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ABSTRACT

This report presents the findings of its investigation into intermodal passenger transfer facilities' operations and services in urban areas of California and the opportunities for how the application of intelligent transportation systems may enhance such operations and services. The project was based initially on a macroscopic assessment of intermodal passenger transfer facility operations and services primarily by means of a review of the literature followed by a three-tier analysis through site visits, institutional aspects, and user views and opinions. Institutional aspects were captured by means of a survey administered to representatives from transit service providers sharing three intermodal passenger transfer facilities: a BART station and a Caltrain station in the San Francisco Bay area and the Santa Fe Depot in San Diego where buses, commuter rail lines, and the San Diego Trolley come together. User views were captured by means of a survey administered to users of the BART station.

From the literature, numerous barriers associated with the successful implementation of passenger intermodal operations and services were identified along with strategies to overcome these barriers. From the site visits, differences across public transit modes, i.e., between rail and bus, across different urban regions, were identified in the level of use of intelligent transportation system technologies and the level of overall coordination among transit service providers sharing a facility. The institutional survey reveal interesting facts regarding how agencies collect and share data and cooperate at the intermodal facilities under investigation as well how facilities are managed and the degree to which agencies use or are planning to use intelligent transportation systems technologies. The user survey was in the San Francisco Bay Area, with findings revealing user insight into how such a facility operates and the services it provides including information on user behavior, the transfer process, user history for this facility, a rating of the facility, and a demographic profile.

Key Words: passenger intermodalism, evaluation, operations, services, institutional issues, survey, intelligent transportation systems

EXECUTIVE SUMMARY

This report constitutes the final deliverable for PATH Project MOU 375 — “Assessing Opportunities for Intelligent Transportation Systems in California's Passenger Intermodal Operations and Services”. The project has examined passenger intermodal operations and services in California and the opportunities for how the application of intelligent transportation systems may enhance such operations and services.

This report has investigated the operations and services conducted at passenger intermodal transfer facilities in urban areas of California. Our primary objective was to assess the current state of passenger intermodal operations and services in California and to identify opportunities to utilize intelligent transportation systems to increase the benefits and reduce the costs of intermodal operations and services. The project was based initially on a macroscopic assessment of intermodal passenger transfer facility operations and services primarily by means of a review of the literature followed by a three-tier analysis through site visits, institutional aspects, and user views and opinions.

From the literature, we see that there are numerous barriers associated with the successful implementation of passenger intermodal operations and services, including funding constraints, condition of physical infrastructure, level of market demand, lack of sufficient data, insufficient performance criteria, and institutional issues. There are three primary strategy areas to utilize to overcome these barriers: 1) policy measures and legislation, 2) physical infrastructure improvements, and 3) deployment of appropriate intelligent transportation systems.

Moreover, little has been done in the area of evaluating passenger intermodalism. Frameworks for the evaluation of the intermodal transfer process have been proposed, however, there is little evidence of such evaluations being performed at any transfer facilities. A possible explanation for this is the lack of data and quantifiable measures of effectiveness. Absence of data on linked intermodal trips poses a barrier to identifying where transfers occur, where intermodal needs are unmet, and where they might be improved. Many measures of effectiveness are not quantifiable, making it more difficult to perform evaluations that can be compared across modes or facilities. These qualitative measures, such as passenger comfort and convenience, are just as important as quantitative measures nonetheless.

Several conclusions can be drawn from the findings of this study, with implications for the continued opportunities for improvement in operations and services rendered at intermodal passenger transfer facilities.

Differences across public transit modes, i.e., rail versus bus, exist in the level of use of intelligent transportation system technologies. Rail facilities tend to exhibit a higher degree of technology for user information and ticketing than bus modes. For example, many of the heavy rail stations (e.g., the Santa Fe Depot in San Diego, the North County Transit Facility in Oceanside, the Diridon Station in San Jose, and the Emeryville Amtrak Depot) utilized not only changeable message signs, but in many cases, used them to provide dynamic, real-time updated information. As we consider a slightly lower level in rail transit, many of the light rail stations used changeable message signs, but Muni Metro was the only light rail transit service provider that appeared to provide real-time, dynamic information. Subsequently looking at buses, there are few changeable message signs at bus facilities (#22 Filmore Line). The monitors at the El Cerrito Del Norte BART Station and at the Transbay Terminal in San Francisco displayed static bus schedule information, but did not make any announcements or provide any new information beyond that which was already posted. Another aspect that we can examine is ticketing. Rail modes generally had some form of automated advanced payment machine. For most of the sites and systems examined, although bus users may use their rail tickets to transfer to bus, the ticketing machines are oriented to rail users. Therefore, one generalization that we hypothesize is that rail modes tend to be more technologically advanced. The evidence that we have seen from our site visits indicates that the ticketing procedures and the traveler information (including in-terminal monitors and changeable message signs) are at a more technologically advanced level than those used for buses.

Another evaluation made was whether the presence of technology differs by area. It appears that the level of technology used in the San Diego area is higher than that used either in the San Francisco Bay Area, or Sacramento. Sacramento appears to employ the least amount of advanced technologies and the San Diego area seems to have the highest use. The extent of Sacramento's advanced technologies seems to lie with the changeable message signs discussed earlier, and the automatic fare payment machines, both associated with the light rail system. San Diego, meanwhile, employs both of the above technologies on a wide scale for both the trolley and Coaster, but also provides Coaster passengers with real-time information on its changeable message signs. Further, San Diego's automatic fare payment machines are quite a bit more advanced than Sacramento's in that they make change, they will accept dollar bills and credit cards, and they display electronic instructions to ticket purchasers. The Bay Area seems to lie somewhere in between Sacramento and San Diego in technology use, providing some real-time information to train platforms, but not using advanced fare payment systems on as wide a scale as San Diego.

Just as the use of advanced technologies seems to have a fairly clear hierarchy by region, the level of fare coordination seems to have an analogous hierarchy. Fare coordination (transfer discounts, single-fare tickets for multiple modes, etc.) seems to be higher in both Sacramento and San Diego than in the Bay Area. Sacramento, which does not employ a high level of technology at any of the sites visited, appears to have quite simple and convenient fare coordination. Passengers simply have to pay one fare, giving them free transfers for 90 minutes on all of the modes and lines that RT operates. Of course, the presence of only two modes (bus and LRT) certainly makes this easier to achieve. However, in San Diego, which has a much more complex and diverse network than Sacramento, a similar ease of fare coordination still prevails. Trolley tickets are valid for riding San Diego Transit buses, and also allow users to purchase discounted tickets on the San Diego Coaster. In the San Francisco Bay Area, however, perhaps because of the complexity of the transit system, fare structures seem to be more autonomous, often forcing passengers to pay separate fares for each mode. There are exceptions in the case of Muni, where passengers who ride either the bus or the light rail may transfer without paying additional fare to the other Muni mode, and for BART, which offers transfer discounts for transfers between BART and bus. However, it still appears that San Diego and Sacramento have achieved a higher level of coordination than the Bay Area. The reasons for such geographical differences were pursued with the agency surveys in the institutional component of the project.

The institutional survey was administered to representatives of transit agencies residing at three urban area passenger intermodal transfer facilities in California, including a BART station and a Caltrain station in the San Francisco Bay area and the Santa Fe Depot in San Diego where buses, commuter rail lines, and the San Diego Trolley come together. The institutional survey results reveal interesting facts regarding how agencies collect and share data and cooperate at the intermodal facilities under investigation. The results also indicate how facilities are managed and the degree to which agencies use or are planning to use intelligent transportation systems (ITS) technologies. Of the three types of data collected (vehicle location, actual arrival time, ridership), the two data types collected most often, in order of importance, were: 1.Ridership data and 2.Actual arrival time. Data collection is predominantly manual and performed on a continuous or daily basis.

As far as the adoption of ITS technologies, a fairly consistent picture emerges from analysis of the data. The most commonly used technologies are electronic fare boxes and surveillance cameras. The second tier of technologies adopted, but at much lower numbers are automatic passenger counters, automatic vehicle location, and traffic signal priority. For the technologies not in use, generally three quarters or more of the respondents report that they are studying the technologies. There thus seems to be a fairly high degree of interest in ITS technologies among the various transit agencies.

The survey results indicate that there is little sharing of data between the transit agencies located at the intermodal sites. Only three out of the nine agencies report sharing data with other agencies and only on a limited basis. However, at two of the intermodal sites, one of the principal agencies (either the owner of the facility or an important partner at the facility) collects ridership and arrival time data for the other agencies. It thus seems as though a certain degree of coordination of schedules occurs at the sites through the aegis of the facility owner or one of the main partners. The shared data is primarily ridership and expected arrival time data and is used for service planning and scheduling.

Reasons given for the limited data exchange between the agencies include: insufficient technology for practical use of data, not enough actual data to share (such as real-time arrival or vehicle location), data is not perceived to be valuable enough (as there are no timed connections at the intermodal sites).

There seems to a common facility management model: generally the site is managed by the owner of the facility, who operates and maintains the site. In one instance the site was managed by an organization comprised of several members located at the site or having authority over agencies located at the site. The interviewees reported being generally satisfied with the management of the intermodal facilities.

While the level of data exchange among the transit agencies at the intermodal facilities does not appear to be high, there is a certain degree of coordination among them for other transit-related objectives. Six out of the nine agencies report conducting either schedule, route, or special event coordination with one or more of the facility partners at the facility. Most of the coordination concerns scheduling or routes.

Though limited in scope to only one user survey of an intermodal passenger transfer facility, that is, the El Cerrito Del Norte BART station in the San Francisco Bay Area, findings provide facility user insight into how such a facility operates and the services it provides. The survey was administered to two thousand users of the station during weekday morning peak commuting hours with 581 returned and completed surveys. It was no surprise that 94% of respondents indicated that the purpose of their trip that morning was commuting to and from work. In terms of what transport mode was used to arrive at and depart from the station for that trip, approximately 55% and 25% of respondents arrived by driving a car and parking at/near the station and by bus, respectively. Also, as expected most respondents departed the station on that trip by

BART (approximately 87% of respondents) yet 7% departed by means of a carpool. Approximately half of respondents rated the facility's operations and services of good to excellent quality. Only about 1 in 5 respondents felt that such services and facility operations had deteriorated since they first began using the station. Regarding traveler information, while no information source was rated above "good" on average, both electronic and paper means of providing information to the traveler were rated between "average" and "good". In particular, information from the Internet via Web-sites was rated 3.6 out of a maximum of 5 in terms of the quality of information provided. As advances are made in information and communications technologies, Web access, in particular, wireless Web access to the Internet, will very likely grow with enhanced quality.

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1.0 INTRODUCTION

This report constitutes the final deliverable for PATH Project MOU 375 — "Assessing Opportunities for Intelligent Transportation Systems in California's Passenger Intermodal Operations and Services". The project has examined passenger intermodal operations and services in California and the opportunities for how the application of intelligent transportation systems may enhance such operations and services. The remainder of this section discusses the motivation for, objectives of, and the methodological approach used in the project.

1.1 Motivation

We are currently in the middle of the re-authorization of the Intermodal Surface Transportation Efficiency Act (ISTEA), in the form of the Transportation Equity Act of the 21st Century (TEA-21). Among the major elements of ISTEA as well as TEA-21 is intermodalism. In a recent PATH study (1) of the relationship between ISTEA and Intelligent Transportation Systems (ITS), interviews were conducted with representatives of California's primary participants in the field of ISTEA implementation and Intelligent Transportation Systems (ITS) representing both the public and private sectors. With respect to intermodalism, there was an almost unanimous concern over its meaning and connection with related terms such as multimodal transportation and multimodalism, and a desire for further research into opportunities for implementation of intermodal operations in the ITS arena.

The literature contains an extensive amount of information on intermodalism, and in particular, one source discusses the issue of an intermodal ITS and the potential benefits that intermodal operations may derive from ITS (1). Intermodalism-related topics discussed in (1) include:

- Objectives of intermodal transportation systems
- Intermodal services
- Intermodal vs. multimodal systems
- Intermodal performance criteria
- Intermodal system benefits and challenges
- Role of ITS in the evolution of intermodal systems including user services, system architecture, technologies, interoperability, Transportation Management Centers, and marketing opportunities
- Implementation

Whether ITS can provide benefits to intermodal operations and services, both freight and passenger, and what those benefits could be has not been completely determined. Moreover, an essential first step before addressing such issues is to understand the current state of intermodal operations and services in California. Providing this baseline of knowledge will assist in linking intermodal systems more effectively with the ITS arena, i.e. understanding where the opportunities are for ITS applications, resolving intermodal system problems via the use of ITS, and facilitating the movement into the implementation phase.

Research is needed in both freight and passenger intermodal studies. While there are areas of overlap between freight and passenger intermodal issues, each of them contains unique aspects as well. Focus on the proposed research would be placed on intermodal operations and services for the movement of people, not freight. Such focus on this single topic would allow an in-depth investigation of passenger intermodal issues.

The results of this project will contribute to the understanding of the current state and performance of passenger intermodal operations and services in California, and potential opportunities for enhanced performance of intermodal operations and services via intelligent transportation systems. In this way, the results of the project would help identify ways in which intelligent transportation systems may be applied to and improve passenger intermodal operations and services, that is, advance the process of integrating ITS into the passenger intermodal arena.

1.2 Objectives

The primary objective of this work was to assess the current state of passenger intermodal operations and services in California based first on a determination of a clear definition of terms such as intermodal and multimodal, and to identify opportunities to utilize ITS to increase the benefits and reduce the costs of intermodal operations and services.

1.3 Project Methodology

To fulfill the project's objective, we developed a four-tier methodology upon which to carry out the study: 1) a macroscopic assessment by means of a review of the literature, 2) observations upon visiting intermodal passenger transfer facilities in California, 3) institutional aspects by means of a survey of , and 4) user views and opinions by means of a survey of users of intermodal passenger transfer facilities. The macroscopic assessment has been documented in the project's first interim report (Reference 2) and looked at the issues of passenger intermodalism and intelligent transportation systems from a more macroscopic level based primarily on our review of the literature. The second stage of the project, i.e., the evaluation by observation at intermodal facilities in California has also been documented in the project's second interim report (Reference 3). surveys distributed at the El Cerrito Del Norte BART Station) and 2) our institutional survey of some of the public transportation agencies we visited and documented in the most recent PATH Technical Note (2000-1).

This is the first of six sections. Section 2 provides general background material. Discussion of survey designs and administration is presented in Section 3, followed by the analysis of survey findings in Section 4. Conclusions are presented in Section 5. .

2.0 BACKGROUND AND MACROSCOPIC ASSESSMENT

This section provides background information and a summary of the literature review conducted during the early stages of the project (2).

2.1 Need for Seamlessness

A good example, which illustrates the need for a new approach to intermodal passenger transportation in the United States, is that which compares the long-distance travels of a package to that of a person. A freight delivery service plans every aspect of the trip that the package will make, which will usually involve several modes. The whole operation from the perspective of the sender of the package is virtually seamless. On the other hand, a person traveling a similar distance cannot go through one service and plan an intermodal trip. Such a person must coordinate his/her own schedule, deal with each mode individually as well as transfers between different parts of the same mode, i.e., bus-to-bus transfers, and pay for each mode separately. This is contingent upon him/her having access to the proper information. With the current resources available to the typical traveler, it is difficult to visualize all the links of a trip and plan accordingly. This fundamental difference between freight and passenger transportation represents the deficiency of intermodal passenger travel in this country.

The importance of an intermodal passenger transportation system is threefold. First, the concept of intermodalism utilizes the existing transportation infrastructure, instead of expanding the supply of the infrastructure to keep up with demand. Expanding roads and highways to meet capacity has been a common approach to congestion mitigation in the past, and has proven to be a very costly and politically contentious solution. The application of intelligent transportation system technologies to the existing transportation system could increase efficiency and productivity of the intermodal system, so that it would operate more as one seamless entity. A second reason for improving passenger intermodalism is to increase the number of transportation alternatives available to the traveling public. Public transportation, in particular, could likely become a more attractive mode due to streamlining the transfer process and other improvements in quality of service. Transit-dependent and formerly auto-dependent populations would benefit from improved accessibility and mobility. In general, an intermodal system that supports commerce, commuting, and other personal travel, would increase productivity and accessibility. This could yield significant gains in economic opportunity, creating a major incentive to improve intermodal efficiency. Increasing the number of viable transportation alternatives can also help to reduce energy consumption, traffic congestion, and automobile emissions. This is critical, especially in light of legislation, such as ISTEA in 1991and the Clean Air Act Amendments of 1990, which have prioritized the reduction of transportation-related impacts on the environment and on public health. A third reason for improving passenger intermodalism is to reduce transfer times and delays. Associated with such benefits is improved service reliability, especially in off-peak times when service is less frequent and there is an enhanced dependence on and an increased significance associated with “making that connection”.

2.2 Challenges to Intermodalism

Numerous challenges have prevented the significant advancement of intermodal passenger transportation, including institutional issues, system integration concerns, hardware and software interoperability, funding constraints, condition of physical infrastructure, level of market demand for intermodal services, user concerns, lack of sufficient data, and insufficient performance criteria. Later discussion addresses the manner in which policy measures; terminal development and intelligent transportation systems have and can continue to help overcome these challenges.

The lack of incentives among transportation agencies to cooperate poses implementation challenges for intermodalism. These may include differences in objectives, organizational biases toward certain modes, concerns about potential liabilities, and local development restrictions. Sometimes, regulations established by a transit property can discourage intermodal travel as well. For instance, restrictions that do not allow bicycles on board transit vehicles during peak hours may deter potential passengers, who might otherwise use a combination of bicycle and transit to commute to work. Restrictions on bicycles lead to tradeoffs among potential riders (bicyclists, non-bicyclists) and the transit operator.

These are barriers created by inter-jurisdictional resistance to a centralized system. System integration would require changes in local agency operations to make them compatible with system-wide procedures and forfeiture of control to inter-jurisdictional management. The tendency for transit agencies to focus solely on their service areas, rather than consider their operations in the context of the regional transportation system, is also an integration barrier.

To establish an intermodal communications network, there must be a continuous synchronization of intermodal operations and the exchange of reliable and timely information. The hardware and software must be reliable, expandable, and upgradeable.

The public sector, i.e., operating agencies, taxpayers, and system users may not be willing to fund capital improvements especially if heavy investment is required. Experts believe, nevertheless, there will be a need for government subsidies to implement and sustain an intermodal system. The challenge to private sector involvement is primarily connected to its desire to view an intermodal project, or really any investment, in terms of its potential viability and profitability as a business venture. The development of public-private partnerships, e.g., the Union Station project in Washington, D.C., however, could offer opportunities for a win-win enterprise whereby both the public reaps benefits from the improvement of the overall transportation system and the private sector earns an acceptable return on their investment.

Many intermodal facilities are inadequate for accommodating intermodal transportation due to poor design or location. Costly renovations or constraints on available land can inhibit the redevelopment of these facilities.

The dominance of the automobile as a primary transportation mode is perceived as a major obstacle to encouraging intermodal travel. It is a concern that only a slight modal shift toward transit would occur with an improved intermodal system, resulting in negligible impacts on congestion mitigation. Moreover, transit has a reputation for being unreliable, inconvenient, and unsafe. The negative perception of transit service may discourage investment in public transportation, and in passenger intermodalism.

Travelers and operators both have concerns about intermodal integration. The traveler may have privacy concerns, especially in some cases of using "smart" fare media where records of personal travel and information on financial accounts are kept. Operators may have difficulty with new hardware or software. They may be unwilling to share information with other transportation agencies they may view more as competitors than as partners.

Without adequate information, agencies and local governments are unable to make informed policy and planning decisions. This includes the lack of sufficiently accurate data on transfer patterns, trips by non-motorized modes, such as bicycling and walking, and the combinations of modes used in intermodal trips. Data deficiency may be due to several reasons. Data collected by regional transportation planning agencies (Metropolitan Planning Organizations or Councils of Government) are primarily mode-specific (on-board a vehicle) rather than facility- or location-specific thus making the job of collecting intermodal passenger transfer facility-specific information more difficult. The mode-specific data would need to be converted to a facility-specific format and this requires the commitment of potentially limited agency resources, in terms of available staff, time to carry out the task, and the functionality and power of its databases. In addition, at an intermodal facility transfers will occur within the same as well as across different agencies. Especially in the case where multiple agencies are involved, data collection would need to be coordinated across organizations and could be more than simply a minor undertaking.

Without standard performance criteria, it is difficult to assess the effectiveness of intermodal systems and how they should be improved. Transfer time tends to be the common measure of intermodal performance, but rarely are other quantitative or qualitative factors considered.

2.3 Policy Measures

The passage of legislation at the federal level has provided the policy support for a national intermodal system. Such legislation has been the primary driver to help focus attention and motivate interest in passenger intermodalism. In particular, ISTEA and its recent reauthorization, the Transportation Equity Act for the 21st Century (TEA-21), have provisions for encouraging further development of an intermodal system. The first paragraph of ISTEA policy calls for the development of a “National Intermodal Transportation System that is economically efficient and environmentally sound, provides the foundation for the Nation to compete in the global economy, and will move people and goods in an energy efficient manner”. The National Intermodal Transportation System (NITS) integrates all modes of transportation and calls for major improvements to public transit. This would contribute to goals of air quality, energy conservation, international competitiveness, and mobility.

ISTEA also promotes the application of advanced technologies to the transportation system. Technologies that focus on public transportation are called advanced public transportation systems (APTS). Of particular importance to passenger intermodalism are the potential beneficial impacts such advanced technology systems may have on the transfer process including the availability of dynamic bus or rail arrival time information for use either pre-trip or en route by means of kiosks or Web sites. As part of an effort to encourage the development of intelligent transportation systems, the U.S. Department of Transportation established a program to develop a national intelligent transportation systems architecture. A unifying architecture would provide a framework for compatible systems across modes and between regions. These national standards could eventually enable seamless movement of passengers and goods across all jurisdictions.

Some of the historical barriers to intermodalism are addressed through ISTEA legislation. For example, there are six management systems authorized by ISTEA to improve the management and maintenance of the transportation system. One of the objectives of establishing these management systems is to emphasize the importance of performance measures.

ISTEA legislation addresses inter-jurisdictional issues by decentralizing transportation planning decisions, and empowering state, regional, and local governments to respond to community transportation needs. In particular, Metropolitan Planning Organizations (MPOs) are authorized to disperse funds among transportation agencies, and can play a crucial role in encouraging cooperation between them. While there are still issues to be resolved among various institutions, the mandate provides a foundation for beginning the process of cooperation. ISTEA has also helped to alleviate funding constraints by apportioning financial resources for intermodal projects.

2.4 Developing Intermodal Terminals

Efforts to improve the physical infrastructure of the intermodal transportation system are evident by the substantial investment in intermodal facilities in many major metropolitan areas. These facilities range in scale from simple projects to major developments that promote the ease and efficiency of transfers between modes as well as within separate parts of the same mode, such as bus-to-bus terminals. Throughout the United States, intermodal facilities are being designed and constructed in response to the promotion of intermodalism by ISTEA legislation. Examples of intermodal facilities which have been developed in California in recent years include the restoration of the Old Southern Pacific Railroad Depot in Sacramento, the redevelopment of the downtown San Francisco Ferry Terminal, the redevelopment of Union Station in downtown Los Angeles, and renovation of the Santa Fe Depot in downtown San Diego. Each of these projects attempts to improve intermodal transfers by bringing several modes together at one facility. For example, the Santa Fe Depot in San Diego combines multiple lines of the San Diego Trolley, Amtrak, the “Coaster” (the commuter rail between San Diego and the north part of San Diego County in Oceanside approximately 45 miles north) and to an extent, local city buses. They also involve restoration of historic structures that are local landmarks in each region.

Because airports are large facilities that serve many passengers and whole regions, landside airport accessibility is somewhat indicative of a region's intermodal connectivity. The robust economy has placed increased demands on airports to accommodate freight and passenger travel, resulting in a number of high-profile intermodal projects at airports all over the world. In Europe, Asia, and the United States, the issue of improving the quality of airport access has inspired major construction and redevelopment projects at several airports such as Heathrow Airport in London, Charles DeGaulle in Paris, Chek Lap Kok in Hong Kong, San Francisco International, and the Saint Louis Airport in Missouri where rail rapid transit connections to their terminals, are either already in operation, under construction, or in the design and planning stages.

Overall, European and Asian cities tend to have superior airport access compared to most major U.S. airports. While the demands for air and ground transportation are comparable in Europe and the United States, the geographical context for ground transportation systems with which the airport must integrate are wholly dissimilar. European airports tend to be connected inter-regionally, often by high-speed rail, while U.S. airports tend to focus on access within the immediate metropolitan region. U.S. airports also face various legislative and bureaucratic complexities. Because airports are public facilities (city/county/state-owned), they inherently have different perspectives than the privately run airlines, and the federally subsidized highway or transit agencies that provide the infrastructure and service for airport access. Few regional transportation systems in the U.S. (exceptions are Atlanta, Chicago, and Washington DC) allow ease of travel between the city center and airport, while most of the time getting to the airport is difficult, frustrating, and expensive. Preference for the automobile in the U.S. has weakened the connection between airports and public transportation. Funding is more probable since the passage of ISTEA, making improvements in such connections more feasible than in the past. The key to achieving better airport access is to invest in intermodal connections, which will not only benefit the airport, but other transportation agencies as well.

In 1996, the Federal Highway Administration (FHWA) and Federal Aviation Administration (FAA) published a guide for airport operators and MPOs, *Intermodal Ground Access to Airports: A Planning Guide*, designed to provide policy guidance and analytical techniques for airport access planning. However, it is suggested that additional work is needed to improve ground access to airports. Data is needed on airport access travel patterns as well as characteristics on the passenger occupancy of vehicles entering an airport. In addition, there is a need to publish more information on airport peaking characteristics for airports with different passenger levels and mixes, as well as a need for development of better tools and models for access planning. ITS technologies can assist in the collection of data not previously obtainable by conventional means. Moreover, improved partner-type relationships among the institutional players would also be useful to help resolve airport access issues. These improvements could include better interagency cooperation, information sharing, and more flexibility toward adapting conventional institutional roles to a changing intermodal environment.

2.5 Evaluating Intermodal Performance

To date, the most commonly used performance measure of passenger intermodalism is transfer time. As long as intermodal connections are unpredictable and unreliable, transfer waiting time continues to be a significant burden to travelers. It has been estimated through both revealed and stated preference traveler survey data that the value associated with an intermodal transfer penalty is approximately weighted three times the actual waiting time. It was also concluded that intermodal transfers have a significantly higher penalty than intramodal transfers do.

One approach to minimizing transfer times that is practiced in Europe is the concept of integrated timed transfer (ITT). The idea behind ITT is to have transit vehicles (buses) converge at common transfer points in a service area at scheduled intervals throughout the day. The advantages of a coordinated system, such as timed transfers, are that travelers are able to make their connections within a short period of time from when they arrive at transfer points. They can also plan trips with more confidence because arrival and departure times are fixed. Integrated time transfers, however, may not be the optimal approach everywhere and that factors such as the transportation infrastructure network design and origin-destination travel patterns among others need to be considered in deciding whether to implement such a system in a particular location. Integrated timed transfers may require some passengers to transfer more than they would without it. However, this would be factored in to an assessment of the net system benefit, using reduction in overall system transfer time as a measure of effectiveness. In addition, under a timed transfer system, a region “blanketed” with transfer points with consistent service throughout the day would be effective. Moreover, timed transfers could even reduce costs if less frequent service is enabled by short transfers.

Little evaluation has been done to measure the quality of connections at intermodal facilities. A feasibility study for the Wisconsin Department of Transportation is one of the few studies, which attempts to evaluate the quality of intermodal connections. It suggests some standard weights, penalties, and time values of transfers depending on particular conditions. Most of the report mainly focuses on establishing criteria for the development of new intermodal facilities.

AlKadri and Benouar suggest two system concepts by which intermodal systems and services could be evaluated. These are *interconnectivity*, which is a quantitative measure dealing with physical connections, and *interconnectedness*, which a qualitative measure of the connections. The three criteria, which can be used to assess a system's interconnectivity and interconnectedness include (a) the quality of infrastructure interconnectivity, (b) the quality of system management, and (c) the performance of the communications link. The quality of infrastructure connectivity is determined by how well the transportation system or facility is designed. It includes the characteristics of the intermodal terminals, the convenience and ease of transfers, the safety of the transfer, and the degree of coverage of the intermodal network. The quality of system management covers issues, such as availability of transfers, level-of-service, reliability, cost distributions, and the efficiency of communications between agencies in meeting operational objectives. The performance of the communications link deals with the accuracy and availability of data, value of information, and user-friendliness of interfaces.

2.6 Use of Intelligent Transportation Systems

Since intermodal trips often involve the use of at least one form of transit, addressing transit performance can lead to improvements in passenger intermodalism. The inability of transit to adequately serve transportation needs is a major deterrent to intermodalism, but one that intelligent transportation system technologies may effectively address. These technologies can improve transit by addressing major problems, such as inconvenient bus routes, anxiety caused by waiting for the bus, long transfer times, safety concerns, and cost to the customer. Intelligent transportation system technologies can be applied to transit in the areas of fleet operation and management, fare collection, and customer information.

Fleet operation and management uses specific technologies, such as automatic vehicle location, advanced transportation management systems integration, signal priority, automatic passenger counters, and geographic information systems. Vehicle location systems are possible through global positioning systems satellite technology that can accurately identify transit vehicle locations. Knowing a vehicle's location is useful in adhering to published schedules of arrival times, in coordinating connections with other vehicles, in responding to emergencies and traffic incidents, and in providing dynamic information to customers. Transportation management systems integration involves the electronic connection between a transit agency's operations center and an external transportation management system. Because the external agency has access to real-time traffic information, it can alert the dispatchers when there are traffic incidents. With signal priority, a central control system can provide "early" and "extended" traffic signal green time for transit vehicles approaching an intersection. This is intended to help transit vehicles stay on schedule, or make up time if they are behind schedule. Automatic passenger counters are an aid in collecting ridership data. These technologies will allow the collection of information, which may currently not be available, such as the number of passengers who board and alight at each stop. Geographic information systems store and display data in a geographic context, allowing it to be analyzed and computed. It can be helpful in making informed planning and policy decisions.

Electronic fare collection involves the use of uniform fare media (usually cards) for fare payment instead of currency. Customers benefit by needing only one fare medium to pay for different modes, thus minimizing the time required for passenger boarding. "Smart Card" technology allows these cards to be used for a variety of tasks in addition to paying transit fare, such as making payments in restaurants, for entertainment, and accessing automatic teller machines. It also reduces the need for transit properties to count, collect, or handle money, which can be time-consuming, costly, and unsafe. Operators can also benefit from using smart cards by having the flexibility to introduce more complex fare structures, the opportunity to reduce fare evasion, and the potential to create partnerships with third party institutions to finance smart card implementation. A more efficient boarding process also makes it easier for transit drivers to stay on schedule.

In the San Francisco Bay Area, an automated fare collection program called TransLink® will be demonstrated and evaluated in the 2001-2002 timeframe, under the sponsorship of the Bay Area's Metropolitan Planning Organization, the Metropolitan Transportation Commission (MTC). Six of the Bay Area's twenty-six transit operators will participate in this demonstration project, which will allow riders with the dual-interface (contact and contactless) TransLink® cards to pay for intra- and inter-operator trips with one card. A central Clearinghouse will disburse the funds to the operators according to where the cards are used. Depending on the findings of the demonstration evaluation, the recommendations resulting from that evaluation, and MTC's final policy decisions, the expansion of TransLink® to all Bay Area transit operators could occur.

Customer information technologies include automated trip itineraries, in-vehicle annunciators (audio announcements), variable message-signs and monitors, and interactive kiosks. Users will have access to better information via human operators, telephone, personal computer, interactive television, handheld devices and wayside devices at transit stations. A pilot project in Europe, Infoten Italia, is an example of a dynamic trip-planning service that provides passenger information for intermodal travel among Germany, France, Austria, Switzerland, and Northeast Italy. This includes access to pre-trip information, information at intermodal exchange nodes, and en-route information, via a variety of interfaces. This project has demonstrated that intermodal travel is improved significantly when there is cooperation among several jurisdictions. In Japan, dynamic and static information is provided to travelers in efforts to increase attractiveness of and improve connections within the transportation system. Some of the real-time technologies currently available to the public are bus arrival countdown systems and park and bus ride information systems.

In 1994 and 1995, a survey of 36 U.S. bus transit agencies was conducted to determine the deployment status and the benefits realized or perceived from intelligent transportation system technologies. Among these, San Francisco and Los Angeles were participants in the study. The agencies were asked about six technologies: advanced vehicle location/computer-aided dispatch systems (AVL/CAD), Smart Cards, automatic passenger counters, automatic annunciation, advanced passenger information, and signal preemption. It was found that among these agencies, the technology or technology cluster most widely used or planned for deployment is AVL/CAD (80%), followed by advanced passenger information systems (64%).

In general, there are few documented results on quantifiable benefits of the deployment of ITS for transit applications. The primary benefits of AVL/CAD include the optimization of routes, which reduces run times and requires fewer vehicles. According to the agencies surveyed, the savings in capital and operating costs make AVL/CAD the only economically justifiable ITS technology given that the investment can be amortized in about two years. Agencies that have AVL/CAD experience improved safety because of shorter emergency response times. On-time performance has improved as well, by 23% in Baltimore and 28% in Milwaukee. None of the agencies in this study project an increase in ridership due to the provision of real-time information to passengers, but feel it is necessary in this technologically advanced age in order to remain competitive with other modes.

2.7 Implementing an Intelligent Intermodal System

The realization of an intelligent intermodal system will require continued support from policy makers, changes in institutional attitudes, substantial investment in infrastructure, and technological expertise. While ITS cannot provide solutions for all the barriers to intermodalism, the evolution of intelligent transportation systems has created new opportunities for improving intermodal operations and services. ITS can encourage intermodalism by maximizing resources, by improving the management and operations of transportation services, and by bridging the gap between the physical and informational infrastructure.

The institutional and inter-jurisdictional issues are some of the more complicated matters that need to be resolved. It is suggested in that we not consolidate our transportation agencies into central command stations, but that the transportation management centers retain their current organization and serve as the nuclei for an intermodal system. It will require a “great reversal” in the manner in which we currently run our transportation system to change from the current practice of relying on the existing physical infrastructure to relying on a new information infrastructure in order to advance to become a fully integrated intermodal system.

3.0 DESIGN AND ADMINISTRATION OF SURVEY INSTRUMENTS FOR SITE SPECIFIC STUDIES

This section describes each of the three elements of the methodological approach we used in our evaluation of intermodal passenger transfer facilities in California in terms of how we collected and analyzed data. The three elements consisted of field survey of site visits, institutional survey based on a subset of the sites visited, and a user survey of one of the site visits.

3.1 Field Survey

The first element of our three-tiered methodology was the site visits, in which we felt that it would be helpful to take on the role of a transit user. Thus, we conducted our site visits by actually riding one mode of transit to the subject facility when possible, and transferring to another mode to leave the facility, noting as much as we could about the facility as we passed through it. In other words, our site visits, which were conducted between December 1999 and April 2000, actually used the facilities in question (3).

In developing the template by which many of our site visits were conducted, we identified four stages of an intermodal transfer. First, the approach to the facility and the quality of service to reach the terminal sets the stage for a passenger’s intermodal experience. Second, a transferring passenger must go through some sort of ticketing process. The third step is the actual transfer itself, including locating the new vehicle, the waiting time, and physical qualities of the terminal. The final step in an intermodal trip is the departure from the terminal, by which, much like the approach category, a user’s experience is greatly affected. The site visits, then, attempted to circumnavigate through these four steps for those sites visited.

The goal of this phase was certainly not to establish any final conclusions or recommendations, but rather, to form hypotheses about the nature of passenger intermodalism and the use of intelligent transportation systems, that could later be tested through our institutional and user surveys. Further, we hoped that this purely anecdotal data, collected by the project team and based only on observations, could provide us with some guidance in actually developing both the user and institutional surveys that we will be later conducting.

With that goal in mind, we do, then, believe that these site visits were valuable, and therefore, attempted to be as methodical as possible in conducting them. In order to assure that all of our site visits were conducted in much the same way, and that all of the information that we sought was collected for each site visit we made, we developed a template containing all of the criteria we hoped to evaluate for each site. On this template there is space to record gathered information regarding fare structures, schedules, physical qualities of the terminal, and any use of technology at the site (see Appendix A for a complete site visit template).

A total of 13 sites were visited in California. In the San Francisco Bay Area we visited:

- Transbay Transit Terminal (San Francisco)
- El Cerrito Del Norte BART Station (El Cerrito)
- Amtrak Depot (Emeryville)
- Embarcadero BART/Muni Station (San Francisco)
- 4th and King Streets Caltrain Station (San Francisco)
- Diridon Caltrain Station (San Jose)

In Metropolitan San Diego, we visited:

- San Ysidro/Tijuana Trolley Station (San Ysidro)
- Santa Fe Depot (San Diego)
- Oceanside Transit Center (Oceanside)
- Old Town Transit Center (San Diego)
- Fashion Valley Transit Center (San Diego)

In the Sacramento Area, we visited:

- Amtrak Depot (Sacramento)
- Arden/Del Paso RT Station (Sacramento)

3.2 Institutional Survey

In the second phase of the project we chose a sample of the intermodal sites we visited. With this sample of approximately four sites, our plan was to interview all of the transit properties with service to these sites. Our goal was to gain a sense of the institutional setting in which the facility operates. We believe that this will give us a sense of one half, the institutional portion, of the two-sided intermodal setting discussed earlier.

The institutional survey probed several different areas. First, we aimed to find out the ways in which each agency stores and maintains their own data. We felt that this could be a valuable indicator as to the level of technology employed by the transit property, and could also indicate the property's willingness to explore opportunities for ITS in improving its overall performance. The second area we examined was inter-agency data sharing arrangements and attitudes. This enabled us to assess the level of cooperation between transit providers and the extent to which they cooperated, or would be willing to cooperate, to optimize the entire intermodal system. Finally, we questioned the transit properties about their own attitudes and institutional policies toward particular intermodal facilities, the relationships they have with other providers at the facilities, and also how they perceive regional intermodalism in general.

The evaluation was conducted through an analysis of responses to mail-out/fax-back surveys (See Appendix B). The surveys were completed by the planning or management staff of the agencies located at the intermodal facilities under study. The surveys were completed between December 2000 and February 2001. The estimated time for completing surveys was between 30 and 45 minutes. Interviewee responses were analyzed according to the different sections of the survey. Since confidentiality was guaranteed and the degree of attribution of results would be limited to groups of individuals it was hoped that the interviewees would provide candid responses.

3.3 User Survey

The goal in conducting the user survey was to obtain information about intermodal passenger transfer facility operations and services directly from users of such a facility. This goal guided the project team in its design of the survey instrument (See Appendix C). We selected the El Cerrito Del Norte BART Station because the it is a significant intermodal site in the San Francisco Bay Area with a large park and ride facility mainly for use by BART patrons and serviced by numerous bus services, including AC Transit, Golden Gate Transit, Vallejo Transit, and West Contra Costa County Transit (WestCAT)[1]. In developing the survey, we were interested in learning about the travelers' means of arrival to and departure from the BART station, travelers' transfer behavior, overall use of the station, quality of traveler information concerning the station, state of the BART station relative to specific criteria, and finally some demographic information about the survey respondents.

Because the survey was to be administered to the general public, we were aware that careful attention be placed on the survey's content, its physical design and length, question types, format, wording, and ordering, and instructions given to participants. We consulted Reference 4 to assist us with these aspects of the survey design. The surveys were of the "self-completion" administration type, i.e., we distributed the survey to BART station users and told people that the survey would require approximately five minutes of their time to complete. At the end of the survey there were instructions on how to return it. The survey was handed out *at random* over the course of two weekdays during the morning including peak commute time, i.e., 6AM to 10AM each day. A total of two thousand surveys were distributed in this way. Financial arrangements were made in advance with the University of California mailing services office (the project paid for postage in advance) so that respondents needed no postage to return the survey and in this way, removed postage as a barrier to responding to the survey. The project team stood outside the BART turnstiles so as to help insure that the survey would be administered to more than just BART customers. We spoke with and received permission from BART prior to conducting the survey. In fact, we gave BART our survey to review and incorporated their comments into our final survey. We also ran a mini-pilot study in advance of the "real" survey to check for problems. Of the two thousand surveys distributed, 581 completed surveys were returned, a 29% response rate.

4.0 FINDINGS FROM SITE SPECIFIC STUDIES

This section contains the results of our analysis of each of the three survey instruments used.

4.1 Field Survey

The field survey consisted of numerous field trips to intermodal passenger transfer facilities in California. The remainder of this section consists of a summary of our observations of these sites

[1] Because of project resource constraints, we performed only one user survey.

followed by an analysis and synthesis of our evaluation. A complete write-up of this portion of the project's evaluation of passenger intermodal sites may be found in (3).

4.1.1 Summary of Site Visit Observations

This section provides a summary of our visits to the thirteen passenger intermodal sites in California (See Section 3.1 for the locations of these facilities.)

Transbay Transit Terminal (San Francisco)

The Transbay Transit Terminal (TTT) has served a number of functions over its existence, including transbay rail service. Now, however, it serves primarily as a bus terminal, with one rail line (San Francisco Municipal Railway (Muni)). The main user of the terminal is Alameda-Contra Costa Transit (AC Transit), which uses the facility as the terminus of its transbay bus service. Also at the station, are Muni buses and rail, San Mateo County Transit (SamTrans), and Golden Gate Transit (all located on the streets surrounding the TTT). Also, private bus companies, including Greyhound, share the space inside the terminal with AC Transit.

There do not appear to be any forms of advanced traveler information services available at the terminal. Traveler information is provided by means of static displays of posted system maps and printed timetables. In addition, there is a large terminal map that shows a user where each bus stop is located to aid the user in his or her intermodal/inter-system transfer. Further, there are small television screens that display the scheduled departure times for the next two buses on each line for Muni and AC Transit. However, these displays are static, and do not update the times with any dynamic, real-time information. Finally, the bus stops at the arrival platform on the upper level used primarily by AC Transit contain printed schedules for each route.

On the trip we made during this site visit, transferring between AC Transit and Muni bus proved to be challenging. Muni bus stops are located at various places around the terminal, rather than one central bus loading location serving the TTT, and this caused some difficulty in locating the particular side of the terminal that our bus served. Moreover, there were no coordinated fare discounts between AC Transit and Muni. Passengers who use the bus to commute across the bay, do not receive a fare discount for transferring to Muni, while those who use Bay Area Rapid

Transit (BART) for their transbay commute, receive what amounts to a half-price discount on all Muni fares, even though the fares are similar on BART and AC Transit for transbay service.

El Cerrito Del Norte BART Station (El Cerrito)

The El Cerrito Del Norte BART Station is a significant intermodal site in the San Francisco Bay Area. In addition to a large park and ride facility mainly for use by BART patrons, the station is served by a number of bus services, including AC Transit, Golden Gate Transit, Vallejo Transit, and West Contra Costa County Transit (WestCAT).

In making the site visit, we rode an on-time BART train to the station having begun our trip at the Berkeley BART station, where we transferred to an AC Transit bus. An AC Transit transfer discount was available from a dispensing machine in the paid area of the BART Terminal, as we made our way to the bus stops. The bus facilities at the station are quite near to the exit area from the BART terminal. There are two lanes of bus bays, which are both within 50 feet of the BART terminal exits. Another attractive feature of this particular transfer facility is that there are transfer discounts available for BART patrons for those who transfer to bus. Finally, similar to the TTT, there are static television screens near the bus waiting areas that display the arrival times of the next two buses for each line that serves the station. These are static and simply reflect the published schedule times, and are not capable of alerting passengers to any incidents or other stochastic deviations from the published schedule. At the BART platforms, however, in addition to the posted schedule, there are changeable message signs that display updated information, including dynamic expected train arrival time information.

Amtrak Depot (Emeryville)

The Emeryville Amtrak Depot is served by a number of Amtrak routes, including the Capitol Corridor, the San Joaquin, and the Coast Starlight. While Amtrak provides the only passenger rail services that use the station, AC Transit, Emery-go-Round, and Amtrak Thruway buses also serve the station. The bus area is on the opposite side of the terminal building as the rail waiting platforms.

Inside the terminal, there are several passenger information and ticketing services. The station supplies automatic ticketing machines in addition to Amtrak ticketing agents. Also, presumably because of the large number of trains and routes serving the station, there are television monitors throughout the terminal that display updated and dynamic arrival times for upcoming trains. This display appears very similar and operates very similarly to the analogous arrival information screens in an airport. In addition to the in-terminal displays, the arrival platform has a changeable message sign that continuously displays the updated arrival times of each train, and also says whether or not the updated arrival time is different from the scheduled time, i.e., the display announces how far behind schedule a given train is running.

Embarcadero BART/Muni Station (San Francisco)

The Embarcadero BART/Muni Station in San Francisco serves both Muni Metro (Light Rail Transit (LRT)) and buses, in addition to BART and it is directly across the street from the Embarcadero Ferry Terminal. Unlike most of the other stations we visited, the Embarcadero BART/Muni station separates its modes vertically rather than laterally. Because two of the modes act as subways as they travel down Market Street, they are located below ground, rather than on the street with the buses. BART platforms are on the bottom level, Muni Metro trains are on the next level, the ticketing and passenger terminal area are on the level directly below street level, and the Muni buses are at street level. Passengers transferring either from Muni Metro to BART or BART to Muni Metro are required to go up to the ticketing/terminal area before going back down to their next mode.

Although they do require passengers to pay a separate fare when transferring between the two modes, Muni and BART have a fare discount arrangement for transferring passengers. Customers in the BART paid area may purchase round trip Muni tickets (for use on either buses or Muni Metro) for the price of a standard one-way ticket. The discounted transfer ticket machines, however, are not easily located and often appear to be out of order. The terminal area has ticket machines for BART users that generally accept cash only, and only give change in coins. However, there are a limited number of such machines that do accept credit and debit cards in the terminal. Muni Metro riders do not need to purchase a ticket at a machine, but rather must put $1 in coins into a turnstile to enter the Muni paid area, where they receive a paper proof-of-payment ticket.

The Muni Metro and BART waiting levels and platforms each have electronic changeable message signs, which announce both train arrivals and provide dynamic train arrival information. However, the signs for each service only announce arrival times for that service at which the sign is operating, i.e., the signs on the Muni level only offer arrival information about Muni trains, while BART signs only provide BART arrival information.

Caltrain Station at 4th & King Streets (San Francisco)

The Caltrain Station at 4th and King Streets in San Francisco serves as the terminus for the Caltrain commuter rail line. At this facility, passengers can transfer to Muni buses, which offer service at the station's curbside, or to Muni Metro (LRT) trains, whose tracks and platforms are adjacent to the Caltrain station, and offer service to downtown San Francisco.

At the time of the site visit, there did not appear to be much technology at the station, although the passenger amenities seemed quite complete. To purchase a ticket, passengers waited in line to buy their ticket from a Caltrain employee. Further, to find which platform their train would be leaving from, passengers merely had to look at a wooden sign above the door to their platform. There did not appear to be any electronic information media available that displayed either static or dynamic information. Thus, it seems that there may be a number of opportunities to develop ITS applications at the station.

Further, there did not appear to be any transfer discounts on fares for passengers transferring to or from Muni. Caltrain patrons who purchase monthly passes may use their passes on SamTrans, Dunbarton Express, and Santa Clara Valley Transit Authority (VTA) buses, however, and special passes may be purchased for a slightly higher price which will provide riders with passes to ride Muni also.

Caltrain has since added some automated ticket machines at some of its facilities. This will reduce the need for employee staffing at many stations, and allow passengers to purchase tickets at hours when the station is not staffed. These ticket machines are now employed at the 4th and King Street Station in San Francisco, although the ticket booth remains staffed. A surcharge is levied on all tickets purchased from Caltrain employees whenever ticket machines are available.

Diridon Caltrain Station (San Jose)

This site visit involved riding Caltrain from San Francisco to the Diridon Station in San Jose, and transferring to a Santa Clara Valley Transit Authority (SCVTA) bus with service to the San Jose Central Business District. The entire trip went according to published schedules, and the VTA bus arrived approximately two minutes after our Caltrain arrived in San Jose.

Similarly to many commuter rail stations that we visited, the San Jose Diridon station is served by a variety of public transportation service providers. In addition to Caltrain commuter rail, the Diridon Station is served by VTA buses, Amtrak trains and Amtrak Thruway buses, the Altamont Commuter Express (ACE) commuter rail, Highway 17 Express commuter bus, and BART Connection buses, which serve the Fremont BART station. Although the station is served by a number of different transit properties, it really only serves two modes: heavy rail and bus.

Although we did not encounter any problems making the transfer connection, there does not appear to be much new technology deployed at the Diridon Station. The fare payment systems for all modes serving the station are in-vehicle or in-station via an agent. There is no automatic fare payment. Further all of the signage and maps at the facility are static, with the exception of changeable message signs over the rail tracks. These signs had just been installed at the time of the site visit and were not yet operational. Thus, it is unknown whether or not dynamic incident information is provided, or just train arrival announcements.

San Ysidro/Tijuana Trolley Station (San Ysidro)

Although the only truly public transportation provider at the San Ysidro/Tijuana Trolley Station is the San Diego Trolley itself, the station does, in fact, exhibit a large amount of passenger intermodalism. Directly adjacent to the trolley platforms, on the street (approximately 50 feet from the trolley platform) is an area where various jitneys, taxis, and shuttle buses stop to transport tourists across the Mexican border (about 1/8th of a mile from the trolley station) to Tijuana.

Given the rather informal nature of this terminal, it comes as little surprise that there is not a high degree of technology or ITS employed there. The trolley station contains automatic ticket machines and changeable message signs above the platforms that announce train arrivals, but do not display any real-time information. However, this level of ITS is focused strictly on the trolley service, and does not contribute to easing passenger transfers between the trolley and the informal jitneys and taxicabs waiting outside. Certainly there are no fare discount arrangements and there appears to be very little coordination among the modes.

Santa Fe Depot (San Diego)

This facility is a major passenger intermodal transfer point in San Diego with the San Diego Trolley, the region's commuter rail line (the "Coaster"), and Amtrak co-located within the facility. San Diego city buses are pick up and drop off passengers at curbside just outside the facility.

Between the trolley and Coaster tracks were automatic ticketing machines for both of these service providers. The Coaster ticket machine functioned properly and allowed for transfer discounts from the trolley. The user first selects his or her ticket type (one-way, senior discount, round-trip, transfer discount, etc.), then his or her destination, then payment type (credit card, cash (machine gives change), or ATM). The machine then prints the ticket and receipt. The user then simply must "validate" his or her ticket in a validation machine next to all of the ticket machines. The function of this validation process allows many tickets to be purchased at once. Then the user may simply insert one ticket in the validation machine each time he or she makes a trip. The validation machine simply prints the date and time of validation, which must be printed on the ticket for the ticket to be used. This validated ticket is only good for just enough time for the ride to be completed, assuring that the ticket may not be used for multiple trips. Further, any discounted transfer fare tickets purchased must be accompanied by a ticket from the other mode.

The Santa Fe Depot terminal building contains the Amtrak ticketing area and a large waiting area for passengers. There was an information booth inside the waiting room, which was staffed by an employee of the San Diego Transit District who was able to aid passengers who wished to navigate the San Diego transit system. Because the information agent at the booth had information about all the different transit services offered not only at the Santa Fe Depot, but throughout the local transit system, new passengers or tourists may get around the area (often by transferring) without a car, and familiar passengers may find alternate, more convenient routes to reach their destination.

Oceanside Transit Center (Oceanside)

The Oceanside Transit Center in Oceanside, about 50 miles north of San Diego's Central Business District, is the terminus both for the San Diego County Coaster commuter rail to the south, and for the Los Angeles County Metrolink commuter rail from the north. The two trains' routes meet at this facility, which is also served by Amtrak, a number of North County Transit District buses, and a park and ride lot.

This facility employs a relatively high degree of technology both for passenger information and for ticketing. Similar to the other Coaster stations, the Coaster ticketing machines are completely automated, supplying users with a variety of ticket types including senior discounts, student discounts, and transfer discounts for passengers who have a valid bus transfer ticket. The Metrolink trains also employ the same type of automatic ticketing machines located adjacent to the Coaster ticket machines and are located outside of the train platform area so passengers transferring between the Coaster and Metrolink must exit the platform area via an underground walkway to purchase a ticket for the train they are transferring to. The rail waiting area also employs some dynamic information through a changeable message sign. At the time we visited the site, the signs were displaying information about an incident on the Coaster, informing passengers that the trains would be arriving late. While this information was rather qualitative in nature, it not only could ease passenger anxiety, but also could serve as a guide for passengers to perhaps choose alternate modes to reach their destination.

Old Town Transit Center (San Diego)

The Old Town Transit Center in San Diego is truly intermodal in nature. In addition to the commuter rail (Coaster) and LRT (San Diego Trolley), the station is served by a number of bus lines from the San Diego Transit system and a park and ride lot. The rail lines for both trolley directions and the Coaster (three tracks) are parallel to one another, and are only separated by waiting platforms between them. This made for very easy rail-to-rail transfers. The buses, however, were located on both sides of the rail platforms. A passenger making a rail-to-bus connection who knows which bus line he or she is transferring to can simply follow the sign to the correct side of the terminal. However, a passenger who does not know which bus to take may go to the incorrect side via an underground walkway, which goes under the tracks. This passenger would then have to turn around and walk underneath the entire terminal again to get to the other side.

The automated ticket machines for both the Coaster and the trolley were located on the platforms, in between the two modes, so that transferring passengers crossing a platform to connect to a rail mode do not have to go out of their way to purchase tickets. Further, these ticket machines are able to print several different types of tickets, including discounted tickets for passengers transferring between modes. In addition, the Coaster platform was served by a changeable message sign that displayed real-time, dynamic incident information that alerted waiting passengers of any unexpected delays that may occur. The trolley platforms also contained changeable message signs, but did not appear to be able to display any dynamic information. Rather, the trolley's message signs displayed the line and destination of any approaching vehicles to help ensure that passengers board the proper train.

Another feature of this station was a portable information kiosk/booth in which an employee of the San Diego Transit District could sit, presumably to aid passengers in navigating the San Diego area on transit. However, we could not obtain the actual information available at this kiosk during our site visit (approximately 6 P.M. on a weeknight), because the kiosk was not staffed, providing no information.

Fashion Valley Transit Center (San Diego)

This station is part of the San Diego Trolley system. We arrived here by trolley and transferred to a bus via a pedestrian bridge and a flight of stairs to the bus platform below. This platform had a number of bus bays, each containing approximately two bus stops. As long as a passenger had a trolley ticket worth at least as much as his or her bus fare, he or she could simply transfer to the bus for free. If a passenger was transferring from the trolley, but did not have a ticket worth the bus fare he or she could simply upgrade their trolley ticket by the necessary amount to reach the cost of the bus fare.

As with all other trolley stops we visited, the trolley platform had overhead changeable message signs, which only announced vehicle arrivals and did not have any dynamic vehicle arrival information. Also, the trolley ticket machines were located both upstairs at the trolley waiting platform and also downstairs at the bus platform to aid passengers transferring to a bus in upgrading their trolley tickets to the posted bus fare value as necessary. This station also had a portable information kiosk just like that found at the Old Town Transit Center. However, as was the case at the Old Town Transit Center, the information kiosk was not open at the time of our site visit.

Amtrak Depot (Sacramento)

Although the Sacramento Rapid Transit District (RT) operates a large number of buses and a light rail line, there is only one bus line that serves the Sacramento Amtrak station. In addition, no other rail services other than Amtrak trains and Amtrak Thruway buses (serving the north coast, the Tahoe region, and the northern central valley) operate at the facility.

In visiting this site, which does exhibit intermodalism between the RT bus, Amtrak Thruway buses, and Amtrak trains, we observed that only a small amount of technology is in use. There are no changeable message signs in the terminal or at the rail platforms, and no user information services were available except for the Amtrak ticket agents in the terminal. The main form of automation at the terminal is an automatic ticketing machine, at which Amtrak patrons may purchase one-way or round trip tickets using credit or debit cards for any station served by the Capitol Corridor route (rail service between San Jose and Sacramento).

In transferring between Amtrak rail and Amtrak Thruway buses, a passenger need not worry about timing his or her connection, because the buses are there exclusively for passengers transferring from the train. Therefore, even if the train is late, the buses still wait for the train's arrival before departing. Passengers transferring to the RT bus at the station simply wait at the inner side of the rail platform, which also serves as a bus curb. There are no discounts on the bus fare for passengers with Amtrak tickets.

Arden/Del Paso RT Station (Sacramento)

The Arden/Del Paso RT Station serves both the RT's light rail line and ten RT bus lines, in addition to a park and ride lot. The buses are located on the curbside of the LRT waiting platform (approximately 20 feet from the tracks). Also in this waiting area are system maps and timetables for each of the buses that serve the station. There were no changeable message signs for announcements at this station.

The ticket machines where passengers can purchase RT tickets for use either on the light rail line or the buses are also located at the station platform. The fare for the bus and for riding the light rail line is the same. Further, tickets are good for 90 minutes from the time of purchase, allowing passengers to transfer between bus lines or between bus and rail without paying additional fares for their entire trip. Passengers may also purchase all-day passes for unlimited rides on all bus lines and the light rail line operated by RT.

4.1.2 Analysis and Synthesis of Site Visit Observations

After collecting the site visit data, there are some comparisons and contrasts that can be made both across regions and across modes. From these similarities and differences, we can form some generalized hypotheses regarding intermodalism, and subsequently test these hypotheses in the institutional and user survey components of the project.

The first cross-site comparison that we can make compares rail modes with bus modes. The rail facilities we visited tended to exhibit a higher degree of technology for user information and ticketing than bus modes. For example, many of the heavy rail stations (e.g., the Santa Fe Depot in San Diego, the North County Transit Facility in Oceanside, the Diridon Station in San Jose, and the Emeryville Amtrak Depot) utilized not only changeable message signs, but in many cases, used them to provide dynamic, real-time updated information. As we consider a slightly lower level in rail transit, we see that many of the light rail stations used changeable message signs, but Muni Metro was the only light rail transit service provider that appeared to provide real-time, dynamic information. Subsequently looking at buses, we see few changeable message signs at bus facilities (#22 Filmore Line). The monitors at the El Cerrito Del Norte BART Station and at the Transbay Terminal in San Francisco displayed static bus schedule information, but did not make any announcements or provide any new information beyond that which was already posted.

Another aspect that we can examine is ticketing. Every rail mode that we visited had some form of automated advanced payment machine, with the exception of Caltrain's San Francisco station (Caltrain has since placed automatic ticketing machines in the 4th and King Streets Station). For most of the sites and systems that we examined, although bus users may use their rail tickets to transfer to bus, the ticketing machines are oriented to rail users.

Therefore, one generalization that we hypothesize is that rail modes tend to be more technologically advanced. The evidence that we have seen from our site visits indicates that the ticketing procedures and the traveler information (including in-terminal monitors and changeable message signs) are at a more technologically advanced level than those used for buses.

The next evaluation we made is whether the presence of technology differs by area. It appears that the level of technology used in the San Diego area is higher than that used either in the San Francisco Bay Area, or Sacramento. Sacramento appears to employ the least amount of advanced technologies and the San Diego area seems to have the highest use. The extent of Sacramento's advanced technologies seems to lie with the changeable message signs discussed earlier, and the automatic fare payment machines, both associated with the light rail system. San Diego, meanwhile, employs both of the above technologies on a wide scale for both the trolley and Coaster, but also provides Coaster passengers with real-time information on its changeable message signs. Further, San Diego's automatic fare payment machines are quite a bit more advanced than Sacramento's in that they make change, they will accept dollar bills and credit cards, and they display electronic instructions to ticket purchasers. The Bay Area seems to lie somewhere in between Sacramento and San Diego in technology use, providing some real-time information to train platforms, but not using advanced fare payment systems on as wide a scale as San Diego.

Just as the use of advanced technologies seems to have a fairly clear hierarchy by region, the level of fare coordination seems to have an analogous hierarchy. Fare coordination (transfer discounts, single-fare tickets for multiple modes, etc.) seems to be higher in both Sacramento and San Diego than in the Bay Area. Sacramento, which does not employ a high level of technology at any of the sites visited, appears to have quite simple and convenient fare coordination. Passengers simply have to pay one fare, giving them free transfers for 90 minutes on all of the modes and lines that RT operates. Of course, the presence of only two modes (bus and LRT) certainly makes this easier to achieve. However, in San Diego, which has a much more complex and diverse network than Sacramento, a similar ease of fare coordination still prevails. Trolley tickets are valid for riding San Diego Transit buses, and also allow users to purchase discounted tickets on the San Diego Coaster. In the San Francisco Bay Area, however, perhaps because of the complexity of the transit system, fare structures seem to be more autonomous, often forcing passengers to pay separate fares for each mode. There are exceptions in the case of Muni, where passengers who ride either the bus or the light rail may transfer without paying additional fare to the other Muni mode, and for BART, which offers transfer discounts for transfers between BART and bus. However, it still appears that San Diego and Sacramento have achieved a higher level of coordination than the Bay Area. The reasons for such geographical differences will be pursued with the agency surveys in the institutional component of the project.

4.2 Institutional Survey

This section presents the results from the analysis of the completed surveys. The sub-sections correspond to the individual survey sections:

- Agency Data Usage
- Interagency Data Sharing
- Management of the Intermodal Facility

- Assessment of the Intermodal Facility
- Relationship Among Agencies Sharing the Intermodal Facility
- Regional Intermodalism and the Transfer Process

The last sub-section presents the lessons learned from this survey. When agency responses differ by intermodal site, this is highlighted in the relevant sections of the survey results. Generally, however, responses did not differ much by intermodal site.

4.2.1 Agency Data Usage

The objective of this part of the survey was to understand general agency data collection methods and to assess the current state of agency use of intelligent transportation systems technologies. Specific questions focused on the type of data collected by agencies, the frequency and type of collection as well as storage procedures. The survey also sought to determine which ITS technologies have been adopted and which ones are under study. The survey asked questions regarding agency data usage and use of intelligent transportation systems as these elements indicate – to some extent - the degree to which agencies can exchange data amongst themselves and hence contribute to intermodalism.

Of the three types of data collected (vehicle location, actual arrival time, ridership), the two data types collected most often, in order of importance, were: 1.Ridership data and 2.Actual arrival time. Data collection is predominantly manual and performed on a continuous or daily basis. Overwhelmingly, data storage is in electronic form and resides in a departmental database (as opposed to an agency-wide database). Table 1 illustrates the breakdown of responses for data types collected for all the 9 agencies located at the three intermodal sites.

TABLE 1 Agency Data Collection Methods

Data Collection	**Vehicle Location Data**	**Arrival Time Data***	**Ridership Data****
Type of Collection			
Automatic	2	1	2
Manual	2	5	7

*Descriptions of actual arrival times on routes or portions of routes

**Records of vehicle loads, i.e., on/off counts and passenger origins and destinations

As far as the adoption of ITS technologies, a fairly consistent picture emerges from analysis of the data. The most commonly used technologies are electronic fare boxes (6 out of 9 respondents) and surveillance cameras (8 out of 9). The second tier of technologies adopted, but at much lower numbers (2 out of 9), are automatic passenger counters, automatic vehicle location, and traffic signal priority. For the technologies not in use, generally three quarters or more of the respondents report that they are studying the technologies. There thus seems to be a fairly high degree of interest in ITS technologies among the various transit agencies. Of the technologies not in use but under study the most popular ones are: electronic fare payment, automatic passenger counters and advanced traveler information systems. Table 2 shows the technology adoption of the various transit agencies located at the two intermodal sites.[2]

TABLE 2 Use of ITS Technologies

	Number of agencies using technologies	**Number of agencies not using technologies**		
		Under Study	**Studied and Not Adopted**	**Not Yet Studied**
Electronic fare box	6		1	
Automatic Passenger Counters	2	4		1
Automatic Vehicle Location	2	3		1
Electronic Fare Payment (e.g. Smart Cards)		5		1
Surveillance cameras in facilities or on board	8			
Advanced Traveler Info. System (ATIS)	1	4		1
Geographic Information Systems (GIS)	1	3		2
Traffic Signal Priority Systems	2	3		

[2] One of the interviewees did not respond for this category so the total number of agencies under consideration for this section is 8. All the numbers do not necessarily add up to a total of 8, as several of the interviewees did not respond to all the categories.

Traveler information is disseminated in a variety of traditional methods including brochures, phone access to live operators and informational booths. Transit agencies also report using more advanced technologies for traveler information dissemination including websites, automated menu-driven phone access and electronic message displays (Table 3). The two prevalent methods of advanced data dissemination are websites and automated, menu-driven phone systems.

TABLE 3 Means of Disseminating Traveler Information

Technologies	Number of agencies using
Automated kiosks	0
Automated, menu-driven phone access	5
Electronic message displays at stations or stations	2
On-board electronic message displays	0
Online material/Web site	7

4.2.2 Interagency Data Sharing

The objective of this part of the survey was to assess the level of information exchange between transit agencies sharing intermodal passenger transfer facilities and to understand agency testing and use of NTCIP (National Transportation Communications for ITS Protocol) standards.

The survey results indicate that there is little sharing of data between the transit agencies located at the intermodal sites. Only three out of the nine agencies report sharing data with other agencies and only on a limited basis. One of these three agencies one shares data when requested by another agency at the site, one does it on a quarterly basis and one on an annual basis. However, at one of the intermodal sites, the owner of the facility – a regional rail operator - annually sends out ridership and arrival time data to all the other bus agencies at the site and receives their routing and arrival time data. It thus seems as though coordination of schedules occurs through the aegis of the facility owner. At another facility, where only two agencies operate, one of the agencies collects ridership and arrival time data for both agencies. The shared data is primarily ridership and expected arrival time data and is used for service planning and scheduling.

Reasons given for the lack of data exchange between the agencies include: insufficient technology for practical use of data, not enough actual data to share (such as real-time arrival or vehicle location), data is not perceived to be valuable enough (as there are no timed connections at the intermodal sites).

The survey also asked questions regarding the potential use of NTCIP (National Transportation Communications for ITS Protocol) standards for transmission of data from a center to a field device or for exchange of data with other public transit agencies. Use of NTCIP standards could facilitate data communications among transit agencies and thus its potential adoption is one indicator of the level of planned intermodal data exchange. None of the 9 agencies report currently testing or using NTCIP standards and half of the agencies did not know what these standards were.

4.2.3 Management of the Intermodal Facility

This part of the survey sought to understand the operation and management of the different intermodal facilities as this could affect their level and quality of intermodalism.

The El Cerrito Del Norte BART Station is a significant intermodal site in the San Francisco Bay Area. The station is served by a number of bus services, including AC Transit, Golden Gate Transit, Vallejo Transit, and West Contra Costa County Transit (WestCAT). The station is managed by BART, which owns and operates it with input from other agencies.
BART performs the following activities: operates and maintains the facility; compiles usage data from each public transportation agency located at the facility; provides guidance and direction in setting priorities and policies for overall facility functioning; assesses the performance of the facility including recommendations for change; works with individual facility partners to help build productive linkages among them; helps identify potential funding sources where and when needed for improvements and represents individual agencies' intermodal interests in other transportation forums.

The Caltrain Station at 4th and King Streets in San Francisco serves as the terminus for the Caltrain commuter rail line. At this facility, passengers can transfer to Muni buses, which offer service at the station's curbside, or to Muni Metro (LRT) trains, whose tracks and platforms are adjacent to the Caltrain station, and offer service to downtown San Francisco. The Caltrain Station is owned and operated by the Peninsula Corridor Joint Powers Board (PCJPB), an organization composed of three members: Caltrain/Samtrans, the Santa Clara Valley Transportation Authority and the City/County of San Francisco.

The PCJPB performs the following activities: operates and maintains the facility; provides guidance and direction in setting priorities and policies for overall facility functioning; assesses the performance of the facility including recommendations for change; helps identify potential funding sources where and when needed for improvements and represents individual agencies' intermodal interests in other transportation forums

The Santa Fe Depot is a major passenger intermodal transfer point in San Diego with the San Diego Trolley, the region's commuter rail line (the "Coaster"), and Amtrak co-located within the facility. San Diego city buses are pick up and drop off passengers at curbside just outside the facility. The facility is owned by the Catellus Development Corporation, which is not located at the facility but operates, maintains and oversees it with input from the transportation service providers at the facility.

4.2.4 Assessment of the Intermodal Facility

This section of the survey sought to assess the level of satisfaction with the current operation of the intermodal facilities under investigation. The following tables report on the El Cerrito Del Norte BART Station and the Caltrain Station results.[3] As far as the El Cerrito Del Norte BART Station is concerned, the interviewees report a high level of satisfaction for all attributes, except the "System and facility management" category that gets an average score of 2.5. Transit agencies report a high level of satisfaction for all the attributes of the Caltrain Station. Results are shown in Tables 4 and 5.

[3] The Santa Fe Depot responses are not summarized here as two out of the four interviewees did not return surveys and one of the respondents did not complete this section.

TABLE 4 Assessment of the El Cerrito Del Norte BART Station

Attributes	Average Level of Satisfaction
Amount of physical space available to transit vehicles	3.8
Quality of approaches to the facility (entrance/exit ramps, lanes, gates etc)	3.8
Inter-agency coordination	3.2
System and facility management by the agencies governing the facility (information exchange, balanced distribution of capital and operational costs among agencies, operational efficiency)	2.5
Overall access to facility (for transit vehicles and passengers)	3.2

Scale from 1 (not satisfactory) to 5 (very satisfactory)

TABLE 5 Assessment of the Caltrain Station at 4th and King Streets in San Francisco

Attributes	Level of Satisfaction
Amount of physical space available to transit vehicles	4.5
Quality of approaches to the facility (entrance/exit ramps, lanes, gates etc)	4
Inter-agency coordination	4
System and facility management by the agencies governing the facility (information exchange, balanced distribution of capital and operational costs among agencies, operational efficiency)	4.5
Overall access to facility (for transit vehicles and passengers)	4

Scale from 1 (not satisfactory) to 5 (very satisfactory)

4.2.5 Relationship Among Agencies Sharing the Intermodal Facility

This section of the survey sought to understand the level of coordination among the agencies sharing the transfer facilities. While the level of data exchange among the transit agencies at the intermodal facilities is not high, there is a certain degree of coordination among them for other transit-related objectives.

Six out of the nine agencies report conducting either schedule, route, or special event coordination with one or more of the facility partners at the facility. Most of the coordination concerns scheduling or routes. Other areas where a considerable degree of coordination was cited were for: joint fare structure policies (e.g., transfer discounts, electronic fare payment etc.) and coordinated public information dissemination activities. Seven out of the nine agencies also reported conducting other coordinated activities among them: emergency drills, paratransit service coordination, joint funding proposals and station improvement coordination. The sharing of the physical space at a facility is generally coordinated and controlled by the agency or entity having responsibility over the facility. When agencies reported not cooperating for any activities this did not necessarily mean for the transit system as a whole but just for the particular facility under investigation. Table 6 summarizes responses to this section of the survey.

TABLE 6 Institutional Arrangements Among Facility-Sharing Agencies

	YES (Number of agencies)	**NO (Number of agencies)**
Schedule, route, or special event coordination	6	3
Joint fare structure policies	7	2
Coordinated public information dissemination activities	6	3
Equipment purchasing partnership agreements	2	7
Cooperate to recommend and/or make facility improvements?	2	7
Other coordinated activities	7	2

4.2.6 Regional Intermodalism and the Transfer Process

The objective of this part of the survey was to identify the key factors — as identified by the transit agencies — affecting the transfer process and contributing to regional passenger intermodalism. Agencies were asked to rate several issues or statements regarding regional passenger intermodalism on a scale of 1 (weakness) to 5 (strength). Results are reported in Table 7.

In the San Francisco Bay Area, transit agencies identified several items that seemed to be “weak” areas in terms of regional intermodalism. Items or issues with average scores of 2.5 or less are: availability of funding for intermodal projects, schedule coordination among agencies, availability of expandable and upgradeable hardware and software, level of synchronization of intermodal operations, level of infrastructure connectivity across the region, cost of land and construction where expansion is required and geography of region. The three lowest scores were: cost of land and construction where expansion is required (1.9), level of infrastructure connectivity across the region (2.0) and availability of funding for intermodal projects (2.1). There were no average scores above a 3.5 indicating that Bay Area transit agencies did not feel there were any elements having a strong positive impact on regional intermodalism.

For the San Diego area, it is more difficult to “extract” meaning from these averages as two of the four participants did not send in their surveys. Nonetheless, the answers from the two responding agencies are included here and do provide some indication of the factors they feel affect regional intermodalism.

TABLE 7 Assessment of Factors Affecting Regional Intermodalism:
San Francisco Bay Area and San Diego

	Average Score	
	SF Bay Area	**San Diego**
Availability of funding for intermodal projects	2.1	2.0
Intermodal component of regional transportation plan	2.7	2.5
Level of cooperation among transit providers for intermodal coordination purposes	2.7	4.0
Diversity of organizational objectives for intermodal services	2.5	2.5
Autonomy of transit jurisdictions	3.0	2.5
Use of different standard operating procedures across operating agencies	2.6	3.5
Accuracy, reliability and timeliness of intermodal information given to customers	2.6	2.5
Quality of service of individual transit agencies	3.3	3.5
Schedule coordination among agencies	2.3	3.0
Monetary cost of transfer to users	3.1	4.0
Public user concerns (e.g. security and safety)	3.0	3.0
Availability of expandable and upgradeable hardware and software	2.4	2.5
Level of synchronization of intermodal operations	2.4	2.5
Accuracy, reliability and timeliness of information exchanged among agencies	2.4	2.0
Market demand for transit service	2.7	3.0
Level of infrastructure connectivity across the region	2.0	1.5
Geographic coverage of transit services	3.1	2.5
Age of transit fleets	2.9	2.5
Overall quality of intermodal facilities	3.0	4.0*
Design of intermodal facilities	3.0	3.0*
Overall access to intermodal facilities	2.9	3.0*
Cost of land and construction where expansion is required	1.9	1.5
Geography of region	2.4	2.0

NB: Scale of 1 (weakness) to 5 (strength). The “*” symbol refers to questions answered by only one of the respondents.

4.3 User Survey

The results of the analysis of the user survey are organized into the following groupings:

- User behavior
- Intermodal facility transfers
- User history
- Intermodal facility rating
- User demographic profile

4.3.1 User Behavior

The first question of the survey asked users of the El Cerrito Del Norte BART station (henceforth referred to as "the BART station") to indicate the purpose of their trip. As shown in Figure 1, 94% of respondents indicated they were "Commuting to or from work", 3.6% indicated they were "Commuting to or from school", 1.7% indicated they were conducting "Personal business/errands", and 0.7% indicated they were on "Job-related business such as sales, delivery, etc.". Tables 8 through 12 show how respondents' stated purpose of their trip varies according to a variety of subgroups, namely gender (Table 8), age (Table 9), level of education (Table 10), level of income (Table 11), and employment status (Table 12). Trip purpose did not vary at all by gender. The only variation in trip purpose by age expectedly came from the youngest and oldest age groups, that is, "18 to 24" and "65 or older", respectively. This is expected since the 18 to 24 year old cohort are more likely to be commuting to and from school than the sample as a whole and the 65 or older cohort is much more likely to be retired than employed. This is reflected in the smaller percentage of those commuting to and from work than the sample as a whole and the larger percentage of 65 or older cohort indicating their trip purpose was "Personal business/errands" than the sample as a whole. There was also variability in trip purpose by educational level with the least educated group ("Grade school or some high school" is highest level of schooling achieved) indicating a considerably larger percentage commuting to and from school than the overall sample, which is also somewhat expected. With respect to income level, we see a pattern similar to educational level in that the lowest income level respondents indicate a higher percentage of commuters to and from school than the overall sample indicated.

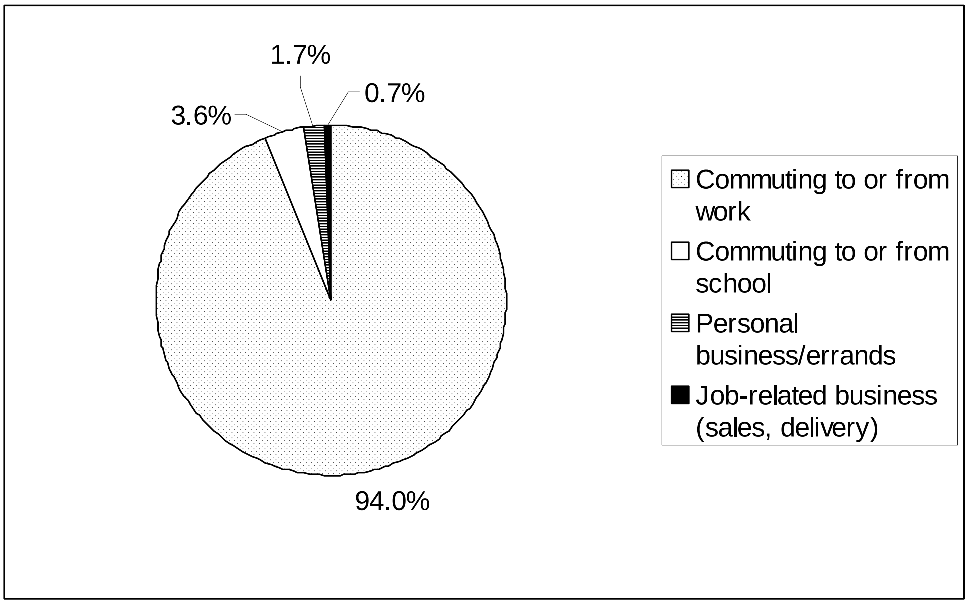

FIGURE 1 Trip Purpose.

TABLE 8 Trip Purpose x Gender

		Gender	
	Overall (581)	**Male (204)**	**Female (377)**
Commuting to and from work	94.0%	95.1%	93.4%
Commuting to and from school	3.6%	2.0%	4.5%
Personal business/errands	1.7%	2.0%	1.6%
Job-related business	0.7%	1.0%	0.5%

TABLE 9 Trip Purpose x Age

		Age					
	Overall (581)	18 – 24 (46)	25 – 34 (113)	35 – 44 (163)	45 – 54 (167)	55 – 64 (80)	65 or older (12)
Commuting to and from work	94.0%	76.1%	93.8%	94.5%	99.4%	95.0%	75.0%
Commuting to and from school	3.6%	23.9%	4.4%	2.5%	0.6%	0.0%	0.0%
Personal business/errands	1.7%	0.0%	0.9%	1.8%	0.0%	3.8%	25.0%
Job-related business	0.7%	0.0%	0.9%	1.2%	0.0%	1.3%	0.0%

TABLE 10 Trip Purpose x Educational Level

		Level of Education					
	Overall (581)	Grade School (5)	High School (31)	Some College (162)	Vocational Training (36)	College Graduate (229)	Graduate Degree (96)
Commuting to and from work	94.0%	80.0%	83.9%	90.7%	94.4%	96.9%	96.9%
Commuting to and from school	3.6%	20.0%	3.2%	8.0%	5.6%	1.3%	1.0%
Personal business/errands	1.7%	0.0%	9.7%	1.2%	0.0%	0.9%	1.0%
Job-related business	0.7%	0.0%	3.2%	0.0%	0.0%	0.9%	1.0%

TABLE 11 Trip Purpose x Income Level

		Income										
	Overall (581)	< 10K (8)	10K – 20K (15)	20K - 30K (41)	30K – 40K (66)	40K – 50K (61)	50K – 60K (76)	60K – 70K (61)	70K – 80K (61)	80K – 90K (51)	90K – 100K (34)	> 100K (107)
Commuting to and from work	94.0%	25.0%	66.7%	92.7%	95.5%	96.7%	96.1%	91.8%	95.1%	100.0%	100.0%	95.3%
Commuting to and from school	3.6%	37.5%	26.7%	2.4%	1.5%	3.3%	2.6%	3.3%	3.3%	0.0%	0.0%	3.7%
Personal business/errands	1.7%	25.0%	6.7%	4.9%	1.5%	0.0%	1.3%	1.6%	1.6%	0.0%	0.0%	0.9%
Job-related business	0.7%	12.5%	0.0%	0.0%	1.5%	0.0%	0.0%	3.3%	0.0%	0.0%	0.0%	0.0%

TABLE 12 Trip Purpose x Employment Situation

		Employment				
	Overall (581)	Employed full time (517)	Employed part time (31)	Retired (5)	Student (15)	Other (2)
Commuting to and from work	94.0%	97.7%	90.3%	20.0%	26.7%	50.0%
Commuting to and from school	3.6%	1.0%	3.2%	0.0%	73.3%	0.0%
Personal business/errands	1.7%	0.6%	6.5%	80.0%	0.0%	50.0%
Job-related business	0.7%	0.8%	0.0%	0.0%	0.0%	0.0%

The second question of the survey asked station users about their mode of transportation to arrive at the BART station. As shown in Figure 2, 55.6% of respondents “Drove a car and parked at/near the station”, 24.6% arrived by bus, 8.4% were dropped off in a car, 7.1% walked to the station, 3.1% took BART, and 1.2% rode a bicycle to the station. Tables 13 through 17 show how respondents’ mode of arrival varies according to the same subgroupings, namely gender (Table 13), age (Table 14), level of education (Table 15), level of income (Table 16), and employment status (Table 17). Arrival mode did not vary by gender. The only variation in arrival mode by age came from the oldest age group (“65 or older”). This is not surprising since the 65 or older cohort is more likely to arrive at the station by means other than their own individual automobile compared to the overall sample. There was also variability in mode of arrival by educational level with the least educated group indicating a greater percentage of bus users than for the overall sample. With respect to income level, we see a pattern similar to educational level in that the lowest income level respondents indicate a higher percentage of bus users than the overall sample indicated. Relative to employment status, we observe that the partially employed and students use the bus more than that indicated by the overall sample, again this is not unexpected.

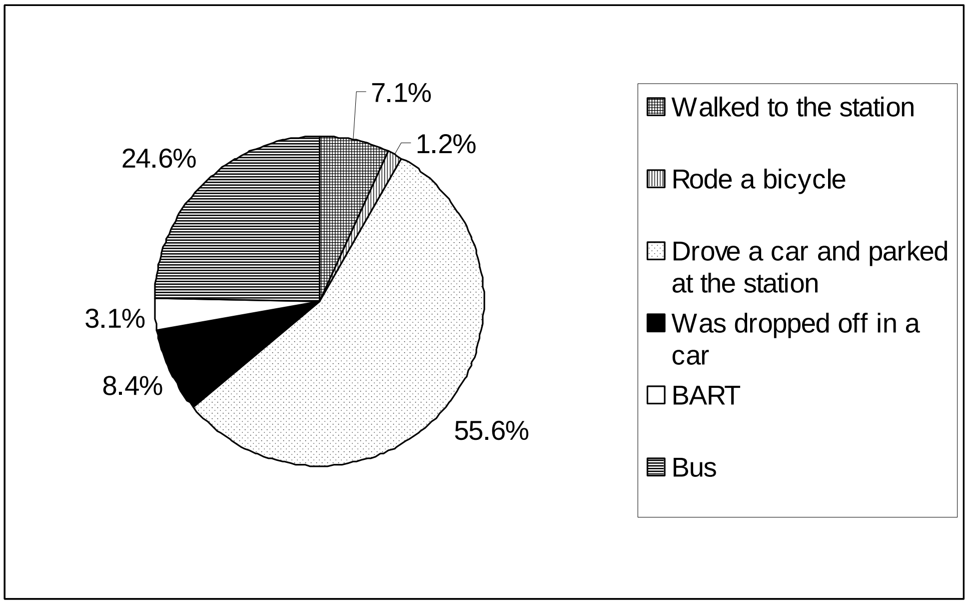

FIGURE 2 Method of Transportation to Arrive at the Station.

TABLE 13 Arrival Mode x Gender

		Gender	
	Overall (581)	**Male (204)**	**Female (377)**
Walked to the station	7.1%	8.3%	6.4%
Rode a bicycle	1.2%	2.0%	0.8%
Drove a car and parked at the station	55.6%	53.4%	56.8%
Was dropped off in a car	8.4%	8.8%	8.2%
BART	3.1%	4.4%	2.4%
Bus	24.6%	22.5%	25.5%

TABLE 14 Arrival Mode x Age

		Age					
	Overall (581)	18 – 24 (46)	25 – 34 (113)	35 – 44 (163)	45 – 54 (167)	55 – 64 (80)	65 or older (12)
Walked to the station	7.1%	6.5%	15.0%	4.9%	4.2%	6.3%	8.3%
Rode a bicycle	1.2%	0.0%	1.8%	1.2%	1.8%	0.0%	0.0%
Drove a car and parked at the station	55.6%	58.7%	54.0%	59.5%	56.9%	51.3%	16.7%
Was dropped off in a car	8.4%	10.9%	8.0%	6.7%	8.4%	12.5%	0.0%
BART	3.1%	2.2%	6.2%	2.5%	2.4%	2.5%	0.0%
Bus	24.6%	21.7%	15.0%	25.2%	26.3%	27.5%	66.7%

TABLE 15 Arrival Mode x Educational Level

		Level of Education					
	Overall (581)	Grade School (5)	High School (31)	Some College (162)	Vocational Training (36)	College Graduate (229)	Graduate Degree (96)
Walked to the station	7.1%	40.0%	3.2%	6.2%	13.9%	7.4%	5.2%
Rode a bicycle	1.2%	0.0%	0.0%	0.0%	0.0%	1.3%	3.1%
Drove a car and parked at the station	55.6%	20.0%	25.8%	59.9%	44.4%	60.3%	58.3%
Was dropped off in a car	8.4%	0.0%	16.1%	10.5%	5.6%	5.7%	8.3%
BART	3.1%	0.0%	9.7%	1.9%	2.8%	3.1%	2.1%
Bus	24.6%	40.0%	45.2%	21.6%	33.3%	22.3%	21.9%

TABLE 16 Arrival Mode x Income Level

		Income										
	Overall (581)	< 10K (8)	10K – 20K (15)	20K - 30K (41)	30K – 40K (66)	40K – 50K (61)	50K – 60K (76)	60K – 70K (61)	70K – 80K (61)	80K – 90K (51)	90K – 100K (34)	> 100K (107)
Walked to the station	7.1%	0.0%	13.3%	14.6%	4.5%	8.2%	6.6%	11.5%	3.3%	7.8%	0.0%	6.5%
Rode a bicycle	1.2%	0.0%	0.0%	0.0%	0.0%	3.3%	1.3%	3.3%	1.6%	0.0%	0.0%	0.9%
Drove a car and parked at the station	55.6%	25.0%	20.0%	34.1%	48.5%	54.1%	56.6%	52.5%	55.7%	60.8%	73.5%	69.2%
Was dropped off in a car	8.4%	0.0%	26.7%	12.2%	4.5%	9.8%	7.9%	8.2%	6.6%	11.8%	5.9%	7.5%
BART	3.1%	12.5%	6.7%	7.3%	4.5%	3.3%	2.6%	1.6%	1.6%	3.9%	0.0%	1.9%
Bus	24.6%	62.5%	33.3%	31.7%	37.9%	21.3%	25.0%	23.0%	29.5%	15.7%	20.6%	14.0%

TABLE 17 Arrival Mode x Employment Situation

		Employment				
	Overall (581)	**Employed full time (517)**	**Employed part time (31)**	**Retired (5)**	**Student (15)**	**Other (2)**
Walked to the station	7.1%	6.2%	9.7%	0.0%	26.7%	0.0%
Rode a bicycle	1.2%	1.4%	0.0%	0.0%	0.0%	0.0%
Drove a car and parked at the station	55.6%	58.2%	29.0%	20.0%	46.7%	0.0%
Was dropped off in a car	8.4%	8.3%	16.1%	0.0%	6.7%	0.0%
BART	3.1%	3.1%	3.2%	0.0%	0.0%	0.0%
Bus	24.6%	22.6%	41.9%	80.0%	20.0%	100.0%

The third question of the survey asked station users about their mode of transportation when they departed the BART station to continue on this same trip. As shown in Figure 3, 86.9% of respondents took BART, 7.1% became part of a carpool, 4.3% departed by bus, 0.9% were picked up, 0.5% walked to their final destination, and 0.4% either rode a bicycle or drove a car. Tables 18 through 22 show how respondents' mode of departure changes according to the same subgroupings, namely gender (Table 18), age (Table 19), level of education (Table 20), level of income (Table 21), and employment status (Table 22). Departure mode did not vary by gender. The only variation in departure mode by age came again from the oldest age group ("65 or older"). This is not surprising since the 65 or older cohort is less likely to be commuting to work and so would be less likely to leave the station via a carpool compared to the overall sample. There was also variability in mode of departure by educational level with the least educated group indicating a greater percentage of bus users and a smaller percentage of carpoolers relative to the overall sample. With respect to income level, we see a pattern similar to educational level in that the lowest income level respondents indicate a higher percentage of bus users and a corresponding smaller percentage of carpoolers than the overall sample indicated. Relative to employment status, we observe similar behavior that the partially employed and students use the bus more and carpooling less than that indicated by the overall sample, again this is not unexpected.

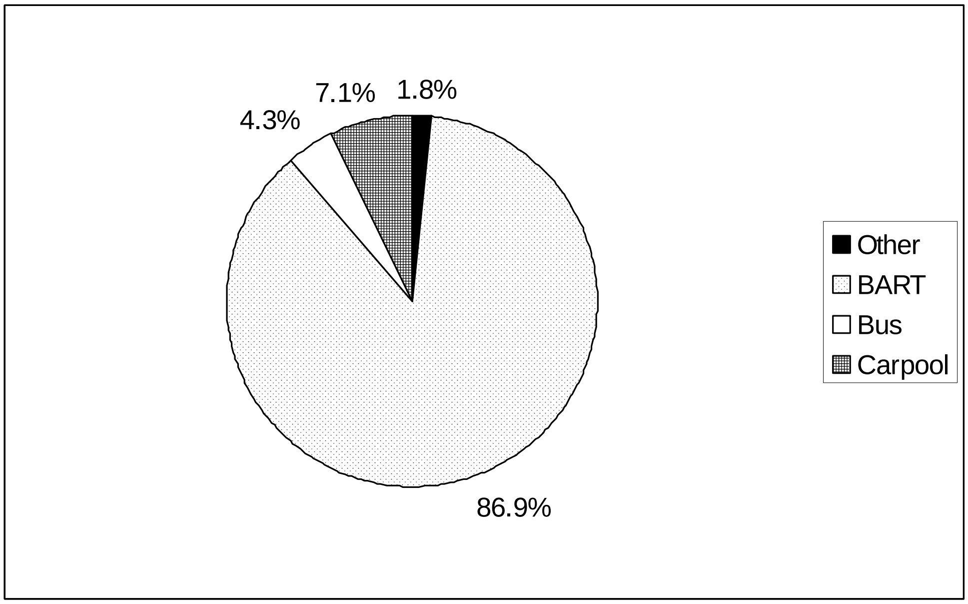

FIGURE 3 Method of Transportation to Depart the Station.

TABLE 18 Departure Mode x Gender

		Gender	
	Overall (581)	Male (204)	Female (377)
Walked to final destination	0.5%	1.0%	0.3%
Rode a bicycle	0.2%	0.5%	0.0%
Drove a car	0.2%	0.0%	0.3%
Was picked up	0.9%	2.0%	0.3%
BART	86.9%	79.9%	90.7%
Bus	4.3%	7.8%	2.4%
Carpool	7.1%	8.8%	6.1%

TABLE 19 Departure Mode x Age

		Age					
	Overall (581)	18 – 24 (46)	25 – 34 (113)	35 – 44 (163)	45 – 54 (167)	55 – 64 (80)	65 or older (12)
Walked to final destination	0.5%	0.0%	1.8%	0.6%	0.0%	0.0%	0.0%
Rode a bicycle	0.2%	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%
Drove a car	0.2%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%
Was picked up	0.9%	0.0%	1.8%	0.6%	0.6%	1.3%	0.0%
BART	86.9%	91.3%	86.7%	88.3%	86.8%	82.5%	83.3%
Bus	4.3%	4.3%	3.5%	3.1%	5.4%	3.8%	16.7%
Carpool	7.1%	4.3%	5.3%	6.7%	7.2%	12.5%	0.0%

TABLE 20 Departure Mode x Educational Level

		Level of Education					
	Overall (581)	Grade School (5)	High School (31)	Some College (162)	Vocational Training (36)	College Graduate (229)	Graduate Degree (96)
Walked to final destination	0.5%	0.0%	0.0%	0.0%	0.0%	1.3%	0.0%
Rode a bicycle	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
Drove a car	0.2%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%
Was picked up	0.9%	0.0%	3.2%	1.2%	0.0%	0.4%	1.0%
BART	86.9%	80.0%	83.9%	88.3%	83.3%	89.5%	86.5%
Bus	4.3%	20.0%	12.9%	2.5%	8.3%	3.5%	1.0%
Carpool	7.1%	0.0%	0.0%	7.4%	8.3%	5.2%	10.4%

TABLE 21 Departure Mode x Income Level

		Income										
	Overall (581)	< 10K (8)	10K – 20K (15)	20K - 30K (41)	30K – 40K (66)	40K – 50K (61)	50K – 60K (76)	60K – 70K (61)	70K – 80K (61)	80K – 90K (51)	90K – 100K (34)	> 100K (107)
Walked to final destination	0.5%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	1.6%	0.0%	0.0%	0.9%
Rode a bicycle	0.2%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Drove a car	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	0.0%	0.0%
Was picked up	0.9%	0.0%	6.7%	0.0%	0.0%	1.6%	0.0%	1.6%	0.0%	2.0%	0.0%	0.9%
BART	86.9%	62.5%	80.0%	82.9%	87.9%	88.5%	85.5%	90.2%	91.8%	86.3%	91.2%	85.0%
Bus	4.3%	37.5%	13.3%	7.3%	4.5%	3.3%	5.3%	4.9%	0.0%	7.8%	0.0%	0.9%
Carpool	7.1%	0.0%	0.0%	7.3%	6.1%	6.6%	9.2%	3.3%	6.6%	2.0%	8.8%	12.1%

TABLE 22 Departure Mode x Employment Situation

		Employment				
	Overall (581)	Employed full time (517)	Employed part time (31)	Retired (5)	Student (15)	Other (2)
Walked to final destination	0.5%	0.6%	0.0%	0.0%	0.0%	0.0%
Rode a bicycle	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%
Drove a car	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%
Was picked up	0.9%	1.0%	0.0%	0.0%	0.0%	0.0%
BART	86.9%	86.8%	90.3%	80.0%	86.7%	100.0%
Bus	4.3%	3.3%	9.7%	20.0%	13.3%	0.0%
Carpool	7.1%	7.9%	0.0%	0.0%	0.0%	0.0%

4.3.2 Intermodal Facility Transfers

The next two of questions dealt with the transfer experience at the BART station. The first question asked how many transfers were made from the start of the trip until arrival at final destination. As results show in Figure 4, 42.5% of respondents indicated that they made no transfers, 38.2% indicated one transfer, 12.9% said two transfers, and 6.4% indicated more than two transfers. The large percentage indicating no transfers is due to the fact that people who arrive at the BART station by means other than by bus or train, such as by car or walking, do not consider the process of changing from their arrival mode to departure mode, e.g. to a BART train, a transfer. Similarly for Figure 5, 55.2% of respondents indicated they made no transfer at the BART station, 25.3% indicated their transfer time at the BART station took 5 to 10 minutes, 8.7% stated their transfer time took at most 5 minutes, 4.7% indicated a transfer time between 10 and 15 minutes, 4.4% indicated a transfer time between 15 and 20 minutes, while the remaining 1.7% of respondents indicated a transfer time of greater than 20 minutes.

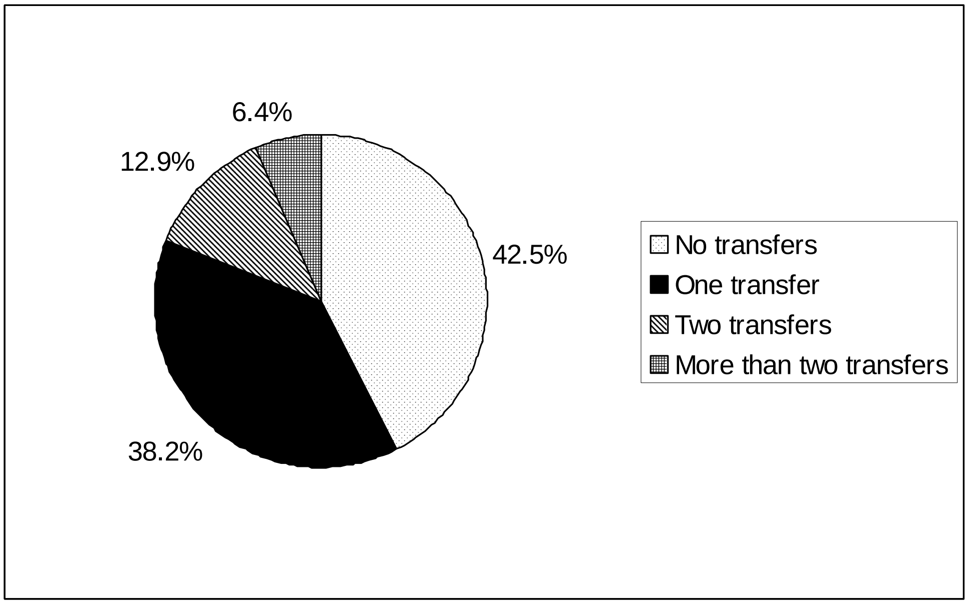

FIGURE 4 Total Number of Transfers for Entire Trip.

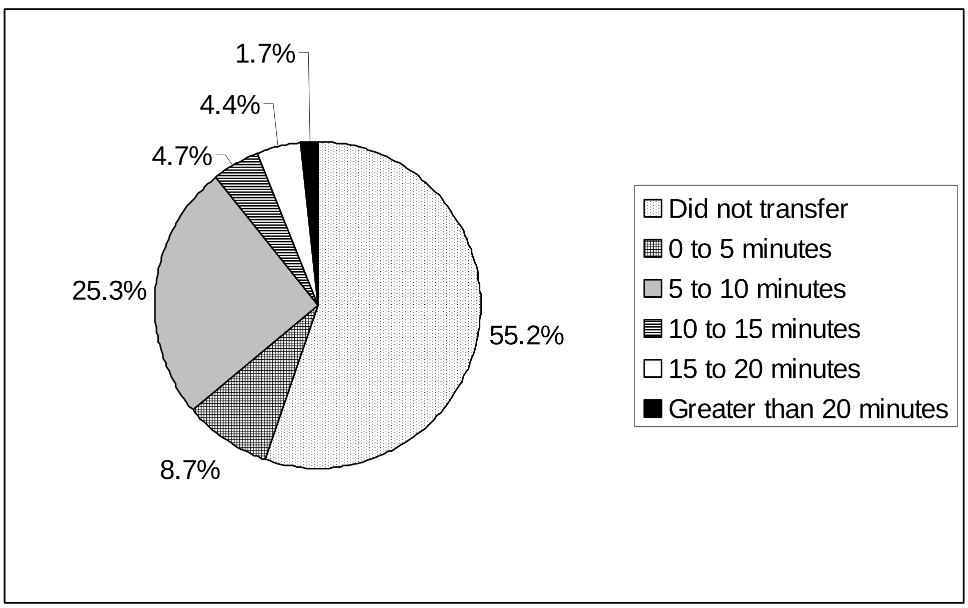

FIGURE 5 Transfer Time at BART Station.

4.3.3 User History

The next set of questions pertained to previous usage of the BART station. The first question asked how many times in the previous seven days had a respondent used the BART station. Results are shown in Figure 6 with 52% of respondents indicating they have used the station between 5 and 9 times in the previous 7 days, 29.8% indicating they used the station at least 10 times, and 18.2% indicating a usage of between 1 and 4 times.

The second question in this set inquired as to the most common trip purpose to the BART station in the last seven days. As shown in Figure 7, 94.7% of respondents indicated they were "Commuting to or from work", 3.1% indicated they were "Commuting to or from school", 1.5% indicated they were conducting "Personal business/errands", and 0.7% indicated they were on "Job-related business such as sales, delivery, etc.". As expected, these results correlate with responses about their purpose for the trip they were currently making.

The third question in this set asked "What year did you first start using the BART station?" As shown in Figure 8, 48.2% of respondents began using the BART station 1995 or earlier, 16.7% started using the BART station in 1999, 11% began using the station in 1998, 10% in 2000 (the year the survey was conducted), 8.6% in 1997, and 5.5% in 1996.

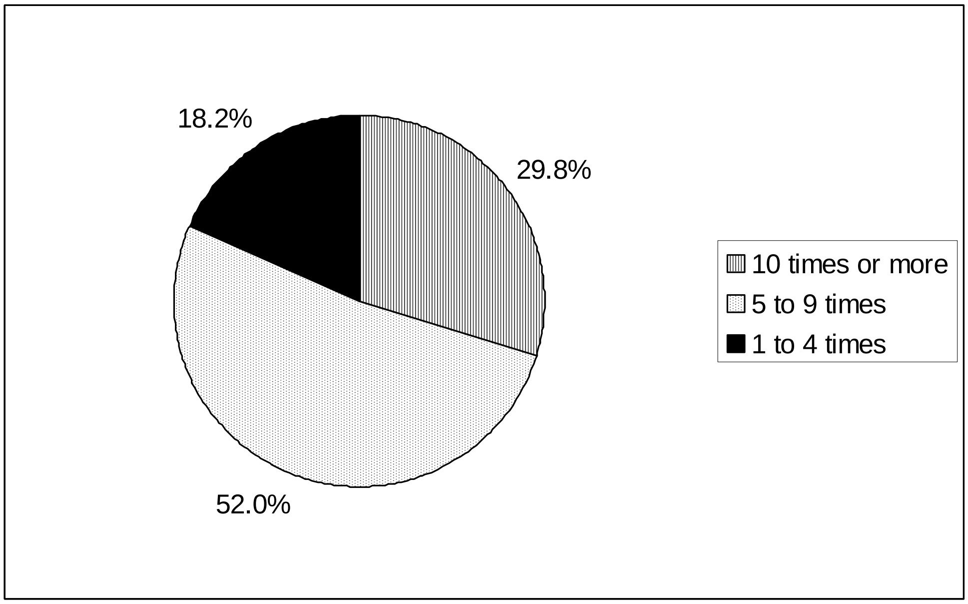

FIGURE 6 BART Station Usage for Previous Ten Days.

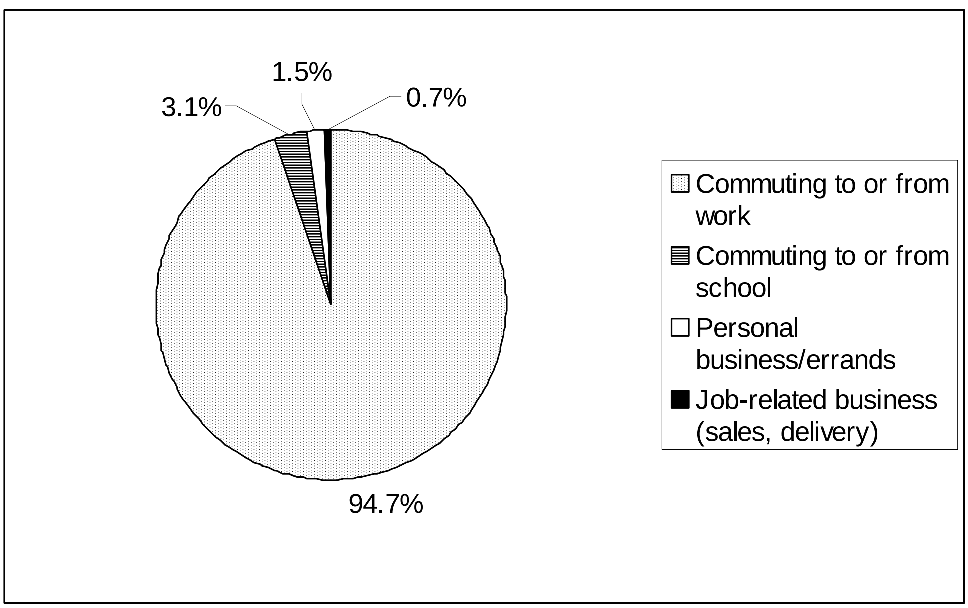

FIGURE 7 Most Common Trip Purpose for Previous Ten Days.

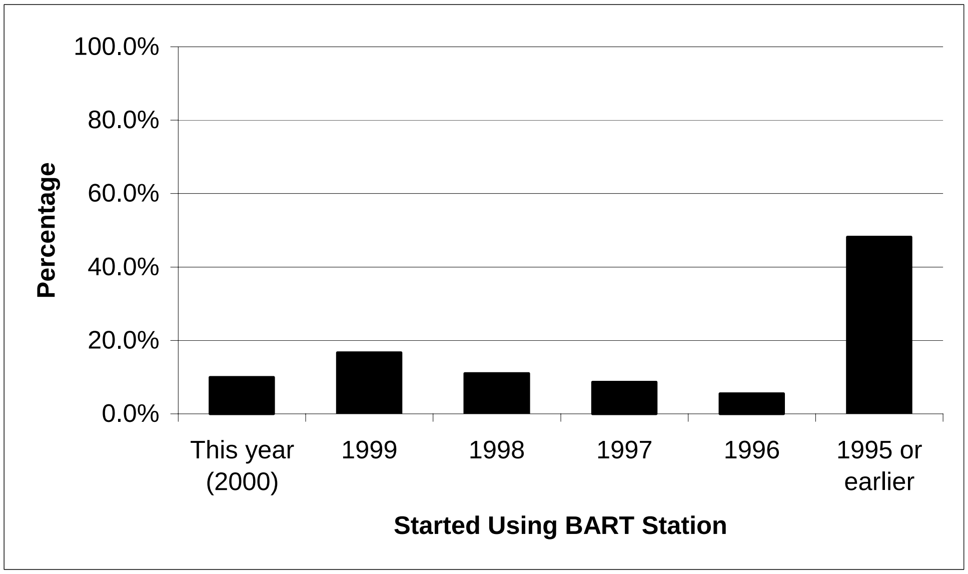

FIGURE 8 Time Frame for First Usage of BART Station .

4.3.4 Intermodal Facility Rating

The next set of survey questions dealt with how users of the BART station viewed the intermodal facility in terms of its operation and the services it provides. The first question was "Overall, how do you rate the BART station today?". Figure 9 shows that 47.1 percent of respondents gave the BART station a "Good" rating, 38% gave it a "Fair" rating, 10.1% a "Poor" rating, and 4.8% an "Excellent" rating.

The next question asked respondents to compare the way the station is today to the way it was when they first started using it. Results, shown in Figure 10, show that 51.2% of respondents rated the station as "The same" relative to when they first started using it. 20.4% of respondents rated the station as "Worse", 17.7% rated it as "Better", and 10.7% as "Have not noticed or cannot tell".

We next investigated changes in how respondents rated the BART station according to when they began using the station. Results, which are shown in Table 23, indicate only minor changes in facility ratings as a function of when station usage began.

The next area of inquiry dealt with how respondents rated the quality of travel information about the BART station delivered from numerous formats, including: printed pamphlets or brochures, posted material at the station, transit agency staff on the telephone or at the station, Web-site on the Internet, Kiosk/information booth at the station. Results are shown in Figure 11 and depict weighted average of ratings for each of the alternative means of acquiring travel information. Respondents were asked to check all sources they have used and to rate, on a scale of 1 (poor) to 5 (excellent), each source they indicated they have used. Results indicate that written material whether on paper or electronically is viewed as higher quality than receiving information from a human source. However, it is important to keep in mind that all but one traveler information source was rated at least "Average", yet on average, no source of information was rated "Good" or "Excellent".

The next area of inquiry asked respondents to rate specific attributes, either operational or service-related, of the BART station on a scale of 1 (poor) to 5 (excellent). Results are shown in Figure 12 and depict weighted average of ratings for each of the alternative attributes of the El Cerrito Del Norte BART station. Respondents were allowed to answer "DK/NA" if they did not know how to rate a particular station attribute or they such an attribute was not applicable to them. As shown in the figure, "Reliability of transit information" was rated highest (Average rating of 3.41 out of a maximum of 5), followed by "Frequency of transit service" (3.36), "Transfer wait time" (3.34), "Ease of access to/from BART station" (3.28), "Information concerning transfers" and "Quality of transit service to/from the station" (3.26), and "Pedestrian safety as a result of station layout" (3.09). Each of these station attributes earned an average rating of at least "Average". There were three station attributes that were, on average, rated between "Average" and "Fair", namely: Station's physical quality (waiting areas, elevators, escalators, and ticket machines), availability of inter-agency monthly passes and transfer discounts, and personal security at station.

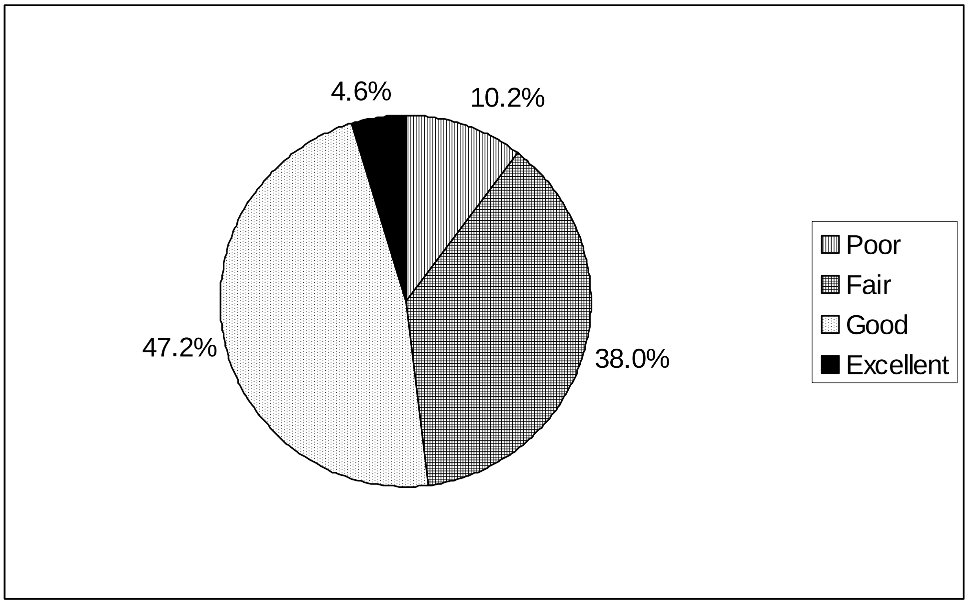

FIGURE 9 Overall Rating of El Cerrito Del Norte BART Station.

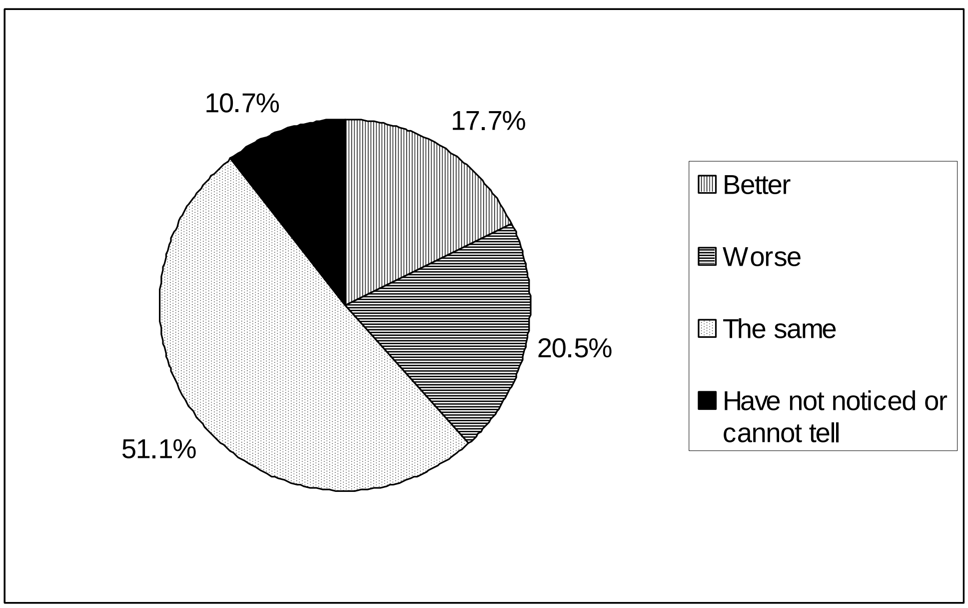

FIGURE 10 El Cerrito Del Norte BART Station: Now vs. First Usage.

TABLE 23 BART Station Rating x Time of First Usage

		Year of First Usage					
	Overall (581)	**2000 (58)**	**1999 (97)**	**1998 (64)**	**1997 (50)**	**1996 (32)**	**1995 or earlier (280)**
Poor	10.2%	3.4%	7.2%	9.4%	16.0%	9.4%	11.8%
Fair	38.0%	34.5%	32.0%	32.8%	34.0%	34.4%	43.2%
Good	47.2%	55.2%	55.7%	57.8%	46.0%	50.0%	40.0%
Excellent	4.6%	6.9%	5.2%	0.0%	4.0%	6.3%	5.0%

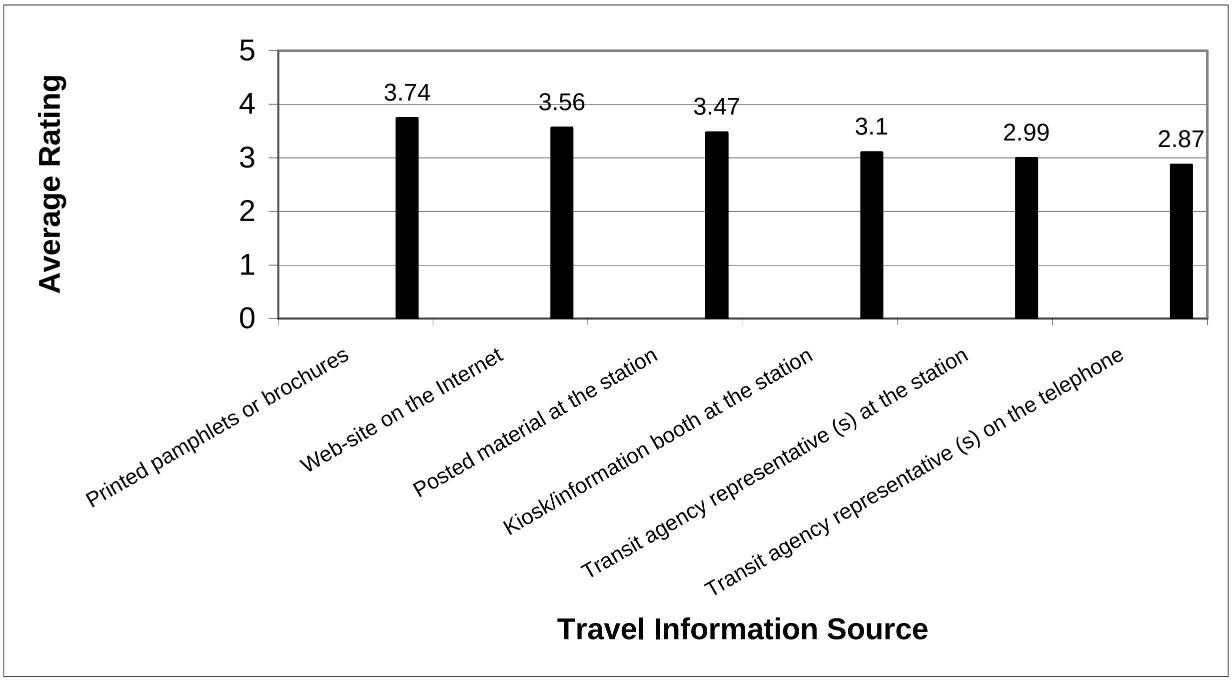

FIGURE 11 Average Rating of Travel Information Sources at BART Station.

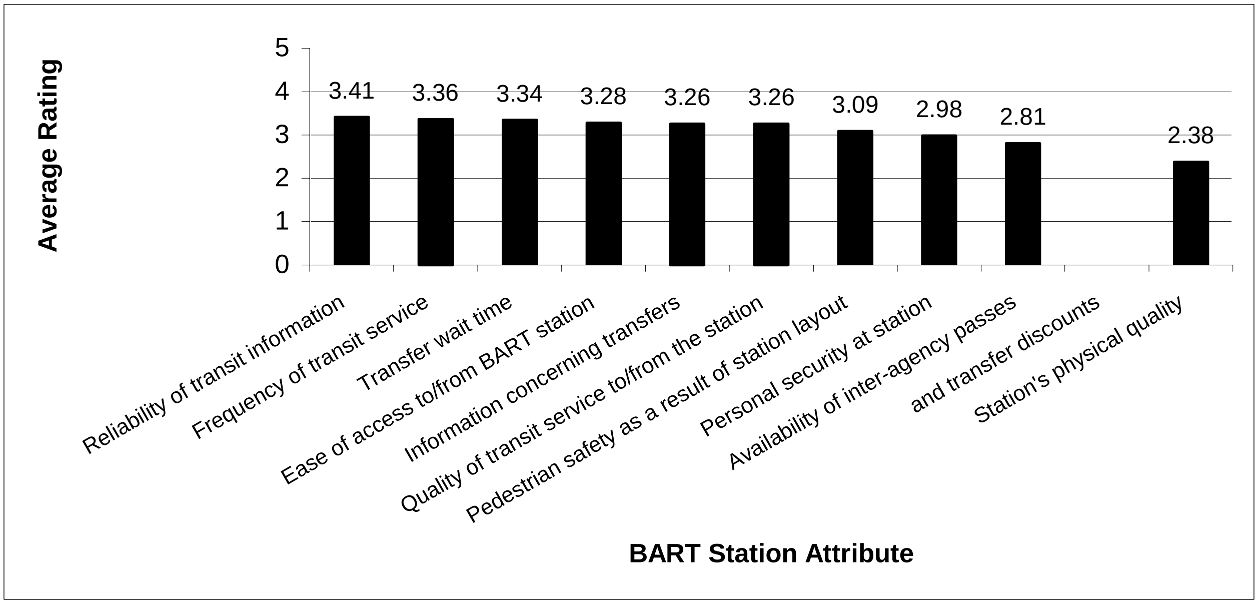

FIGURE 12 Average Rating of BART Station Attributes.

4.3.5 User Demographic Profile

At the end of the survey, station users were asked to provide demographic information for comparison purposes including gender, age, level of education, income level, and employment status. Figures 13 through 17 show the results of this demographic profiling. For Figure 15, the “Other” category consists of “Grade school or some high school” and a college graduates with technical or vocational training.

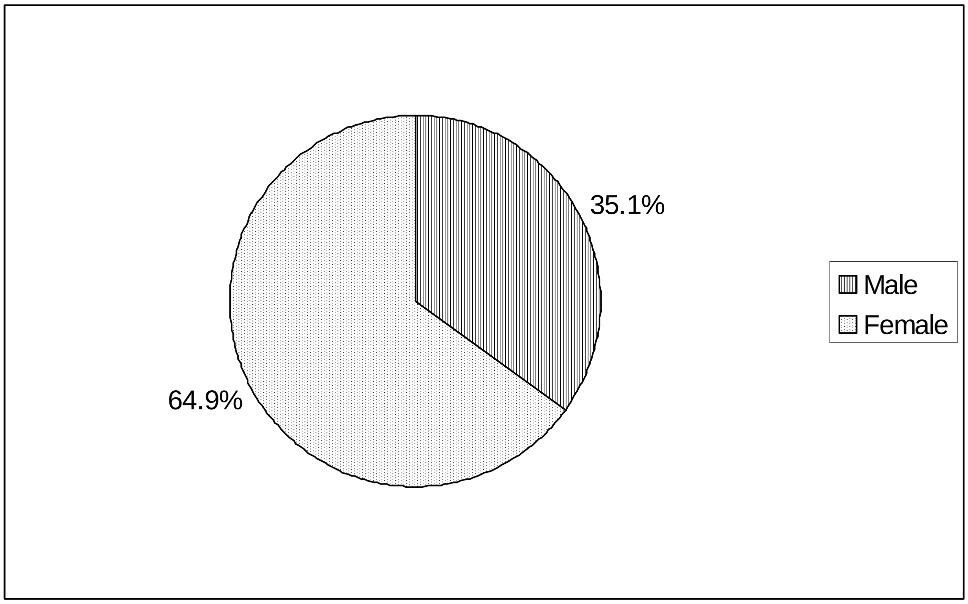

FIGURE 13 Gender.

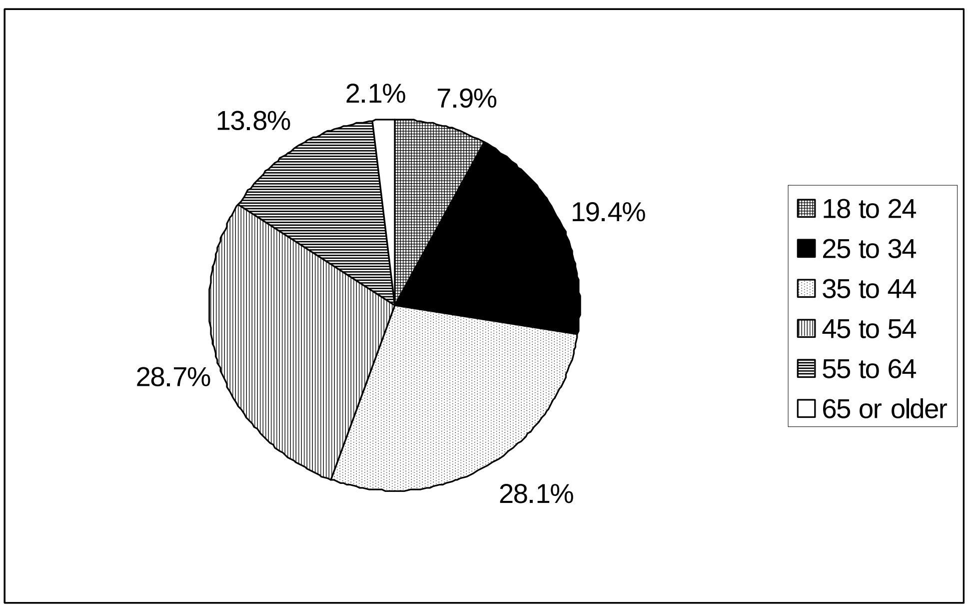

FIGURE 14 Age.

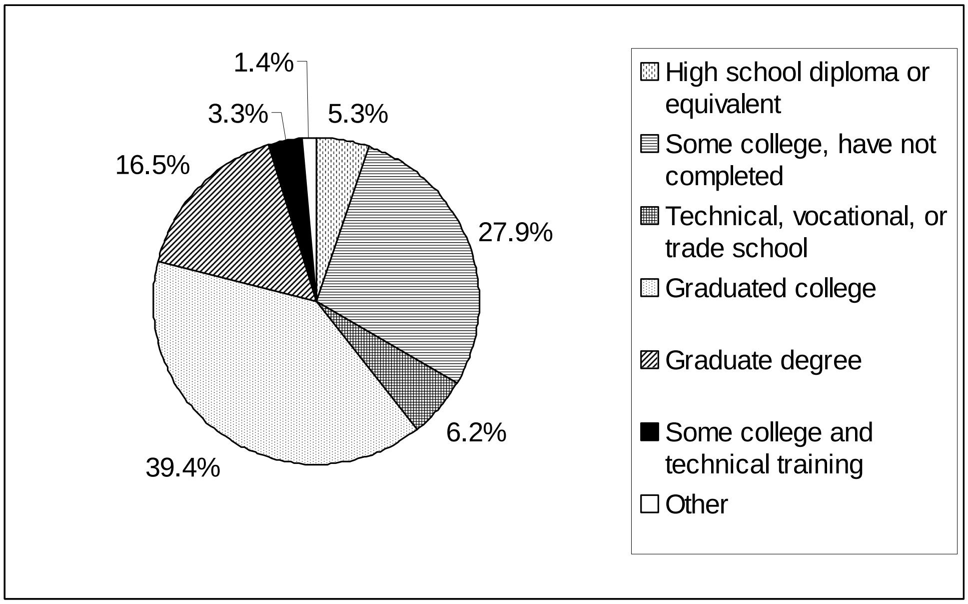

FIGURE 15 Levels of Education.

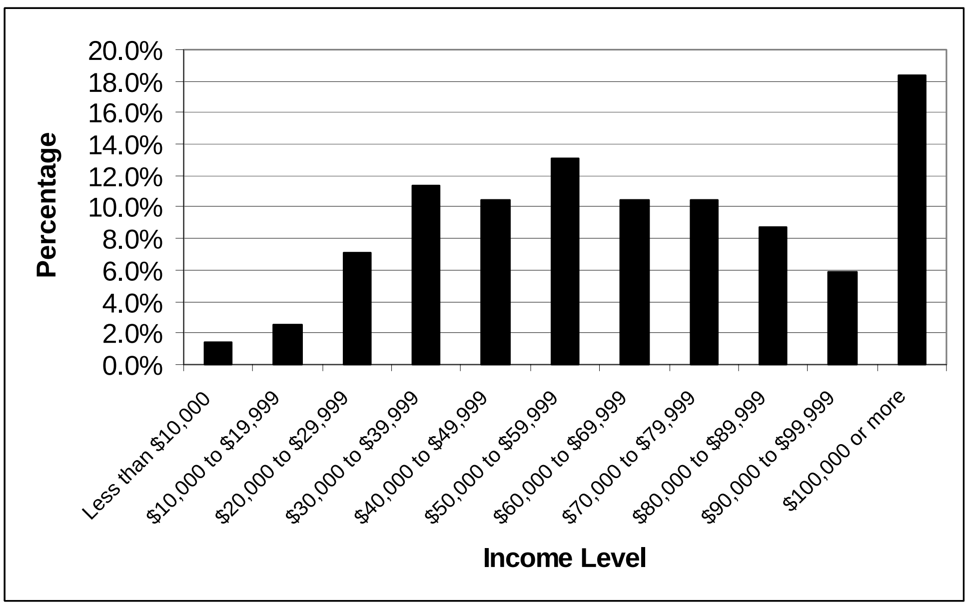

FIGURE 16 Levels of Income.

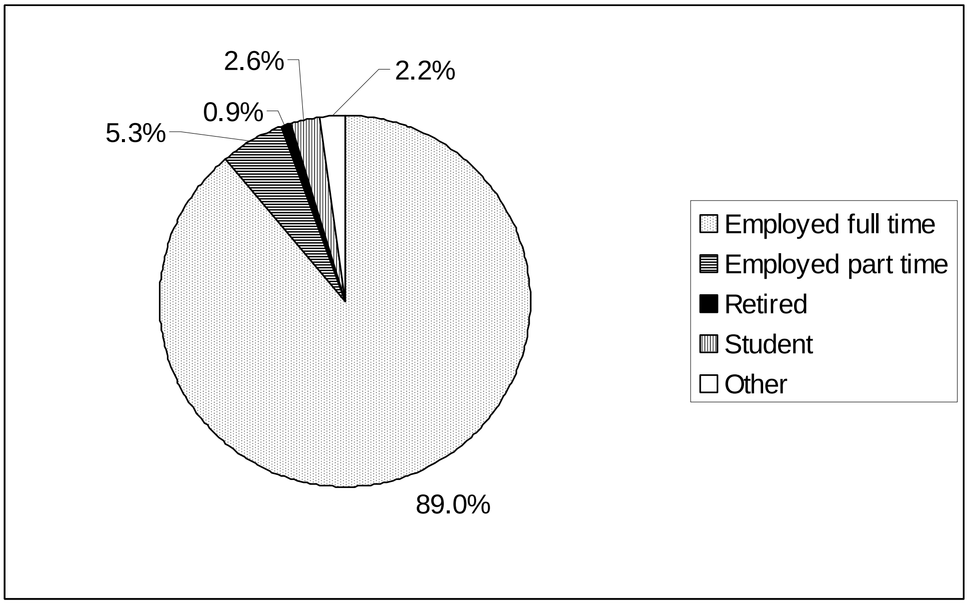

FIGURE 17 Employment Situation.

5.0 CONCLUSIONS

This report has investigated the operations and services conducted at passenger intermodal transfer facilities in urban areas of California. Our primary objective was to assess the current state of passenger intermodal operations and services in California and to identify opportunities to utilize intelligent transportation systems to increase the benefits and reduce the costs of intermodal operations and services. Conclusions that can be drawn from the findings of this study have implications for continued opportunities for improvement in operations and services rendered at intermodal passenger transfer facilities.

While there are numerous barriers associated with the successful implementation of passenger intermodal operations and services, there are, nonetheless, strategies to overcome these barriers: 1) policy measures and legislation, 2) physical infrastructure improvements, and 3) deployment of appropriate intelligent transportation systems.

Unfortunately, little has been done in the area of evaluating passenger intermodalism. Frameworks for the evaluation of the intermodal transfer process have been proposed, however, there is little evidence of such evaluations being performed at any transfer facilities. A possible explanation for this is the lack of data and quantifiable measures of effectiveness. Absence of data on linked intermodal trips poses a barrier to identifying where transfers occur, where intermodal needs are unmet, and where they might be improved. Many measures of effectiveness are not quantifiable, making it more difficult to perform evaluations that can be compared across modes or facilities. These qualitative measures, such as passenger comfort and convenience, are just as important as quantitative measures nonetheless.

From the field survey observations, differences across public transit modes, i.e., rail versus bus, exist in the level of use of intelligent transportation system technologies. Rail facilities tend to exhibit a higher degree of technology for user information and ticketing than bus modes. For example, many of the heavy rail stations utilized not only changeable message signs, but in many cases, used them to provide dynamic, real-time updated information. As we consider a slightly lower level in rail transit, many of the light rail stations used changeable message signs, but it was a rarity that light rail transit service providers provided real-time, dynamic information. Subsequently looking at buses, there are no changeable message signs at bus facilities only static displays of bus schedule information, with no additional announcements or provide any new information beyond that which was already posted. Another aspect that we can examine is ticketing. Rail modes generally had some form of automated advanced payment machine. For most of the sites and systems examined, although bus users may use their rail tickets to transfer to bus, the ticketing machines are oriented to rail users. Therefore, it seems as though rail modes tend to be more technologically advanced.

The presence of technology tends also to differ by geographical area. It appears that the level of technology used in the San Diego area is higher than that used either in the San Francisco Bay Area, or Sacramento. The extent of Sacramento’s advanced technologies seems to lie with the changeable message signs and automatic fare payment machines, both associated with the light rail system. San Diego, meanwhile, employs both of the above technologies on a wide scale, but also provides passengers with real-time information on its changeable message signs. Further, San Diego’s automatic fare payment machines are quite a bit more advanced than Sacramento’s. The Bay Area seems to lie somewhere in between Sacramento and San Diego in technology use, providing some real-time information to train platforms, but not using advanced fare payment systems on as wide a scale as San Diego.

Just as the use of advanced technologies seems to have a fairly clear hierarchy by region, the level of fare coordination seems to have an analogous hierarchy. Fare coordination seems to be higher in both Sacramento and San Diego than in the Bay Area. Sacramento has quite simple and convenient fare coordination. However, in San Diego, which has a much more complex and diverse network than Sacramento, a similar ease of fare coordination still prevails. In the San Francisco Bay Area, however, perhaps because of the complexity of the transit system, fare structures seem to be more autonomous, often forcing passengers to pay separate fares for each mode. However, it still appears that San Diego and Sacramento have achieved a higher level of coordination than the Bay Area.

The institutional survey results reveal some interesting facts regarding how agencies collect and share data and cooperate at the intermodal facilities under investigation. The results also indicate how facilities are managed and the degree to which agencies use or are planning to use ITS technologies. Of the three types of data collected (vehicle location, actual arrival time, ridership), the two data types collected most often were ridership data and actual arrival time. Data collection is predominantly manual and performed on a continuous or daily basis.

As far as the adoption of ITS technologies, what emerges from the data analysis is that most commonly used technologies are electronic fare boxes and surveillance cameras. The second tier of technologies adopted is automatic passenger counters, automatic vehicle location, and traffic signal priority. Technologies not in use are, however, generally being studied. There thus seems to be a fairly high degree of interest in ITS technologies among the various transit agencies.

Results also indicate that there is little sharing of data between the transit agencies located at the intermodal sites. However, there is nevertheless a certain degree of coordination of schedules through the aegis of the facility owner or one of the main facility partners. The shared data is primarily ridership and expected arrival time data, and is used for service planning and scheduling. Reasons given for the limited data exchange between the agencies include:

insufficient technology for practical use of data, insufficient data to share data is not perceived to be valuable enough. There is common facility management mode with the site generally managed by the owner of the facility, who operates and maintains the site. While the level of data exchange among the transit agencies at the intermodal facilities is not high, there is a certain degree of coordination among them for other transit-related objectives.

Though limited in scope to only one user survey of an intermodal passenger transfer facility, that is, the El Cerrito Del Norte BART station in the San Francisco Bay Area, findings provide facility user insight into how such a facility operates and the services it provides. Approximately half of respondents rated the facility's operations and services of good to excellent quality. Only about 1 in 5 respondents felt that such services and facility operations had deteriorated since they first began using the station. Regarding traveler information, while no information source was rated above "good" on average, both electronic and paper means of providing information to the traveler were rated between "average" and "good". In particular, information from the Internet via Web-sites was rated 3.6 out of a maximum of 5 in terms of the quality of information provided. As advances are made in information and communications technologies, Web access, in particular, wireless Web access to the Internet, will very likely grow with enhanced quality.

The San Francisco Bay Area is about to undergo (under the leadership of the Metropolitan Transportation Commission, the area's metropolitan planning organization) a demonstration of technology and service for an implementation of a "Smart" transit fare card, called TransLink. If the test is successful and expanded to include more than just the Bay Area's six largest transit service providers, TransLink will eventually provide for the entire Bay Area an important means of implementing intelligent transportation system technologies to enhance coordination and cooperation among the region's more than two dozen transit service providers.

REFERENCES

(1) Al Kadri, M. and Hamid Benouar, "Intermodal ITS? A Systems Perspective on the Terminology, Feasibility, and Implementation Challenges", *Proceedings of the 1996 Annual Meeting of ITS America*, Volume 2, pg. 891-900, April 1996.

(2) Miller, M.A. and Camille Tsao, "Assessing Opportunities for Intelligent Transportation Systems in California's Intermodal Operations and Services — *Review of Literature*", PATH Technical Note 99-1, California PATH Program, University of California, Berkeley, August 1999.

(3) Mitchell, Chris and Mark A. Miller, "A Field Survey of Site Visits to Passenger Intermodal Transfer Facilities in California", PATH Technical Note 2000-1, California PATH Program, University of California, Berkeley, July 2000.

(4) Richardson, A. J., Elizabeth Ampt, and Arnim Heyburg, *Survey Methods for Transport Planning*, Eucalyptus Press, 1995.

APPENDICES

APPENDIX A: **INTERMODAL PASSENGER TRANSFER FACILITY SITE VISIT SURVEY TEMPLATE**

APPENDIX B: **INSTITUTIONAL SURVEY**

APPENDIX C: **EL CERRITO DEL NORTE BART STATION USER SURVEY**

APPENDIX A: INTERMODAL PASSENGER TRANSFER FACILITY SITE VISIT SURVEY TEMPLATE

Date: ___________________

Arrival Mode: ___________________

Departure Mode: ___________________

Ticketing:

-Are discounted transfer fares available (either in-vehicle or in the terminal)?
____ Yes ____ No

-Does a user need to pay a separate fare for the "transfer-to" mode?
____ Yes ____ No

-Does a user need to purchase a new ticket before boarding?
____ Yes ____ No

-If Yes:

-Was the ticket machine "well signed?"
____ Yes ____ No

-Did the machine function properly?
____ Yes ____ No

-If user needs needed correct change, was there a change machine nearby?
____ Yes ____ No

-Were the fare structures clear?
____ Yes ____ No

-If No:

-Was the fare structure clear for a new user before boarding?
____ Yes ____ No

Additional Description: ___________________________________
____

-How are fares collected (e.g. on-board, in the terminal)?
____

-Was the fare a flat fare?
____ Yes ____ No

-Do users need correct change?
____ Yes ____ No

-What type of ticket is used?
____

-Was there a queue of passengers at the turnstile or the ticket-purchasing machine?
____ Yes ____ No

Additional Description: ____

Transfer/Mobility in Transfer Terminal:

-Does more than one line serve this terminal (e.g. multiple bus lines at a stop, multiple trains at a BART station, etc.)?
____ Yes ____ No
Additional Description: ____

-If Yes, was it clear where to board our particular vehicle?
____ Yes ____ No
Additional Description: ____
____

-Was it clear which vehicle to board? (If multiple lines stop at the same platform.)
____ Yes ____ No

-Was there a system route map in the terminal?
____ Yes ____ No

-If Yes, did it show integrated information about other transit providers?
____ Yes ____ No

-Was there a station agent present?
____ Yes ____ No
Additional Description: ____
____

-If Yes, do they have information on all systems, or just one?
____

-Was the waiting area covered? Was it indoors?
____

-How long did we wait for our vehicle?
____

-What is the scheduled headway for this vehicle/line during this time of day?
____

-Was there a schedule posted in the terminal?
____ Yes ____ No
-If Yes, was it accurate?
Bus was 5 minutes late.
-Was there any real-time information provided?
____ Yes ____ No

-What security features, if any, are present in the terminal?
____

-Does the terminal facility seem safe?
____ Yes ____ No
-If Yes, please provide more details.
____

-Does the terminal appear well maintained?
_____ Yes _____ No
-Please provide additional details.
____

-Is the “transfer-to” mode inside the same terminal as the “transfer-from” mode?
_____ Yes _____ No
-Please provide additional details.
____

Departure from the Transfer Station:

-What was the total fare for the <u>entire</u> trip broken down by trip legs?
____

-What was the total travel time and how is that time spent in-vehicle and waiting?
____
____

APPENDIX B: INSTITUTIONAL SURVEY

Name: __________________________ Phone Number: ______________________

I. AGENCY DATA USAGE

Objective: To understand general agency data collection methods and to assess the current state of agency use of intelligent transportation systems technologies.

A. Data Collection and Storage

1. Please check all of your agency's applicable data collection and storage procedures in the following table. (*Check all applicable items*).

Data Collection	**Vehicle Location Data**	**Arrival Time Data***	**Ridership Data****
Type of Collection			
Automatic			
Manual			
Collection Frequency			
Continuously			
Daily			
Weekly			
Monthly			
Annually			
Data Storage	**Vehicle Location Data**	**Arrival Time Data***	**Ridership Data****
Type of Storage			
Electronic			
Paper			
Not stored			
Storage Procedure			
Agency-wide database/archive			
Departmental database/ archive			

*Descriptions of actual arrival times on routes or portions of routes
**Records of vehicle loads, i.e., on/off counts and passenger origins and destinations

2a. Does your agency collect crime-related data that can be identified by specific location, i.e., data for a particular bus or train, individual bus stops, individual train stations?
☐-Yes, where: ☐-Bus stop ☐-Bus/Train station ☐-In-vehicle
☐-We collect such data, but it cannot be identified by location.
☐-No, we do not collect this data.

2b. Does your agency collect ridership data that can be identified by specific location, i.e., data for a particular bus or train, individual bus stops, individual train stations?
☐-Yes, where: ☐-Bus stop ☐-Bus/Train station ☐-In-vehicle
☐-We collect such data, but it cannot be identified by location.
☐- No, we do not collect this data.

B. Use of Technology

1. Please describe the status of your agency's use of the following technologies (*Check all appropriate boxes*):

	HOW LONG IN USE?	**NOT IN USE**		
		Under Study	**Studied and Not Adopted**	**Not Yet Studied**
Electronic fare box				
Automatic Passenger Counters				
Automatic Vehicle Location				
Electronic Fare Payment (e.g. Smart Cards)				
Surveillance cameras in facilities or on board				
Advanced Traveler Info. System (ATIS)				
Geographic Information Systems (GIS)				
Traffic Signal Priority Systems				
Other (specify):				

2. Are either advanced traveler information systems (ATIS) or facility surveillance cameras currently in use at the <name of intermodal passenger transfer facility>?

ATIS: ☐-Yes ☐-No Surveillance cameras: ☐-Yes ☐-No

C. Dissemination of Traveler Information

1. Through what media does your agency provide traveler information? (*Check all applicable items*)

☐-Printed material/brochures
☐-Phone service to an agency operator
☐-Informational booth
☐-Electronic message displays at stations
☐-Electronic message displays at stops
☐-Fixed signs at stops and stations
☐-Online material/Web site
☐-Automated, menu-driven phone access
☐-Automated kiosks
☐-On-board electronic message displays
☐-Other: ______________________________

II. INTERAGENCY DATA SHARING

Objective: To assess the level of information exchange between transit agencies sharing the <name of intermodal passenger transfer facility> *and to understand agency testing and use of NTCIP standards.*

1. Does your agency share data (e.g. vehicle location, arrival time, ridership data) with any of the public transit agencies located at the <name of intermodal passenger transfer facility>?

☐-Yes. Please list these agencies: ____
☐-No, briefly explain why not and then *Proceed to Question 5*:

____

2. What data do you send to these public transit agencies, in what format, and how frequently?

Data		Format	Frequency
Routing:	Yes / No	__________________________	____________________
Arrival time:			
Real-time (actual)	Yes / No	__________________________	____________________
Static (expected)	Yes / No	__________________________	____________________
Ridership:	Yes / No	__________________________	____________________
Other: ________	Yes / No	__________________________	____________________

3a. What data do you receive from these public transit agencies, in what format and how frequently?

Data **Format** **Frequency**
Routing: Yes / No __________________________ ____________________
Arrival time:
Real-time (actual) Yes / No __________________________ ____________________ Static
(expected) Yes / No __________________________ ____________________
Ridership: Yes / No __________________________ ____________________
Other: ________ Yes / No __________________________ ____________________

3b. In what ways does your agency use this data?

4. What *additional data*, if any, would you like to receive from these agencies, in what format, and how frequently?

Data	**Format**	**Frequency**
___________________	_________________________	__________________
___________________	_________________________	__________________
___________________	_________________________	__________________
___________________	_________________________	__________________
___________________	_________________________	__________________

5. Are you currently testing or using NTCIP (National Transportation Communications for ITS Protocol) standards for your transmission of data from a center to a field device or to exchange data with other public transit agencies?

☐-Yes (*Proceed to Question 6*)
☐-No (*Proceed to Question 8*)
☐-Don't know what NTCIP standards are (*Proceed to Part III – Management of the Intermodal facility*)

6. Do you find that NTCIP standards help or hinder your operations and if so why?

7. As you purchase new field devices and establish communications protocols for your systems do you plan for these to be NTCIP compatible?

☐-Yes (*Briefly explain why and then proceed to Question 9a.)*

☐-No (*Continue with Question 8*)

8. Please briefly explain why you do not use or plan not to use NTCIP standards?

9a. Are there other standards you currently use or plan to use for data for your field devices and communications systems? If so, what are they?

9b. Why do you prefer these standards?

III. MANAGEMENT OF THE INTERMODAL FACILITY

> *Objective: To understand the operation and management of the* <name of intermodal passenger transfer facility> *referred to in this section as "the facility"*.

1. What entity has operational and management authority over the facility?

____

2. Does this entity consist of one or several organizations?

☐ One organization (*Proceed to Questions 3 & 4)*
☐ Several organizations (*Proceed to Questions 5 & 6)*

3. How would you describe this entity? (*Please check only <u>one</u>.)*

☐-It owns the facility and is the main transportation service provider at the facility.
☐-It does not own the facility but is the main transportation service provider at the facility.
☐-It is not located at the facility but oversees it with input from the transportation service providers at the facility.
☐- Other (*Please describe*): ____

____

4. Which of the following activities are performed by this entity? (*Please check <u>all</u> activities that apply then proceed to Part IV-Assessment of the Intermodal Facility on page 6)*

☐-Operates and maintains the facility
☐-Compiles usage data from each public transportation agency located at the facility
☐-Provides guidance and direction in setting priorities and policies for overall facility functioning
☐-Assesses the performance of the facility including recommendations for change
☐-Works with individual facility partners to help build productive linkages among them
☐-Helps identify potential funding sources where and when needed for improvements
☐-Represents individual agencies' intermodal interests in other transportation forums
☐-Other activities: ____

____

5. Which one statement most closely describes how this entity is organized? (*Please check only <u>one</u>)*

☐ -It consists <u>only</u> of members from each agency located at the facility equally represented on a governing board or committee.
☐ -It consists of members from each facility agency represented in equal numbers on a governing board but also consists of other organizations.

☐ -Another organizational setup: ____

____

6. Which of the following activities are performed by this organization? (*Please check* *all* *activities that apply then proceed to Part IV-Assessment of the Intermodal Facility on page 6)*

☐-Operates and maintains the facility
☐- Provides guidance and direction in setting priorities and policies for overall facility functioning
☐-Compiles usage data from each agency located at or in the immediate proximity to the facility
☐-Assesses the performance of the facility including recommendations for change
☐-Works with individual facility partners to help build productive linkages among them
☐-Helps identify potential funding sources where and when needed for improvements
☐-Represents individual agencies' intermodal interests in other transportation forums
☐-Other activities: ____

____

IV. ASSESSMENT OF THE INTERMODAL FACILITY

Objective: To assess the level of satisfaction with the current operation of the <name of intermodal passenger transfer facility>, referred to in this section as "the facility".

1. Please rate the facility in terms of the following attributes on a scale from 1 (not satisfactory) to 5 (very satisfactory)?

Attributes	Level of Satisfaction				
Amount of physical space available to transit vehicles	1	2	3	4	5
Quality of approaches to the facility (entrance/exit ramps, lanes, gates etc)	1	2	3	4	5
Inter-agency coordination	1	2	3	4	5
System and facility management by the agencies governing the facility (information exchange, balanced distribution of capital and operational costs among agencies, operational efficiency)	1	2	3	4	5
Overall access to facility (for transit vehicles and passengers)	1	2	3	4	5
Other (please specify):	1	2	3	4	5

2. Do you think any of those attributes with scores of 1-3 could be improved by means of intelligent transportation system (ITS) technologies?

☐-No
☐-Yes. Please specify:

Attributes to be improved	ITS Technologies
Amount of physical space	
Quality of approaches	
Inter-agency coordination	
System and facility management	
Overall access to facility	
Other	

V. RELATIONSHIP AMONG AGENCIES SHARING THE INTERMODAL FACILITY

Objective: To understand the level of coordination among the agencies sharing the <name of intermodal passenger transfer facility>, referred to in this section as "the facility".

1. Do you conduct any *schedule, route, or special event coordination* with any of your facility partners at the facility?

   ☐-No. Briefly explain why not ____________________
   ☐-Yes. Please describe how this coordination is performed and with whom (*Check all boxes that apply*):

   ☐-Schedule: How? ____________ Partner(s)? ____________
   ☐-Route: How? ____________ Partner(s)? ____________
   ☐-Special event: How? ____________ Partner(s)? ____________
   ☐-Others: How? ____________ Partner(s)? ____________

2. Which of the following categories most closely matches your agency's current relationship with your facility partners with respect to *joint fare structure policies (e.g., transfer discounts, electronic fare payment etc.)*? (*Check all that apply for each category and provide a brief description*)

   ☐-Under study: ____________________

   ____

   ☐-Being developed: ____________________

   ____

   ☐-In-use: ____________________

   ____

   ☐-None of the above: ____________________

3. Do you engage in any *coordinated public information dissemination activities* with any of your facility partners?

   ☐-No. Briefly explain why not ____________________
   ☐-Yes. Please describe these activities:

____

____

4. Do you engage in any *equipment purchasing partnership agreements* with any of your facility partners?

☐-No. Briefly explain why not ____
☐-Yes. Please describe this work:

____

____

5. How do you coordinate the *sharing of the physical space* at the facility?

____

____

____

6. Do you work with any of your facility partners *to recommend and/or make facility improvements*?

☐-No. Briefly explain why not
____.
☐-Yes. Check all boxes that apply and please describe this work

☐-Recommend facility improvements: ______________________________________

____

☐-Make facility improvements: ______________________________________

____

7. Do you engage in any other *coordinated activities* with your facility partners?

☐-No.
☐-Yes. Describe these activities:

____

____

VI. REGIONAL INTERMODALISM AND TRANSFER PROCESS

Objective: To identify the key factors affecting the transfer process and contributing to regional passenger intermodalism

Please rate each of the following factors on a scale from 1 (weakness) to 5 (strength) in terms of how they affect the transfer process and passenger intermodalism in your geographic region?

Strength	**Weakness**				
- Availability of funding for intermodal projects	1	2	3	4	5
- Intermodal component of regional transportation plan	1	2	3	4	5
- Level of cooperation among transit providers for intermodal coordination purposes	1	2	3	4	5
- Diversity of organizational objectives for intermodal services	1	2	3	4	5
- Autonomy of transit jurisdictions	1	2	3	4	5
- Use of different standard operating procedures across operating agencies	1	2	3	4	5
- Accuracy, reliability and timeliness of intermodal information given to customers	1	2	3	4	5
- Quality of service of individual transit agencies	1	2	3	4	5
- Schedule coordination among agencies	1	2	3	4	5
- Monetary cost of transfer to users	1	2	3	4	5
- Public user concerns (e.g. security and safety)	1	2	3	4	5
-Availability of expandable and upgradeable hardware and software	1	2	3	4	5
- Level of synchronization of intermodal operations	1	2	3	4	5
- Accuracy, reliability and timeliness of information exchanged among agencies	1	2	3	4	5
- Market demand for transit service	1	2	3	4	5
- Level of infrastructure connectivity across the region	1	2	3	4	5
- Geographic coverage of transit services	1	2	3	4	5
- Age of transit fleets	1	2	3	4	5
- Overall quality of intermodal facilities	1	2	3	4	5
- Design of intermodal facilities	1	2	3	4	5
- Overall access to intermodal facilities	1	2	3	4	5
- Cost of land and construction where expansion is required	1	2	3	4	5
- Geography of region	1	2	3	4	5

APPENDIX C: EL CERRITO DEL NORTE BART STATION USER SURVEY

UC Berkeley is conducting this survey to assist Caltrans on improving transit services. Your answers will be kept strictly confidential.

We would like to ask questions specifically about the trips you make to the El Cerrito Del Norte BART Station. The survey will take about 5 minutes to fill out. **When you have completed the survey, please fold it along the dotted lines and peel off the sticker on the back to seal it and drop it in the mail by June 1, 2000. NO POSTAGE NEEDED.**

1. What was the purpose of your trip?
   - ☐-Commuting to or from work
   - ☐-Commuting to or from school
   - ☐-Sight-seeing/tourism
   - ☐-Personal business/errands
   - ☐-Job-related business such as sales, delivery, etc.
   - ☐-Other (Specify:_________________________)

2. What method of transportation did you use <u>to arrive</u> at the El Cerrito Del Norte BART station?
   - ☐-Walked to the station
   - ☐-Rode a bicycle
   - ☐-Drove a car and parked at/near the station
   - ☐-Was dropped off in a car (e.g., Taxi Cab)
   - ☐-BART
   - ☐-AC Transit
   - ☐-Golden Gate Transit
   - ☐-Vallejo Transit
   - ☐-WestCAT
   - ☐-Other (Specify___________________________)

3. What method of transportation did you use <u>to leave</u> the El Cerrito Del Norte BART station?
   - ☐-Walked to final destination
   - ☐-Rode a bicycle
   - ☐-Drove a car
   - ☐-Was picked up (e.g., Taxi Cab)
   - ☐-BART
   - ☐-AC Transit
   - ☐-Golden Gate Transit
   - ☐-Vallejo Transit
   - ☐-WestCAT
   - ☐-Other (Specify___________________________)

4. Please check <u>all</u> the methods of transportation you used (or will use) from the start of your trip until you arrived at your final destination.
   - ☐-Walking
   - ☐-Bicycling
   - ☐-Bus
   - ☐-BART
   - ☐-Other Rail (Specify: ______________________)
   - ☐-Ferry
   - ☐-Car or van
   - ☐-Taxi Cab
   - ☐-Other method (Specify: ____________________)

5. How much time did it take you from the start of your trip until you arrived at your final destination?
   - ☐-Less than 30 minutes
   - ☐-30 — 45 minutes
   - ☐-45 minutes —1 hour
   - ☐-1 hour —1 hour 15 minutes
   - ☐-1 hour 15 minutes —1 hour 30 minutes
   - ☐-1 hour 30 minutes or greater

6. How many transfers (for example: bus to bus or BART to bus) did you make from the start of your trip until you arrived at your final destination?
   - ☐-None
   - ☐-1
   - ☐-2
   - ☐-More than 2

7. How much time did you spend at the El Cerrito Del Norte BART station waiting to make your transfer?
   - ☐-Did not transfer ☐-0 to 5 minutes
   - ☐- 5 to 10 minutes ☐-10 to 15 minutes
   - ☐-15 to 20 minutes ☐-20 to 25 minutes
   - ☐-25 to 30 minutes ☐-Greater than 30 minutes

8. How many times in the last seven days did you use the El Cerrito Del Norte BART station?
   - ☐-10 times or more
   - ☐-5 to 9 times
   - ☐-1 to 4 times
   - ☐-Not sure
   - ☐-Do not know

9. What was the most common purpose for your trips to the El Cerrito Del Norte BART station in the last seven days?
   - ☐-Commuting to or from work
   - ☐-Commuting to or from school
   - ☐-Sight-seeing/tourism
   - ☐-Personal business/errands
   - ☐-Job-related business such as sales, delivery, etc.
   - ☐-Other (Specify:________________________)
   - ☐-Not sure
   - ☐-Do not know

10. What year did you first start using the El Cerrito Del Norte BART station?
   - ☐-This year (2000)
   - ☐-1999
   - ☐-1998
   - ☐-1997
   - ☐-1996
   - ☐-1995 or earlier

11. Overall, how do you rate the El Cerrito Del Norte BART station today?
   - ☐-Poor
   - ☐-Fair
   - ☐-Good
   - ☐-Excellent

12. How would you compare the way the El Cerrito Del Norte BART station is today to the way it was when you first started using it? Would you say the current facility is better, worse or the same?
   - ☐-Better
   - ☐-Worse
   - ☐-The same
   - ☐-Have not noticed or cannot tell

13. How would you rate the quality of travel information (e.g. schedules, routes etc.) about the El Cerrito Del Norte BART station from each of the following sources on a scale of 1 (poor) to 5 (excellent)?

    Please check all that apply and circle a number for each check mark you make.

    ☐-Printed pamphlets or brochures
    1 2 3 4 5
    (poor) (excellent)

    ☐-Posted material at the station
    1 2 3 4 5
    (poor) (excellent)

    ☐-Transit agency representative(s) on the phone
    1 2 3 4 5
    (poor) (excellent)

    ☐-Transit agency representative(s) at the station
    1 2 3 4 5
    (poor) (excellent)

    ☐-Web-site on the Internet
    1 2 3 4 5
    (poor) (excellent)

    ☐-Kiosk/information booth at the station
    1 2 3 4 5
    (poor) (excellent)

    ☐-Other source (Specify: ________________)
    1 2 3 4 5
    (poor) (excellent)

Please complete the survey on the next page.

14. Now we would like to ask you specific questions about the state of El Cerrito Del Norte BART station. Using a scale of 1 to 4, with 4 being Excellent and 1 being Poor, how would you rate the following aspects of the El Cerrito Del Norte BART station. *(If you feel you don't know how to rate any of these or they are not applicable, please circle "DK/NA).*

	POOR	FAIR	AVERAGE	GOOD	EXCELLENT	DON'T KNOW OR NOT APPLICABLE
a) Transfer wait time	1	2	3	4	5	DK/NA
b) Frequency of transit service	1	2	3	4	5	DK/NA
c) Information concerning transfers	1	2	3	4	5	DK/NA
d) Transit information from individual agencies	1	2	3	4	5	DK/NA
e) Quality of transit service to/from the station	1	2	3	4	5	DK/NA
f) Station's physical quality (e.g. waiting areas, elevators, escalators, and ticket machines)	1	2	3	4	5	DK/NA
g) Availability of inter-agency monthly passes and transfer discounts	1	2	3	4	5	DK/NA
h) Ease of access to/from BART station	1	2	3	4	5	DK/NA
i) Pedestrian safety as a result of station layout	1	2	3	4	5	DK/NA
j) Personal security at station	1	2	3	4	5	DK/NA

15. Are you ______ male or ______ female ?

16. Which of the following categories includes your age?
   - ☐-18 to 24
   - ☐-25 to 34
   - ☐-35 to 44
   - ☐-45 to 54
   - ☐-55 to 64
   - ☐-65 or older

17. What was the last grade or year of school that you completed?
   - ☐-Grade school or some high school
   - ☐-High school diploma or equivalent
   - ☐-Some college, have not completed
   - ☐-Technical, vocational, or trade school
   - ☐-Graduated college
   - ☐-Graduate degree (e.g., Master's, Ph.D.)

18. Which of the following categories best describes your household annual income before taxes for last year?
   - ☐-Less than $10,000
   - ☐-$10,000 to $19,999
   - ☐-$20,000 to $29,999
   - ☐-$30,000 to $39,999
   - ☐-$40,000 to $49,999
   - ☐-$50,000 to $59,999
   - ☐-$60,000 to $69,999
   - ☐-$70,000 to $79,999
   - ☐-$80,000 to $89,999
   - ☐-$90,000 to $99,999
   - ☐-$100,000 or more

19. What is your employment situation?
   ☐-Employed full time ☐-Employed part time
   ☐-Retired ☐-Student
   ☐-Other (Specify: ______________________)

Thank you very much for participating in this survey. Now just fold it along the dotted lines and peel off the sticker on the back to seal it and drop it into any mailbox.
NO POSTAGE NEEDED

PLEASE MAIL BY JUNE 1, 2000