of household income spent on public transport | |

## STEPS FOR APPLYING THE FRAMEWORK




- Define the core problem, objectives and intended outcomes of the intervention.
- Select relevant indicators and metrics across the four pillars.
- Refine benchmarks, thresholds and metrics to reflect local context and policy priorities.

- Use the Prioritisation Tool to establish project priorities and assign weightings across the pillars.
- Apply the Self-Assessment Tool to score selected indicators against the defined benchmarks.
- Aggregate results to generate overall performance profiles and identify cross-domain relationships.

- Visualise results using summary tables and comparative charts to support interpretation.
- Interpret outcomes across the domains to identify strengths, gaps, synergies and trade-offs.
- Use insights to inform decision-making, iterate and refine interventions, and guide future applications.

## WHEN TO USE THE FRAMEWORK

The framework can be applied at different stages of the policy and project cycle, depending on the purpose of the assessment. It can be used during:

- **early-stage planning** to define scope, priorities, outcomes and success criteria;
- **pre-implementation** to measure current performance across identified framework criteria;
- **implementation** to understand how an intervention is performing and identify areas for refinement; and/or
- **post-implementation review** to evaluate outcomes, including trade-offs and co-benefits and inform future scaling or replication.

It can also be applied iteratively across all stages of the policy cycle, using a combination of quantitative, qualitative and participatory evidence.

## SUITABLE SCALES FOR APPLICATION

While the framework was initially developed for neighbourhood-scale* and place-based interventions, its application can be extended across a range of scales, from individual street interventions to neighbourhood-level programmes and city-wide strategies.

At a neighbourhood or place-based scale, the framework can assess the wide-ranging co-benefits of interventions that often fall below the threshold of cost-benefit analyses. At this scale, it is generally easier to define project scope, intended outcomes and spatial boundaries, making it more feasible to observe and interpret changes over time and link specific design decisions with measurable outcomes across domains.

When applied at a larger scale, the framework can support the evaluation of integrated mobility strategies and policies, helping planners assess how city-wide interventions perform across multiple domains simultaneously.

At either scale, the framework encourages planners to situate interventions within broader urban mobility goals—such as reducing private car dependency, supporting active travel, or meeting climate and equity targets—so that localised impacts can also be understood in terms of their contribution to larger strategic objectives.

*Neighbourhood scale refers to the everyday, human-scale environments where public life unfolds—typically within a 5- to 15-minute walking distance. These are places where people can access most of their daily needs and are small enough to be experienced on foot, yet large enough to influence how people interact, move and connect in daily life.

By applying the framework iteratively across all stages of the policy cycle—from early planning to post-implementation review—cities can continuously refine their interventions and respond to emerging challenges and opportunities. This approach not only strengthens the evidence base for sustainable mobility but also fosters a culture of learning and collaboration across disciplines and stakeholders.

Through shared experiences, ongoing monitoring and evaluation, and iterative improvements, the framework serves as a catalyst for more inclusive, effective, and resilient urban mobility solutions. Its value lies not only in the outputs it generates, but in the cross-domain conversations it enables.

A more detailed explanation of the methodology and application can be found in the Practitioner's Guide. Scan the QR Code below to access the Practitioner's Guide or access it at https://go.gov.sg/clcbook-sustainablemobility.

# 03

## Applying the **Framework**

Applying a cross-domain lens to real-world interventions reveals how mobility can deliver benefits beyond transport outcomes. Co-benefits and trade-offs become more visible, strengthening the evidence to support more informed decision-making.




# The Cross-Domain Approach in Practice

Cities are increasingly recognising the need to prioritise active mobility, public transit and other low-emission modes of travel to address climate change, improve public health and foster social equity.

This chapter explores how cities around the world are experimenting with various mobility strategies—ranging from expanding public transportation networks and reclaiming streets for pedestrians and cyclists, to integrating green infrastructure and implementing data-driven mobility solutions. The following case studies are from cities that illustrate diverse and context-specific approaches to transforming urban mobility. Examples from these case studies highlight the importance of local context in shaping effective solutions while also demonstrating that certain principles—such as equity, accessibility and environmental sustainability—remain universal.

By studying how these cities navigate their unique circumstances, we gain valuable insights into the adaptive and forward-looking approaches required to create more liveable urban environments. These approaches suggest that while the goals of sustainable mobility are shared, the paths to achieving them must be as varied as the cities themselves.

CASE STUDY

# Superblocks
## | Barcelona

*The Superblocks have not only helped enhance mobility outcomes within the neighbourhoods but also delivered wide-ranging health and social benefits with more public spaces dedicated for gathering, play and connection.*

Barcelona is widely recognised as one of Europe's leading cities for sustainable urban mobility. The city's compact urban form, combined with its extensive multimodal land transport network—such as its metro, trams, buses and bike-share system—enable strong connectivity, supporting over 80% of trips made by walking, cycling or public transport today.[32]

This was, however, not always the case. As one of Europe's densest cities, Barcelona grappled with a complex urban paradox in the 2000s. While its dense urban fabric supported walking and vibrant street life, cars occupied approximately 50% to 70% of its roads, which led to fewer green and public spaces being accessible for recreational activities. Interconnected challenges such as air and noise pollution, road safety issues and limited opportunities for physical activity prompted the city to rethink how its street space was allocated.[33]

The Barcelona City Council introduced the Superilles, or Superblocks, programme in 2016 to reclaim its streets for public use and to enhance mobility, environmental and social outcomes in the city.



## Barcelona
*in numbers*

Area (2025)
**101.4 km²**

Population (2025)
**1.71 million**

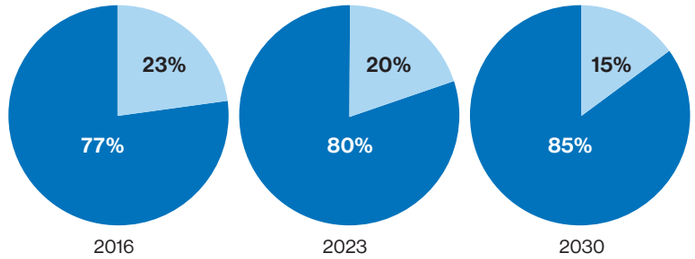
Population Density (people per km²) (2025)
**~16,900**

Average Green Space per Capita (2016)
**7 m²**
(below the World Health Organization's recommendation of 9 m² per capita)

Cars per km² (2021)
**5,844**
(highest car density in Europe)

Noise Pollution Resulting from Road Traffic (2020)
**>86%**

### Modal Share




* Sustainable mobility modes include walking, cycling, public transport and personal mobility devices.

*Note: Figures are rounded off to the nearest decimal*

### Urban Mobility Plan 2025–2030

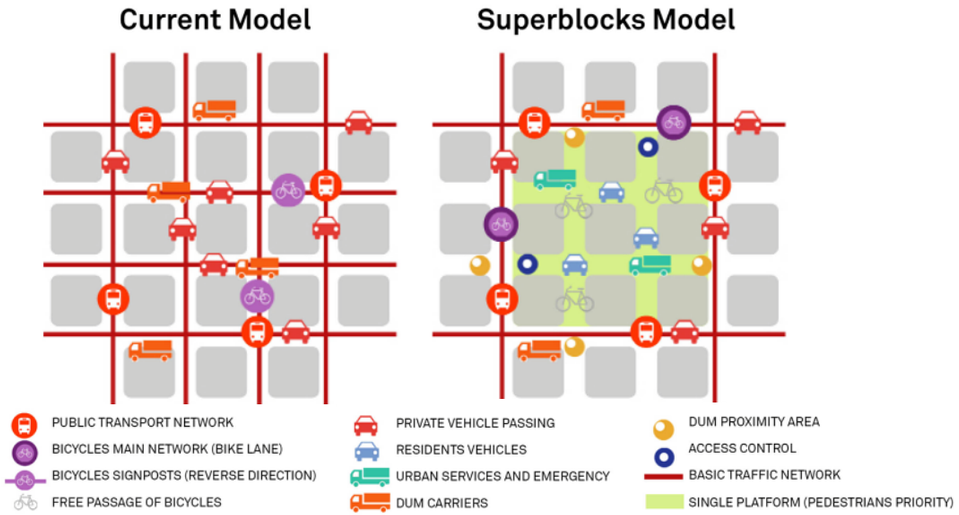
The plan sets out a roadmap to transform the city's transport system towards a more sustainable and people-centric model. Building on a sustainable mode share of over 80%, it targets 85% of all journeys to be via sustainable modes by 2030, while reducing private vehicle use and increasing public transport, cycling and personal mobility trips.[34]

The main goals of the Urban Mobility Plan are to:

- Reduce private car use
- Improve air quality
- Expand liveable public space
- Address urban inequalities

**Sources:** Instituto de Estadística de Cataluña (Area,[35] Population,[36] Population Density[37]), Barcelona City Council (Modal Share[38]), Ajuntament de Barcelona (Green Space per Capita,[39] Cars per km²,[40] Noise Pollution,[41] Urban Mobility Plan[42]) (see endnotes for citations in full)

## RECLAIMING STREETS FOR THE PEOPLE




Road space within the Superblocks is reclaimed to prioritise pedestrians and active mobility modes, and to introduce more public spaces for the community.

A Superblock typically consists of a group of nine city blocks, on a three-by-three grid, aggregated into a larger unit. Within each Superblock, through-traffic is restricted by design, with only local access permitted for residents, deliveries and emergency services. Motorised vehicles must enter and exit in the same direction, eliminating shortcutting traffic and calming vehicle speeds. Major through-traffic is redirected to perimeter arterial roads designed to absorb the redistributed flows.[43] This design reclaims up to 70% of former road space for pedestrians, cyclists, urban greenery, play areas and community use.[44]

At its core, the Superblocks programme aims to:

- Improve air quality
- Reduce noise pollution
- Expand accessible public space
- Promote health and well-being
- Improve road safety

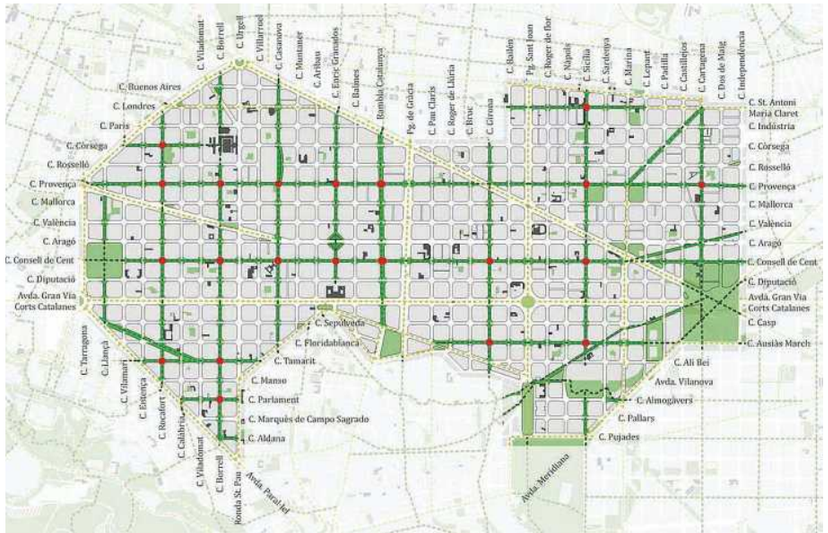
## EARLY IMPLEMENTATION AND ITERATION

Between 2016 and 2019, Barcelona launched its first three Superblocks under the city's "Omplim de vida els carrers" ("Let's fill the streets with life") campaign in the neighbourhoods of Poblenou, Sant Antoni and Horta.

The first Superblock in Poblenou faced considerable resistance due to its ad hoc rollout, limited community input and concerns about gentrification and displacement. In response, the City Council revised its approach, making citizen consultation and participation one of the core elements in the planning and design of subsequent Superblocks. This early experience underscored the importance of strong local governance, iterative design and meaningful participation to legitimise the project and secure long-term support, resulting in much better reception in Sant Antoni and Horta.

The Superblocks helped reclaim streets for play, recreation and social life—vital elements in a city with limited green space.

## ADAPTING THE MODEL TO THE GREEN AXES IN EIXAMPLE




Planned network of Superblocks and Green Axes in the Eixample district.

Building on lessons from the pilots, Barcelona adapted the Superblocks concept to introduce the Green Axes plan for the Eixample district—one of the city's most congested and polluted areas. The revised strategy aims to rebalance Eixample's car-dominated grid by improving active mobility infrastructure, expanding tree cover, improving sustainable drainage and transforming intersections into public spaces. The Green Axes initiative is estimated to create 21 green corridors and 21 urban squares, adding nearly 0.4 km² of pedestrian space and greenery to the district.[45]

The concept has inspired a broader shift towards integrating Superblocks with complementary urban initiatives such as safer school streets, new cycling lanes, major avenue redesigns and new public parks. These demonstrate that the Superblocks programme is not a static blueprint but a flexible, evolving toolkit that can be adapted and scaled to the local context to realise mobility, environmental and social benefits citywide.

## INTERPRETING SUPERBLOCKS THROUGH A CROSS-DOMAIN LENS

The framework was applied to the Superblocks in Sant Antoni and Poblenou, retrospectively, to reveal the cross-domain impacts of the initiative at the neighbourhood level.

Qualitative and quantitative sources, as well as published studies, were drawn upon to conduct the analysis. The Prioritisation Tool was applied to determine the outcome priorities for the Superblocks programme. While these weightings were not used in the original planning process, they serve to demonstrate how the framework can reflect local priorities in future applications.

| PILLAR | PRIORITY | RATIONALE |
|---|---|---|
| MOBILITY | Medium | The Superblocks programme aimed to reorganise street space, improve walking and cycling infrastructure, and introduce traffic calming measures as a means of achieving broader goals around liveability. |
| ENVIRONMENTAL | High | Improving air quality, reducing noise pollution and introducing urban greenery were key outcomes of the Superblocks programme, particularly in dense areas with limited public space. |
| SOCIAL & HEALTH | High | A primary goal of the Superblocks programme was to improve safety, well-being, social cohesion and public health outcomes. |
| ECONOMIC | Low | Improving economic outcomes was not a primary focus of the Superblocks programme, although improved public space and increased footfall may support local activity and neighbourhood vitality over time. |

The outcome priorities for the Superblocks programme, as determined by the application of the Prioritisation Tool.

## MOBILITY PILLAR OUTCOMES

- Traffic calming measures in the Sant Antoni Superblock led to a 17% decrease in traffic.[46]
- A significant increase in active travel was observed, with more residents feeling safer within the Superblock, and choosing to walk or cycle, especially in areas where improvements in street design were accompanied by green space enhancements and traffic calming measures.
- However, there were concerns about displaced traffic causing increased congestion on boundary roads.[47] This highlights the importance of considering system-level impacts or externalities outside the project boundary for place-based or neighbourhood-scale interventions.

## ENVIRONMENTAL PILLAR OUTCOMES

- The Poblenou Superblock was reported to have added 193 new trees and created 7,608 $m^2$ of space for greenery in the neighbourhood,[48] enhancing environmental outcomes of the area.
- In Sant Antoni, there were reported improvements in air pollution, with nitrogen oxide ($NO_2$) levels falling by 25% and PM10 levels by 17%, alongside reductions in noise.[49] In Poblenou, measured changes were limited, but residents provided qualitative feedback that there was a reduction in both air and noise pollution.[50]
- However, recent air pollution modelling suggests that these gains may not be uniform across the city. Studies caution that reductions in $NO_2$ concentrations within the Superblocks may be offset by increases in surrounding areas due to traffic re-routing.[51] This highlights the need to be cognisant of unintended trade-offs to areas outside of the project's boundary.


Mapping the cross-domain outcomes associated with the Superblocks.

The Sant Antoni and Poblenou Superblocks have not only improved the safety of the neighbourhoods, but have provided more public spaces to support stronger social cohesion.

## SOCIAL & HEALTH PILLAR OUTCOMES

- The Sant Antoni and Poblenou Superblocks have not only improved the tranquillity and safety of these neighbourhoods, but have also provided more public spaces for social cohesion, enhancing the mental well-being of their users.[52]
- In Sant Antoni, it was reported that there was a diverse mix of users in the area, alongside longer dwelling times. In Poblenou, families and office workers, in particular, have been observed to use the repurposed spaces for play and informal gatherings. Where co-creation processes were embedded, residents have described stronger social ties and a deeper sense of community ownership.[53]
- A citywide health impact assessment found that full implementation could prevent 667 premature deaths annually, primarily through reductions in air pollution, traffic noise and heat exposure, alongside increased physical activity and access to green space. This translates to an average life expectancy gain of nearly 200 days and €1.7 billion in annual savings.[54]
- Early resistance in the Poblenou Superblock underscored concerns over gentrification, prompting later pilots to adopt stronger community participation frameworks.

## ECONOMIC PILLAR OUTCOMES

- While not a primary objective of the Superblocks programme, improved street environments and reclaimed public space have supported local foot traffic and retail vitality in Sant Antoni and Poblenou.
- At the same time, enhanced liveability has raised concerns over gentrification which would lead to the risk of rising rents and displacement,[55] highlighting the importance of coupling urban design with housing and equity safeguards.

Repurposed street space for play and community life in the Poblenou Superblock.

When viewed through the framework, Barcelona's Superblocks programme delivers co-benefits far beyond mobility alone, redefining how well-designed urban spaces can contribute to better public health, environmental resilience and social equity. The city's latest Urban Mobility Plan 2025–2030 further reflects this recognition and continues to prioritise active mobility infrastructure, expand public transport, improve accessibility and safety, and reduce dependency on cars.

CASE STUDY

# Low Traffic Neighbourhoods
## | London


*Modal filters on a road in Kingston upon Thames, one of the boroughs with LTNs.*

London is often recognised as a leader in urban transport innovation. Its world-famous Tube, dense bus network and growing cycling network have helped make sustainable modes available for daily travel.

Yet historically, car dependency was deeply entrenched across much of the city. Poor air quality and negative health outcomes were among its most visible consequences. Congestion was a key issue too—residential streets, which make up around 80% of London's road network, became increasingly affected by rat-running, as navigation apps diverted drivers away from congested main roads. This was further compounded by an inactivity crisis—many short trips that could be walked or cycled were still made by car due to unsafe roads and a lack of protected infrastructure, particularly for vulnerable groups.[56]

To address these challenges, the Mayor's Transport Strategy (MTS) embedded the Healthy Streets Approach as its central framework—a people-centred vision for making streets safer, healthier and more inviting for everyone. Alongside city-wide measures, initiatives such as Low Traffic Neighbourhoods (LTNs) were introduced at the neighbourhood scale to encourage a shift in travel behaviour towards more active and low-carbon modes, with the ambition that 80% of all trips in London would be made on foot, by bike or by public transport by 2041.[57]



# London
## *in numbers*

Area (2025)
**1,572 km²**

Population (2025)
**9.65 million**

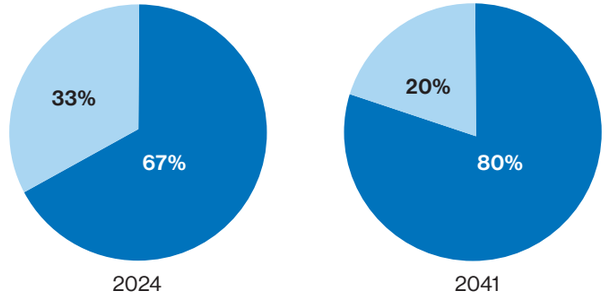
Population Density (people per km²) (2025)
**~6,139**

NOx Pollution Resulting from Road Transport
**~50%**

Fatal Collisions with Speed Reported as a Contributing Factor (2024)
**~50%**

Congestion Cost per Driver (2024)
**£942**
London topped the INRIX 2024 Global Traffic Scorecard as the most congested city in Europe

### Modal Share




* Sustainable mobility modes include walking, cycling, public transport and personal mobility devices.

### Mayor's Transport Strategy (MTS)

Informed by the Healthy Streets Approach, the MTS sets out a plan for how the city will shift towards sustainable mobility, with an emphasis on walking, cycling and other forms of active mobility.

The main goals of the MTS are to:

- Improve air quality and enhance public health
- Reduce car dependency
- Transition to a zero-emission bus fleet by 2034

**Sources:** Greater London Authority (Area,[58] Population,[59] Population Density[60]), Transport for London (Modal Share,[61] NOx Pollution,[62] Fatal Collisions with Speed Reported,[63] Mayor's Transport Strategy[64]), INRIX (Congestion Cost[65]) (see endnotes for citations in full)

## RECLAIMING RESIDENTIAL STREETS

LTNs emerged as a simple yet effective strategy to translate some of the ambitions of the MTS on the ground. They gathered momentum through the Mini-Holland active travel programme, which combined protected cycle lanes, redesigned town centres, safer crossings and public realm improvements. LTNs were a central tool within this wider approach to reduce through-traffic on residential streets by using modal filters, bollards or planters, and by prioritising the needs of pedestrians and cyclists.

When COVID-19 hit, the city faced a new imperative—keeping people moving safely while public transport capacity was reduced. More than 100 LTNs appeared across London in less than a year to promote walking and cycling as viable alternative transport modes. However, the rapid rollout revealed several challenges such as perceived unfairness, displacement of traffic to boundary roads and lack of consultation, resulting in mixed responses from the public.[66]


A crowd outside the Ealing Council House protesting the LTN scheme in 2021.

## LESSONS FROM WALTHAM FOREST AND EALING

Varied experiences in two of London's boroughs illustrate how different implementation approaches shaped the outcomes of LTNs.

In Waltham Forest, the council had been laying the groundwork to introduce LTNs since 2018, engaging residents and stakeholders before any schemes were in place, and using their feedback to refine features and address concerns. With the implementation of the LTNs, early resistance gave way to broad local support as residents experienced quieter streets, cleaner air and safer spaces for walking and cycling. By 2020, the borough had recorded significant rises in active travel and improvements in air quality and road safety—evidence that reclaiming local streets could deliver cross-domain gains when supported by careful co-creation and sufficient time for adaptation.[67]

In contrast, when the Ealing council introduced LTNs in 2020, they rolled out multiple LTNs rapidly and without sufficient public engagement. As a result, concerns over traffic displacement to boundary roads, lack of access to emergency access services, and perceived negative impacts to local businesses triggered strong resident pushback, leading to the removal of most of the schemes within a year.[68]

These contrasting experiences highlight the need for effective planning with careful phasing and communication, underpinned by strong governance. They also highlight that LTNs do deliver co-benefits when they are part of a broader neighbourhood transformation. When paired with protected cycle infrastructure, an improved public realm and complementary services, LTNs make alternatives to driving genuinely attractive—particularly when equity is considered so that benefits and impacts are fairly distributed across different user groups.

## INTERPRETING LOW-TRAFFIC NEIGHBOURHOODS THROUGH A CROSS-DOMAIN LENS

The framework was applied to the LTN programme retrospectively to study its cross-domain impacts, drawing on evidence from schemes across multiple boroughs. The assessment draws upon a combination of published academic studies, borough-level monitoring reports, and strategic policy documents, including the MTS and Transport for London's Healthy Streets Approach, to conduct the analysis. The Prioritisation Tool was applied to determine outcome priorities for the LTN programme. While these weightings were not part of the original planning process, they serve to demonstrate how the framework can reflect local priorities and support cross-domain interpretation in future applications.

| PILLAR | PRIORITY | RATIONALE |
|---|---|---|
| MOBILITY | High | Reducing through-traffic and improving infrastructure for walking and cycling were central to the LTN model. |
| ENVIRONMENTAL | High | Improving air quality and reducing noise pollution were some of the key motivations of the LTNs, particularly in areas affected by high traffic volumes and congestion. |
| SOCIAL & HEALTH | High | Addressing road safety, improving conditions for active travel and responding to broader public health concerns, including low physical activity levels, were very important considerations for the LTNs. |
| ECONOMIC | Low | Economic outcomes were not a primary focus for the LTNs, although improved street environments may influence local activity and access to neighbourhood amenities. |

The outcome priorities for the LTN programme, as determined by the application of the Prioritisation Tool.

### MOBILITY PILLAR OUTCOMES

- According to London-wide studies, the median number of vehicles on the roads inside LTNs has decreased from 1,200 to 650 per day, with 74% of streets within LTNs recording reduced traffic and minimal impacts on peripheral traffic.[69,70] In addition, residents living inside LTNs have shown behavioural shifts towards active modes of transport.
- A longitudinal study of the boroughs involved in the Mini-Holland programme from 2017 to 2021 found that people walk or cycle more often, with average walking and cycling time increased by up to 66 minutes and over 20 minutes, respectively, compared to control areas.[71] Many short car trips have also been replaced by local journeys on foot or by bike.
- In parts of the Dulwich Village LTN, 20% of people cycling at peak times were found to be children, reflecting the extent to which reduced traffic enables younger residents to use streets more independently.[72]
- Car and van ownership among residents of Waltham Forest LTNs fell by 6% between 2015 and 2019, and residents within the Lambeth LTN reported a 6% reduction in miles driven—suggesting that LTNs influence travel behaviour beyond the immediate neighbourhood and over sustained periods.

### ENVIRONMENTAL PILLAR OUTCOMES

- Air pollution levels, particularly $NO_2$, dropped inside many of the LTNs. Those in the borough of Islington saw an average decline of $NO_2$ by 8.9% and 5.7% at the periphery and within the boundaries, respectively, compared to control groups.[73]
- However, some boroughs experienced mixed effects, with boundary roads recording no change or marginal increases in $NO_2$.[74] This underscores the need to balance potential trade-offs in air quality on boundary roads if broader network management measures are not in place.

## SOCIAL & HEALTH PILLAR OUTCOMES

- Streets in Waltham Forest's LTNs were found to be 3 to 4 times safer for walking and cycling—without creating negative impacts on safety at their boundaries. Over 40% of residents within LTNs in Birmingham, Bournemouth, Ipswich and Salford also experienced an increase in road safety.[75]
- Road injuries fell by around 35% inside LTNs and 2% at boundaries, demonstrating that removing through-traffic makes streets safer for people walking and cycling.[76]
- A 10% reduction in crime was recorded in Waltham Forest's LTNs from 2012 to 2019.[77]
- In Waltham Forest, no adverse changes to emergency service response times were observed, and there is some evidence of marginal improvement on boundary roads.
- The cleaner air, lower noise levels and additional space for play and social life have been found to contribute to everyday health gains. In Waltham Forest, 31% of survey respondents agreed that LTNs help to foster a sense of community in the neighbourhood, while 29% felt that LTNs improved social ties.[78]
- Evidence also highlights the differentiated impacts of LTNs on specific user groups; for instance, people with specific accessibility needs can experience easier and more pleasant journeys, greater independence, and benefits to both physical and mental health.[79]

## ECONOMIC PILLAR OUTCOMES

- Survey results showed a moderate economic uptick within LTNs in Birmingham, Bournemouth, Ipswich and Salford, with 14% to 17% of respondents visiting local dining places and shops more frequently after implementation.[80]
- Despite tangible economic benefits, there is awareness that public improvements need to safeguard against gentrification, potential decline in footfall if the scheme is not well-received, and rising rents that could price out local businesses. [81]


Mapping the cross-domain outcomes associated with Low-Traffic Neighbourhoods.

The cross-domain impacts of LTNs highlight their role not just as local traffic measures, but as part of a wider shift in how London approaches mobility and street use. This shift is reflected across the city's broader transport strategy: the Elizabeth Line has demonstrated how transformative infrastructure can generate economic uplift and improve connectivity at metropolitan scale, while the Ultra Low Emission Zone has shown how bold policy can deliver measurable improvements in air quality across a complex, multi-borough city. The strong public support for Oxford Street Pedestrianisation further illustrates how Londoners' appetite for liveable streets extends well beyond any single neighbourhood.

Together, these initiatives reveal how a city can align governance, infrastructure, and community engagement in pursuit of shared urban objectives—and in doing so, offers a compelling model of what sustained commitment to sustainable mobility can achieve.

CASE STUDY

# Friendly Streets
## | Singapore


*An artist's impression of the Friendly Streets at Choa Chu Kang Avenue 2.*

Singapore's limited land necessitated an integrated approach to transport infrastructure and land-use planning from the outset. The city's urban mobility landscape has, over the decades, transformed significantly into a dynamic tapestry of interconnected transportation systems, where urban planning initiatives and technological innovations foster seamless, sustainable and inclusive mobility for its residents.

This integrated approach is reinforced at the policy level through national strategies like the Singapore Green Plan 2030, which sets ambitious environmental targets across the whole of government, and the Land Transport Master Plan 2040, which guides the transformation of Singapore's transport system towards a greener and more connected future.

This reflects a broader recognition that mobility systems shape not only how people travel, but also how neighbourhoods function and how public spaces are experienced. Alongside investments in rail expansion, cycling networks and bus services, increasing attention has been placed on the design of streets and public spaces that support everyday mobility. It is within this context that the Land Transport Authority (LTA) introduced the Friendly Streets programme, a neighbourhood-scale initiative to make Singapore's residential streets safer and more accessible, and to support walk-cycle-ride (WCR) modes.



# Singapore
## *in numbers*

Area (2025)
**744.3 km²**

Population (2025)
**6.11 million**

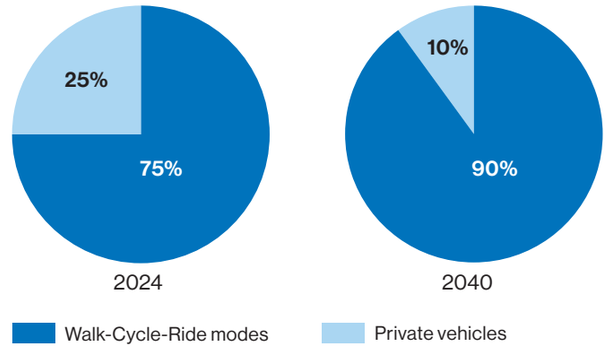
Population Density (people per km²) (2025)
**~8,300**

Land Used for Land Transport Infrastructure (2020)
**11.4%**

Accessibility and Proximity (2025)
**9 in 10**
Households Within 20 Minutes of Their Nearest Neighbourhood Centre via WCR Modes

Total Cycling Paths (2025)
**760 km**

### Modal Share
(Peak Period)




### Land Transport Master Plan 2040

Aligning with the goals of the Singapore Green Plan 2030 to enhance the provision of sustainable transportation modes, the Land Transport Master Plan 2040 sets out the vision and strategies to create an accessible, sustainable and inclusive land transport system by encouraging commuting via its WCR approach.

This is coupled with a focus on creating mobility solutions to deliver these wider benefits:

- Greener streets that improve environmental quality
- Public spaces that promote health and social connection
- Infrastructure that supports economic vitality

**Sources:** Department of Statistics Singapore (Area,[82] Population,[83] Population Density,[84] Land Used for Land Transport Infrastructure[85]), Land Transport Authority (Modal Share,[86] Accessibility and Proximity,[87] Total Cycling Paths,[88] Land Transport Master Plan[89]) (see endnotes for citations in full)

## REFRAMING SAFER NEIGHBOURHOOD STREETS

In Singapore, the most frequent and routine journeys—walking to a nearby Mass Rapid Transit (MRT) station, accompanying children to school, or accessing parks and community facilities—take place within neighbourhoods. These everyday trips are shaped by the design and conditions of neighbourhood streets, which serve multiple functions: providing vehicle access while also supporting walking and cycling for short-distance trips. In residential areas, these streets are often shared spaces where motorists, pedestrians and active mobility users interact within the same environment.

As Singapore continues to encourage more walking and cycling as part of its WCR approach, there is an increasing emphasis on improving how streets function as shared spaces. This includes reimagining and redesigning road spaces to ensure that different modes can coexist more safely and comfortably within neighbourhood streets, making them more accessible to commuters of all ages and abilities and encouraging more considerate behaviour among road users.


Pedestrians using a raised zebra crossing at the Friendly Streets in Ang Mo Kio.

## CREATING SAFER SHARED STREETS

The Friendly Streets programme, introduced by the LTA, reflects a shift in how neighbourhood streets are understood and designed as shared spaces that support a wide range of users, modes and activities.

The programme specifically targets areas with high pedestrian activity and key amenities, such as MRT stations, schools and neighbourhood centres, where improvements to street conditions can have the greatest impact on everyday mobility. It is guided by three key objectives:

- to make walking safer and more comfortable
- to improve access to key destinations, and
- to encourage more gracious behaviour among road users.

Rather than relying on large-scale infrastructural changes, Friendly Streets focuses on targeted interventions within residential areas, combining physical design measures and behavioural cues.[90] These include widened footpaths, the addition of barrier-free and raised zebra crossings, longer pedestrian crossing times, and shorter waiting times at signalised crossings to improve access and walking comfort to key destinations. Visual elements such as gateway treatment, with reduced speed limits and green road surfaces, are used to signal to motorists to slow down and watch out for pedestrians. Traffic signs with a bright smiling sun emblem have been installed along all Friendly Streets to connote a welcoming environment where the community can move around in a safe, comfortable and enjoyable way.


Mapping the cross-domain outcomes of the Friendly Streets programme.

In addition, Friendly Streets may opportunistically bring about improvements to bus stops and connections to MRT stations to support more seamless first- and last-mile journeys within the public transport network. The impact of such interventions is often most visible not only within individual streets, but in how they strengthen connections across the wider neighbourhood.

Prior to implementation, the LTA engaged residents and local stakeholders to better understand needs and challenges within each neighbourhood.[91] While some motorists raised concerns about reduced traffic speeds, most residents supported the proposed traffic calming measures and pedestrian-friendly features and gave feedback on the proposed scheme.

The LTA used this feedback to refine the design and location of interventions where feasible—shifting crossing locations, redesigning crossing types to reflect local demographics, and optimising the scope of traffic calming measures, especially in areas with a larger number of competing needs. By responding to local needs, Friendly Streets reflects a paradigm shift in street design that is not only functional but grounded in how residents use and experience their neighbourhoods.

## INTERPRETING FRIENDLY STREETS THROUGH A CROSS-DOMAIN LENS

So far, Friendly Streets pilots have been implemented in several neighbourhoods across Singapore, including Ang Mo Kio, Bukit Batok West, Tampines, Toa Payoh and West Coast. The framework was applied retrospectively to these pilots to gain meaningful insights into the cross-domain potential of the Friendly Streets programme. As an early-stage programme, the evidence base draws primarily from observed behavioural data and perception surveys from residents in these pilot sites, rather than data from longitudinal studies. Nonetheless, initial findings across the four pillars offer meaningful insights into the programme's cross-domain potential.

| PILLAR | PRIORITY | RATIONALE |
|---|---|---|
| **MOBILITY** | High | The Friendly Streets programme was primarily designed to improve the safety and accessibility of neighbourhood streets for all road users. Reducing vehicular speed limits and supporting active mobility were central objectives guiding the design of the programme. |
| **ENVIRONMENTAL** | Low | While not a primary focus, environmental improvements are embedded within the design approach. Measures such as traffic calming and support for active mobility may contribute to reduced noise levels and calmer street environments. |
| **SOCIAL & HEALTH** | Medium | Improving safety, particularly for pedestrians and other vulnerable users, was a key consideration in the design of the programme. The emphasis on safer and more inclusive streets reflects strong alignment with social and public health outcomes. |
| **ECONOMIC** | Low | While not a primary focus, the programme supports neighbourhood accessibility and street usability. These improvements strengthen everyday access to amenities and may contribute to local activity and neighbourhood vitality over time. |

The outcome priorities for the Friendly Streets programme, as determined by the application of the Prioritisation Tool.

## MOBILITY PILLAR OUTCOMES

- Across the pilot sites, over 50% of motorists agreed that the green road markings and humps were useful in encouraging them to slow down. Average vehicle speeds decreased by up to 25% following the introduction of traffic calming measures.[92]
- Active mobility volumes—including pedestrians and cyclists—increased along the pilot corridors, suggesting that when streets are perceived as safer and more comfortable, residents are more willing to walk or cycle for neighbourhood trips.
- These outcomes are also reflected in user perceptions: 95% of residents reported improved comfort and confidence when walking or cycling within neighbourhood streets, and over 80% indicated they would choose to walk more following implementation.[93]
- The observed modal shift has been little to date, which is consistent with the early-stage nature of the pilots. Long-term monitoring will be needed to assess whether behavioural changes translate into measurable reductions in traffic intensity and associated environmental impacts.

## ENVIRONMENTAL PILLAR OUTCOMES

- The observed reduction in vehicle speeds is likely to contribute to lower traffic noise levels, particularly in residential settings, which in turn will help to create quieter street environments.
- The traffic calming measures could discourage through-traffic on residential streets over time. Where fewer vehicles pass through, neighbourhood streets may experience reduced traffic intensity, contributing to lower emissions and calmer pedestrian-friendly environments in the long term. Long-term monitoring will be needed to assess whether reductions in traffic intensity and associated environmental impacts translate to sustained behavioural changes.

## SOCIAL & HEALTH PILLAR OUTCOMES

- The response from residents has been positive, with 9 in 10 agreeing that their walking and cycling experiences have improved.[94]
- The observed reduction in vehicle speeds has direct implications for safety, particularly in residential environments where pedestrians and cyclists share space with vehicles.
- Lower traffic speeds are associated with reduced risk and severity of road traffic incidents. For Friendly Streets, this translates to improved safety for vulnerable users, including children and seniors.
- Beyond safety, the programme places strong emphasis on inclusivity and accessibility. Features such as barrier-free crossings, wider footpaths and improved crossing times make streets easier to navigate for a wider range of users, especially those with mobility needs.

## ECONOMIC PILLAR OUTCOMES

- Friendly Streets may also influence neighbourhood vitality by improving how residents access nearby destinations.
- Safer and more comfortable streets can encourage residents to walk or cycle to local amenities such as shops, schools, parks and community facilities. This can strengthen everyday neighbourhood connections and support more active use of local spaces.
- While it is challenging to quantify the economic impacts of the programme, the improvements to street accessibility and liveability provide a foundation for broader neighbourhood vitality over time.

## MOVING TOWARDS SAFER AND MORE LIVEABLE NEIGHBOURHOODS

The Friendly Streets pilots represent an early but instructive step in refining how Singapore's neighbourhood streets can better support safer shared use. Initial findings suggest that targeted interventions—when designed to respond to local context and implemented with community input—can meaningfully influence both driver behaviour and residents' willingness to walk or cycle for everyday trips.

The pilots provide useful insights into how different traffic calming measures influence driver behaviour and street usage. Beyond the immediate outcomes observed from the pilots, the impact of Friendly Streets extends beyond individual street segments to influence how neighbourhoods function as connected systems. Interventions such as traffic calming measures and enhanced pedestrian crossings strengthen mobility connections to nearby destinations, including neighbourhood centres, markets, parks and public transport nodes.

By improving the quality and continuity of these local connections, the programme supports safer, more inclusive and more comfortable short-distance trips within neighbourhoods, often extending beyond the immediate project boundary. When complemented by other active mobility options such as bike share programmes, these conditions contribute to a stronger active mobility environment.

These insights highlight an important aspect of the programme: its ability to respond to the specific spatial and functional needs of different neighbourhoods. Rather than applying a uniform solution, Friendly Streets interventions can be tailored to strengthen local connections. They can also be progressively extended across neighbourhoods to enhance safety, connectivity and liveability within existing street networks.

# Insights from Using a Cross-Domain Lens

The Barcelona, London and Singapore case studies demonstrate how sustainable mobility interventions influence a wide range of outcomes that extend beyond transport performance alone. They also demonstrate that while each intervention is shaped by its local context, evaluating it through a cross-domain lens reveals recurring co-benefits and trade-offs.

Some of the common co-benefits observed are:

- Interventions that prioritise walking, cycling and safer streets contribute to increased physical activity and mental well-being, in addition to enhanced safety and social cohesion.
- Reductions in traffic volumes and vehicle speeds contribute to positive environmental impacts such as lower emissions and noise levels, while the reallocation of street space creates opportunities for greening and improved microclimates.
- Improvements to accessibility and the quality of public space are associated with increased footfall and street-level activity, supporting local businesses and enhancing neighbourhood vibrancy.

Some of the potential recurring trade-offs and tensions include:

- The displacement of vehicular flows to the peripheral areas of the intervention boundary, highlighting the importance of considering system-level impacts.
- Gentrification due to the provision of enhanced amenities for residents, which may also result in rising property values, underscoring the need to be cognisant of unintended consequences of interventions.

## COMPLEMENTING EXISTING APPROACHES

Many sustainable mobility initiatives—especially smaller-scale, people-centred interventions—which generate broader social, environmental and equity outcomes—are often difficult to monetise using just a cost-benefit analysis (CBA).

To address this, the framework recommends pairing a CBA with multi-criteria analysis (MCA) to capture both tangible and intangible benefits of sustainable mobility initiatives. The application of both approaches helps cities assess smaller-scale, people-centred interventions that may fall outside typical investment thresholds, while also capturing intangible or distributed benefits that matter for liveability. Combining both analyses in parallel can provide decision makers with a holistic understanding of the initiative and policy impacts by reflecting project priorities, while making relationships and trade-offs between domains more explicit.

To ensure both approaches work effectively in parallel, cities should identify early on which indicators are assessed under each method. For example, where environmental benefits are already monetised through a CBA, an MCA can focus on less tangible dimensions such as perceived safety, local quality of life or access equity. Used together, these approaches support a more complete and transparent understanding of impact, enabling cities to make more informed, outcome-led decisions.



| CBA METRIC | COMPLEMENTARY CROSS-DOMAIN METRICS | WHAT A COMBINED APPROACH ANSWERS |
|---|---|---|
| **Travel time savings** | • Average vehicle speed<br>• Active travel levels<br>• Street use and experience<br>• Mental well-being | Are changes in speed creating safer, more comfortable and more actively used streets?<br>Are changes in street conditions improving mental well-being? |
| **Vehicle throughput** | • Mode share for walking and cycling<br>• Local air and noise levels<br>• Placemaking/vibrancy of public spaces<br>• Reduced fatalities | Does reduced car use support healthier and more sustainable travel patterns and improved environmental conditions?<br>Does reduced vehicle throughput translate to increase in social interaction, recreation and everyday activity? |
| **Property value uplift** | • Social diversity index or user profile mix<br>• Affordability measures | Are neighbourhood improvements inclusive, or do they risk displacement of long-term residents? |
| **Operating cost savings** | • Local retail footfall<br>• Small business revenue<br>• Street-level vibrancy | Are street changes supporting local economic activity and everyday use? |
| **Revenue from retail or small businesses** | • Increased footfall<br>• Dwell time<br>• Noise levels | Is improved street design attracting more people and supporting local businesses?<br>Is increased footfall creating a greater nuisance for residents? |
| **Accident rates** | • Perceived safety<br>• Physical activity trends or active mobility modal share | Are safer conditions improving perceptions of safety, and encouraging walking and cycling across different user groups? |
| **Infrastructure cost per user** | • Public space per capita<br>• Green space gains | Do investments unlock liveability benefits and broader climate resilience? |
| **Noise nuisance cost** | • Residents exposed to noise above WHO limits<br>• Perceived comfort levels | Do lower noise levels reduce stress?<br>Who benefits from quieter streets, and who might be left out? |

Example of how cities can complement standard CBA metrics with cross-domain or MCA metrics to better understand the broader impacts of sustainable mobility initiatives.


# 04

## Institutionalising the **Approach**

Recognising the broader value of sustainable mobility is one thing—ensuring it shapes how cities translate priorities into action is another. This requires embedding cross-domain thinking into the institutions, systems and practices that govern urban life, and building the conditions for it to last.

# Building the Conditions for Change

Cities such as Barcelona, London and Singapore have already begun to incorporate broader liveability considerations into mobility planning and decision-making. In many instances, these efforts have been supported by deliberate shifts in how data is collected, how stakeholders are engaged, and how outcomes are defined and evaluated.

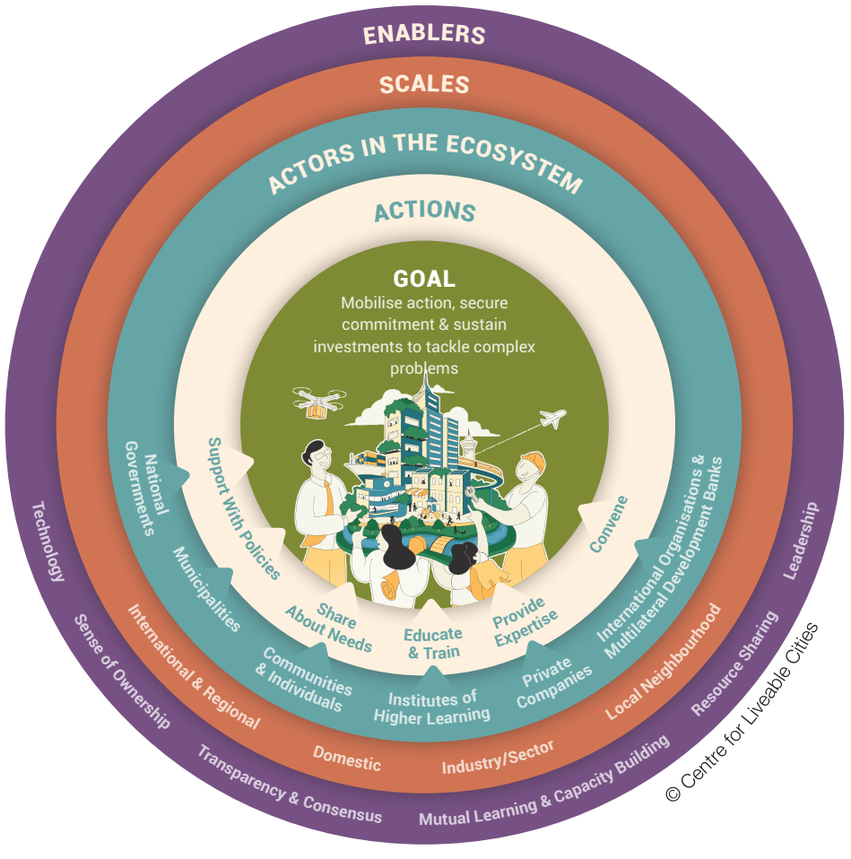
Importantly, these examples illustrate that cross-domain thinking often emerges through practice. Pilot projects, policy experiments and iterative learning processes have allowed cities to test new approaches, refine their methods and build stronger evidence bases over time. This marks an important departure from single-domain evaluation, towards a more integrated understanding of value.

Yet, these experiences also highlight an important reality: adopting a cross-domain approach is an ongoing institutional shift. It requires cities to consistently integrate cross-domain insights into planning, appraisal and implementation processes. This involves building the capacity to collect and interpret new forms of data, aligning priorities across agencies and establishing shared frameworks that can support more integrated decision-making. It also requires recognising that existing assessment tools, while still valuable, will require complementary approaches to capture the full range of outcomes that cities increasingly seek to achieve.

The question now is not *whether* cross-domain impacts matter, but *how* to operationalise them in a way that is robust, repeatable and scalable. Cities can build this institutional capacity over time to effectively integrate cross-domain insights into everyday policy and practice, supporting more balanced and outcome-based decision-making.

# Enablers for Cross-Domain Decision-Making

Institutionalising cross-domain approaches depends on a set of enabling conditions. These enablers reflect the core institutional capacities needed to move from project-based experimentation to system-wide application. They shape how cities prioritise outcomes and how decisions are made across sectors and scales.




A conceptual framework for applying a systems approach to capture the cross-sectoral and multi-scalar 'system' of urban partnerships.

1

## GOVERNANCE AND POLICY ALIGNMENT

Institutionalising a holistic measurement system begins with clear governance. Cross-domain metrics must be embedded in decision-making processes with clear accountability for outcomes.

Coordination across agencies is equally critical. Measurement frameworks must reflect the cross-cutting nature of sustainable mobility by aligning objectives and reporting cycles across departments. This horizontal coordination across agencies and sectors needs to be matched with vertical alignment across levels of governance, ensuring that performance can be tracked coherently across scales.

Embedding cross-domain objectives into planning and budget processes from the outset ensures that they move beyond aspiration and into practice. When liveability-related metrics are integrated into policy and funding decisions, they are more likely to influence how resources are allocated and prioritised. This helps anchor them within governance structures to support long-term commitment.

Together, these foundations determine who is responsible, what they are accountable for and how measurement informs decision-making.

### WHAT CITIES CAN DO

- Define clear accountability for cross-domain outcomes across agencies
- Align objectives and indicator frameworks across sectors and levels of government to enable coherent performance tracking
- Embed cross-domain metrics into planning, budgeting and funding decisions
- Establish shared ownership of outcomes that incentivises cross-agency collaboration and sustains long-term commitment



BOX STORY

## REFRAMING TRANSPORT AS A HEALTH INVESTMENT— LESSONS FROM COPENHAGEN

Aligning mobility policy with wider liveability goals has helped Copenhagen embed cycling as a long-term public investment rather than a standalone transport initiative.

In Copenhagen, the case for cycling infrastructure has long been made not just in transport terms but in heath and fiscal ones too. Danish research over the years has demonstrated that cycling reduced health problems and work absences, and saved taxpayer money in a state-funded healthcare system. This gave city leaders a cross-domain argument that brought health agencies into conversations previously dominated by transport planners alone.[95]

This reframing had practical consequences for how investment decisions were made and who shaped them. Health authorities became more involved in cycling infrastructure because greater bicycle traffic was recognised as a preventive health measure.[96] Achieving cycling targets became explicitly integral to the city's health plan, its environmental goal of carbon neutrality and its broader liveability agenda—embedding mobility objectives across multiple policy domains rather than treating them as the sole concern of a transport department.[97]

This illustrates that sustainable mobility initiatives achieve lasting impact when their objectives and benefits are shared across departments. By cultivating shared responsibility for outcomes, cities can build systems that adapt and thrive—regardless of future challenges or shifts in governance.

2

## INTEGRATED DATA AND MEASUREMENT SYSTEMS

Cross-domain frameworks should include indicators and metrics that reflect the wide range of outcomes delivered by sustainable mobility initiatives and complement existing approaches where possible. Organising indicators across national, city and project scales—with each level informing the next—makes it possible to assess whether individual initiatives are collectively contributing to long-term strategic goals.

Effective measurement also requires integrating data across agencies and modes. Multi-modal transport data covering public transport, cycling, walking, and emerging shared and electric mobility, should flow into shared platforms that enable interoperability and reduce duplication. A shared evidence base helps resolve conflicting narratives and supports meaningful comparisons across cities and contexts.

Crucially, combining qualitative and quantitative evidence allows cities to capture both lived experience and behavioural change. This ensures that the system reflects outcomes that matter to communities, and not just those that are easy to measure. Bringing together real-time data with longer-term surveys and participatory inputs creates a more complete and credible understanding of impact that can better inform policy, support investment decisions and build public trust.

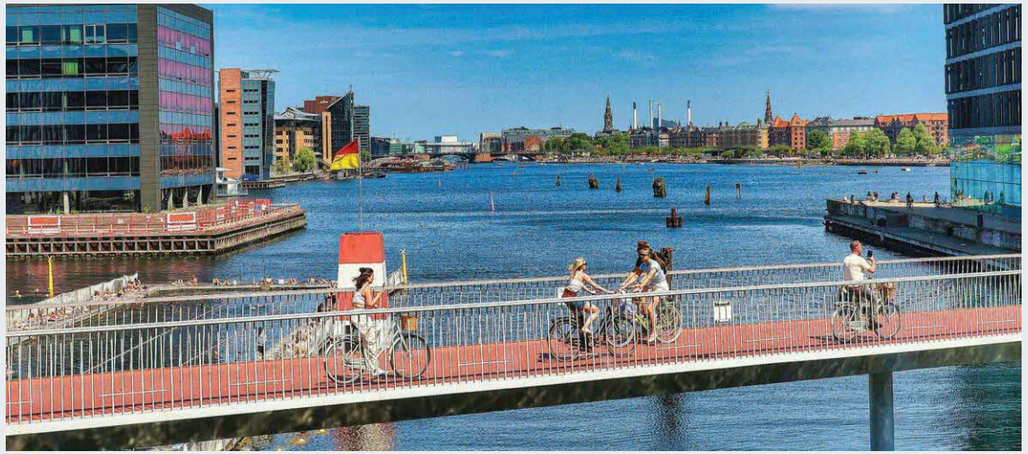
### WHAT CITIES CAN DO

- Define what gets measured and why before designing data collection systems
- Embed monitoring and evaluation into project planning from the outset, not just as a post-implementation add-on
- Integrate data across modes, agencies and platforms to build a shared evidence base
- Combine quantitative metrics with qualitative insights to capture lived experience
- Leverage project-level data to inform city and national level initiatives to better understand system-wide impacts



BOX STORY

## MEASURING WHAT MATTERS— COPENHAGEN'S BICYCLE ACCOUNT



Long-term monitoring of cycling patterns and user experience has helped Copenhagen build a robust evidence base to support integrated and outcome-oriented mobility planning.

Published every two years since the late 1990s, Copenhagen's Bicycle Account helps the city monitor cycling conditions, track progress towards policy goals and identify areas for further improvement. The first account tracked 10 key indicators, selected jointly by the city's traffic department and a group of regular cyclists, covering infrastructure investment, network length, modal share, accident statistics, and cyclists' own perceptions of safety and maintenance.[98] From the outset, it combined operational data with qualitative evidence from residents—a deliberate choice to capture both what the system delivered and how it was experienced.

Rather than using it as a retrospective report, the city used the Bicycle Account as a live planning tool to identify key problems, follow up on measurable targets and adjust its approach over successive cycles. The yearly report was directed towards the city's Technical and Environmental Committee, giving an overview of prioritised cycling measures, their effects, the status of politically set goals and citizen satisfaction, making proposals for specific initiatives relevant to budget negotiations.[99]

Over time, the Bicycle Account has evolved into a governance and communication tool that has helped Copenhagen track progress and identify priorities, while making cycling data easily accessible to all stakeholders.

3

## STAKEHOLDER ENGAGEMENT AND COMMUNICATION

Involving civil society, community groups and vulnerable populations ensures that the framework captures lived experience alongside operational data. This goes beyond consultation to include more collaborative forms of engagement, where stakeholders contribute to shaping objectives, identifying relevant indicators and interpreting results. This strengthens ownership of decisions and increases the relevance of interventions to local needs.

Private sector actors including mobility operators and data providers have an increasingly important role to play as well. Bringing them into the measurement ecosystem through clear regulatory requirements or incentive frameworks can surface data and insights that public agencies cannot generate alone, while aligning industry practice with broader sustainability goals.

Effective communication plays an equally important role—in translating complex metrics into accessible and clear narratives for stakeholders, and in helping to sustain political and public support over time. Sharing information through dashboards and regular reporting allows stakeholders to engage meaningfully with evidence, fostering accountability and closing the feedback loop between evidence and action. When stakeholders can see how data is collected, interpreted and applied, the system gains legitimacy as a shared public resource rather than an internal administrative function.

### WHAT CITIES CAN DO

- Engage communities, civil society and vulnerable groups in shaping objectives and defining what counts as success—not just in validating outputs
- Use participatory approaches to incorporate lived experience into measurement
- Translate findings into accessible narratives and publish them regularly to sustain accountability and public trust



BOX STORY

## BUILDING SUPPORT FOR MOBILITY REFORM— NEW YORK CITY'S CONGESTION PRICING CAMPAIGN


New York City's congestion pricing programme demonstrates the importance of sustained stakeholder engagement, coalition-building, and clear communication in navigating trade-offs and building support.

New York City's Central Business District Tolling Programme—the first congestion pricing scheme in the United States—took nearly two decades from first proposal to implementation. Its eventual success was not primarily a story of government leadership, but of sustained coalition-building and honest public engagement.

As the government worked to advance the programme, an external coalition—the Campaign for New York's Future—brought together over 100 civic groups, ranging from large businesses to small community organisations.[100] Rather than simply promoting the benefits of congestion pricing, the coalition invested years in directly addressing the equity concerns of outer borough communities who feared the policy would hurt them. Detailed educational materials demonstrated that the majority of New Yorkers, including those in affected neighbourhoods, did not own cars and were reliant on the very public transit system that congestion pricing revenues would fund.[101] Proposals were adapted to reduce tolls in outer boroughs, showing that opposition was heard rather than dismissed.

This case underscores that public acceptance of mobility reforms is built not only through technical evidence, but through sustained engagement that acknowledges concerns and communicates impacts clearly.

4

## CAPACITY BUILDING

Designing a robust measurement system is one challenge; ensuring the capability to operate and interpret it is another. At the core of this is building dedicated analytical teams with the technical skills to collect, process and make sense of data. This must be supported by organisational practices, such as documentation, and knowledge management systems to preserve institutional expertise. Capacity-building efforts should ensure that planners and officials are able to interpret metrics and translate them into policy and investment decisions.

Capacity building must extend beyond specialist teams. Cross-sector literacy is necessary to ensure that officials working in health, finance, the environment or planning can engage meaningfully with mobility data relevant to their domains. Building this broader institutional fluency takes time and benefits from structured learning such as drawing on pilots, peer city experiences and case study reviews to refine the approach iteratively.

Sustaining this capacity also requires sufficient funding for the measurement system, to ensure that monitoring approaches are not deprioritised when budgets come under pressure. Given that measurement often spans multiple agencies and levels of government, cost-sharing models can help distribute responsibility while strengthening collective ownership. Access to external expertise and tools, alongside regular review cycles to update indicators as technologies and policy priorities evolve, further supports the long-term relevance and continuity of the system.

### WHAT CITIES CAN DO

- Build dedicated teams with the technical skills to manage and interpret data
- Strengthen cross-sector understanding of mobility outcomes across agencies
- Document processes and lessons to retain and scale institutional knowledge
- Secure long-term resources to sustain measurement and continuous tracking



BOX STORY

## INSTITUTIONALISING GENDER MAINSTREAMING— LESSONS FROM VIENNA


Mariahilfer Straße, Vienna's pilot district for gender mainstreaming, was redesigned as a pedestrian-priority shared space with wider pavements and improved public amenities.

Vienna's decades-long effort to incorporate gender mainstreaming into urban planning illustrates how a new analytical lens becomes institutional practice.

Rather than promoting gender sensitive planning as an abstract concept, officers started with a series of small, carefully selected pilot projects—parks, streetscapes and public spaces—chosen specifically for their likelihood of success and to build momentum. Visible results gave politicians something to show their constituents and created pressure to continue.

Lessons from pilot projects were compiled into an accessible, narrative-led gender mainstreaming manual, showing what had worked and how it could be replicated. Effective documentation turned precedent into demand, allowing politicians in other districts to see what had been achieved and want the same for their constituents.

Officers also invested in building analytical capacity to understand how different groups actually used spaces by developing a social space analysis methodology that combined observation, data and local knowledge to inform design. This expertise was developed through doing, not training alone. Crucially, it revealed that addressing social needs within mobility and urban planning, rather than separately, consistently delivered broader benefits, highlighting the value of a cross-domain approach.

Institutionalising a holistic measurement system for sustainable mobility is ultimately an organisational challenge as much as a technical one. The enablers outlined here do not operate in isolation. They are mutually reinforcing, and the absence of any one of them tends to undermine the others. Strong governance without data is rhetoric. Good data without capacity is noise. Capacity without resources depletes. And all of it, without sustained engagement and communication, risks becoming an internal exercise disconnected from the communities it is meant to serve.

The city cases further suggest that institutionalisation rarely follows a neat sequence. It is built through pilots and precedents, by strategically building relationships and coalitions, and through consistent documentation that turns local practice into transferable knowledge. What the most instructive examples share is not a perfect system designed in advance, but a commitment to learning by doing—and to building the institutional structures that allow that learning to take root.



OPINION

# Creating a Common Language to Achieve Shared Goals

**Tan Wearn Haw**
Director,
Strategic Planning
and Collaborations,
Health Promotion Board

**Nicole Cheah**
Senior Manager,
Strategic Planning
and Collaborations,
Health Promotion Board

*Our health and daily living environment are intertwined. The spaces where we live, work, play and commute are more than just backdrops to our daily routines—they actively shape our well-being.*

The cycling track at Singapore's Play@Heights Park in Lorong 2 Toa Payoh is one of many features promoting recreational physical activity in the neighbourhood. The track is linked to surrounding blocks by sheltered walkways to improve resident accessibility.

Our health and daily living environment are intertwined. The spaces where we live, work, play and commute are more than just backdrops to our daily routines—they actively shape our well-being. Urban infrastructure influences how we move through our environment, how we interact with our surroundings, and even who we meet. The compounded effects of these experiences have an outsized impact on our health in the long term. Measuring and monitoring the influence of the built environment on health outcomes would thus allow us to better understand how urban design can create health-promoting spaces for the community.

The built environment's impact on physical activity is significant.[102] Residents with greater access to public transport and active mobility modes are more likely to be physically active because of walking or cycling on a daily basis.[103] In 2023, 78.5% of Singapore residents achieved a sufficient level of total physical activity per week*, with commuting being the largest contributor to this.[104] This is unsurprising given that a daily average of 3.4 to 4 million trips were taken on Singapore's public transport system that year.[105]

Neighbourhoods with higher-quality pedestrian infrastructure and open spaces that incorporate better aesthetics, safety and maintenance are associated with higher levels of active mobility and recreational physical activity.[106] Pedestrian walkways and bicycle lanes help to reduce urban traffic congestion and air pollution as people choose active mobility options over vehicular transport.[107] This has a range of positive health effects, including a reduction of respiratory illnesses due to improved air quality.

*Pedestrian walkways and bicycle lanes help to reduce urban traffic congestion and air pollution as people choose active mobility options over vehicular transport. This has a range of positive health effects, including a reduction of respiratory illnesses due to improved air quality.*

Research in Europe and the UK has also tied the reduction of noise, particulate matter and traffic accidents that come from the shift to active transport to reduced healthcare expenses. For example, a net avoided cost of £6 billion within a 20-year period was forecasted for the UK National Health Service stemming from such a modal shift. In Sweden, Stockholm County's healthcare budget saw a net economic benefit of 8.7% from initial investments in sustainable mobility—including an annual savings of €900 per person from shifting from car- to bike-friendly transport infrastructure.[108]

* Sufficient total physical activity refers to doing at least 150 minutes of moderate-intensity physical activity, at least 75 minutes of vigorous-intensity physical activity, or an equivalent combination of moderate- and vigorous-intensity physical activity per week.

Having a robust public transport system also enables social connections and community resilience. A National University of Singapore study on ageing in place found that well-connected mobility networks empower older adults to maintain active lifestyles and diverse social connections within and beyond their neighbourhoods. Singapore's comprehensive public transport system allows seniors to regularly access social spaces—from food courts and coffee shops to community centres. This is crucial for fostering 'ageing in networks', where older adults can maintain meaningful social ties across different locations, contributing to stronger community bonds and personal resilience in later life.[109]

These findings are consistent with studies in Hong Kong, where the built environment at the neighbourhood level has been shown to play a crucial role in promoting health outcomes for frail older adults—having metro stations closer to their homes significantly improved both service utilisation and quality of life for seniors. When public transport was easily accessible, older adults were more likely to use community services and maintain better health conditions.[110] With global life expectancy projected to increase by 4.6 years by 2050,[111] investing in sustainable mobility infrastructure as complementary to preventive health strategies will be crucial for alleviating increased burden on the healthcare system in the future.

## MEASURING A 'HEALTHY' SYSTEM

The National Population Health Survey series, jointly conducted by the Ministry of Health (MOH) and Health Promotion Board, tracks and provides information on the health, risk factors and lifestyle practices of Singapore residents, as well as the prevalence of non-communicable and chronic diseases in Singapore.

At the same time, Healthier SG (HSG), a national initiative by the MOH, monitors the effects of preventive health efforts at a regional level within Singapore. The indicators monitored under HSG include both medium-term health outcomes such as physical activity levels, and long-term health outcomes such as prevalence of chronic diseases (e.g., diabetes, hypertension and hyperlipidaemia) and healthcare cost. Since lifestyle risk factors, especially physical activity and unhealthy diets, are major drivers of chronic diseases, some of these indicators could be applied as conceivable measures of the built environment's impact on population behaviour and health.

## BRIDGING SECTORS THROUGH A COMMON LANGUAGE

The growing synergies between the urban planning and health sectors present an opportunity to improve liveability in cities. In Singapore, the Urban Redevelopment Authority's Draft Master Plan 2025 envisions a Happy Healthy City by integrating health-promoting elements into urban design, such as the provision of recreational spaces and enhanced access to active mobility networks.

Achieving collective outcomes across sectors can be supported by creating a common language to unite existing efforts through the development of frameworks that encompass a range of cross-domain indicators. Efforts to do so are already underway in Singapore. For instance, the Healthy Precincts Framework by the MOH Office for Healthcare Transformation tracks the effects of socio-environmental determinants on residents' behaviour and health outcomes. The framework looks at domains such as the built environment, transport, access to healthy foods and environmental quality to provide a holistic picture that informs policy, programming and decision-making.

A similar approach was taken by the UK's Office for National Statistics, in the form of a Composite Health Index. The Index was intended to measure the stock of health across communities and provide granular insights using 56 indicators across three domains—healthy places (wider determinants of health), healthy lives (health-related behaviours) and healthy people (healthy outcomes). Although funding for the Index ceased in 2024, there are views that the Index should be revived as the state of health could impact the UK's future economic growth and gross domestic product potential.[112]

While the creation of such frameworks requires time, effort and expertise across sectors and disciplines, they are instrumental in establishing structures and processes that facilitate collaboration, data sharing and aggregation. This is an important foundation for complex multi- and cross-sectoral engagement, partnerships and mobilisation. For example, when tied to the implementation of a sustainable mobility project, pre- and post-implementation data collection across sectors can create robust datasets to yield conclusive evidence demonstrating multisectoral impacts on the well-being of the population—be it in pursuit of health, improved mobility or beyond.

*Creating a common language through the development of frameworks is instrumental in establishing structures and processes that facilitate collaboration, data sharing and aggregation.*

Sungei Tampines, which is connected by a bridge to Pasir Ris Park. By 2026, 8 in 10 residents living in public housing will have access to a cycling network within minutes under the new Islandwide Cycling Network programme. In towns like Pasir Ris and Tampines, comprehensive cycling networks are already in place.

Note: The views and opinions expressed in this article are solely those of the authors and do not necessarily reflect the official policy or position of the Health Promotion Board.

OPINION

# The Journey to Sustainable Mobility Requires All on Board

## Samuel Chng

Research Assistant Professor and Head,
Urban Psychology Lab,
Lee Kuan Yew Centre for Innovative Cities,
Singapore University of Technology and Design

*When a comprehensive narrative demonstrates that sustainable mobility serves to benefit the people and planet while ensuring economic competitiveness, citizens, businesses and policymakers alike will be nudged towards making more sustainable mobility choices.*


Sharing of the 3P+ partnership to advocate for greater collaboration among stakeholders.



The shift towards sustainable mobility—whether through cycling, walking, electric vehicles or public transportation—offers benefits beyond reducing carbon emissions. Improved public health, reduced congestion, energy savings and enhanced social cohesion are among some of the under-recognised benefits. However, fully understanding these benefits requires the development of better measurement frameworks that make them more apparent. For instance, tools that can quantify the advantages of active mobility on health, and link these to reduced healthcare costs, or models that simulate how the electrification of mobility contributes to both cleaner air and reduced congestion, will help frame sustainable mobility as more than just an environmental issue.

To facilitate this, cities must focus on ensuring that their sustainable mobility initiatives and plans impact not only emissions but also areas like well-being, quality of life, productivity and the creation of new economic opportunities. When a comprehensive narrative demonstrates that sustainable mobility serves to benefit the people and planet while ensuring economic competitiveness, citizens, businesses and policymakers alike will be nudged towards making more sustainable mobility choices.

## A 3P EFFORT IS NECESSARY

Making sustainable mobility a reality requires cooperation among the public, private and people (3P) sectors, each playing a distinct yet complementary role. In the public sector, governments must invest in infrastructure such as cycling lanes and public transportation networks, while simultaneously implementing policies that reduce car and fossil fuel dependency. This requires long-term planning and a strong will to implement policies that may not be popular but are necessary for the transition towards sustainable mobility.

Private sector organisations can drive innovation through products and services such as the use of electric vehicles, bike- and ride-sharing systems, and autonomous vehicles. They can also promote the use of sustainable modes of transport among employees by offering public transport subsidies and facilitating remote work options that reduce the need for commutes.

The people sector plays a critical role in civic engagements to encourage buy-in for sustainable mobility. Advocacy groups championing causes that push for sustainable mobility can raise awareness and lend pressure for change. Grassroots champions can help normalise sustainable transportation modes to accelerate their uptake. Public participation and co-creation in planning and policymaking can ensure that introduced initiatives and changes meet community needs and are well-supported.

## BUILDING A STRONGER 3P+ PARTNERSHIP

The reality is that cooperation between the 3P sectors may be lacking, and this impedes progress in adopting sustainable mobility. This calls for a 3P+ partnership—where academia is the plus. While academia is independent from all 3Ps, it is a valuable ally, as its responsibility is (and its legitimacy rests upon) the production of rigorous research and testing of solutions which can help make sustainable mobility a reality. Researchers can develop the frameworks and tools needed to provide data that informs government policymaking and private sector strategies. Likewise, researchers can develop technological innovations to refine sustainable mobility solutions. Furthermore, they are able to offer evidence-based insights for nudging individuals towards adopting sustainable mobility habits.

Around the world, challenges confronting the achievement of sustainable mobility differ. Some cities have a greater-than-average acceptance of public transport and active mobility, but face resistance in the transition to electric mobility and other clean technologies. Other cities may face more fundamental challenges, such as expanding basic public transport infrastructure. Nevertheless, in both scenarios, success depends on partnerships across sectors and an ability to recognise that sustainable mobility needs to holistically benefit the people and planet while ensuring economic feasibility. As we strive for greener cities globally, we must recognise all the benefits of sustainable mobility, and not simply address the technical aspects of mobility alone. Hence, a coordinated 3P+ approach that involves the public, private and people sectors working with academia can only accelerate the transition to sustainable mobility.

*This calls for a 3P+ partnership—where academia is the plus. While academia is independent from all 3Ps, it is a valuable ally, as its responsibility is (and its legitimacy rests upon) the production of rigorous research and testing of solutions which can help make sustainable mobility a reality.*

# Conclusion

*By expanding how we define and measure success, cities can unlock new ways of designing and delivering mobility—ones that prioritise people, places and more liveable cities.*

As cities reimagine their transport systems for a more sustainable future, it is not only the interventions that must evolve—so too must the ways we measure their impact. What we measure, and how, signals what we value. In dense, complex urban environments where trade-offs are inevitable and resources are finite, the true value of a mobility intervention lies not just in its transport outcomes, but in its ability to support liveability, resilience, equity and health goals.

The experiences documented over the course of this research show that these co-benefits are not abstract—they are measurable, communicable and transformative. They demonstrate that when measurement frameworks are designed to capture the shared value of sustainable mobility, they bring together institutions, communities and resources around common outcomes that no single domain or discipline could achieve alone.

The shift is already underway. Cities are beginning to redefine what counts as value in mobility—moving from single-domain performance metrics to holistic frameworks that embed well-being, climate, equity and economic vitality as core criteria. Evidence also shows that holistic measurement frameworks alone are not enough. They must be institutionalised—anchored in governance, sustained by resources, built through capacity and legitimised through genuine engagement with the people they are meant to serve. Measurement, in this sense, is not a technical exercise. It is a means of steering change, aligning institutions and building public trust for lasting urban transformation.

Ultimately, no institution can drive this shift alone. Progress depends on collective action across various stakeholders—each bringing different knowledge, resources and accountability to this joint undertaking. By expanding how we define and measure success, cities can unlock new ways of designing and delivering mobility—ones that prioritise people, places and more liveable cities.

# Endnotes


1 Rebecca Solnit, *Wanderlust: A History of Walking* (London: Penguin Books, 2021).

2 Mariana Mazzucato, *Mission economy: a moonshot guide to changing capitalism* (New York: Harper Business, 2021).

3 Dan Hill, *Designing Missions: Mission-oriented innovation in Sweden* (Sweden: Vinnova, 2022).

4 Dan Hill and Anja Melander, "Strategic Design for Public Purpose: Enriched and Expanded Practices for Human-Technology Interaction", in *Human-Technology Interaction*, ed. Elena Malakhatka and Mikael Wiberg (Cham: Springer, 2025).

5 Carlos Moreno, *The 15-Minute City: A Solution to Saving Our Time and Our Planet* (Hoboken: Wiley, 2024).

6 Dan Hill et al., (2024) "Cities beyond proximity", *Philosophical Transactions of the Royal Society A* 382.2285 (2024), https://doi.org/10.48550/arXiv.2411.12335.

7 Ibid.

8 Hill, *Designing Missions*.

9 E.F. Schumacher, *Small Is Beautiful: A Study of Economics As If People Mattered* (London: Blond & Briggs; New York: Harper Collins, 1973).

10 "Streetmeter" analysis tool, accessible at https://streetmeter.net/about-streetmeter.

11 Hill, *Designing Missions*.

12 Iain McGilchrist, *The Master and His Emissary: The Divided Brain and the Making of the Western World* (New Haven: Yale University Press, 2019).

13 Rainer Kattel et al., *Dynamic Capabilities for Transformative Change in City Governments* (UCL Institute for Innovation and Public Purpose, Working Paper Series (IIPP WP 2025-03), 2025), https://www.ucl.ac.uk/bartlett/sites/bartlett/files/dynamic_capabilities_for_transformative_change_in_city_governments.pdf.

14 Hill, *Designing Missions*.

15 New York City Department of Transport, *Measuring the Street: New Metrics for 21st Century Streets* (New York City Department of Transport, 2012).

16 Government Offices of Sweden and World Health Organization, "Vision Zero—no fatalities or serious injuries through road accidents", last updated 14 October 2019, https://www.roadsafetysweden.com/about-the-conference/vision-zero---no-fatalities-or-serious-injuries-through-road-accidents/.

17 International Transport Forum, *Sweden: Road Safety Country Profile 2024* (Paris: OECD Publishing, 2026).

18 Kees van Ommeren, "Investing in Bicycle Parking Saves Cities Money", Dutch Cycling Embassy, 17 August 2022, https://dutchcycling.nl/knowledge/blogs-by-experts/investing-in-bicycle-parking-saves-cities-money/.

19 van Ommeren, "Investing in Bicycle Parking Saves Cities Money".

20 BiTiBi Project, *BiTiBi Booklet: Building Better Business Links to Bike & Ride* (Utrecht: BiTiBi Consortium, 2017).

21 Leah Watetu Mbugua, "Examining the Societal Costs and Benefits of Integrating Bike Sharing Systems and Public Transport: A Case Study of the OV-fiets in the Netherlands", Master Thesis, TUDelft, https://repository.tudelft.nl/record/uuid:70ca79cc-d6de-47c3-a707-88068d233008.

22 Francisco Edson Macedo Filho et al., "Cycle highway effects: Assessing modal choice to cycling in the Netherlands", *Transportation Research Part A: Policy and Practice* 189 (2024): 104216, https://doi.org/10.1016/j.tra.2024.104216.

23 Rosanne Vanpée and Bruno Van Zeebroeck, *A comparative cost-benefit analysis of cycling within the Benelux and North Rhine-Westphalia* (Transport & Mobility Leuven, 2022), https://www.benelux.int/wp-content/uploads/2023/03/Report_Cycling_Benelux_Executive_Summary-1.pdf.

24 International Energy Agency (IEA), "Greenhouse Gas Emissions from Energy Data Explorer", 22 October 2025, https://www.iea.org/data-and-statistics/data-tools/greenhouse-gas-emissions-from-energy-data-explorer.

25 IEA, "IEA Energy and Carbon Tracker 2025", October 2025, https://www.iea.org/data-and-statistics/data-product/iea-energy-and-carbon-tracker-2025.

26 Kate Kelland, "Lack of exercise costs world $67.5 billion and five million lives a year", *Reuters*, 28 July 2016, https://www.reuters.com/article/world/lack-of-exercise-costs-world-675-billion-and-five-million-lives-a-year-idUSKCN1072RX/.

27 Transport for London, "The Economic Benefits of Walking and Cycling", n.d., https://tfl.gov.uk/corporate/publications-and-reports/economic-benefits-of-walking-and-cycling.

28 New York City Department of Transportation, *The Economic Benefits of Sustainable Streets* (New York City: Department of Transportation, 2013).

29 Marco Dean, *A Practical Guide to Multi-Criteria Analysis* (London: Bartlett School of Planning, University College London, 26 January 2022).

30 Marco Dean, "Chapter Six—Multi-criteria analysis", *Advances in Transport Policy and Planning* 6 (2020): 165–224, https://doi.org/10.1016/bs.atpp.2020.07.001.

31 Dean, *A Practical Guide to Multi-Criteria Analysis*.

32 https://dades.ajuntament.barcelona.cat/dades-basiques-de-mobilitat/.

33 Ajuntament de Barcelona, "Let's Fill Streets With Life: Establishing Superblocks in Barcelona", 20 May 2016, Commission for Ecology, Urban Planning and Mobility, https://ajuntament.barcelona.cat/ecologiaurbana/sites/default/files/en_gb_MESURA%20GOVERN%20SUPERILLES.pdf.

34 Ajuntament de Barcelona, "2030 Agenda".

35 Instituto de Estadística de Cataluña (Statistical Institute of Catalonia), "Population density. Municipalities with more than 20,000 inhabitants", last updated 2 December 2025, https://www.idescat.cat/indicadors/?id=aec&n=15228&lang=en.

36 Ibid.

37 Ibid.

38 Barcelona City Council, "Basic Mobility Data", last updated 27 October 2025, https://dades.ajuntament.barcelona.cat/dades-basiques-de-mobilitat/?_sv_p_id=-XJJxKLFGo9km0eN.

39 Ajuntament de Barcelona, "Let's Fill Streets With Life".

40 Jordi Garriga Mas, "Air pollution in the city", *Barcelona Metròpolis* 123 (Barcelona: Ajuntament de Barcelona, 2022), https://www.barcelona.cat/metropolis/en/contents/air-pollution-the-city.

41 Ajuntament de Barcelona, "Resilience Plan Diagnosis: Where is the population most exposed to noise pollution located?", December 2020, https://coneixement-eu.bcn.cat/widget/atles-resiliencia/docs/en_gb_210823_ER_EP1_Cont_ac%C3%BAst_PDF%20final.pdf.

42 Ajuntament de Barcelona, "2030 Agenda", 16 January 2025, https://ajuntament.barcelona.cat/agenda2030/en/mesbarcelona/actualidad-mes-barcelona/el-nou-pmu-2025-2030estableix-lobjectiu-darribar-al-85-de-desplacaments-en-modes-sostenibles-i-reduir-lus-delvehicle-privat-1477245.

43 Mark Nieuwenhuijsen et al., "The Superblock model: A review of an innovative urban model for sustainability, liveability, health and well-being", *Environmental Research* 251.1 (2024): 118550, https://doi.org/10.1016/j. envres.2024.118550.

44 Mueller et al., "Changing the urban design of cities for health".

45 Barcelona City Council, "Superilles", n.d., https://ajuntament.barcelona.cat/superilles/en/superilla/eixample.

46 Barcelona City Council, "Freshening up the Sant Antoni Superblock", 15 February 2023, https://www.barcelona.cat/infobarcelona/en/tema/urban-transformations/freshening-up-thesant-antoni-superblock_1255336.html.

47 Natalie Mueller et al., "Changing the urban design of cities for health: The superblock model", *Environment International* (2020): 105132, 10.1016/j.envint.2019.105132.

48 Jordi Honey-Rosés, "Barcelona's Superblocks as Spaces for Research and Experimentation", *The Journal of Public Space* 8.2 (2023): 1–20, DOI:10.32891/jps.v8i2.1646.

49 World Health Organization, "Barcelona: Using urban design to improve urban health", 26 October 2021, https://www.who.int/news-room/feature-stories/detail/barcelona-using-urban-design-to-improve-urban-health.

50 Nieuwenhuijsen et al., "The Superblock model".

51 Ibid.

52 Ibid.

53 Ibid.

54 Mueller et al., "Changing the urban design of cities for health".

55 Nieuwenhuijsen et al., "The Superblock model".

56 Carlton Reid, " 'Rat-running' increases on residential UK streets as experts blame satnav apps", *The Guardian*, 25 September 2020, https://www.theguardian.com/world/2020/sep/25/rat-running-residential-uk-streets-satnav-apps.

57 Jacob Evans, "Twice as many car trips in outer London—report", *BBC*, 6 June 2023, https://www.bbc.com/news/articles/cnd9y2w8183o.

58 Greater London Authority, "Land Area and Population Density, Ward and Borough", n.d., https://data.london.gov.uk/dataset/land-area-and-population-density-ward-and-borough-e1zp8/.

59 Ibid.

60 Ibid.

61 Transport for London, *Travel in London 2025: Consolidated estimates of total travel and mode shares* (Transport for London, 2025), https://content.tfl.gov.uk/travel-in-london-2025-consolidated-estimates-of-total-travel-and-mode-shares-acc.pdf.

62 Transport for London, "Air quality", n.d., https://tfl.gov.uk/corporate/about-tfl/air-quality.

63 Transport for London, "Road casualties at their lowest levels outside of the pandemic", 29 May 2025, https://tfl.gov.uk/info-for/media/press-releases/2025/may/road-casualties-at-their-lowest-levels-outside-of-the-pandemic.

64 Transport for London, "The Mayor's Transport Strategy", n.d., https://tfl.gov.uk/corporate/about-tfl/the-mayors-transport-strategy.

65 INRIX, *2024 INRIX Global Traffic Scorecard* (INRIX, January 2025).

66 Nicolas Bosetti et al., *Street Shift: The Future of Low-Traffic Neighbourhoods* (London: Centre for London, June 2022).

67 London Borough of Waltham Forest, "South Leytonstone Low Traffic Neighbourhood (LTN)", last updated 12 March 2026, https://www.walthamforest.gov.uk/parking-roads-and-travel/active-and-sustainable-transport-schemes/current-schemes/south-leytonstone-low-traffic-neighbourhood-ltn.

68 Tom Edwards, "Low Traffic Neighbourhoods: Anger, hate and the politics of the planter", BBC, 17 September 2020, https://www.bbc.com/news/uk-england-london-54180647.

69 Transport for London, *The impacts of Low Traffic Neighbourhoods in London: A summary of evidence* (Transport for London, February 2024).

70 Asa Thomas and Rachel Aldred, *Changes in motor traffic inside London's LTNs and on boundary roads* (London: Active Travel Academy, University of Westminster, 2023), https://www.wearepossible.org/s/Changes-in-motor-traffic-inside-Londons-LTNs-and-on-boundary-roads-3.pdf.

71 Rachel Aldred, Anna Goodman and James Woodcock, "Impacts of active travel interventions on travel behaviour and health: Results from a five-year longitudinal travel survey in Outer London", *Journal of Transport & Health* 35 (2024): 101771, https://doi.org/10.1016/j.jth.2024.101771.

72 Transport for London, *The impacts of Low Traffic Neighbourhoods in London*.

73 Ibid.

74 Xiuleng Yang et al., "Evaluation of low traffic neighbourhood (LTN) impacts on NO2 and traffic", *Transportation Research Part D: Transport and Environment* 113 (2022): 103536, https://doi.org/10.1016/j.trd.2022.103536.

75 Tracy Logan et al., *Low Traffic Neighbourhoods Residents' Survey* (London: Department of Transportation, 2021).

76 Jamie Furlong et al., "Low Traffic Neighbourhoods in London reduce road traffic injuries: a controlled before-and-after analysis (2012–2024)", *Injury Prevention* 2025: 1–7, https://doi.org/10.1136/ip-2024-045571.

77 Transport for London, *The impacts of Low Traffic Neighbourhoods in London*.

78 Logan et al., *Low Traffic Neighbourhoods Residents' Survey*.

79 Greater London Authority, "London Assembly: Low Traffic Neighbourhoods", n.d., https://www.london.gov.uk/who-we-are/what-london-assembly-does/questions-mayor/find-an-answer/low-traffic-neighbourhoods-10.

80 Logan et. al, *Low Traffic Neighbourhoods Residents' Survey*.

81 Department for Transport, *Low Traffic Neighbourhood Review* (London: UK Government, 2024), https://www.gov.uk/government/publications/low-traffic-neighbourhood-review.

82 Department of Statistics Singapore, "Environment", last updated 12 March 2026, https://www.singstat.gov.sg/find-data/explore-data-themes/society/environment/our-data-explained.

83 Department of Statistics Singapore, "Population", last updated 24 March 2026, https://www.singstat.gov.sg/find-data/explore-data-themes/population.

84 Ibid.

85 Department of Statistics Singapore, "Land Use Allocation", last updated 30 January 2024, https://tablebuilder.singstat.gov.sg/table/TS/M891211.

86 Data provided by Land Transport Authority and from LTA's *Green Ahead: Sustainable Practices in Land Transport*, 23/24 Sustainability Report (Singapore: Land Transport Authority, 2024).

87 Land Transport Authority, *Land Transport Master Plan 2040* (Singapore: Land Transport Authority, 2019).

88 Data provided by Land Transport Authority.

89 Land Transport Authority, *Land Transport Master Plan 2040*.

90 Land Transport Authority, "Friendly Streets: Creating more inclusive neighbourhoods and gracious communities", last updated 13 April 2026, https://www.lta.gov.sg/content/ltagov/en/upcoming_projects/road_commuter_facilities/friendly-streets.html.

91 Ministry of Transport, "Speech by Senior Minister of State for Transport, Dr Amy Khor on the Launch of 10 New Friendly Streets", 14 January 2025, https://www.mot.gov.sg/news-resources/newsroom/speech-by-senior-minister-of-state-for-transport--dr-amy-khor-on-the-launch-of-10-new-friendly-streets/.

92 Data provided by Land Transport Authority.

93 Ibid.

94 Land Transport Authority, "Ten New Friendly Streets by 2026", 14 January 2025, https://www.lta.gov.sg/content/ltagov/en/newsroom/2025/1/news-releases/ten-new-friendly-streets-by-2026.html.

95 Tools of Change, "How Copenhagen Became a Cycling City", n.d., https://toolsofchange.com/en/case-studies/detail/752/.

96 Anna Garrett, "Cost-benefit of cycling infrastructure", Cycling Solutions, n.d., https://cyclingsolutions.info/cost-benefit-of-cycling-infrastructure/.

97 Urban Sustainability Exchange, "The City of Copenhagen's Bicycle Strategy", n.d., https://use.metropolis.org/case-studies/cycling-in-copenhagen.

98 Tools of Change, "How Copenhagen Became a Cycling City".

99 City of Copenhagen, "Copenhagen – The Best Cycling City in the World", Urban Development Copenhagen, n.d., https://urbandevelopmentcph.kk.dk/mobility-cycling/copenhagen-the-best-cycling-city-in-the-world.

100 Kate Slevin, "Moving to Cleaner and More Equitable Transportation: Building Local Support for NYC's Congestion Pricing Programme", in *Urban Solutions* Issue 26 (Singapore: Centre for Liveable Cities, 2025), 44–51.

101 Ibid.

[102] Yiyu Wang et al., "The Impact of the Built Environment and Social Environment on Physical Activity: A Scoping Review", *International Journal of Environmental Research and Public Health* 20 (2023): 6189, https://doi.org/10.3390/ijerph20126189.

[103] Ibid.

[104] Ministry of Health, "National Population Health Survey", 2023, https://www.moh.gov.sg/resources-statistics/reports/national-population-health-survey-2023.

[105] Land Transport Authority, "Public Transport Ridership", 2024 lta.gov.sg/content/dam/ltagov/who_we_are/statistics_and_publications/statistics/pdf/PT_Ridership_Monthly_2019-2023.pdf.

[106] Wang et al., "The Impact of the Built Environment and Social Environment on Physical Activity".

[107] Ibid.

[108] Sarah Michel, Nicola Banwell and Nicolas Senn, "Mobility Infrastructures and Health: Scoping Review of studies in Europe", *Public Health Review* 45 (2024):1606862, doi: 10.3389/phrs.2024.1606862.

[109] Siyao Gao et al., "More Than Aging in Place: 'Aging in Networks'; in Singapore", *Annals of the American Association of Geographers* 114 (2024) :9, 2132-2152, doi: 10.1080/24694452.2024.2370922.

[110] Shuangzhou Chen et al., "A Path Analysis of the Effect of Neighborhood Built Environment on Public Health of Older Adults: A Hong Kong Study", *Frontiers in Public Health* 10 (2022) :861836, doi: 10.3389/fpubh.2022.861836.

[111] Institute for Health Metrics and Evaluation (IHME). *Global Burden of Disease 2021: Findings from the GBD 2021 Study* (Seattle: IHME, 2024).

[112] Jonathan Pearson-Stuttard and Sally C Davies, "The Health Index: a framework to guide health-driven prosperity", *The Lancet* 405 (2025): 777, https://doi.org/10.1016/S0140-6736(25)00010-8.

# Image Credits

(Page numbers indicated below)

**Ajuntament de Barcelona**
64, 70, 72

**Alain Rouiller via Unsplash**
105

**C.Stadler/Bwag, CC BY-SA 4.0 via Wikimedia Commons**
32

**Centre for Liveable Cities**
15, 49, 53, 101

**Chris Bruntlett**
42, 43, 44, 47

**Curro Palacios/ Ajuntament de Barcelona**
2–3, 71, 77

**Dan Hill**
20, 24, 28–29

**David Berkowitz, CC BY-2.0 via Wikimedia Commons**
96

**Department for Transport (UK)**
85

**DreamyBeluga, CC BY-SA 4.0 via Wikimedia Commons**
115

**f11photo via Adobe Stock**
16

**Gugerell, CC0 1.0 via Wikimedia Commons**
109

**Healthy Streets**
38

**Jack Fifield, CC BY-2.0 via Wikimedia Commons**
78

**Jacky Ho**
116

**Jane Kratochvil, CC BY-NC-ND 2.0 via Flickr**
120

**JoachimKohler-HB, CC BY-SA 4.0 via Wikimedia Commons**
66

**Johan Wessman, CC BY-2.0 via Wikimedia Commons**
103

**Joyt via Adobe Stock Photos**
8

**Land Transport Authority**
86, 88, 90

**Lars Ploughmann, CC BY-SA 2.0 via Flickr**
11

**Marc A. Hermann/ MTA, CC BY-4.0 via Wikimedia Commons**
107

**Melvin Loi, CC BY-SA 2.0 via Wikimedia Commons**
13

**New York City Department of Transportation via Flickr**
36

**Nicole Cheah**
111

**Oscar Giralt/ Ajuntament de Barcelona**
68, 75

**Roger Green, CC BY-SA 4.0 via Wikimedia Commons**
80

**Southend-on-Sea City Council via Flickr**
75 (top)

**Teo Zhiyi**
119, 128

**Tian Ying Lee**
62, 98