

Thinking Outside the Bus:

Understanding User Perceptions of Waiting and Transferring in Order to Increase Transit Use

Final Report
December 2007

Prepared for:
The California Department
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(Caltrans)

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16. ABSTRACT Efficiently and effectively run public transit systems are essential components of and crucial contributors to the proper functioning of a region's overall transportation network. However, travel by public transit is a complex process that involves more than simply people moving about on buses and trains. A typical door-to-door trip involves walking from one's origin to a bus stop or train station, waiting for a vehicle to arrive, boarding the vehicle, traveling in the vehicle, alighting from the vehicle, and then walking to one's final destination. In many cases, the trip also involves transfers; travelers alight from one transit vehicle, move to a new stop or platform, wait for another transit vehicle, board that vehicle and continue this process until they reach their last stop or station at which time they then must walk to their final destination. Therefore, transit travelers expend a great deal of their time, energy, and patience outside of buses and trains, and this contributes greatly to both their actual and perceived burden of transit travel. This added burden influences the travelers' decisions on whether or not to take transit in the future. Given the relative convenience of door-to-door travel by foot, bicycle, taxi, or private vehicle for many trips, public transit systems are often at a competitive disadvantage when competing for passengers. This research examines ways to increase the attractiveness of public transportation and reduce the perceived burden of the time spent outside of vehicles during transit trips.			
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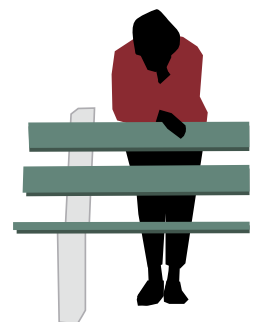
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Preface

This document is the Final Report for the Research Technical Agreement (RTA) between the California Department of Transportation (Caltrans) and the University of California at Los Angeles (UCLA). The RTA is entitled “Tool Development to Evaluate the Performance of Intermodal Connectivity (EPIC) to Improve Public Transportation”. Caltrans’ primary interest in this research was interconnectivity among transportation modes in California and the development of a methodology to evaluate connectivity performance, which could provide a new and needed tool to improve passenger transit trips.

This project was a collaborative effort between UCLA and the University of California at Berkeley (UC Berkeley). The overall project Principal Investigator was Professor Brian Taylor at UCLA, and Professor Samer Madanat served as the Principal Investigator for UC Berkeley. Mr. Mark Miller was the Project Manager working with Dr. Hiroyuki Iseki of the University of Toledo; at the start of the project Dr. Iseki was a Post-Doctoral Researcher at UCLA. Additionally, two Graduate Research Students at UCLA, Mr. Michael Smart and Ms. Adina Ringler, were members of the project team. Professor Taylor provided overall technical guidance and support to the project team for all project tasks. In addition to managing the project, Mr. Miller conducted research in the areas of reviewing the literature, designing and administering both project surveys and the institutional interview guide, and documenting research findings. Dr. Iseki developed the transfer penalties/travel behavior conceptual framework as part of his review of the literature; he also worked on designing the transit passenger survey and analyzing its responses as well as documenting its findings. Mr. Smart worked on designing and administering both project surveys and the institutional interview guide, analyzing responses to the transit operators survey and the institutional interview guide, and documenting their findings. Ms. Ringler worked on designing and administering the transit passenger survey, analyzing its responses, and documenting its findings. Additional information about the four authors of this report is provided in the “About the Authors” section of this report.

¹ UC Berkeley is under subcontract to UCLA.



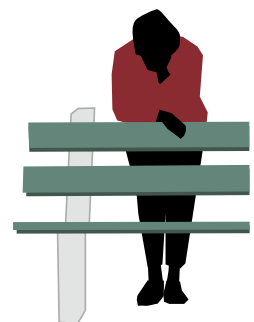
The two key products of this research are:

- The transfer penalties/travel behavior conceptual framework, which was based on our review of the state-of-the-practice for evaluating intermodal and intramodal connectivity, and
- The preliminary transit connectivity assessment tool

The framework allowed us to consider various attributes of transit stops, stations, and transfer facilities and guide us in our subsequent analysis of user perceptions of walking, waiting, and transferring experiences. Our research findings, especially the preliminary Assessment Tool, have taken substantive steps toward determining the connectivity of transit systems, its influences on travelers' satisfaction with transit services, and ways that public transit systems can reduce the burdens of out-of-vehicle "travel" times to help make public transit more attractive resulting in ridership increases.

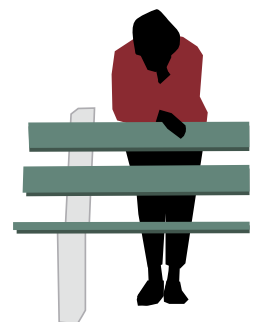
This Final Report has integrated each of our project's components into a cohesive product documenting the significance of transit connectivity's contribution toward increasing transit usage.

In this report, we describe transit trips made with transfers, the types of transfer venues, and transit connectivity. We follow this with a discussion of our transfer burdens/travel behavior conceptual framework. After this we discuss the three types of stakeholders we focused on in our assessment of transit stops, stations, and transfer facilities; next we present the methodological approach we employed in this assessment. We then discuss our findings together with presentation of our Attribute Assessment Tool. Finally, we discuss next steps for this line of research.



Acknowledgements

This work was performed under the sponsorship of the State of California Business, Transportation and Housing Agency, Department of Transportation (Caltrans), Division of Research and Innovation (DR&I) (Interagency Agreement #65A0194). The contents of this paper reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California. The authors thank Mr. Bruce Chapman of DR&I who managed this project for Caltrans. The authors also thank Ms. Adina Ringler, a former Graduate Student Researcher for this project at the University of California, Los Angeles, for her significant contributions to this research. The authors would also like to thank former UCLA student Mr. Ting Sit who helped design and administer the survey, and collate and analyze the data; UCLA students Mr. Syed-Abrar Ahmed, Ms. Lanka Ranasinghe, and Ms. Karla Vasquez who helped administer the survey; UCLA student Ms. Vanessa Fernandez who translated the survey from English into Spanish; Los Angeles County Metropolitan Transportation Authority (Metro), Metrolink, Santa Monica Big Blue Bus, and Culver CityBus for allowing us to survey their passengers; the nearly 750 Los Angeles County transit riders and nearly 200 transit managers representing agencies around the U.S. who took time out of their busy schedules to give us their thoughts and views on how to make waiting for transit a less onerous experience; Ms. Michelle Tse and Ms. Rowena Barlow in the Business Office of the UCLA School of Public Affairs and Mr. Ken Castro-Oistad and Ms. Virginia Anders of the UCLA Office of Contracts and Grants Administration for their administrative support of this project.



Executive Summary

Transit travelers expend a great deal of their time, energy, and patience outside of buses and trains – but the in-vehicle experience captures the lion’s share of attention from transit managers.

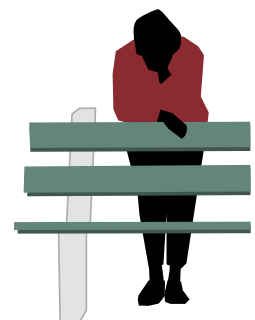
A typical door-to-door trip involves walking from one’s origin to a bus stop or train station, waiting for a vehicle to arrive, boarding the vehicle, traveling in the vehicle, alighting from the vehicle, and then walking to one’s final destination. In many cases, the trip also involves transfers, contributing to both their actual and perceived burden of transit travel. This research examines ways to increase the attractiveness and reduce the perceived burden of the time spent outside of vehicles during transit trips.

In order to learn more about how wait times at stations and stops are perceived, and how they can be made better, we surveyed approximately 750 transit passengers in metropolitan Los Angeles, as well as 175 transit operators nationwide.

We surveyed passengers at stops and stations and asked them to assign a level of importance to each of a list of attributes, and then to tell us how satisfied they were with each attribute. We combined these two scores using Importance-Satisfaction Analysis to identify which attributes passengers found most important and which needed the most improvement.

We surveyed transit operators, asking them to do two things: to rate by importance a series of objectives for transit stops and stations, and also to guess how their operators would respond to a user perception survey (described above). We used the former to construct a rank-ordered list of transit operators’ priorities for stops and stations, and the latter to see just how accurately operators understand their riders’ priorities.

From our analysis of the passengers/users perspective, one principal finding stands out clearly:



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The most important determinant of user satisfaction with a transit stop or station is frequent, reliable service in an environment of personal safety, and only indirectly the physical characteristics of that stop or station.

From the sixteen attributes we examined, users ranked safety and on-time performance most important, and amenities least important:

Most Important

1. I feel safe here at night
2. I feel safe here during the day
3. My bus/train is usually on time
- ⋮
14. It is easy to get around this stop/station
15. There are enough places to sit
16. There are places for me to buy food or drinks nearby

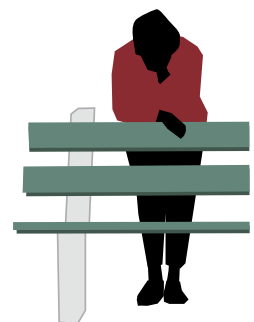
Least Important

A companion part of our analysis compared how transit managers and neighboring communities viewed transit stops and stations. Perhaps reassuringly, our principal finding precisely matches that of the transit user investigation:

For operators, safety- and security-related factors far outweighed other attribute factors at transit stops, stations, and transfer facilities.

Telephone interviews confirmed this finding, with most interviewees stressing the importance of safety and security. One interviewee told us that “safety trumps all” other concerns. Following safety and security, operators rated the following attributes as most important:

2. Reducing pedestrian/vehicle conflicts
3. Schedule coordination
4. Minimizing operating costs



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We also compared transit managers' views of what was important to their riders with riders' own views from our analysis of Los Angeles County transit riders. While transit operators appear to have a fairly accurate understanding of what attributes are important to their, there are several points of disparity:

- The transit managers surveyed correctly assumed that safety and security were very important to riders, but they tended to underestimate the importance of specific safety-related factors, such as the presence of security guards and emergency assistance.
- It also appears that, controlling for other factors, transit managers overestimate the importance of station cleanliness and schedule information to their riders.

This report further develops a Preliminary Assessment Tool that transit operators can use to guide their efforts at improving existing transit stops and stations, or in developing plans for new facilities. The Preliminary Assessment Tool, sketched briefly, guides the operator in:

1. Determining the priority of improvements to stops and stations
2. Devising a user perception survey for stations and stops of particular interest, and
3. Analyzing the survey results to produce a ratings matrix using Importance-Satisfaction Analysis

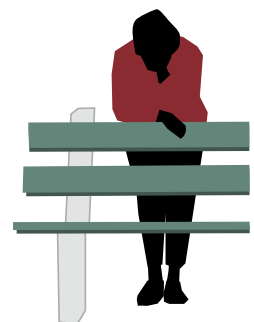


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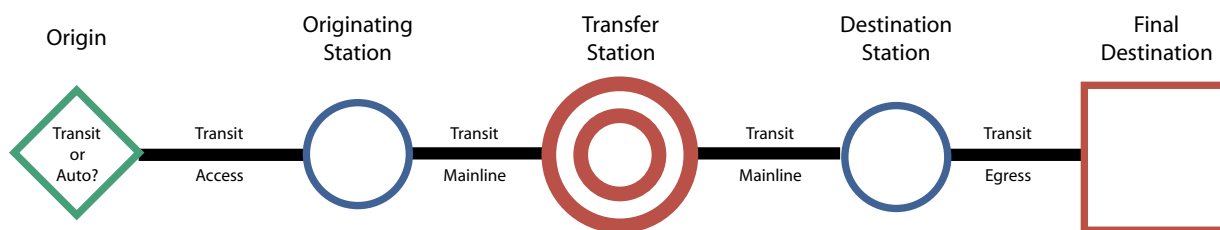
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Thinking Outside the Bus: Waits and Transfers in Transit Travel

A typical door-to-door transit trip involves walking from one's origin to a bus stop or train station, waiting for the vehicle to arrive, boarding the vehicle, traveling in the vehicle, alighting from the vehicle, and then walking to one's final destination. In many cases, the trip involves transfers; travelers alight from one transit vehicle, move to a new stop or platform, wait for another transit vehicle, board that vehicle and continue this process until they reach their last stop or station at which they walk to their final destination. Figure 1 shows a schematic diagram of the major components involved in a transit trip involving a transfer.

FIGURE 1 A Transit Transfer Trip



Source: Metropolitan Transportation Commission, *Transit Connectivity Study*, March 2006.

Transit stops and transfer facilities are obviously not all the same and can differ relative to numerous factors, for example with respect to:

- Physical size of the station or facility
- Travel modes serving the location
- Number of lines per transit operator
- Number of operators, and
- Amenities offered to travelers there.

At one extreme, we can have the bare minimum of attributes: An on-street bus stop that serves two lines of the same transit agency with only posted time-point schedules, no real-time bus arrival times, and not even a bench for waiting passengers to sit on (Figure 2 Simple Bus Stop: Downtown Los Angeles).



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At the other end consider Union Station in downtown Los Angeles, which, as an off-street facility, accommodates both intermodal and intra-modal (bus, shuttles, light rail, heavy rail, commuter rail, and inter-city rail) transfers among different transit agencies and different lines of the same agency (Figure 3 Los Angeles Union Station).

FIGURE 2 Simple Bus Stop: Downtown Los Angeles



FIGURE 3 Los Angeles Union Station



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We describe in Table 1 how transit stops, stations, and transfer facilities may be grouped by the following set of factors in which wait and transfer locations can differ:

- Volume of passengers and activities
- Number of interfacing routes
- Number of interfacing modes
- Physical configuration
- Investment in facilities
- Transit center type (community, regional, or other), and
- Whether or not it is a joint development with commercial use of facility.

TABLE 1 Classification of Transit Stops, Stations, and Transfer Facilities

Descriptor	Attributes
I. Local stop serving a single transit mode	On-street curb loading area serving 1 or 2 bus routes or a station with a grade-level platform for rail
II. Slightly upgraded form from Classification I	On-street bus turnout serving two or more routes with loading bays separated from regular traffic lanes, or a passenger-car level, raised platform rail station, which may have auto parking and vehicle interface facility.
III. Completely off-street	A bus transfer facility at this level is an off-street turnout with loading platforms serving multiple routes. A rail station is an at-grade but raised platform station with a possible pedestrian overpass or underpass, auto parking, and bus transfer facilities.
IV. An urban grade-separated multi-modal transit facility	With exclusive bus access provisions and elevated or subway rail access; it may have large parking areas, and a level 2 or 3 bus-transfer facility. This level facility could be incorporated into a major activity center with joint development by others.
V. A major center-city, regional, grade-separated, multi-modal, multi-level bus or rail-transfer facility.	The significant capital investment is spent in pedestrian circulation elements, waiting room, ticket selling and other passenger processing facilities, and concession spaces. An example is the San Francisco Trans-Bay Bus Terminal.

Source: Fruin, John J. 1985. *Passenger Information Systems for Transit Transfer Facilities*, In *Synthesis of Transit Practice*, 7, edited by N.C.T.R.D. P. (U.S.). Washington, D.C.: Transportation Research Board National Research Council.

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Thus, transit stops and transfer facilities vary greatly. For example, there are

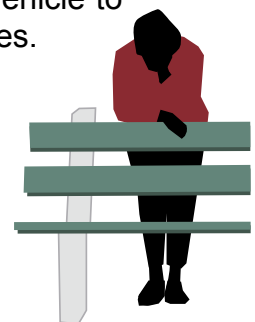
- Bus stops
- Light rail stations
- Heavy rail stations
- Commuter rail stations
- Ferry docks, and
- Terminals

In general, the more transit users at stops and transfer facilities, the more complex a transfer facility is. We highlight the following three types of transit stop/transfer facilities:

A **transit mall** is a special street set aside for exclusive use of buses and/or light rail vehicles in a city center or other high activity center that focus on pedestrian movement and activities, and include design components that are related to both transit and urban design, such as waiting shelters, the use of landscaping, street furniture, shopping and other civic activities. Transit malls are often combined with a development of adjacent property, which consists of shopping and office activities as well as transit-related retail and services.

A **transfer center** is a facility whose primary purpose is to facilitate easy transferring between transit modes and routes and can be combined with transit-related developments, concessions to accommodate users with convenience shopping, (e.g. newsstands, snacks, flowers, and teller machines) or coordinated with a full scale shopping center. Such centers are usually located entirely or partially off-street. They also incorporate a more elaborate and extensive shelter and more passenger amenities than ordinary bus stops. These centers are typically located in suburban or edge-of-city locations in the metropolitan area with sufficient area to allow access and circulation of multiple travel modes as well as automobile parking.

An **intermodal terminal** is a facility that provides key transfers among transit modes, which may include local bus, bus rapid transit, intercity bus, light rail, heavy rail, intercity passenger rail, ferry, or automated guideway transit. Such facilities may also have a variety of other services and connections, including parking, drop-off, ticket vending, and information booths. These facilities are a fixed location where passengers interchange from one route or vehicle to another that has infrastructure, normally only shelters and/or benches.



Transit Connectivity: The Key to the Wait/Transfer Experience

Public transit passengers typically must wait for and transfer between buses and trains during their journeys, and this constitutes the connectivity between distinct parts of a passenger's transit trip from origin to destination. Thus, the travel time spent outside of transit vehicles while waiting and transferring plays a significant role in the passenger's overall transit trip experience.

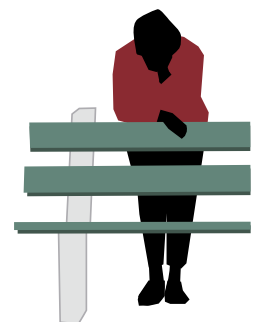
But what exactly is transit connectivity? How does one define, measure, and evaluate connectivity? Although the importance of transit transfer connectivity has been recognized for several decades, surprisingly little of what researchers have learned about out-of-vehicle travel behavior today explicitly informs transit planning practice. Efforts to improve connectivity at stops and stations have proven to be less effective than expected for the following reasons:

- Both practitioners and researchers tend to pay more attention to quantity and quality of in-vehicle travel for its more intuitively obvious effects on ridership.
- Stops and stations vary in size, modes served, location, and amenities; they are hard to analyze comprehensively using uniform criteria.
- Most of the literature on stops and stations is descriptive in nature and lacks a theoretical framework to explain how improvements of transfer facilities affect people's travel behavior and, in turn, overall transit ridership.

Good connectivity is reflected in a convenient and 'seamless' transit system by reducing travel times, providing more reliable connections, making it easier to pay and ensuring that transfers are easy and safe.

Poor stop and station connectivity creates barriers that impede customers' ability to make efficient multi-operator trips. When connectivity is poor, multi-operator transit trips are frustrating, time-consuming, and costly, lowering service quality for users and making transit unattractive for new customers.

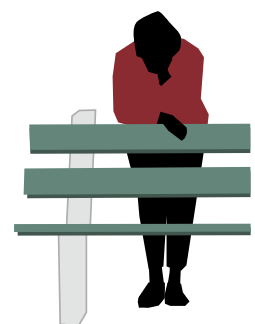
Source: Metropolitan Transportation Commission, Transit Connectivity Study, March 2006.



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Most previous studies of transit stops, stations, and transfer facilities have compiled laundry lists of out-of-vehicle trip attributes that contribute to or detract from travelers' transfer experiences; however, they have largely failed to consider the relative importance of each of these attributes — positive and negative — or whether and how these attributes influence ridership separately or in concert with another. As a result, we know little about which attributes are most important, under which circumstances, and in what combinations with other factors. In other words, we know very little about the effects of stops, stations, and transfer facilities on transit ridership and network performance. This state of knowledge based on past studies of the subject is incomplete because it fails to guide transit agencies toward planning practices that effectively improve the quality of transfers at transit centers that actually result in a ridership increase.

In our research on transit stops, stations, and transfer facilities we have addressed these shortcomings by developing a theoretical framework for understanding the relationship between transfer-facility attributes and travel behavior, which we discuss below.



Transfer Penalties/Travel Behavior Conceptual Framework

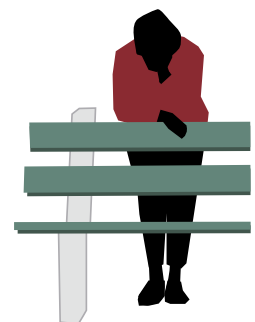
The concept of the transfer penalty represents generalized costs — including monetary costs, time, labor, discomfort, inconvenience, etc. — involved in transferring from one vehicle to another, between the same mode, or different transportation modes (e.g. bus to train, walk to bus, etc.). We use the term transfer penalties in two ways. Viewed broadly, transfer penalties are used to represent all of the monetary, time, and labor expenditures involved in waiting and walking, experiencing discomfort, worrying about safety, and any other inconvenience and emotional stress involved in waiting and transferring, and thus can generally be viewed as an impedance to travel.

Viewed more narrowly, transfer penalties are the impedance in transferring, excluding easily quantified factors, such as waiting time, walking time, and transfer fares. In other words, a narrow definition of transfer penalties considers costs beyond the monetary and time costs associated with transferring.

For the more easily quantified transfer penalties, such as walking and waiting times, there are differences between actual and perceived values for these times. People perceive time differently depending on the circumstances. While actual waiting time is the difference between a passenger's and his/her vehicle's arrival at a boarding location, perceived waiting time can be considerably longer depending on waiting conditions such as vehicle arrival time uncertainty, comfort, security, and safety. Thus the generalized cost of waiting can greatly increase beyond the cost of actual waiting time.

“Understanding what affects the transfer penalty can have significant implications for a transit authority. It can help identify which types of improvement to the system can most cost-effectively reduce this penalty, thus attracting new customers, and helping determine the value of improvements to key transfer facilities”

Source: Guo Z. and N.H.M. Wilson, “Assessment of the Transfer Penalty for Transit Trips: Geographic Information System-Based Disaggregate Modeling Approach”, Transportation Research Record, Vol. 1872, 2004, pp. 10-18.



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Traveler's perceived walking distance and time can also be substantially greater than their actual walking distance and time. Physical conditions and adequate information are both important in determining both actual and perceived walking distance and time. The shortest walking time is determined by the most direct path and a traveler's walking speed. When a traveler is familiar with a stop location or transfer facility, walking paths can be direct and walking times minimized. However, unfamiliar stops or facilities and/or poor information lead to wandering, stress, and uncertainty about how and where to make the connection. Thus, the location, layout, and information at transfer stops and stations can significantly influence the perceived transfer experience as well as actual walking distance/time and waiting time, and both affect the likelihood of using transit in the future.

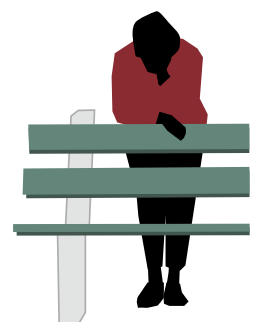
Differences in actual and perceived travel, waiting, and transfer times can be viewed as different valuations of time for different activities, and such different valuations of time for different trip attributes are weighted differently. In choosing a travel mode, travelers make decisions based on their perceived total generalized cost of taking a trip by various modes, which can depend substantially on their perceptions of travel (including transfer) attributes, such as time, labor, comfort, and safety.

The perceived burdens of waiting time, walking time, and transferring suggests the following three broad categories of factors contribute to transfer penalties:

A common rule of thumb is that walking and waiting time are considered by transit users to be two to three times as onerous as in-vehicle travel time.

- Operational factors, such as headways, reliability, on-time performance of service and availability of adequate information.
- Physical environmental factors at facilities related to safety, security, comfort, and convenience
- Passenger options, such as whether they are forced to wait or whether they can be productive while waiting.

Given this, transit managers can take various measures to lower the burden (or generalized cost) of waiting, walking, and transferring by addressing



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both actual and perceived waiting time, perceived walking time, transfer burdens, and fares paid. Figure 4 presents our conceptual framework for determining the generalized cost of transferring in the overall context of transit travel. Perceived waiting and walking time are determined by actual time plus the weights that travelers assign to waiting and walking, which vary by the attributes, conditions, and environments of stops, stations, and transfer facilities.

We group the factors listed above into four groups:

1. The monetary cost of a transfer (fare);
2. Factors that affect the actual transfer time and distance;
3. Factors that influence people's perception of waiting and walking (e.g. the weights users assign to waiting and walking), and
4. Other factors that affect perceptions of transferring that are not taken into account by the first three groups.

The matrix at the bottom of Figure 4 notes which aspects of three factors – transfer fare, time schedule and operation, and transfer facilities – affect four aspects of traveler impedance: (1) monetary cost, (2) actual travel time and distance, (3) perceived travel time and distance, and (4) other penalties. This is discussed further below.

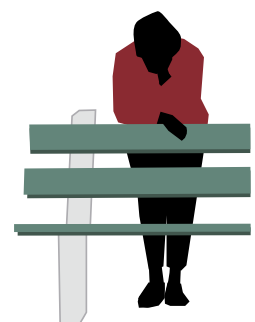
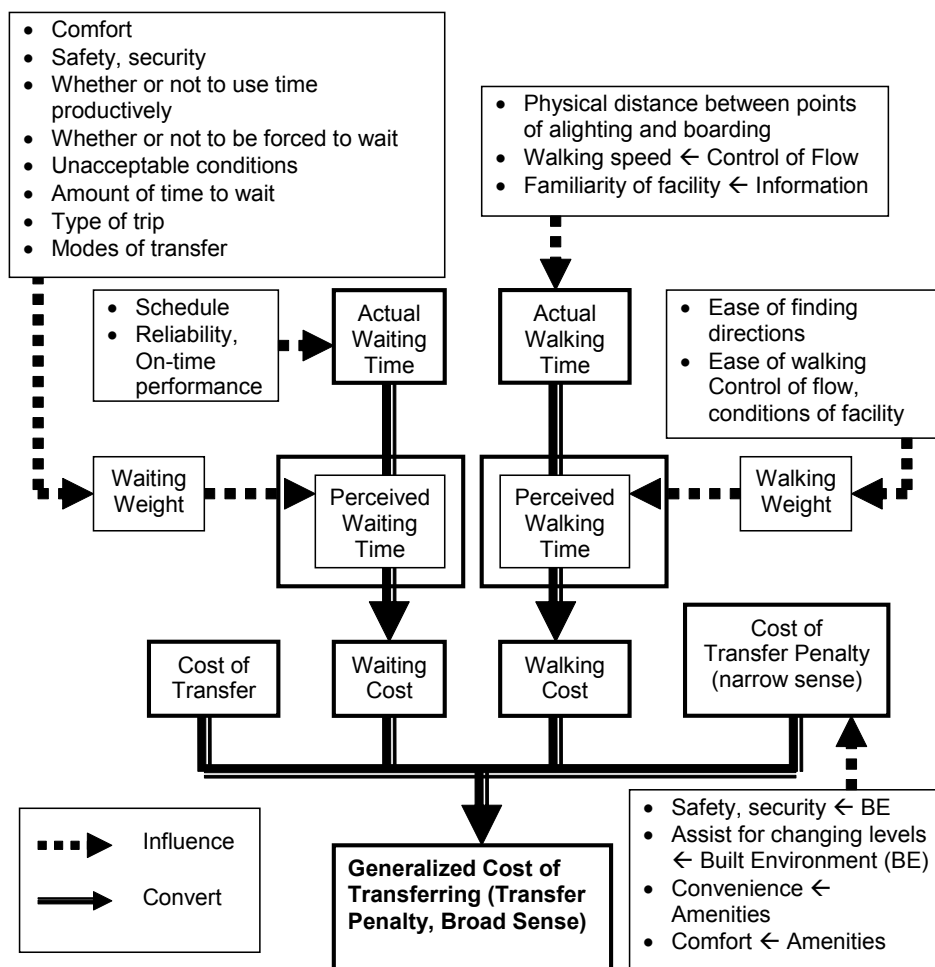


FIGURE 4 Conceptual Wait/Walk/Transfer Impedance Framework for Public Transit



Factors affecting:	Monetary	Actual		Perceived		Other penalties
		Time	Distance	Waiting	Walking	
Transfer fare	○					
Time schedule						
Vehicle scheduling		○				
Reliability/On-time		○		○		
Real-time schedule		○		○		
Transfer Facilities						
1) Access			○		○	
2) Connection and reliability		○		○		
3) Information			○	○		○
4) Amenities				○	○	○
5) Security and Safety				○	○	○

Transfer fares

In the context of the total costs of a transit trip, the penalty of a transfer fare is typically relatively small. It is often free or quite low for most intra-urban transit services. For short trips, however, transfer fares can be relatively large on a per-mile-traveled basis, and may disproportionately affect the burden of short trips with transfers.

Schedule and operation

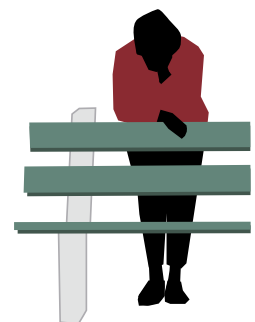
Service frequency, schedule adherence, and schedule information (both posted and real time) affect both actual and perceived waiting time. Obviously, increasing service frequency reduces average waiting and transferring times. Poor coordination between lines, modes, and systems, and lack of schedule adherence can significantly increase transfer wait times; not surprisingly, improved coordination has been shown to increase transfer rates.

As noted above, frequent service can substantially (and nonlinearly) reduce the perceived burden of waiting. And frequent, reliable service has been shown to substantially reduce transfer burdens because travelers can count on short average wait times and can reliably time their arrival at stops and stations to minimize waiting.

Transfer facilities

Physical attributes of transfer facilities likely affect walking time and effort, waiting time and effort, convenience, comfort, safety, and indeed many other components of transfer burdens. In general, “passenger friendly” and “user friendly” transfer facility attributes can be grouped into the following five categories:

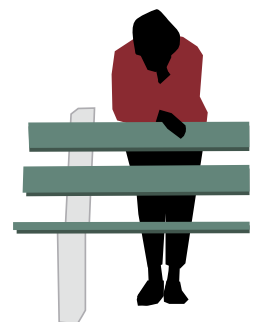
1. Facility design can affect access by defining the distance between alighting and boarding locations, improving off-vehicle passenger flow, and providing clear and comprehensible directions. Perimeter-oriented bus depots, for example, have been shown to increase transfer walk distances and inhibit pedestrian flows. Further, confusing or incomplete signage, or poorly located ticket machines and information kiosks can significantly increase both the actual and perceived distances walked in stations and transfer facilities.
2. Connection and reliability are determined by time schedules and schedule adherence, and have been repeatedly shown to strongly influence transfer burdens and transit use.



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3. Complete, concise, and easy-to-understand information has been shown to reduce the actual (by reducing wandering) and perceived burden of transferring, especially for new or occasional transit users.
4. Amenities, such as benches, shades, water fountains, and rest rooms, affect comfort and convenience while passengers are waiting and transferring. Through increased comfort and convenience, these amenities can affect perception of waiting and walking time as well as other burdens of transferring.
5. Security and safety also influence perception of waiting, walking, and transfer burdens. Safety and security can be a “deal breaker” for travelers if levels of perceived risk exceed thresholds over which they will no longer consider traveling by transit, and will instead travel by other modes or forgo the trip entirely.

Even though the passenger perspective regarding transit connectivity is of utmost importance, we have found many references in the literature to transit connectivity from the transit operator and the neighboring community’s perspective. Looking at these three aspects has provided us with a complete picture of assessing transit connectivity. We begin to explore these additional perspectives together with continuing our in depth examination of the passenger perspective in the next section.



Three Perspectives on Transit Stops and Stations – Users, Managers, and Neighbors

In assessing how effectively stops, stations, and transfer facilities operate, we identified three primary stakeholder groups from whose perspectives such evaluations have been performed. These are:

- Passengers/users
- Transit Operators
- Neighboring Communities/Businesses & Residents

Passengers/Users

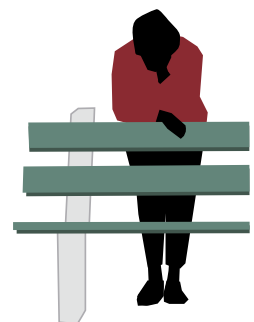
Passengers/users are the clients who use stops, stations, and transit transfer facilities and who have specific desires and expectations for such facilities. Previous travel behavior research suggests that transit users' principal concerns are with quickly and easily boarding their desired vehicle. Toward that end, users desire:

- Minimum transfer time and distance,
- Convenience,
- Comfort, and
- Safety and security.

Which of these is most important under what circumstances, however, is less well known. However, when transfer facilities are designed and/or renovated to make transferring more safe and secure, pleasant, faster, and less problematic, people accept facilities more favorably and are more likely to accept the necessity of transferring in their transit trips.

Transit Operators

When a transit operator owns the property under which a stop or transfer facility sits, it can largely control the design and operation of the stop or



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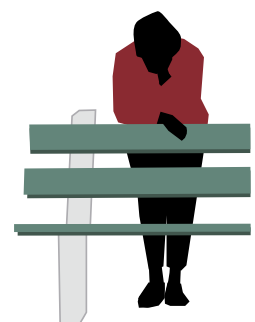
facility. In most cases, however, transit operators do not own the land under their stops and stations and must therefore work and negotiate with a wide variety of public and private stakeholders.

Neighboring Communities/Businesses & Residents

Any transit stop or transfer facility — whether it is located in an urban or suburban environment, or whether it hosts intra-modal or intermodal transfers — does not exist in a vacuum. It and its users necessarily interact with adjacent neighborhoods and districts. As such, the people who live and/or work near the stop or facility, and the people who own and operate commercial establishments in the vicinity of the stop or facility have a stake in the facility that may be largely unrelated to its utility to transit users. These include:

- Community image and pride — architectural, cultural, and historic preservation
- Joint development and partnerships
- Safety and security
- Environmental impacts on surrounding neighborhood
- Neighborhood economy / local employment
- Physical and social impacts on neighboring land uses

Accordingly, the research described below sought explicitly to examine perceptions of transit stops and transfer facilities from the differing perspectives of these three groups. And it is to this research we now turn.



Methods of Investigation

In our investigation of each of the three stakeholder perspectives, we employed a variety of research methods:

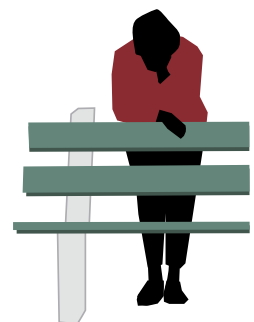
Passengers/Users

We designed and administered a user survey based on the five principal transit stop and station attribute categories thought in the literature to affect transfer penalties:

- Access: Management of passenger flow control and directional information
- Connection and Reliability: Distance and time to make connections; on-time performance/frequency of bus/train
- Information: What, where, and how passengers acquire information
- Amenities: Comfort, service, weather protection, and cleanliness of station/stop
- Security and Safety: Station/stop equipment, infrastructure, or personnel that provide passengers with a safe and secure environment

Our objective was to provide an accurate portrait of transit riders at the system-wide level, by service-type, by time of day and day of week, and by location. This portrait included the following information:

- Demographic characteristics of riders at every transit transfer facility in terms of:
 - Age
 - Gender
 - Income
 - Ethnicity
 - Car availability
 - Modal preference
- Trip characteristics, including
 - Trip purpose
 - Pre- and post-trip mode
 - Transfer rate
 - Time of day and day of week
 - Service type;
- Frequency of use, and
- Evaluation of transit services and amenities



Thinking Outside the Bus

For each of the five attribute categories, the research team crafted a series of specific questions. The resulting survey, which was made available in English and Spanish, consisted of 29 questions and was self-administered to 749 transit users at 12 transit stops and stations around metropolitan Los Angeles. In total we approached 1,023 transit users and 274 of them refused to participate in the survey yielding a 73% response rate. Moreover, the 749 surveys were not entirely completed as some users had to stop providing responses to catch their bus or train. The survey was designed to assess the importance of and satisfaction with various aspects of transit stops, stations, and transfer facilities from the transit rider's perspective. The dozen transit stop and transfer sites were selected to secure the widest possible variation in the following:

- Transfer facility types (See Table 1)
- Available modes (bus, rail)
- Type of passenger loading (on- or off-street)
- Time of day
- Weather

A significant component of the survey was soliciting respondents' views on their satisfaction with, and level of importance of, various stop/station attributes (listed in Table 2). A copy of the User Survey Instrument may be found in Appendix C of this report, which consists of a copy of our interim deliverable documenting our evaluation of transit stops and stations from the perspective of transit users.

Transit Operators

We designed a transit system manager survey to collect the following information from respondents:

- Operators' estimation of how important various evaluation factors are to their own passengers
- Operators' views of what evaluation factors are important from their own perspective

The survey was administered by means of a web-based online nationwide survey of transit managers. The survey instrument (which is available in Appendix C) was designed to both mirror many of the questions in our user survey, and to ask about political and operational concerns not directly related to passenger use of stops or stations. From the Federal Transit Administration's 2005 National Transit Database we selected all 400 transit

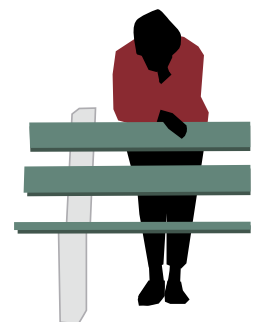


TABLE 2 Survey Questions on User Importance and Satisfaction

Stop/Station Attributes	Criteria Category
This station/stop area is clean	Amenities
There are enough places to sit	Amenities
There are places for me to buy food or drinks nearby	Amenities
There is a public restroom nearby	Amenities
There is a shelter here to protect me from the sun or rain	Amenities
The signs here are helpful	Information
It is easy to get schedule and route information at this stop/station	Information
It is easy to find my stop or platform	Access
It is easy to get around this stop/station	Access
I usually have a short wait to catch my bus/train	Connection and Reliability
My bus/train is usually on time	Connection and Reliability
I feel safe here during the day	Safety and Security
I feel safe here at night	Safety and Security
There is a way for me to get help in an emergency	Safety and Security
This stop/station is well lit at night	Safety and Security
Having security guards here makes me feel safer	Safety and Security

operators with at least one fixed-route/fixed-schedule transit line in service in the United States. We sent the general manager of each an electronic invitation to either respond to our survey or to designate a member of his/her staff to do so. We received a total of 175 completed responses, for a 43% response rate.

Neighboring Communities/Businesses & Residents

Finally, we developed a set of questions that were used during telephone interviews with a representative sample of transit operators in the United States in order to gain further insight into the transit operators’ perspective, as well as to gather illustrative anecdotes about transit stops and stations. Twenty agencies were selected by a weighted sampling methodology, with the probability of inclusion in our sample weighted by the agency’s annual ridership figures. Of these, 8 agencies participated, for an effective response rate of 40%. During these interviews, we also gathered data on the role of stop and station neighbors – both private and commercial – in shaping the design, location, and operation of transit stops and stations. These interviews focused in particular on community advocacy for and against the location, re-location, and/or expansion of transit stops and stations. Due to budget limitations, however, we did not survey or interview stop- or station-adjacent stakeholders directly.

Primary Findings

From our analysis of the passengers/users perspective, one principal finding stands out quite clearly:

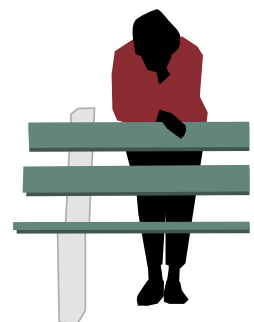
The most important determinant of user satisfaction with a transit stop or station is frequent, reliable service in an environment of personal safety, and only indirectly the physical characteristics of that stop or station.

In other words, most transit users would prefer short, predictable waits for buses and trains in a safe, if simple or even dreary, environment, over long waits for late-running vehicles. This is true even if such long waits occur in the most elaborate and attractive transit stations and especially so if users fear for their safety. While this finding will come as no surprise to those familiar with past research on the perceptions of transit users, it does present a contrast to much of the descriptive and design-focused research on transit stops and stations.

In total, we examined sixteen stop and station attributes (listed in Table 2), using a technique known as the *Importance-Satisfaction Analysis* method, which seeks to identify those attributes passengers find most important (importance level) and those attributes in need of the most improvement (satisfaction level). Respondents' level of satisfaction with each attribute under current conditions at the 12 survey sites in the Los Angeles metropolitan area indicates that users are least happy with factors related to access, followed by some factors related to security and safety and connection and reliability. When we considered the level of satisfaction and importance ratings in tandem, factors that require improvement pertain most to security and safety and connection and reliability, and least to amenities. Of the sixteen attributes, users ranked safety and service quality factors as most important (the top six of the sixteen attributes) as shown in the following list:

Most Important

1. I feel safe here at night (78%)
2. I feel safe here during the day (77%)
3. My bus/train is usually on time (76%)
4. There is a way for me to get help in an emergency (74%)
5. This stop/station is well lit at night (73%)
6. I usually have a short wait to catch my bus/train (70%)



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In contrast, stop and station-area amenities were ranked as least important by users:

Least Important

11. It is easy to get route and schedule information at this stop/station (62%)
12. There is a public restroom nearby (59%)
13. This stop/station is clean (58%)
14. It is easy to get around this stop/station (57%)
15. There are enough places to sit (50%)
16. There are places for me to buy food or drinks nearby (34%).

However, when we statistically related users' satisfaction with various stop/station attributes with their overall satisfaction with their wait/transfer experiences, we got similar, though not identical, results:

Most Important

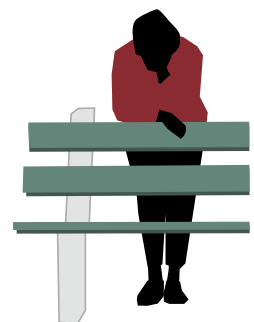
1. It is easy to get around this stop/station.
2. I feel safe here during the day.
3. Having security guards here makes me feel safer.
4. it's easy to find my stop or platform.
5. The stop/station is well lit at night.
6. My bus/train is usually on time.

In contrast, the following stop and station-area attributes were ranked as least important (bottom six of the sixteen attributes):

Least Important

11. This stop/station is clean.
12. There is shelter here to protect me from the sun or rain.
13. There is a way for me to get help in an emergency.
14. There are enough places to sit.
15. There are places to buy food or drinks nearby.
16. There is a public restroom nearby.

While informative, rank-ordered lists like these can be problematic if users "split their votes" among similar, yet important factors, such as "I feel safe



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here at night” and “This stop/station is well-lit at night.” To correct for this problem, we employed an ordered-logit regression model to measure the independent influence of each of 16 wait/transfer attributes on overall user satisfaction. This analysis tends to eliminate all but one of closely related factors, while elevating presumably less-important factors that independently influence users’ overall levels of satisfaction. The results of this modeling exercise are telling:

Most Important

1. My bus/train is usually on time.
2. Having a security guard here makes me feel safer.
3. This stop/station is well lit at night.
4. I feel safe here during the day.
5. It is easy to get around this station/stop.
6. The signs here are helpful.

Of the 16 stop and station attributes that we evaluated, transit users assigned the highest importance to factors related to security and safety, and then to factors related to connection and reliability. In contrast, stop and station-area amenities were ranked as least important by users. We do not claim that amenities are not important to travelers; more than half ranked information, the presence of public restrooms, cleanliness, and ease of navigation as important attributes. However, travelers definitely prefer safe, frequent, and reliable service over these other factors.

Based on this analysis we have identified a simple hierarchy of transfer burdens perceived by users, shown in Figure 5. This figure summarizes the findings from our transit user investigation succinctly.

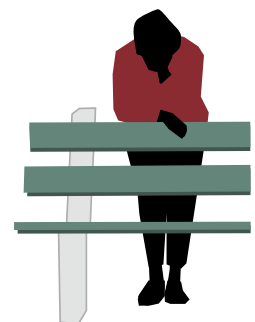
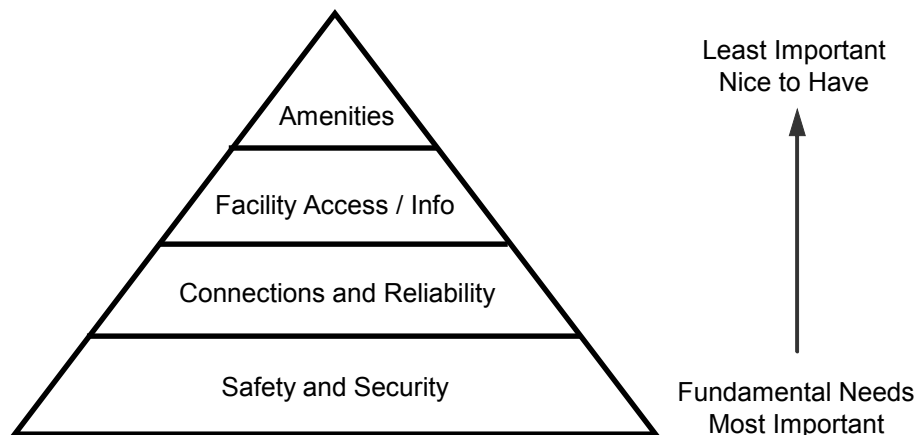


FIGURE 5 Hierarchy of Traveler Wait/Transfer Needs

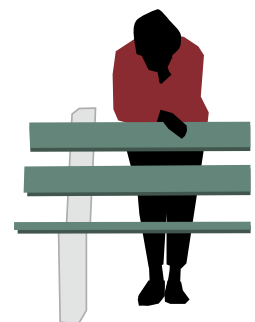


In addition to surveying transit users, we conducted an nationwide online survey of transit operators, asking them about their objectives at transit stops, as well as about their perceptions of users' and neighboring communities' priorities for stops and stations. From our analysis of the survey results, we find that transit operators' top priority is precisely the same as that of the users of their systems:

Safety and security related factors far outweighed other attribute factors at transit stops, stations, and transfer facilities.

Following safety and security (#1), ten other factors cluster relatively closely as important factors in the views of the transit managers surveyed. We list them in order of priority:

2. Pedestrian/vehicle conflicts
3. Schedule coordination
4. Operating costs
5. Stop/station equipment reliability
6. Comfortable environment
7. Adequate stop/station space
8. Inter-agency coordination
9. Facilitate passenger flows
10. Accommodate vehicle movements
11. Protect passengers from weather.



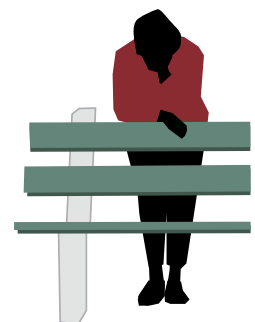
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The survey results further suggest that transit operators value user-oriented attributes such as physical comfort and seamless transferring higher than other, non-user-oriented, attributes. This may be due to the immediacy and constancy of user-related factors such as the provision of clean and comfortable transfer stops and stations, while non-user attributes such as joint development typically occurs infrequently.

Our online survey results show that, while transit operators appear to have a fairly accurate understanding of what attributes are important to their riders at transit stops and transfer stations, there are several points of disparity. While operators correctly assumed that safety and security were very important to riders, they tended to underestimate the importance of specific safety-related amenities, such as the presence of security guards and emergency assistance. It also appears that, controlling for other factors, operators overestimate the importance of station cleanliness and schedule information to their riders. We note, however, that there was a mismatch in geographical coverage for this comparison; our riders' survey collected data from Los Angeles County transit riders, while our operators' survey collected data nationwide. It is likely that this mismatch has overemphasized some disparities, while downplaying others. These findings should be considered preliminary and further research should examine both subgroups that cover the same general location. Next steps and follow-on research are discussed in a later section of this report.

Our telephone interviews served to highlight these findings. Interviewees relayed to us many anecdotes in which safety and security concerns “trumped” all other concerns. For example, comfort concerns (ample and comfortable seating) often defer to security concerns (benches that are not conducive to sleeping). Another telephone interviewee told us of a station redesign that resulted in a safer environment for pedestrians, but which was far less aesthetically pleasing. Yet another interviewee from a city with a “very high murder rate” told us that city police are present at station design meetings, and that personal safety and security concerns always outweigh aesthetic, design, and passenger comfort concerns. Less obvious and more nuanced tradeoffs are made throughout the set of objectives; our ranking describes the propensity of transit operators to value one attribute more highly than others, and assigns estimates of the magnitude of these propensities.

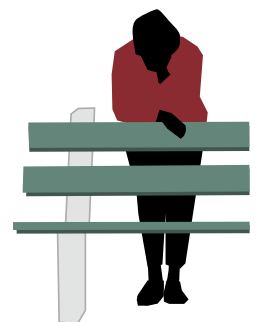
Additionally, we talked to transit operators about the role of the community in planning, operating, and maintaining transit stops and transfer facilities. We heard from many respondents that the community often serves as



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opposition, and that its input usually comes indirectly through politicians and community leaders. Furthermore, we heard that community concerns are typically voiced in response to planned changes, rather than during initial planning stages.

We also determined that other stakeholders (specifically local government entities) control the design and location of most transit stops and stations. We also found that adjacent businesses and residents exert significant influence over the location, design, and operation of stops and stations. Often, transit agencies have surprisingly limited control over the siting and design of stations and stops.



Preliminary Assessment Tool: Putting Research into Practice

Based on the findings reported above we have developed a 3-step process (synthesized in Figures 6 & 7) that transit operators can employ as a tool to guide them as they consider making improvements to already existing transfer facilities or developing initial plans for new facilities.

- Step 1: Use the Hierarchy of Traveler Wait/Transfer Needs (Figure 5 above) to determine the priority of improvements to any stop or station. We endeavored in this research to produce generalizeable findings from our analysis by surveying a large number of transit users at a wide variety of facilities.²
- Step 2: For transit stops and stations serving particular user populations (children, immigrants, the elderly, etc.) or for stops/stations in unique environments (adjacent to airports, amusement parks, hospitals, etc.), the user perception survey instrument developed and tested in this study can be used to survey the perceptions of passengers.
- Step 3: Use the survey results to conduct an Importance-Satisfaction (I-S) Analysis (documented in detail in Appendix C) to produce an I-S Ratings matrix showing Average Importance and Satisfaction ratings for the users and/or stops surveyed as shown schematically in Figure 6 below.

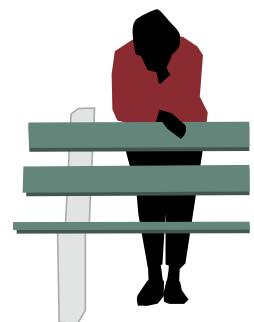
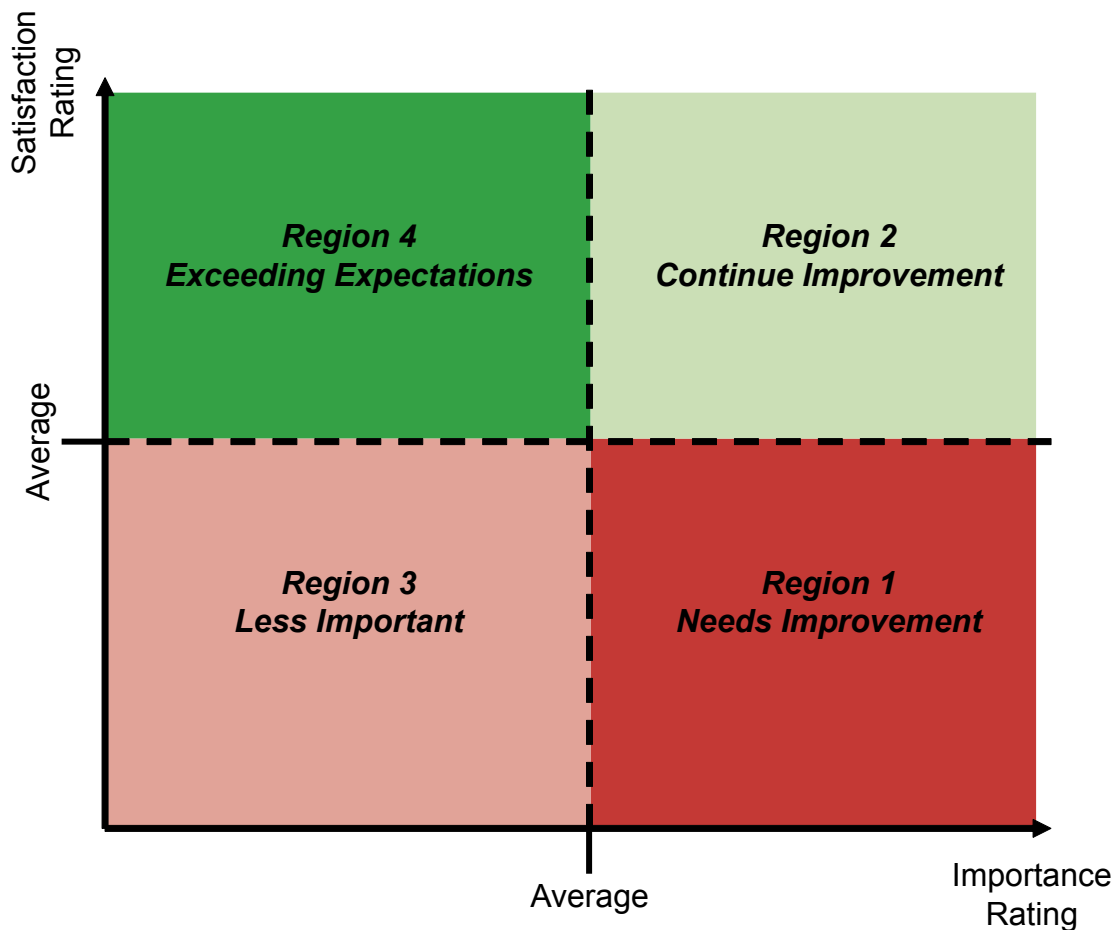
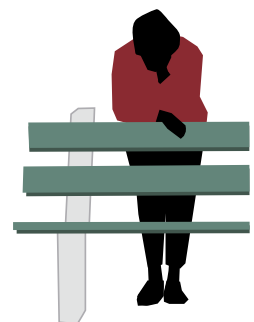


FIGURE 6 I-S Ratings Graph Template



- **Region 1** is an area where – for the surveyed users or stops – facility attributes have above-average importance but a less than average level of satisfaction, meaning that **these attributes should be high priorities for improvement**.
- **Region 2** is an area where attributes have above-average importance and above-average level of satisfaction, meaning that **priority should be given to maintaining the quality of these attributes**.
- **Region 3** is an area where attributes have less than average satisfaction levels but also less than average importance ratings; improvement to such attributes are **warranted only at low cost or if all of the attributes in Regions 1 and 2 have been fully addressed**.
- **Region 4** is an area where attributes have above average levels of satisfaction and importance ratings less than average; **such attributes exceed expectations and warrant no further attention**.



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We suggest that transit operators employ this 3-step process in successive stages using the flow chart below (Figure 7). This chart guides users in identifying the order – consistent with our research findings – in which to improve a targeted transit stop or station. We’ve thus structured the flow chart so users’ priorities in the Hierarchy of Traveler Wait/Transfer Needs (Figure 3 above) are addressed in order of importance: first with Safety and Security attributes, second with Connections and Reliability attributes, third with Access and Information attributes, and lastly with Amenities-related attributes.

² We hope to broaden and extend the analysis used to develop this hierarchy in a subsequent phase of this research by analyzing a wider array of transit users and facilities beyond Los Angeles County in order to present our findings with more confidence as generalizable to most transit operating environments in California.

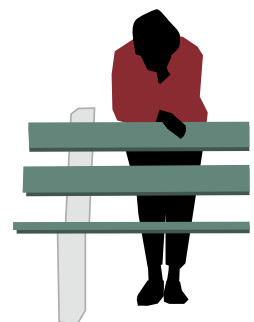
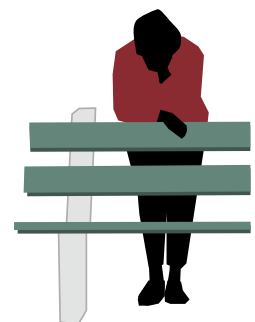
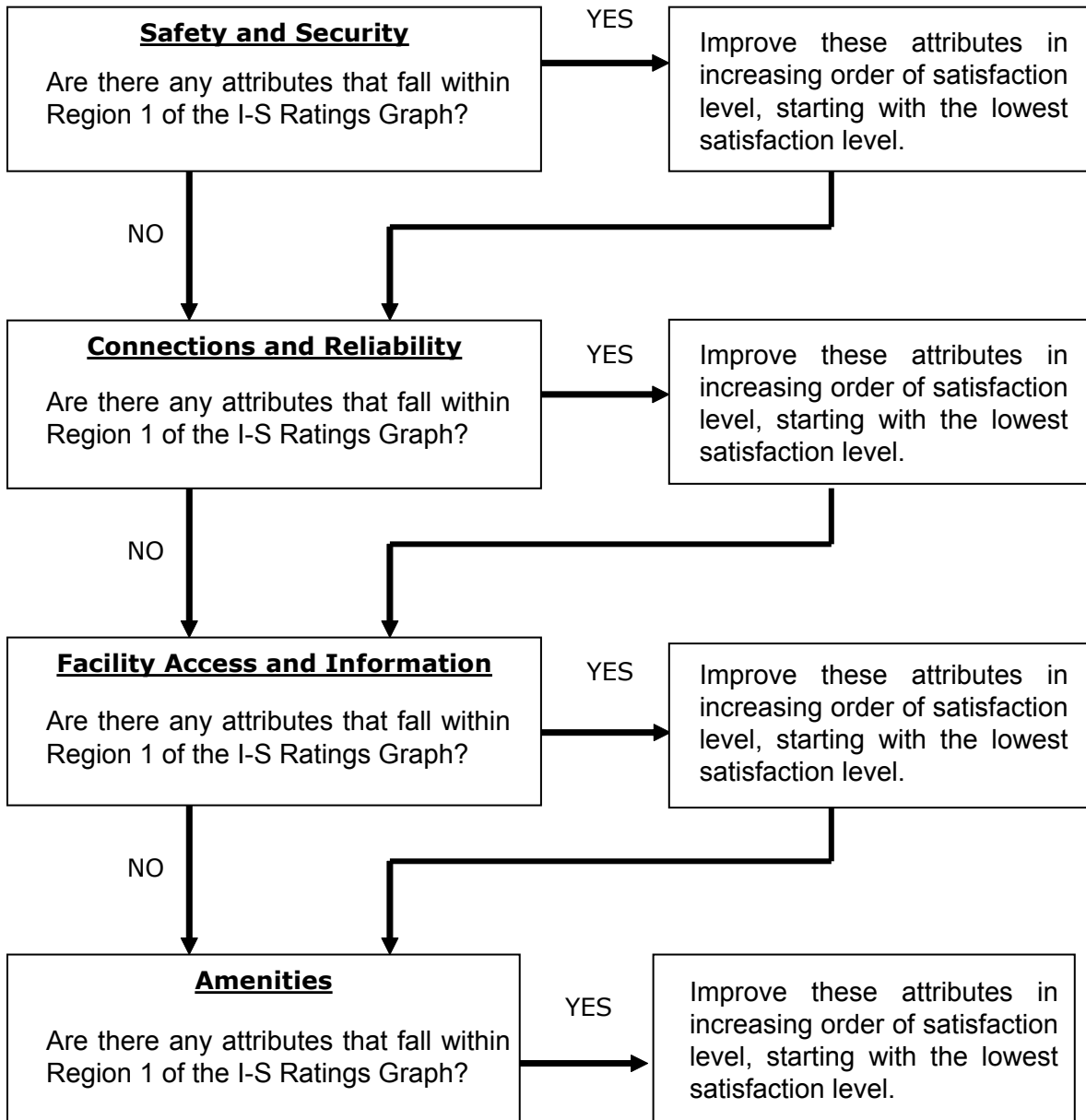


FIGURE 7 Stop/Station Evaluation Flow Chart



Next Steps / Future Research

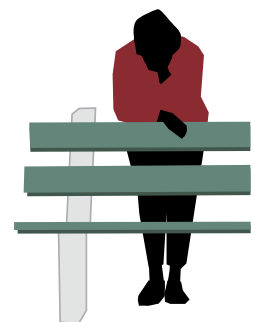
The major milestone of this project was the development of a conceptual behavioral framework of the passenger's wait/transfer experience based on our review of the state-of-the-research of travel behavior. We used this framework to capture both transit user and manager perceptions of transfer burdens, which allowed us to advance considerably the body of research on transit stops and stations that to-date has been largely descriptive.

The findings of our research, together with the development of our preliminary assessment tool, have taken substantive steps toward:

- Determining the connectivity of transit systems and how this connectivity (as well as other service attributes) influences travelers' satisfaction with transit services, and
- Examining how public transit systems can reduce the burdens of out-of-vehicle "travel" times in order to help make public transit more attractive resulting in ridership increases.

There are, however, limitations to our research conducted to date. In this project, we surveyed over 700 transit users to determine the factors affecting their perceptions of waiting, walking, and transferring during a trip. Within each category of attributes, the users' satisfaction level was correlated with data from a detailed inventory of 12 stops and transfer facilities in Los Angeles County to identify significant linkage between users' perceptions of transit services and the built environment at stops, stations, and transfer facilities. While we secured a large number of surveys of users' perceptions, the fact that these were collected at just a dozen, locations – though diverse for Los Angeles County – did not give us sufficient variability in the facilities data inventories to statistically link the physical and operational characteristics of transit stops and stations with users' perceptions of them. In other words, we were unable to evaluate the relative importance of facility attributes in directly determining users' overall satisfaction levels.

Nonetheless, our evaluation framework has provided us with a strong theoretical foundation to expand our study of transit users and facilities

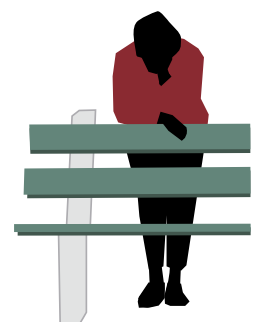


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beyond Los Angeles County. Accordingly, we are working with Caltrans to develop a follow-on scope of work to the research reported here, specifically, to:

- Evaluate user perceptions across a wider cross-section of users and a much wider array of transit systems;
- Expand our stop/station Assessment Tool to apply to a broader range of transit user populations and operating environments;
- Embark on a field implementation phase; and
- Expand our stakeholder analysis to include the perceptions and motivations of local governments that control the location of development of most transit stops and stations.

We aim in our next phase of this research to expand our inventory of stops and stations from 12 to 50 across California, with a goal of surveying approximately 2,000 users. This expanded approach will help make the findings of this effort considerably more generalizable to cities and transit operators in large and small cities around California. Moreover, by field testing the findings of our Phase I and II work at specific transit stops and stations, we can conduct before and after testing to determine if, indeed, this research can help transit operators attract more riders by cost-effectively addressing the specific aspects of waiting for and transferring among transit vehicles that transit users find most burdensome.



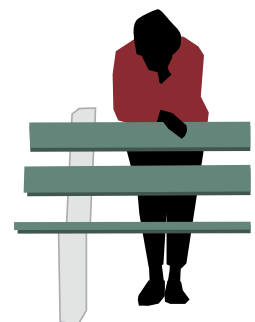
About the Authors

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Brian Taylor is a Professor of Urban Planning, and Director of the Institute of Transportation Studies at UCLA. His research centers on both transportation finance and travel demographics. He has examined the politics of transportation finance, including the influence of finance on the development of metropolitan freeway systems and the effect of public transit subsidy programs on both system performance and social equity. His research on the demographics of travel behavior has emphasized access-deprived populations, including women, racial-ethnic minorities, the disabled, and the poor. His work in this area has also explored the relationships between transportation and urban form, with a focus on commuting and employment access for low-wage workers. Professor Taylor teaches courses in transportation policy and planning and research design. Prior to coming to UCLA in 1994, he was an Assistant Professor in the Department of City and Regional Planning at the University of North Carolina at Chapel Hill, and before that a Transportation Analyst with the Metropolitan Transportation Commission in Oakland, California.

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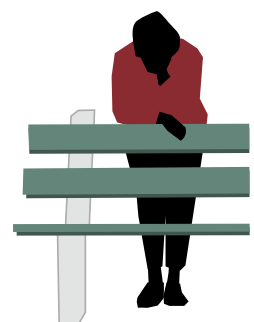
[MARK A. MILLER, UNIVERSITY OF CALIFORNIA, BERKELEY AND LOS ANGELES](#)

Mark Miller is a Research Specialist at the California PATH (Partners for Advanced Transit and Highways) Program at the University of California, Berkeley where he has worked for eighteen years. During this time his research has focused on developing evaluation frameworks and methodologies and performing impact assessments of intelligent transportation systems (ITS) technologies in the setting of field tests and case studies. His work experience has been well balanced between quantitative and qualitative investigations covering both technical and non-technical (deployment, societal, and institutional issues) aspects of ITS. Mr. Miller has significant work experience in the areas of transit operations research and policy and behavioral research, including bus rapid transit, and commercial vehicle operations.

Since 2003, Mr. Miller has also been a Visiting Scholar at the Institute of Transportation Studies (ITS) within the School of Public Affairs at the University of California, Los Angeles. Since arriving at UCLA, Mr. Miller has worked to expand PATH's visibility and presence in southern California and to forge and strengthen ties between the Los Angeles and Berkeley campuses of the Institute of Transportation Studies, worked closely with graduate students on PATH projects, and given lectures on Intelligent Transportation Systems.

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Michael Smart is a second-year doctoral student at UCLA. His research interests include transportation and social equity, access to the labor market, and travel behavior. He has recently completed an analysis of the SAFETEA-LU earmarking process and is currently working on a detailed look at carpooling among immigrant communities. He graduated with a Master's degree in City Planning from the University of Pennsylvania in Philadelphia and has previously worked with Professor Myron Orfield at the University of Minnesota Law School's Institute on Race and Poverty.



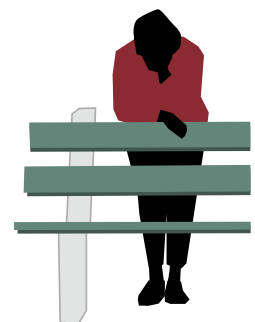
Bibliography of Project Documentation

Interim Project Deliverables

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Appendices of Interim Deliverables

Appendix A

The Effects of Out-of-Vehicle Time on Travel Behavior: Implications for Transit Transfers

Appendix B

Evaluating Connectivity Performance at Transit Transfer Facilities

Appendix C

Evaluating Transit Stops and Stations from the Perspective of Transit Users

Appendix D

Evaluating Transit Stops and Stations from the Perspective of Transit Managers

