CONTENTS

Introduction

Cities don't function if everyone is in their own car. It doesn't matter whether people are driving or being driven. It doesn't matter if the car is electric or automated. A city is many people living close together. That means there is little space per person. Cars take up lots of space per person, so there isn't room for them all.

As a result, we get in each other's way, frustrating each other's lives, in the phenomenon we call traffic congestion. But the problems caused by car dependence go far deeper. They include fatalities and injuries, an ambient massacre of the innocents that we are expected to treat as normal. They also include profound contributions to pollution and climate change. Electric cars will help, but they are still more energy intensive and rely on more polluting processes per passenger than public transit does.

In cities, we need to move a lot of people in a small amount of space. Walking is always the best choice, for those who can. But once we must travel beyond our walking range, there are two options. We can use devices that help us travel without using much more space than our bodies take. This is the domain of micromobility or person-sized vehicles: bicycles, scooters, skateboards, and so on. Or we can gather in larger vehicles that will carry many of us efficiently, which is the core idea of public transit.

But public transit has another role, even where space isn't an issue. Many people can't drive, and many people shouldn't be driving. If you can afford it, you can hire someone to drive you, but many people can't afford this for the amounts of travel that they need to do. For these people, transit

is the foundation of their ability to reach all the opportunities they need to create a better life. This is why some public transit is often provided even in rural areas, where the efficient use of space is not an issue.

The frustrations of urban transport have fed a growing public interest in public transit in many countries. But when well-intentioned people look at the public transit around them, many conclude that it does not make sense for them to use it. There are many good reasons not to use public transit. It may not go where you need it to go, or at the right time. Perhaps you can get there three times faster by driving, or at half the cost. You may know from experience that you can't trust your service to come on time. The vehicles and staff may fail to meet the most basic standards for civility, safety, and comfort. Your transit network may be too confusing, requiring you to wade through too much detail to figure out whether the service is useful to you.

Even if you decide that you can't use it yourself, you may support public transit in hopes that someone will use it, because there is obviously not enough room in your city for everyone to drive, or enough space to build more freeways and to widen streets. You may also understand the many kinds of long-term harm, to people and the environment, that arise from too many cars and too much pavement. You may even fear that driving your car while wanting fewer cars in your city is some sort of hypocrisy on your part. (Often it's not. You may live and travel in an area that's been designed in such a way that no reasonably efficient transit can ever provide you with useful service.)

These common frustrations explain why, in many urban regions, support for public transit is wide but shallow. Voters typically support transit in general, but most don't know how to decide whether a transit proposal is good or bad. They may want better transit for themselves or their communities but have no idea how to make it happen.

For this reason, too, it's easy to create distractions in the public transit conversation. There will always be new technologies for sale, claiming to be "disrupting" or "transforming" public transit. Some of these ideas seek to spare us from sharing a vehicle with strangers, and as a result, they end up looking a lot like cars. An elite figure like Elon Musk can say that transit is terrible because it involves "a bunch of random strangers," but as I'll argue, bringing strangers together to share a ride is exactly how public transit succeeds.

What is quality public transit? Who can realistically expect to be served by it? What kinds of quality matter? How do we recognize and nurture them? What are the goals we want transit to achieve, and how do we navigate tough spots where these goals conflict?

Debates about transit proposals commonly lose track of these questions. Too often, we defer to a small group of intensely interested people (such as developers, activists, neighborhood groups, labor unions, and purveyors of transit technology) because the debate seems too technical for most of us to follow. As a result, we sometimes end up with transit investments that don't really do what we expected or that have side effects that should have been foreseen.

Transit debates also suffer from the fact that our leading decision makers are especially likely to be motorists. No matter how much you support transit, driving a car every day can shape your thinking in powerful, subconscious ways. For example, in many debates about proposed rapid transit lines, the speed of the proposed service gets more political attention than how frequently it runs, even though frequency, which determines waiting time, often matters more than speed in determining how long your trip will take. Your commuter train system will advertise that it can whisk you into the city in 39 minutes, but if the train comes only once every 2 hours and you've just missed one, your travel time will be 159 minutes, so it may be faster to drive, or even walk.

I can explain the concept of frequency to a group of well-intentioned leaders, and they may understand why it's important. But what they know is the experience of driving, where speed matters and frequency doesn't. So when they make a decision about a transit project, they are likely to give frequency too little weight. The result can be services that are very fast but don't come when we need them or that take too much time to connect from one service to another.

The unconscious assumptions of motorists are just one example of how people try to think about public transit as though it were something else. Everyone tries to translate a question into terms that they understand. Economists may talk about transit in terms of profitability, as though that were its goal. Equity and social justice advocates think of it as a tool for meeting the needs of people who have been excluded or marginalized. Architects and urban designers care about how it feels to move through a city, so they often focus on the aesthetics of the transit vehicle and infrastructure.

Urban redevelopment advocates categorize services according to how well they stimulate development.

None of these perspectives is wrong; transit can serve all these interests and more. But to achieve that broad level of service, these points of view have to be brought together into a clearer conversation.

To aid that conversation, this book aims to give you a grasp of how transit works as an urban mobility tool and how it fits into the larger challenge of urban transport. This is not a course designed to make you a qualified transit planner, although some professionals will benefit from it. My goal is simply to give you the confidence to form and advocate clear opinions about what kind of transit you want and how that can help create the kind of city you want.

WHO IS THE PUBLIC? WHO IS AN EXPERT?

When our elected leaders make decisions about transit, they face a noisy mix of competing interests. An older adult has trouble walking to a bus stop, so they want the stops placed closer together. Others want the bus stops farther apart, so that the buses run faster. Some merchants want the bus to loop through their shopping center to bring customers. Other merchants oppose bus service to their shopping center because it's bringing "undesirable" people. Suburb A wants a proposed rail transit line to go underground through their community, to preserve their ambience. Farther out on the proposed line, Suburb B wants the whole line elevated, so that the line is cheap enough to get all the way to Suburb B in its first phase.

Transit professionals are not always in a position to clarify the debate. Some of them lack a sufficiently broad view of their product or have been trained to think only about one aspect of it. Many more have the understanding but lack the confidence. Even worse, professionals working for public transit authorities often find their time consumed by daily crises and controversies and simply don't have time to take a wider view.

For a variety of reasons, transit planning has not evolved as a credentialed discipline—like law, engineering, or architecture—where everyone must pass a particular course of studies before they can be licensed to work. As a result, people are sometimes hired into transit planning or management without transit experience.

This openness of the field has many advantages. The last thing we need is another closed and revered priesthood enforcing a uniform dogma, like the twentieth-century highway engineers who did so much to make life impossible without a car. The principles of transit planning are simple enough that you don't need a graduate degree to understand them. Anyone who is willing to keep learning should be welcomed into the transit professions.

On the other hand, there really are some facts about how transit works, and they are not all intuitively obvious. In fact, some of them will seem intuitively wrong until you stop to think about them. Most of these facts arise from math, geometry, and occasionally physics, so they're true everywhere, of every technology, and in every culture. If you're going to form intelligent opinions about transit, so that you advocate projects that actually serve your goals, you'll need to understand these basics.

These underlying facts of transit force us to make hard decisions, but they also open up possibilities. My aim is to help you see the unavoidable hard choices and to form your own view on them, but also to help you feel optimistic about the range of things transit can do and how a smart use of transit can improve your community. Like any box of tools, transit can do a lot of useful things, but only if you know each tool's purpose. Much of the noisy confusion in transit debates is the sound of people using a hammer to turn a screw or a screwdriver to pound nails.

LISTEN TO YOUR PLUMBER: VALUES VERSUS EXPERTISE

A core idea of this book is that we will have clearer conversations, and make better decisions, if we distinguish carefully between values and expertise and understand their interplay in our transit debates.

Values are statements about your community's ideals, goals, and priorities. They answer questions like these:

- What is transit's purpose? How should we measure the results of our transit system? Ridership? Revenue? Emissions? Complaints?
- What counts as adequate and useful transport? For example, what is the minimum level of quality that transit should be aiming for?
- What kind of city do you want? Public transit, like all transport infrastructure, can have big impacts on the form, feel, and functioning of your city, so it's important to understand those impacts in advance.

Experts like me can clarify these questions but shouldn't be answering them for you. *My job in this book is not to make you share my values but to give you the tools to clarify and advocate yours*. You, and your community, get to choose what you want and why. An expert's job is to help with how. It's a crucial distinction, one that often gets lost in transit debates.

But here's the catch: The expert gets to ask you questions that clarify what you want. Say you hire a man to fix your plumbing. He goes to work, but soon he encounters a point where he could do one thing or another, and it has to be your decision. He says, "I can fix it up for now for $50, and it'll work for a year or so. Or, if I replace the whole assembly and connect it with a new doohickey, it'll be just like new, but that would be about $700, and it would take a week for the part to arrive."

The plumber's question reveals that values (what) and expertise (how) have to interact more than once. A transit planner working for your community is like a plumber: They are there to implement your values, not their own. Their job is to determine how, not what. But you can't just tell the expert what you want and leave the room. When a leader or manager does this ("Just do this—I don't care how you do it!"), they are likely to be unhappy with the results. The values and the expertise must engage in a conversation.

Fortunately, as with plumbing, the questions that transit experts will have about your values are predictable. The same questions come up over and over. For this reason, the best way to form a resilient and credible opinion about transit is to think carefully about these typical "plumber's questions" and to discuss them within your community. This book is designed to help you do that.

These questions are hard, because they're about choosing between different things that you like. Your plumber is asking you whether you'd like to save money now or have a more permanent fix. "Both" is not a useful answer. A transit expert helping your community has to ask many similar questions. Here are a few of the hard ones that we'll explore:

- Is transit mostly about serving a peak period or rush hour commute pattern, or is its top priority to provide a consistent service all day? (chapter 7)
- Would you rather have a direct but infrequent service or a more frequent service that requires a connection? (chapter 12)

- Should transit stops be close together, so that they are easy to walk to, or further apart, so that service runs faster? (chapter 6)
- Is the goal of your transit system to carry as many people as possible? Or to serve disadvantaged people who really need the service, no matter where they live? Or something else? Or is it a balance of these, and if so, where do you strike that balance? (Chapter 10)

These questions arise, unavoidably, from the underlying geometry of transit. Many people are trying to make transit do things that are geometrically impossible, so it's important to start by exploring how transit works in geometric terms before going on to debates about what kind of technology to buy.

TECHNOLOGY: TOOL OR GOAL?

When someone asks me what I do, and I say I'm a transit planner, their next question is almost always about transit technology. They ask my opinion about a rail transit proposal that's currently in the news. They ask what I think of gondolas or ferries or some vehicle that has just been invented. They assume, like many journalists, that the choice of technology and vehicle is the most important transit planning decision.

Transit technology choices do matter, but the fundamental geometry of transit is exactly the same for buses, trains, and ferries. If you jump too quickly to the technology choice question but get the geometry wrong, you'll end up with a useless service no matter how attractive its technology is.

What's more, the most basic features that determine whether transit can serve us well are not technology distinctions. Speed and reliability, for example, are mostly about what can get in the way of a transit service. Both buses and rail vehicles can be fast and reliable if they have an exclusive lane or track. Both can also be slow and unreliable if you put them in a congested lane with other traffic. Technology choice, by itself, rarely guarantees a successful service, and many of the most crucial choices are not about technology at all.

New technologies are especially challenging to think about. Tech companies backed by venture capital can fund huge marketing campaigns to

convince us that their invention will be here tomorrow, that it will change everything, and that anyone who questions them is a dinosaur. But like all inventions, these ideas are new and untested, so their claims are hard to evaluate.

The early twenty-first century has been an era of wildly oversold transport technologies. We were promised that totally driverless cars would be on the road in just a few years, raising the possibility that abolishing the paid driver would unleash vast new quantities of passenger transport of all kinds. Flying cars were always in the news. Demand-responsive transit or "microtransit" was another wave of excitement. In that case, the product exists and has its uses, but as we'll see in chapter 5, its relevance is more limited than much of the hype suggests.

By the time you read this, something new will be promising to "disrupt" public transit and telling you to throw out books like this one that didn't anticipate that invention. In response, my advice is to lean into the wind.

To stand up on a windy day, your body will lean in the direction that the wind is coming from. It leans just hard enough that it balances out the force of the wind, so that you stand up straight.

The wind in this metaphor is the big marketing budgets of the inventors of new technologies. They want you to fall over in one direction, toward believing uncritically in their product. But if you're too cynical, if you assume that everything they're selling is nonsense, that's like falling over in the other direction. The marketing has still forged your opinion by making you believe its exact opposite. Instead, you have to sense the pressure of the marketing and apply exactly enough skepticism to counterbalance it, but not more. That's the only way to stay upright, so that you can see.

TRANSIT AND URBAN FORM

Many of the "plumber's questions" about transit will be easier or harder because of the way your city is laid out. The physical design of cities determines transit outcomes far more than transit planning does. Your particular location in the city, and the nature of the development and street patterns, will govern the quality of transit you can expect. For that reason, one of the most urgent needs related to transit is to help people make smarter decisions about where to locate their homes and businesses, depending on the level of transit mobility that matters to them.

These decisions, aggregated across the whole population and over many years, can change the shape of your city for better or for worse. Ultimately, our cities grow and change due to individual decisions about where to locate things. It may seem that the developers, planners, and politicians are making these decisions, but we are all part of the market they serve. So everyone contributes to determining whether transit can work in a particular city or development. The last part of the book, starting with chapter 15, is about how to make those choices more wisely.

WHO AM I? WHO ARE YOU?

Finally, because so little agreement exists about what constitutes expertise in transit, it is only fair that I answer the question, "Who is this guy, and why should I care what he thinks?"

Since 1990, I have been a consultant specializing in transit service design—that is, designing transit networks and their schedules to provide the best possible service to a community, according to the values each community expresses. I've also worked as an in-house consultant in major transit agencies, serving temporarily as part of their staffs. In many cities, from small towns to large urban areas, I can point to places where my service designs are working on the street and have made transit more relevant to people's lives. The core pleasure of my professional life is to see transit working well in the real world.

Ever since I was ten years old and began riding the city buses across Portland, Oregon, to school, I have been an attentive customer of transit, constantly musing about how this or that could work better. Phoning the planners at Portland's transit authority, TriMet, I found them interested in talking with me and receptive to new ideas, so I never learned the debilitating cynicism that so many citizens feel—the sense that their transit authorities are so stuck in their ways that there's no point in providing input.

I spent my twenties completing a PhD in a literature field, so I'm extremely sensitive to the workings of language. This experience has been foundational to my work as a transit planning consultant. Throughout the book, I'll point out situations where word choices matter and where the structure of our language may be preventing us from thinking clearly.

As the first edition of this book was going to press in 2011, I started my own consulting firm, Jarrett Walker + Associates, that helps cities and transit

authorities all over the world think about planning issues, especially the design of bus networks. As I write this in 2023, we are fifteen people in three offices in North America and Europe. We have worked on many major rethinkings of transit networks, in places ranging from big cities like Dublin and Houston to rural areas and the smallest towns. I continue to comment on public transit issues on my blog HumanTransit.org. Much of the material of this book was first developed there.

But enough about me. Who are you?

In writing this book, I imagine that you, the reader, are a curious and thoughtful person who cares about whether we find our way to more rational forms of urban mobility. Perhaps you work or study in a field related to transit, such as land use planning, traffic engineering, or real estate development. You may be a community or business leader, a journalist, or a committed activist. Perhaps you have come to transit issues from another concern, such as the economic development of your city, or the rights of people with disabilities, or the well-being of seniors, or some form of environmentalism. Perhaps you have used and admired the transit systems of other cities and wonder whether those systems are possible where you live. Perhaps you are someone who doesn't like what is happening to your city, who is not sure how to evaluate the transit disputes flaring around you, and who wants to hold more confident opinions. If you have clear ideas about what you want for your city and you're curious about how transit can help, this book is for you.

WHERE ARE YOU?

The core ideas of this book apply anywhere in the world. For that matter, they'd apply on other planets if there were urban civilizations with public transit there.[1] Mostly I will be talking about geometric and physical facts and how those facts define our alternatives. Cultural differences are important to the work of planning, but they don't change those facts.

However, one key fact differs between developed and developing countries. The cost of running transit in wealthy countries is dominated by the cost of labor—drivers, mechanics, and so on. In the developing world, labor is much cheaper, and fewer people own cars, so transit costs less to operate and has a larger customer base. That means transit is often a profitable small

business—as small as one driver and their bus—and therefore is often abundant but poorly organized. Cheaper labor also means that smaller vehicles are economical, so developing-world cities tend to have a diverse range of minibuses, shared taxis, and the like.

Although transit's costs and markets differ in the developing world, the same limitations of urban space do apply. Often, the abundance of minibuses and shared taxis is enough to create near gridlock even without many private cars. Today, the developing world is the site of frenetic development of modern bus systems, bus rapid transit, and sometimes rail transit. Many developing cities have dire traffic congestion and pollution, and an urgent need to create alternatives, so I hope readers in the developing world will find the book useful as well.

Writing about transit to a global audience presents one problem. In discussing this topic, North Americans tend to use different words from what you will hear in the rest of the world. When I use words like *transit*, *transportation*, *streetcar*, or *curb*, I'm speaking in a North American dialect. In a book that happens to be published in the United States, this is unavoidable. When I first use a word that is distinctly North American, I'll mention the words you might hear in other countries. In two cases, I'll use a word from outside North America if it's clearer or simpler, and I know North Americans will understand it. (You'll see *transport* instead of *transportation* and *authority* instead of *agency* for the government in charge.) Whatever form of English you speak, I want you to understand.

WHO ARE WE? WHO DECIDES?

Throughout this book, I use *we* to mean you and your fellow residents of a democratically governed city, along with me as your hired transit planning expert. In short, I assume that if you get together with your fellow citizens and think together with the benefit of an expert's advice, you can arrive at a resilient view of what you want transit to do—and thus of what kind of transit you need.

If you've spent any time following transit politics in a big urban area, this notion may seem naive. Perhaps you've dealt with cities where a tangle of government agencies work on transit, often quarrelling more than they cooperate. Perhaps you've dealt with bureaucracies that seem defensive,

trapped by their own fears and habits, and unwilling to engage you in respectful conversation.

Perhaps, too, you suspect that a small, self-interested elite really makes all the decisions that matter and that public consultation is just a show. If so, you're probably wrong about that. In thirty years in this business, I've seen plenty of frustrating, confused, and hijacked decision processes. If I wanted to be bitter and cynical, I have the experience to justify it. But I've seen another pattern: The involvement of more informed and caring citizens, expressing themselves with courtesy, clarity, and persistence, almost always leads to better outcomes.

In any debate, there will be people at the decision table who care only about their personal interests and needs. If those people dominate, you'll get decisions that serve those interests but may not serve your city.

But in situations where lots of citizens care and choose to learn a bit about transit so that they can advocate more clearly and confidently, better decisions get made, decisions that lead to better mobility, a stronger economy, a more just society, or whatever goal the community is pursuing. Political leaders make good decisions when informed and caring voters demand it. It's only when leaders sense that citizens have given up or don't care that they may let narrower interests carry the day. So if you're willing to learn a bit about how transit works, what it does well, what it doesn't do, and how it fits into the larger challenge of the city, your opinion will count.

RESPECT FOR TRANSIT

Throughout this book, you'll be asked to develop a respect for public transit not just as a tool but also as an area of expertise. Many people think they understand transit because they understand something that's connected to it, such as urban design, operations management, economics, or traffic engineering. Get all those people in a room and they start arguing and talking past one another, often hurling jargon as a weapon. Other citizens listen to a bit of this and decide that transit is impossible to figure out.

It's not hard to understand transit and how it can serve our values and needs, if we approach it with some respect. Let's try.

ONE

What Transit Is and Does

The term *public transit* (or *public transport*) is used to mean various things. Dictionaries and other authorities disagree on its meaning.[1] In this book, it means a passenger transport service focused on travel within a region, open to all passengers, with the ability to carry multiple passengers who may have different origins, destinations, and purposes.

Let's take this definition apart:

- *Passenger transport service*: Public transit customers are passengers, which means they are not driving the vehicle.
- *Focused on travel within a region*: We don't usually use *public transit* to describe long-distance services between distant cities, such as airlines. We are usually talking about travel within an urban region and possibly its surrounding rural area. Many of the points in this book also apply to intercity services, but those are not this book's focus.
- *Open to all passengers*: The word *public* in *public transit* means "open to the entire public." People can be excluded from public transit only if they break the rules or fail to pay any required fare. The word *public* can be confusing in debates about whether transit should be operated by the government or by the private sector. In the developed world, where wage costs are high, transit is usually subsidized by government, but it may still be operated either by government or by private companies. In those conversations, *public transit* can be misunderstood as meaning "transit operated by the public sector—that is, government—rather than by private companies." That is *not* the meaning in this book or the

prevalent meaning in most of the developed world. Even privately operated transport services are expected to welcome all paying customers; in fact, the failure to do so can become a civil rights issue in some countries.[a]

- *That can carry multiple passengers whose trips can have different origins, destinations, and purposes*: Transit, in the sense used in this book, does not include
  - Carpools and vanpools, where several people with the same destination share a ride;
  - School buses, where school is the only origin or destination served;
  - A family in their car, or any other group that's intentionally traveling together;
  - Taxis and ridehailing services such as Uber and Lyft, unless they can be shared by strangers who did not coordinate with each other.

There are many ways for multiple people to ride a vehicle together, all of which are better for the environment than each of those people driving (or being driven) alone. Carpools, school buses, and shared taxis are all useful parts of a city's transport mix. But they are not public transit as this book and most of the industry use the term.

At its core, transit is about multiple people riding in one vehicle even though they are not intentionally traveling together or even going to the same places. The core challenge of transit design, then, is how to run vehicles so that people with different origins, destinations, and purposes can make their trip at the same time and will be motivated to choose transit to do so. This book is all about meeting that challenge.

TRANSIT'S THREE EFFICIENCIES

Compared to anything that you can do with cars, public transit is supremely efficient in three ways:

[a] A service open to only a subset of the public—such as a paratransit van that serves people with disabilities on demand—can count as public transit if it specifically serves people who cannot access regular transit services. Even though it is closed to other riders, it serves the goal of a total service offering that is available to everyone.

- Efficient use of *space*. In dense cities, where space is scarce, transit enables people to travel beyond their walking range without taking up too much space.
- Efficient use of *labor*, compared to other modes that require hired labor. You can hire a driver to drive you alone, but a vehicle with lots of passengers will use that driver's time more efficiently, which is why its fare is usually lower.
- Efficiently minimizing emissions, or what we might call efficient use of the *atmosphere*. By carrying more people in fewer vehicles, transit produces lower emissions per person and thus has a large role in minimizing air pollution and its impacts on the climate, compared to cars.

If you follow the technology news, you may have heard claims that these problems now have other solutions.

- Efficient use of the atmosphere, through reduced emissions that cause climate change, can be improved with zero-emission vehicles. However, the emission reductions needed to halt climate change require less driving, not just cleaner cars. In most countries, only some electricity production comes from renewable resources, with the rest depending on fossil fuels. Electric vehicle manufacturing is also a resource-intensive process that produces waste and pollution.[2]
- Efficient use of labor can be achieved by eliminating paid labor, using autonomous driving. Despite many years of hype, this technology is not ready to fully eliminate the paid driver anytime soon for services mixing with traffic. So transit is likely to remain important in its ability to serve many people with few paid staff hours.
- Efficient use of space has no other technological solution.

This last point is critical. You can apply all kinds of technology to cars, but the defining feature of the car is that it protects you from sharing space with strangers. To do this, it must maintain walls around every traveler or traveling party and allow each to move independently. Those moving walls take up a lot of space. Again, a city is lots of people close together, so cities have little space per person. Space in cities must be used efficiently.

When we talk about physical space, we're talking about geometry, and *technology never changes geometry*.

If I asked you, "How many adult elephants would fit in a wineglass?," I bet you would feel very certain about your answer, because you'd recognize this as an example of the blindingly obvious fact that objects don't fit in containers that are smaller than themselves. Too many cars won't fit in a city for the same reason, and that's something no technology will change.

TRANSIT'S ROLE IN A COLLABORATION OF MODES

While this book is about transit, I never imply that transit is or should be the dominant alternative to the private car. Many ways of sharing vehicles have important roles to play in the larger project of reducing car dependence. These include many forms of carpooling and vanpooling, which typically carry people from a similar area of origin to a common destination, as well as carshare programs, which provide members with hourly self-service car rental. These programs are important complements to transit, but they are not this book's focus.

In focusing on transit, I am also not denying the role of the active modes, such as cycling and walking.[b] Quite the opposite. Virtually every transit rider is also a pedestrian, so transit ridership depends heavily on the quality of the pedestrian environment where transit stops. The ability and willingness of people to walk a short distance to a stop or station is what makes it possible to gather many people with many intentions on a single vehicle, which is the essence of transit's project.

Cycling, meanwhile, has grown rapidly in cities that have chosen to accommodate it. But even in the most bicycle-dominated countries, such as the Netherlands, transit has a crucial market. Local bus service has a somewhat smaller role there because bicycles take so much of the short-distance market, but in the longer-distance market, trips over 5 kilometers (3 miles) or so, cycling and transit reinforce each other, not just by rewarding similar kinds of land use but also by permitting trips done partly by cycling and

[b] Throughout this book, I will have to ask some people with disabilities and their advocates to tolerate my use of the terms *walking* and *pedestrian*. These terms are sometimes considered objectionable because a person in a wheelchair is technically not walking or traveling by foot, but I must speak of walking so often that fully inclusive phrases such as "walk or roll" would be tiresome. My use of these terms includes people in wheelchairs and similar devices that allow them to travel at typical pedestrian speeds.

partly by public transit. Many cities and transit authorities are looking at how to expand the potential for these "cycle + transit" trips.

So even as these other sustainable transport modes grow, we will need public transit. Among the sustainable transport alternatives, public transit is unique in two crucial respects. First, only public transit can carry large numbers of people in a single vehicle with a single driver,[c] even as these people travel from different origins to different destinations for different purposes. At the intense levels of demand found in high-density cities, public transit is an efficient use of both energy and scarce urban space and is often the most attractive option for trips that are too long to walk or cycle.

Second, public transit delivers people from one part of the city to another *as pedestrians*, eliminating all the challenges of storing a personal vehicle. The pedestrian is the foundation of contemporary urban design, and walking is the ideal mode of travel for both health and sustainability. If you want to encourage pedestrian life, you need to connect pedestrian-intensive places to one another in a way that the pedestrian can use. Transit can be ideal for this purpose.

WHAT IT COSTS

If you want an efficient public transit system, you need to understand the costs of providing transit so that you can compare them to the benefits. Many influential people are confused about how transit's costs work. Here are the two biggest things to remember:

- The cost of providing public transit is dominated by the operating cost, not construction or equipment cost.
- In wealthy countries, operating cost is mostly the cost of labor.

If you come to public transit with experience in professions that build things, such as highways, buildings, and other civic infrastructure, you are

[c] Most public transit vehicles have one on-board employee, whom I'll call the *driver*. Many US transit authorities prefer the word *operator*, but that word would be confusing to readers outside North America, for whom *operator* usually means a company running public transit service.

likely to get this wrong. What highways and buildings have in common is that their cost is mostly in their construction. Their operations and maintenance costs are small compared to their construction cost. So it makes sense, when talking about most infrastructure, to focus on the problem of how to justify the cost of building it.

Transit just doesn't work like this, especially in wealthy countries where the cost of labor is high. As long as every transit vehicle requires an employee, the cost of labor is the primary constraint on the quantity of public transit. Obviously, major pieces of transit infrastructure have huge construction costs, but construction happens once, while operations are forever, so operating costs are always likely to dwarf construction costs in the long run.

For example, in the 2000s and 2010s, many US cities invested in inner-city streetcars (trams) with the goal of encouraging certain kinds of development. Many of these lines were so short or circuitous that they did not replace any bus services, so their operating costs were entirely new. In these cases, the eternal operating cost had to be counted to determine whether the project was worthwhile.

Another common mistake in transit infrastructure planning is to save on construction cost by making operations more expensive. For example, a transit station design might save money by accepting that the buses will have to drive an awkward path to serve it. This saves money once but wastes precious operating time forever.

Finally, many people I meet are certain that smaller vehicles must be cheaper to operate. People often complain that they see big buses running nearly empty, and assume that this is evidence of waste. That's wrong, at least in wealthy countries. Those empty seats on the big bus cost the transit authority very little, because the operating cost isn't in the seats. Most of the cost is for the driver and other costs such as maintenance that don't vary much by vehicle size. That's why a smart transit authority deploys the largest vehicle that it might ever need in the course of a day. If a bus will get fifty people on board just once a day, perhaps when a school lets out, then it's best for that bus to be big all the time, because the labor cost of pulling out a separate bus at the end of the school day is far greater than the cost of running empty seats.

Some transit authorities do have lower operating costs for smaller vehicles, but if so, that's not because of the vehicle; it's because of what the labor agreement says about the vehicle. Many transit labor agreements allow the

driver of a smaller vehicle to be paid somewhat less. But the difference usually isn't nearly enough to make it possible to, say, replace one big bus with two vans half the size.

Starting in the 2010s, we began to see many private companies, including Uber and Lyft, offering themselves as part of a transit network. If you compare these directly to the transit authority's big buses, these services may sometimes look decent in terms of cost-effectiveness (cost per rider). But in these cases, you should also look at how much of the savings lies in the driver's compensation and think about whether, in the end, you'll get what you pay for in terms of service quality and reliability. Maybe you will, but you should think about it.

You may want to think about the social and moral dimensions of driver compensation. The labor arrangements of public transit authorities usually compensate an experienced driver enough that they can raise a family with a working partner. The overall stability of your society will depend in part on what percentage of the population has that kind of security.

But you should also expect driver compensation to follow free market forces. Public transit experienced a worldwide staffing crisis in the early 2020s, as the job of driving a bus or train wasn't attractive to enough people at the rates being offered. There are many aspects of this problem, but at bottom, we'll have to pay drivers enough that enough of them will want to do the job. That means labor will continue to be the single dominant constraint on the quantity of public transport. All through this book, we'll be dealing with the problem of how to use that precious resource efficiently.

MORE ON OPERATING COST

In general, operating cost roughly doubles if you:

- Double the total length of the transit lines you operate, either by extending existing lines or by creating new ones;
- Double frequency, for example, by reducing the time between consecutive vehicles on a transit line from 30 minutes to 15 minutes; or
- Double the duration of service, for example, by expanding from eight hours a day to sixteen hours a day.

But one popular improvement saves operating cost: increasing speed. If you were able to cut the travel time of a service in half—that is, double its average speed—your operating cost would drop by up to half. That's because most operating cost is labor, so it varies with time rather than distance. Run faster, and you use labor more efficiently.

For more on operating cost, see www.humantransit.org/02box. For now, remember: Route distance, frequency, and span all *cost*, but *speed* saves.

TWO

What Makes Transit Useful?

Seven Demands and How Transit Serves Them

If you spend any time inside the offices of a public transit authority, you get used to seeing messages like "The customer comes first!" and "Service is our business!" Posted in the elevator or in the lunchroom, these messages are supposed to focus employees on a particular mission called service.

But what kind of service do we need to provide so that people will use it? What is this mysterious thing called service anyway?

THE SEVEN DEMANDS

In the hundreds of hours I've spent listening to people talk about their transit needs, I've heard seven broad demands that potential riders have of a transit service:

1. It takes me where I want to go.
2. It takes me when I want to go.
3. It is a good use of my time.
4. It is a good use of my money.
5. It respects me in the level of safety, comfort, and amenity it provides.
6. I can trust it.
7 It allows me spontaneity to change my plans.

I've listed the demands in the order in which you, as a customer, usually evaluate them. Usually, you would first evaluate transit in terms of whether it exists at all in the places where you need it (demand 1). Then you would consult a schedule or app to see whether it runs when you are traveling (demand 2). Next, you might compare the cost of transit (in money and time) with the benefits (demands 3 and 4) to decide whether transit is worth trying compared to your alternatives.

Now you are ready to try the service. You notice whether you feel safe, comfortable, and respected as a passenger and whether you can put your travel time to good use (demand 5). If you become a regular customer, you start noticing whether the service works the same way day after day—in short, you decide whether you can trust it (demand 6).

Finally, as your own needs vary from day to day, you begin to discover how well the service responds to those changes (demand 7). Can you get home, or to school, in the middle of the day to tend to a sick child? Can you, on the spur of the moment, stop off at a cinema and see a movie, knowing that it is still possible to get home three hours later? Can you just go wandering, exploring the city spontaneously, if you feel like it?

These seven demands, then, are dimensions of transit quality. They don't yet tell us how good we need the service to be, but they will help us identify the kinds of goodness we need to care about. We can use these as one starting point for defining useful service.

SIDE ISSUES AND SIDE EFFECTS

Do these demands encompass everything that people ask of their transit authorities? Of course not. There are two other important categories of demands.

First, a transit authority hears feedback about how it functions as an employer, as a company, and as a corporate citizen. These issues include fairness to workers, sponsorship of community events, relations with other government authorities, and so forth. These are all important, but they are common to all organizations, regardless of their product. For that reason, I will set them aside for this book's purpose. You don't need to understand transit to understand these issues.

Second, transit authorities get many comments about the side effects of their equipment and facilities. The big side effects of transit are emissions,

noise, vibration, and the way various transit vehicles affect the look and feel of the urban environment.

But these comments aren't about the basic work of public transit, either. An especially noisy and polluting bus has the same impact regardless of whether it's a public transit bus or a tour bus. Other technologies attract advocacy because of positive side effects. For example, streetcars and light rail (usually called trams outside North America) are both popular in part because of how they look and feel in the urban streetscape.

In considering side effects, we need to think about transit the way we think about a fire department. Firefighting has lots of side effects, including the street space that the big trucks need and the noise of their sirens. Now and then, those effects become so objectionable that people complain about them, and fire departments have to respond to those complaints, as they should. So there's a value trade-off here, an example of the plumber's question: Should we reduce the effectiveness of firefighting a little in order to mitigate some of its impacts?

Still, all sides of that debate can see that there is a job called "firefighting" that is the defining purpose of these companies. That doesn't mean that it's the only thing that matters or that its efficiency should be ranked above all its other impacts. But discussions about impacts usually reflect a shared understanding that the firefighters' main job is to put out fires and that everyone has an interest in seeing that job done well.

When it comes to transit, the balance of power in these conversations is different. Not everyone recognizes that transit has a defining task and that a transit authority has to maintain a primary focus on that mission even as it tries to manage its side effects. The next chapter explores how to define that mission.

THE ELEMENTS OF USEFUL SERVICE

So how does transit meet the seven demands that we identified earlier? How do we translate the demands into specific things that transit authorities have to provide and measure? Figure 2-1 shows how each of the seven demands is tied to a measurable feature of transit service. Don't worry if it looks complex. We'll step through the key points. Still, you may find it useful for reference as we explore how the various transit concepts are connected.

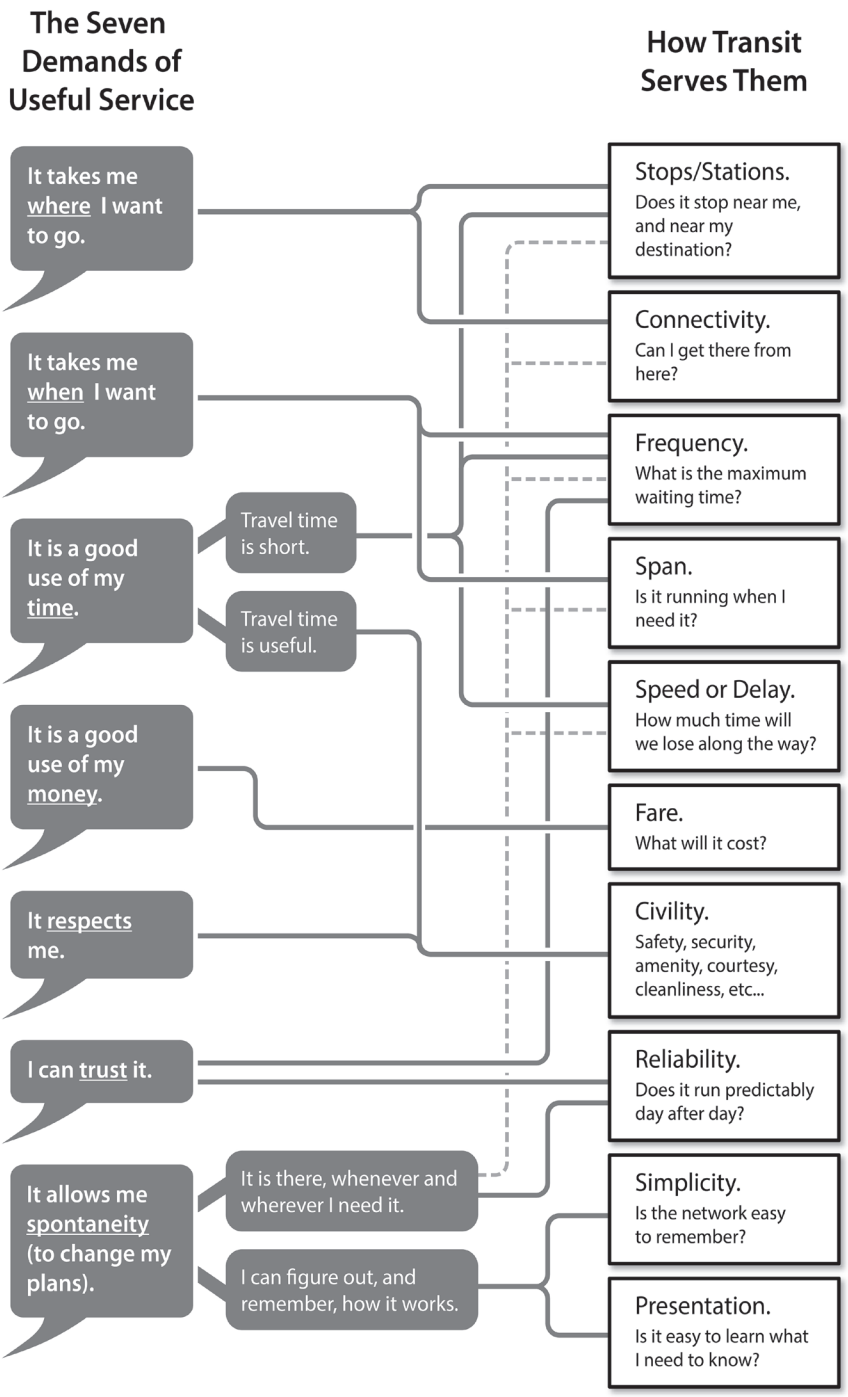

FIGURE 2-1. Seven desires for useful transit and how transit serves them. (Credit: Eric Orozco)

Demand 1: It Takes Me Where I Want to Go

The first demand involves two key measurable features of a transit system.

First, the location of *stops and stations* determines how close transit service comes to each place that anyone might want to come from or go to. We'll discuss stops and stations in chapter 6 and the lines that they form in chapter 5.

Second, *connectivity* is a measure of whether transit links where you are (your origin) with where you want to go (your destination). Stops near your origin and destination do not guarantee connectivity: A transit authority may serve both point A and point B but be unable to take you from A to B in a reasonable amount of time. Chapters 12 and 13 explore connectivity, which arises mostly from how well different services work together.

Demand 2: It Takes Me When I Want to Go

The second demand also encompasses two measurable features.

First is the question of whether transit runs at all when you need it; the answer to this is the *span* of service. Span is indicated by the scheduled time of the first and last trip in each direction.

Next is the question of whether the service runs often enough that you can leave when you want to go or arrive when you want to arrive. The measure of how often transit runs is *frequency*. Frequency is usually described by the number of minutes between consecutive trips, so lower scores are better. A service that runs every 15 minutes, for example, is twice as useful, and twice as expensive to operate, as one that runs every 30 minutes.

Frequency is one of the most misunderstood concepts in transit. We'll return to it often throughout the book, especially in chapter 8.

Demand 3: It Is a Good Use of My Time

The third demand includes all the ways of making travel time useful to the passenger. These efforts can involve providing reading lights, electrical outlets, phones, internet access, and other facilities that enable a passenger to work, sleep, or do something else valuable while waiting and riding.

But above all, we want travel time to be short. Travel time is usually a dominant element of a passenger's decision about whether to use transit routinely, and for this reason, the models that predict ridership give it huge weight. We'll explore travel time more in the next chapter.

When we think of saving time, we usually think of speed. When we're driving, the average speed that we'll achieve is the measure of how fast we'll cover the distance to our desired destination. When people who usually by travel by car think about a transit issue, they often focus on how fast the vehicles can go. But for transit, the vehicle speed is a small part of the picture. What matters is how much time it takes to complete an entire desired trip, including walking and waiting. So to understand this demand, we have to look in more detail at all the phases of a trip and the potential for delay involved with each. We'll come back to that in the next chapter, and we'll dissect speed further in chapter 9.

Demand 4: It Is a Good Use of My Money

This fourth demand is simple, since fares are the primary monetary cost of transit use. People compare the cost of using transit with the cost of getting somewhere in some other way, and this can strongly influence their decision. Chapter 11 explores fares.

Demand 5: It Respects Me

At its core, the fifth demand is about whether the rider feels valued as a customer, as a citizen, and as a human being. Obviously, this demand is so subjective that it could come apart into a million values.

Fortunately, most of us do agree on some things that contribute to our sense of being respected. For example, comfort, courtesy, safety, and security all signify we are valued as human beings and as customers.[1] Some of these features also give value to our time, so they follow also from the third demand.

All these values fall under a large category that I'll call *civility*. These values are not about transit's ability to transport us but, rather, about its ability to treat us like human beings while it is doing so. Some level of civility is essential if we are to carry a diverse range of customers.

Definitions of civility vary from one culture to the next. In some cultures, for example, civility includes separate seating areas for men and women. Passenger railways in India may not offer the personal space and comfort that a North American or European visitor would expect, but they do meet the expectations that prevail in India, so they're popular. By definition, civility includes whatever expectations are widely shared within the culture.

(continued...)

INDEX

Page numbers indicating figures and textboxes are in italics. Tables are in bold type.