GENERAL PLANNING CONSULTANT
TECHNICAL MEMORANDUM 3.5.3
ANALYSIS AND RECOMMENDATIONS FOR CALCULATING BUS SYSTEM REVENUE

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1. INTRODUCTION

The primary purpose of this technical memorandum is to document the current method used to estimate fare box related revenues, and to assess if this existing method is appropriate and accurate, and furthermore, if it could be enhanced.

As a preface to this discussion, it is important to first review an important element in estimating farebox revenue--the construction of the zone-to-zone fare matrix. Hence, the first section of this memorandum documents the current method used to build these fare matrices, problems with the current method and some logical alternative methodologies for future consideration.

The second part of this memorandum documents the current method used to estimate farebox revenue and introduces suggested alternatives to this estimation.

2. METHODOLOGY FOR BUILDING FARE MATRICES

2.1 INTRODUCTION

There are three possible methods to produce fare matrix input for the revenue estimating model. These methods produce fare matrices with varying sophistication such that the results are produced with varying levels of accuracy.

The first and currently used method involves a specialized subroutine using UMODEL to build the fare matrices. The second method, investigated by the SCRTD staff, is to use UPATH to directly build the fare matrices. The third method involves the use of a specialized program which would use UPATH path files and provides it own more flexible logic to build fare matrices. The following section summarizes each method and addresses the advantages and disadvantages of each.

2.2 CURRENT METHOD: UMODEL SUBROUTINE

The current method used to build fare matrices involves a subroutine within UMODEL using transit skims as input. A base fare is assumed for all transit modes. However, since this program does not read the path files directly, it is structured to assume that a transfer would occur only from a lower mode number to the next higher mode number. Hence this method does not recognize the true order of mode usage within a given interchange and does not allow more than one transfer to be considered. In order to determine incremental zone fares associated with rail travel, transit skims are then converted to transit distances and used to calculate the number of distance specified zones traveled. This subroutine then produces fare matrices for both the peak and base periods which reflect the total fare for each interchange, including the following elements: base fares, transfers, zone fares, and station parking costs.

2.2.1 Problems with Current Method

Two basic problems arise within the structure of the program itself. First, the variable used to store the transfer charges was incorrectly entered in the final equation used to calculate the total fare for each interchange. Second, the program is charging a zone fare for each defined zone of rail travel when in fact the first zone is "free."

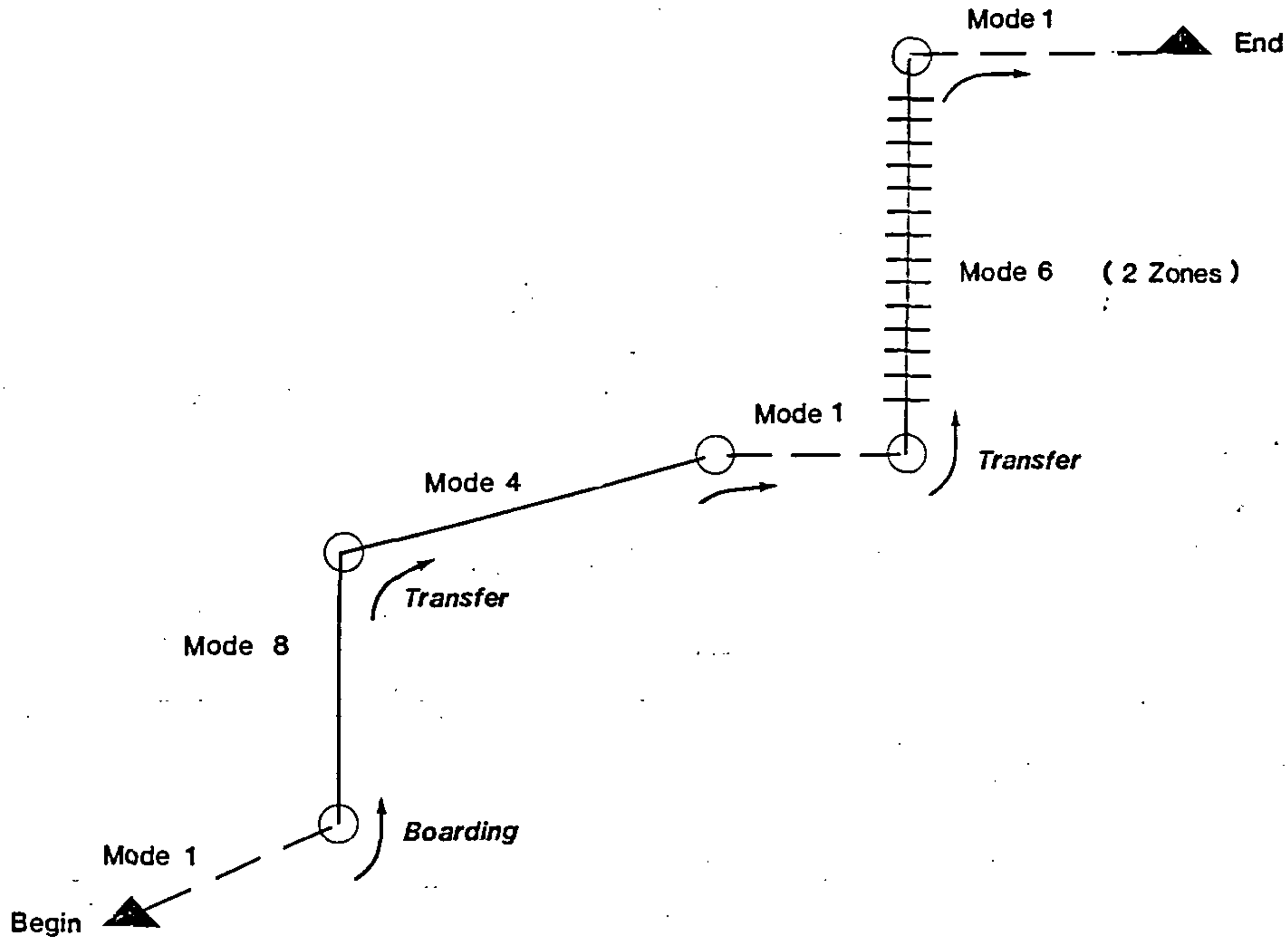
As indicated previously, an additional operational problem exists within the program logic. Since the subroutine does not read path files, it does not recognize the true order of mode usage within each interchange, rather it is structured to only recognize trip segments from lower mode numbers to the next highest mode numbers.

2.2.2 Example of Calculated Fare

For example, the fare for a trip involving the modes shown in Figure 2-1 is inprecisely calculated using this method.

Figure 2-1

Example of Transit Path



Mode Number	(1)	(8)	(4)	(1)	(6)	(1)	Total
Travel Mode	Walk	Other Bus	RTD Bus	Walk	Rail	Walk	
Actual Fare	-	50 ¢	10 ¢ (transfer)	-	25 ¢	-	$0.85
Computed Fare by Current Method	-	50 ¢	10 ¢ (transfer)	-	50 ¢	-	$1.10
Computed Fare by Corrected Current Method	-	50 ¢	10 ¢ (transfer)	-	25 ¢	-	$0.85

First, the program only recognizes the transfer between Modes 4 and 6, and therefore, ignores the transfer between Modes 8 and 4. As a result, the program does not charge the 50 cent boarding fare for Mode 4. Second, the program charges for the first three miles of rail travel when in fact the first zone is free to the patron. If the structural problems of the program are corrected, an even larger disparity in fare results which truly reflects the impact of the operational problems with the program.

2.3 UPATH METHOD

In addition to creating path files, UPATH also provides a powerful fare matrix building capability. Since UPATH explicitly traces the logical order of travel modes, it can be used to provide accurate fare calculation. For instance, as shown in the previous example (Figure 2-1), to avoid a double charge of base fare due to a transfer using a dummy walk link into a rail station, fare link cards must be used to "override" such situations. Likewise, many similar errors in logic can be prevented by using these fare link cards.

2.3.1 Problems with UPATH Method

Since fare link cards must be designed for each instance of a special case, a very large number of fare link cards must be constructed. Hence, this process is quite cumbersome and time consuming. With this level of manual effort, other types of errors may, of course, be generated.

2.4 SPECIALIZED PROGRAM

This method relies upon UPATH to provide the path files, but instead of using UPATH's capability in building matrices, it uses a separate FORTRAN program to provide the appropriate and more specifically tailored logic. Since the logic is left to a FORTRAN program, no manual labor is required in creating the numerous fare link cards used in the UPATH method, as a dummy walk link can be differentiating from a centroid walk connector directly.

2.5 RECOMMENDED APPROACH

The existing method, with its known inaccuracies and problems provides a minimum acceptable level of accuracy and is operational. The UPATH method suffers severely from the amount of manual effort required to prepare the inputs, and as such, cannot be considered a viable option for the future. A specialized FORTRAN program solves all of the technical logic problems and would be precise in its calculation of fare. Development of such a program would involve a substantial investment of time and cost, but is clearly the only appropriate direction to take in the future.

3. METHODOLOGY FOR ESTIMATING FARE REVENUE

3.1 INTRODUCTION

Transit fare revenues are currently estimated using distance-weighted transit skims, transit trip tables, and fare matrices and are estimated for separately for both peak and base time periods. The UMATRIX program, used to calculate these fare revenues, is run twice--once to isolate Metrorail revenue and subsequently to isolate light rail revenues. By subtracting the two rail system revenues from total revenue, bus system revenue is then determined. This general procedure is discussed in more detail below.

3.2 ISOLATING RAIL AND BUS REVENUE

In order to isolate Metrorail and light rail revenues, the UMATRIX program produces four basic revenue matrices for each type of rail service. As in the case of isolating Metrorail revenues, the following matrices are produced:

1. Pure Metrorail Trip Revenue
2. Pure Non-Metrorail Trip Revenue
3. Metrorail Portion of Revenue for Multimodal Trips
4. Non-Metrorail Portion of Revenue for Multimodal Trips.

To build these four revenue matrices, UMATRIX first uses the transit skims, which have been converted to transit distances rather than travel times, and determines which modes are used by each interchange, according to the four revenue types described above. If the interchange contains <u>only</u> Metrorail trips or absolutely <u>no</u> Metrorail trips, the program multiplies the number of trips by the total fare and writes the product to the appropriate revenue matrix (either "Pure Metrorail Trip Revenue" or "Pure Non-Metrorail Trip Revenue"). If the interchange contains a trip consisting of Metrorail <u>and</u> either light rail or bus, revenue is calculated as indicated above, however the revenue is apportioned to each mode according to its share of the total travel distance. The Metrorail portion of this revenue is then written to the revenue matrix for "Metrorail Portion of Revenue for Multimodal Trips," and the remaining revenue is written to the matrix for Non-Metrorail Portion of Revenue for Multimodal Trips." This entire procedure is then repeated for isolation of light rail revenue as well.

To exemplify this procedure, Tables 3-1 and 3-2 provide the revenues estimated for the MOS-1 network which includes the Long Beach Light Rail and was based upon the year 2000 trip tables. Table 3-1 provides revenues generated by isolating Metrorail, where total Metrorail revenue is approximately $3,466,000. Likewise, Table 3-2 provides revenues generated in isolating light rail, where total light revenue is approximately $5,709,600. The total system revenue is approximately $122,979,200.

TABLE 3-1

ISOLATION OF METRORAIL REVENUES (*)

Trip Purpose	Mode of Access	Revenue Matrices: Revenue Metrorail	Revenue Bus + LR	Revenue - Combination: Metro Rail Portion	Bus + LR Portion
Base:					
HBO + OTO	Walk	$ 449,482	$ 63,038,944	$ 315,713	$ 692,018
Peak					
OTW	Walk	68,332	5,184,335	56,661	167,668
HBW	Walk	127,200	33,631,040	432,378	1,668,366
HBW	PNR	703,225	9,963,895	878,650	1,804,096
HBW	KNR	221,225	2,964,788	213,113	398,037
TOTAL		$1,569,464	$114,783,002	$1,896,515	$4,730,185

TOTAL REVENUE = $122,979,166

TOTAL METRO RAIL REVENUE = $1,569,464 + 1,896,515 = $3,465,979

(*)Source: MOS-1 Alternative: Year 2000; computer run date September 7, 1984.

Trip Purpose Key:
- HBO - Home Based Other
- OTO - Other to Other
- OTW - Other to Work
- HBW - Home Based Work

TABLE 3-2

ISOLATION OF LIGHT RAIL REVENUES (*)

		Revenue Matrices			
				Revenue - Combination	
Trip Purpose	Mode of Access	Revenue Light Rail	Revenue Bus + MR	Light Rail Portion	Bus + MR Portion
Base:					
HBO + OTO	Walk	$ 241,967	$ 61,904,736	$1,726,318	$ 623,177
Peak					
OTW	Walk	10,677	5,332,959	92,250	41,109
HBW	Walk	180,975	33,544,064	1,493,539	640,579
HBW	PNR	441,150	11,484,104	1,040,513	384,097
HBW	KNR	155,500	3,185,462	326,700	129,500
TOTAL		$1,030,269	$115,451,325	$4,679,320	$1,818,462

TOTAL REVENUE = $122,979,376

TOTAL LIGHT RAIL REVENUE = $1,030,269 + 4,679,320 = $5,709,589

(*)Source: MOS-1 Alternative: Year 2000; computer run date September 7, 1984.

Trip Purpose Key: HBO - Home Based Other
OTO - Other to Other
OTW - Other to Work
HBW - Home Based Work

3.3 APPORTIONING BUS REVENUE

To determine total bus system revenue, the Metrorail and light rail revenues are subtracted from the total system revenue, thus yielding the total bus revenue for all bus companies operating within the system. In using the above-mentioned rail revenues and total system revenues, the total bus revenue is approximately $113,803,600 (more specifically, $122,979,200 - $3,466,000 - $5,709,600 = $113,803,600).

The current method used to allocate SCRTD's share of this total bus revenue is to use system bus boardings obtained from ULOAD output, such that SCRTD's share is assumed to be the same as its portion of total bus ridership.

The number of bus boardings by mode for SCRTD and other municipal bus companies is shown in Table 3-3. SCRTD's share of total bus boardings is approximately 84 percent; therefore, SCRTD's share of bus revenue is assumed to be 84 percent of the total $122,979,200, which is approximately $103,302,500.

3.4 PROBLEMS WITH EXISTING REVENUE ESTIMATING PROCEDURE

As the UMATRIX program handles interchanges with multimodal trips containing rail travel, it allocates total trip revenue among modes according to a travel distance. Since revenue apportionment is based upon travel distance and the fare matrix only provides the <u>total</u> fare for each interchange, this method does not explictly recognize the disproportionate contribution of Metrorail and light rail zone fares.

Zone fares, which currently consist of a 25 cent charge for each three miles of rail travel, are "mixed" in with all other fares within the fare matrix and thus are apportioned among all modes, not just the rail modes.

TABLE 3-3

SCRTD'S PORTION OF TOTAL BUS REVENUE (*)

Total Ridership	RTD	Other	Total
Mode 4:	$1,927,356	--	$1,927,356
Mode 5:	381,484	$ 24,007	405,491
Mode 8:	--	424,997	424,997
TOTAL	$2,308,840	$449,004	$2,757,844

SCRTD's Share of Bus Boardings = $\frac{\$2,308,840}{\$2,757,844}$ = 83.7% = 84%

*Source: MOS-1 Alternative: Year 2000; computer run date September 10, 1984.

4. ALTERNATIVE METHODS TO ESTIMATING FARE REVENUE

A possible short-term solution to the problem with the current method used to estimate fare revenues would be to breakdown total fare for each interchange into its fare components: base fare, transfers, zone fares, and station parking costs. This can be accomplished by minor modifications to the subroutine used to build fare matrices and provides a better fare apportionment between modes.

As a long-term solution, the use of a specialized FORTRAN program to calculate the fare matrices will more accurately estimate fares, as well as revenue. Since the program traces each path, it can accurately allocate fares by mode and by bus company, thereby automatically compiling more detailed data necessary in estimating fare revenue by mode and by bus company.