Cost/Revenue Analysis for Mission Valley Transit Development

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In economic terms, the development of a light rail project is compared with a personal automated people mover project in the Mission Valley section of San Diego, California. The two developments are analyzed as investments in the public transportation infrastructure and the differences between the two as investments are evaluated.

Five miles north of downtown San Diego is Mission Valley, a commercial center with a collection of offices, shopping centers, and hotels. Mission Valley generates 110,000 internal daily trips, nearly all by automobile (*1*). As a result, traffic in the area can become congested, with over half the time spent on a given trip consumed by waits at intersections. It is suspected that the congestion limits commerce, by discouraging discretionary trips. Examples of discretionary trips include lunches and extensions of shopping trips to additional shopping centers. Two organizations are proposing solutions to alleviate these conditions, the San Diego Metropolitan Transit Development Board (MTDB) and a local transportation advocacy group, the San Diego Maglev Organization. Figure 1 locates Mission Valley within the San Diego region.

MTDB has completed the design for an extension of the San Diego Trolley system into Mission Valley. The trolley route runs along a line from Old Town, near Interstate 5, 9.8 km (6.1 mi) west to Jack Murphy Stadium, near Interstate 15. The MTDB has planned nine stations, each serving existing or planned activity centers. According to published accounts, difficulties in obtaining environmental approvals may delay construction. The trolley route traverses wetland and flood plain areas, and these environmental conditions require significant mitigation measures.

In the summer of 1994, the San Diego Maglev Organization (SDMO) endorsed a separate transportation improvement plan for Mission Valley. The group recommended a 43.5-km (27-mi) network of personal automated people movers (APMs), also known as personal rapid transit, as the best method for conveying people throughout the commercial center. It would serve all areas served by the trolley, and extend west toward Sea World and the Sports Arena, while serving the hotels and office buildings south of Interstate 8. The small guideway would be built next to existing streets and developed areas, and, therefore, will be environmentally benign.

COST COMPONENTS

It is possible to classify costs for both the trolley and personal APM systems into three basic component groups. The first component group includes the guideway, stations, and any central facilities, including maintenance buildings and control centers. A second group includes vehicles and vehicle accessories. A third group includes systems for controlling vehicle operations, including both hardware and software components. Cost comparison tables for the trolley and personal APM systems follow. Table 1 compares capital cost, and Table 2 compares operating cost. Trolley costs were provided by the MTDB. Personal APM costs were developed from information provided by various automated people mover manufacturers with systems in operation.

Guideway, Stations, and Central Facilities

The vehicle guideway is the most significant capital cost for both the trolley and the APM. Stations, maintenance facilities, and offices represent fewer significant expenditures. The guideway for the trolley is, in part, constructed as an earthen berm, and in other parts as an elevated concrete structure. Guideway widths are up to 6 m (20 ft). The personal APM guideway is constructed of steel, and with a width of 1¼ m (4 ft) is much smaller.

Capital costs for the trolley infrastructure are $208 million, $10.6 million/lane-km ($17 million/lane-mi). Capital costs for the APM infrastructure are $175 million, $4 million/lane-km ($6.5 million/lane-mi). As compared to the trolley, the comparatively low unit cost is a result of a smaller guideway size. The small size provides three advantages: (a) guideway sections can be manufactured in factory conditions, (b) the guideway can be assembled quickly with less expensive construction equipment, and (c) the personal APM serves a wider area with more stations, improving system accessibility.

The MTDB projects maintenance and administrative costs for the trolley at $0.39/passenger-km ($0.62/passenger-mi), with the administrative portion being one-half of that cost. APM network maintenance and administrative costs are estimated to be $0.03/passenger-km ($0.05/passenger-mi). While part of the difference in costs may be because of the relative size of administrative staffs, it is mostly because of the greater use rate expected for the personal APMs.

Figure 2 illustrates the service area distinctions between the trolley and personal APM for a subregion within Mission Valley, including Fashion Valley Shopping Center, Hazard Center, and Mission Valley West Shopping Center. The solid thick line represents the trolley alignment, with the two rectangular blocks locating planned stations. The personal APM guideway is a series of connected loops, running parallel to surface streets. Note that one loop runs around the perimeter of the Fashion Valley Shopping Center. Small solid circles locate possible APM stations. In the same service area in which the trolley has two stations, 21 stations serve the APM network. More off-line stations could be added to the network, if suggested as needed by the transportation marketplace.

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FIGURE 1 Mission Valley location map.

Vehicles

The trolley and personal APM approaches differ dramatically in vehicle size and number. The trolley is on the scale of the traditional, large-passenger vehicle first used to allow a single operator to transport large groups of people. Using computer automation, the APM vehicles are much smaller, holding up to three passengers. The small vehicle strategy provides the transit operator with a strategy for serving the varied needs of thousands of passengers.

Capital cost for a two-car trolley vehicle is $1.2 million, or $18,750 per available seat. Estimated capital costs for an APM vehicle are $45,000, or $15,000 per available seat. Despite the narrow difference, the APM has a higher level of comfort and safety built into the APM vehicle. The APM also bears the cost of communications and entertainment consoles. Although the trolley offers additional standing room, from a cost-per-seat basis, large passenger vehicles are not necessarily more efficient than small passenger vehicles. Small vehicles are more efficient in terms of the ratio of passenger-kilometers to available seat-kilometers (*2*).

The primary operating cost for propelling the two different vehicles is for electric power. It requires further analysis to learn how the trolley and APM compare with respect to energy use. The constant acceleration and deceleration of the heavy trolley vehicle should require significant amounts of energy. The APM does not stop at intermediate stations, and therefore needs less power for acceleration.

Control Systems

The San Diego Trolley is a manually driven system, with the operator controlling vehicle speed, and an engineer controlling track switching. The technology used for trolley control systems is essentially unchanged from century-old railroad technology. Personal APMs are automatically controlled vehicles, with a handful of operators remotely supervising the operations of hundreds of vehicles. The APM uses state-of-the-art control system technology only available for the last 5 years, given enhancements of the computer microprocessor.

Capital costs for the trolley control systems are small, consisting of a few rail switches and signal lights. Estimated costs for Mission Valley are $231,000/lane-km ($372,000/lane-mi). The APM requires an extensive communications system, networking local information processors with vehicles and the central command station. The cost for this system is estimated at $847,000/lane-km ($1,363,000/lane-mi). Greater costs are a result of additional communication hardware installed on the guideway, and the cost of programming a site-specific network.

The cost situation reverses with respect to operating costs. Since each trolley vehicle requires an operator, the cost per seat-

TABLE 1 Capital Cost Comparison

Component	Trolley Per Lane-Km	Trolley Mission Valley	Personal APM Per Lane-Km	Personal APM Mission Valley
Administration	$306,000	$6,000,000	$260,000	$11,300,000
Engineering	$433,000	$8,500,000	$155,000	$6,750,000
Right-of-Way	$1,731,000	$34,000,000	$0	$0
Prof. Services	$51,000	$1,000,000	$281,000	$12,200,000
Constr. Mgmt.	$611,000	$12,000,000	$143,000	$6,200,000
Construction	$6,200,000	$122,000,000	$1,912,000	$83,100,000
Utility Relocat.	$143,000	$2,800,000	$0	$0
Ctrl. Systems	$231,000	$4,540,000	$847,000	$36,800,000
Vehicles	$1,003,000	$19,700,000	$2,174,000	$94,500,000
Contingency	$986,000	$19,366,000	$440,000	$19,150,000
Totals	**$11,695,000**	**$229,906,000**	**$6,212,000**	**$270,000,000**

TABLE 2 Operating Cost Comparison

Component	Trolley Annual	Trolley Passenger-Km	Personal APM Annual	Personal APM Passenger-Km
Administration	$1,248,000	$0.20	$246,000	$0.002
Maintenance	$1,228,500	$0.195	$2,075,000	$0.016
Prof. Services	In Admin.	$0.00	$246,000	$0.002
Insurance	In Admin.	$0.00	$164,000	$0.001
Security	In Admin.	$0.00	$410,000	$0.003
Promotion	In Admin.	$0.00	$164,000	$0.001
Pass. Services	In Admin.	$0.00	$410,000	$0.003
Operators	$468,000	$0.075	$1,230,000	$0.009
Power	$97,500	$0.016	$3,280,000	$0.025
Reserves	$0	$0.00	$410,000	$0.003
Totals	**$2,964,000**	**$0.486**	**$8,610,000**	**$0.065**

kilometer to control the vehicle is $0.02. Since a single APM operator can handle up to 360 vehicles and the average vehicle speed is higher, the cost per seat-kilometer to control the vehicle is $0.003. This is 17 percent of the cost to control the trolley. On an annualized basis, the cost per seat-kilometer for the trolley control system is $0.025 and for the APM is $0.006.

REVENUE

Revenue from passenger fares is only one source of income available to transit operators. Two other sources include services offered on board transit vehicles and advertising promotions. Most transit operators do not offer on-board services, although a few have experimented with ideas like teaching classes on commuter train cars. Most transit operators only lightly use advertising as a source of income.

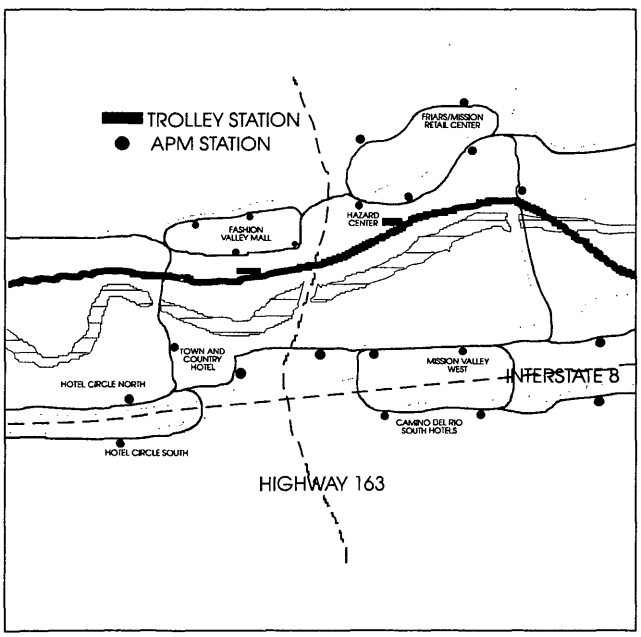

FIGURE 2 Close-up view of trolley and people mover alignments.

Passenger Fares

Fares for the trolley range from $1.00 to $2.25 per passenger, and are based on the number of zones through which a passenger travels. The MTDB establishes fare levels as a matter of policy. An APM operator should base fares on vehicle-kilometers traveled, with discounts available for volume customers. APM fare levels will depend on market considerations.

The Mission Valley trolley route is expected to attract 4,000 passengers each day, with fares averaging $1.40. This will produce an annual fare income of $1.5 million, and represent a market share of 3 percent. The MTDB anticipates that the farebox recovery rate will be 50 percent, consistent with existing trolley route performance, and likely the best light rail recovery rate in the United States. The average cost to ride the trolley will be $0.23 per kilometer ($0.37 per mile), with the average trip lasting 6 km (3.75 mi). As Figure 3 illustrates, nearly all of the revenue generated by the trolley comes from fares.

SDMO expects the APM to attain higher ridership levels. Two primary reasons are the greater level of individual service, and that every activity center in Mission Valley can be served by the APM. The organization anticipates that the APM will capture a 30 percent share of the area's internal trips, and induce additional trips equaling 10 percent of current trips, for a total of 45,000 trips per day. Ridership forecasts using methods employed by the MTDB for an earlier people mover study support this level of use (*1*). SDMO expects the average trip length to be 11 kilometers (7 miles), at an average charge of $0.10 km ($0.16 mi), producing an annual income from fares of $13.1 million.

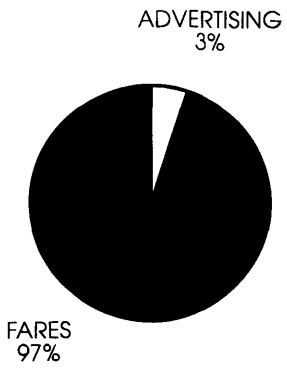

FIGURE 3 Trolley revenue breakdown.

On-Board Services

Of all the advantages of personal APMs over traditional light rail transit, the most important is the ability to offer services during a trip, in a consumer-oriented environment. Besides providing a high level of privacy, the APMs also cater to consumer needs such as convenience, timeliness, and intangibles resulting in feelings of *Glow, Tingle, and wow* (*3*).

The Mission Valley Trolley would receive no revenue from on-board services. The large-passenger trolley vehicles do not easily adapt to the provision of such services. Trolley rail infrastructure does not support the communication networks required for most information-based services. Furthermore, services could not be delivered to customers with any degree of privacy.

The APM would generate revenues from an array of services offered to passengers. Revenue will come from both passengers and commercial sponsors. For example, an investment broker will be paying a fee to be the sole provider of investment services on the APM network. Many passengers will be willing to pay for telephone services, or entertainment services, such as video games. The marketplace will decide precisely which services are offered. The operator would expand popular services and end unpopular services. As Figure 4 illustrates, the revenues generated from services are half as much as revenues generated by fares.

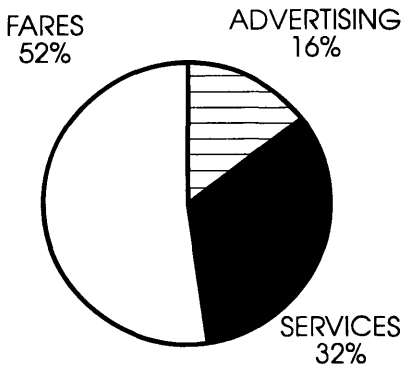

FIGURE 4 Personal APM revenue breakdown.

Advertising and Promotions

Public transportation has capitalized on advertising and promotion opportunities in a small way. Most transit operators rely on vehicle display signs, which generate a small revenue. Advertising revenue has not been aggressively pursued, most likely because transit operators have always seen themselves exclusively as providers of a basic transportation commodity. The challenge for operators is to see themselves as serving other, consumer-oriented needs, such as the need for information related to personal commerce.

The Mission Valley Trolley will gain a small income from advertising placards within the vehicles and kiosks at the trolley stations. Like most transit operators, MDTB does not forcefully pursue promotion opportunities. Furthermore, the limited ridership provides advertisers with a small target audience, decreasing the value of transit advertising space.

The APM will pursue advertising and promotional opportunities aggressively. Commercial sponsors can paint vehicles with their corporate colors and logos. For example, Coca-Cola may wish to have two dozen vehicles painted with the design of its *Diet Coke* can. This type of dedication of an entire vehicle to an advertisement has already been done for buses by public transit agencies, in cities including Phoenix and Santa Ana. Commercial sponsors may also want to have promotions tied to the APM.

PUBLIC TRANSIT AS INVESTMENT

A remarkable aspect of the Mission Valley APM project is its responsiveness to treat expenditures in the public infrastructure as an investment. Traditional public transportation ignores these types of economic considerations. However, with a market-oriented transit system, for-profit investment in transit may yet become a reality.

Funding Strategy

Public transit funding has traditionally come from a combination of federal and state sources. Most other transportation funding is based on expenditures by both the public and private sectors. For example, the public sector usually builds roads and highways with money generated by taxes and vehicle-related fees. Most of the vehicles traveling on the roads and highways are cars, buses, and trucks purchased by private individuals or by private-sector organizations.

The proposal for financing the Mission Valley APM network creates two related financial entities. The first entity is a guideway district, responsible for developing and maintaining the guideway infrastructure. A second entity is an operating company, responsible for providing and operating APM vehicles. Ownership of the guideway district might be public, public and private, or completely private. The operating company would be best managed as a private, for-profit business, responsive to the needs of the local transportation marketplace. Figure 5 illustrates the relationships established under this dual entity structure.

One emphasis in planning the APM financial structure is to create an organization driven by market forces. This organization will then provide the level of transportation and related services demanded by the public. As demonstrated in all areas of an economy, the appropriate reaction to market forces by a provider of goods or services yields an optimum level of public service (*4*).

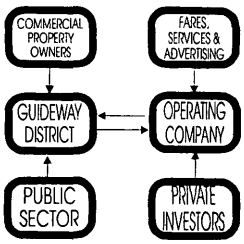

FIGURE 5 APM funding structure diagram.

APM Guideway District

The purpose of the APM guideway district is to raise capital for guideway construction and maintenance. For Mission Valley, it is proposed that the city of San Diego provide escrow funding for the District, whose members will include property owners within Mission Valley. Both the city of San Diego and local commercial property owners will enjoy benefits from APM development, and therefore should play a leading role in funding the project.

The guideway district pays for guideway development in two ways. The first source of income is from lease payments made by the operating company for use of the guideway. A second source of income is special assessments made against district members. A premise behind these assessments is that a higher lease rate earned by the properties outweighs the cost of the assessment. Furthermore, showing a lower need for parking areas and reduced traffic impacts of higher building densities may allow property owners to negotiate high floor-area-ratios with city planning officials and the City Council.

From an investment standpoint, the guideway district is comparable to the traditional public utility. The members of the district guarantee bondholders a minimum level of financial performance. These members work together to ensure the financial soundness of the guideway infrastructure. Concurrently, these members share in the benefits of increased commercial activity encouraged by the personal APM network.

APM Operating Company

The purpose of the APM operating company is to provide, operate, and maintain vehicles to serve passengers using the APM network. In San Diego, it is possible that the operating company could be funded as a start-up. A more likely scenario is that an existing company will view this as a business growth opportunity, and create a division to serve this need. SDMO has identified several prospective companies that could serve in this role.

All of the operating company revenues are related to system usage. The company would decide fares by the amount of ridership these fares will encourage. Revenues from on-board service sponsors licensing access to customers will depend on the size of the market from which they can draw. Merchandising sales will depend on the popularity of the system, an extension of its usage. Operating costs will also vary based on system usage, although any scenario will be exceeded by vehicle depreciation costs.

The operating company is a higher risk investment than the guideway district, with a greater potential for large profits. A poorly used system will not produce the returns needed to pay for a heavy investment in vehicles. Moderate traffic on the system will allow a reasonable rate of return on investment. The proposed APM network can hold heavier-than-expected traffic flows, and would result in elevated profits for investors in the operating company. Figure 6 illustrates three projected return on investment scenarios for the operating company, based on different ridership levels.

CONCLUSION

A key element of the transportation planning process is an analysis of capital and operating costs. However, to gain an accurate perspective of the cost of a transportation improvement plan, these costs must be considered in relation to the income it will generate. Key elements that traditional costing approaches overlook include market share and use of capital. If an investment in transportation cannot attract a significant portion of the market, the expense is an ill-considered use of public funds. When a guideway costing nearly $12.5 million/lane-km ($20 million/lane-mi) to build is used only once every 15 minutes, capital is being used inefficiently.

Whether financed by the public or private sector, or both, transportation project managers should consider the return on investment. Public bodies need to conserve financial resources for projects that truly meet public needs. Market considerations are, therefore, an appropriate element of transportation planning. With these considerations in place, planners and elected officials may begin to reconsider whether spending $70,000 per passenger to build transit systems is the correct use of public funds. Traditional investment analysis tools provide an existing framework for making these decisions.

Few light rail systems like the trolley would be built without funding from the federal government (*5*). The Mission Valley People Mover proposed by the SDMO shows promise as a successful transportation project, because it is fiscally responsible in its investment as a capital project. Not only is the project financially viable, it can become a catalyst for economic growth through a renewed promotion of commerce within Mission Valley. Significantly, the project provides these benefits while enhancing the natural environment. The SDMO hopes to get this proposal accepted by another organization, the Regional Transportation Technology Alliance (RTTA). RTTA is a San Diego organization established to help San Diego companies reach transportation markets. If the proposal is accepted, RTTA could then begin coordination efforts between the

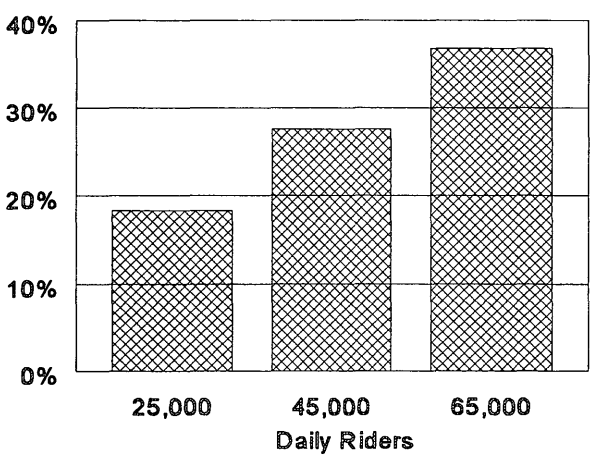

FIGURE 6 APM return-on-investment scenarios.

city of San Diego and Mission Valley property owners. The conclusions reached in this paper will then be tested by the development of a Personal APM network within the next 3 years.

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