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Current Practice and a Proposed Framework

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Short-Range Transit Planning:
Current Practice and a Proposed Framework

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16. Abstract

The research described in this report explored the service and operations planning process in the transit industry in a two-phase approach. In the first phase a detailed assessment of current short range transit planning practice was undertaken through a survey of a dozen transit properties and a detailed investigation of two properties. This phase of the research provided a fuller understanding of the existing process, the constraints which any changes in the process should satisfy, and the weaknesses both as recognized by the planners themselves and as identified by disinterested observers. From this base, the second phase suggested a framework for structuring improvements to the planning process to deal with some of the more significant deficiencies.

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EXECUTIVE SUMMARY

Transit authorities in the 1980's face many difficult problems, including changing ridership patterns, spiraling costs of providing service, new Federal regulations, and changing sources and amounts of funding. It is essential that a transit authority be able to respond to these changes and that it operate as efficiently and effectively as possible given the external environment. To do this, an agency must be able to respond quickly and effectively to both internal and external changes. It must be able to assess resource utilization and outstanding needs and be able equitably to allocate available resources accordingly. This requires that a transit authority have a short range planning process to identify which problems should be dealt with and which strategies should be implemented to resolve them.

The research described in this report explored the service and operations planning process in the transit industry in a two-phase approach. In the first phase a detailed assessment of current short range transit planning practice was undertaken through a survey of a dozen transit properties and a detailed investigation of two properties. This phase of the research provided a fuller understanding of the existing process, the constraints which any changes in the process should satisfy, and the weaknesses both as recognized by the planners themselves and as identified by disinterested observers. From this base, the second phase suggested a framework for structuring improvements to the planning process to deal with some of the more significant deficiencies.

The survey of current practice identified five critical weaknesses which frequently were perceived to have a negative impact on the outcome of the planning process:

a) unavailability of adequate and reliable information on current performance
b) difficulty in adhering to the agency's goals and standards
c) internal and external political pressures
d) lack of inter- and intra-agency cooperation
e) an artificially limited set of feasible options

In the development of the proposed modifications to the short range transit planning process, the existing process was used as a starting point. Modifications were suggested to deal with some of the above weaknesses, in recognition of the following characteristics of the planning context:

1. Properties are pursuing multiple goals, and often different goals are associated with different routes and periods of the day. Analysis must be structured at a detailed enough level to allow performance to be assessed against each objective for each period of operation.

2. Short range planning is only one (typically rather small) activity within a property, and its effectiveness depends on the interfaces with other elements of the organizaiton. Only by considering these interdependencies can it be ensured that actions recommended by planning will be acceptable to the organization as a whole.

3. Planning resources are and will remain tightly constrained, so it is important to focus on services with high potential for positive payoff.

4. Planners must be able to respond quickly and effectively to changes in the operating situation of the property, such as unexpected changes in budget.

5. Since the state of the art in transportation systems analysis is far from perfect, quantitative methods should be used to supplement the planner's judgment and experience, not replace it.

Perhaps the most important change suggested in the planning process is to move away from an exclusive reliance on problem centered screening of services requiring study and possible change. This reliance, which is tied to the widely accepted practice of setting service standards and flagging "substandard" routes, may mean that the planner does not consider opportunities which may exist for improvement on routes with "acceptable" performance. For example, strategies such as segmenting service on a route into express and local portions, establishing service zones, or having some vehicles deadhead in the lightly travelled direction to improve productivity are never likely to be viable on "problem" routes, yet they may be quite useful on high ridership corridors. By improving productivity on such routes, resources might be made available to better tackle the true problem routes. Thus a second focus of attention to be added to the problem-centered approach would be an action-centered screening to identify opportunities for improvement on routes where no problems exist. Modifications were also proposed to recognize the multiple objectives that transit operators are striving to achieve and to deal with the problem of the presentation of data in forms more directly useful in planning.

A general seven-step planning process was suggested incorporating the findings of the survey of current practice and the proposed modifications. This process was organized around the two major elements of problem identification and problem resolution. The suggested Short Range Transit Planning Process can be applied to most transit authorities because it draws its structure from current planning practice, but is designed to ameliorate problems in that process.

By adopting the approaches outlined in this report, it is possible both to examine critically a transit authority's planning process and to formulate a new, or restructure an existing, planning process. The strength of the approach comes from a knowledge of the component tasks and decisions of the planning process and an understanding of the factors that influence and shape it--notably, what data and information are available, what methods of analysis may be employed, and what are the relevant constraints. A change in the structure of a transit authority's planning process will rarely be effective unless it is accompanied by changes in the planning tools and how they are used. Similarly, it is ineffective to introduce new planning tools into the process unless there is a thorough understanding of their strengths and weaknesses and how they can best be used within the planning process. In summary, the structure of the planning process provides a solid basis for effectively and efficiently using a transit authority's planning resources.

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CHAPTER 1: INTRODUCTION

1.1 Background

Short range transit planning has been the focus of considerable study over the past decade. As emphasis on planning shifted at the Federal level from major capital investments to managing existing facilities and resources to improve services and productivity, the contrast between the complicated, computer-based models used for long range urban transportation planning and the ad hoc, judgmental and experience-based planning process typically used within transit agencies quickly became apparent. In recent years, a great deal of effort has been directed towards improving the ability of planners working in transit systems to make better decisions on service changes in response to changes in resources available or shifts in travel demand. These research initiatives have covered a broad spectrum, ranging from more scientifically based data collection programs to improved methods for estimating the impacts on operating cost and ridership which will result from a service change.

The move towards formalizing and structuring the transit planning process has also included a considerable amount of work on the definition of performance measures which can be used either at the individual route level or at the system level. Many systems have adopted service policies which rely heavily on performance measures and standards to drive the planning and change process.

At the same time that these new research initiatives have been undertaken, the environment within which the transit planner must function has changed dramatically. In the early and mid 1970's, Federal and state level financial assistance to the transit industry increased substantially, in line with the increased public expectations about the role transit could play in solving a plethora of urban and societal problems such as environmental pollution and profligate energy consumption. This affected transit planning in two ways. First, additional planners were needed to help plan the transit service expansions which took place as a result of increased resources for transit operations. Many of these new planners were well-educated but had little, if any, knowledge of the transit industry and lacked the judgment and experience needed for transit planning. Second, the service changes which were occurring were almost exclusively of an expansionary type because of the increasing resources available. In this expansionary environment, good data on existing services and a solid planning process are not critical to survival because existing passengers do not lose service and public scrutiny is not very intense. This combination of factors gave systems little incentive to review critically their planning process.

However, starting in the late 1970's and continuing to the current time, the transit operating environment has changed dramatically and has affected the planning process directly. Local, state, and Federal budgetary pressures have brought an end to the expansionary climate for transit. Many systems have already gone through significant service cutbacks or are preparing for future cuts. Once again, the planning process has been affected in two ways. First, the resources available for planning have often been cut back as part of general efforts to reduce overhead expenses and save as much as possible of the service. Second, the planning staff has been under greater pressure than previously to make cost-effective service changes which are subject to intense public scrutiny since some passengers will lose service. The combination of increased pressure to make and defend unpopular decisions with reduced planning resources available thus makes the planning problem much more difficult.

This report describes research conducted at the Massachusetts Institute of Technology over the past two and a half years into methods for improving short range transit planning. The research had two primary objectives:

1. To review the current practice in short range transit planning and hence to identify principal shortcomings which are not currently being addressed by other research.

2. To develop a framework within which improvements to transit planning can be placed, focusing on the identification of problems in an existing system and the design of alternatives to alleviate these problems.

The report is structured in three main chapters. In Chapter 2, the scope of short range transit planning is defined. Chapter 3 presents the results of the review of current transit planning practice, and in Chapter 4, the framework for improved transit planning is presented.

CHAPTER 2: SHORT RANGE TRANSIT PLANNING: SCOPE AND BASIC ACTIVITIES

Short Range Transit Planning (SRTP) is the process of monitoring the operation of a transit system and planning modifications that can be implemented during one of the next several schedule changes, generally within a period of a year. An important implication of this definition is the short time frame of SRTP: some changes to the transit system are not available in SRTP. Examples of these actions include acquiring new vehicles, changing the general configuration of the network (e.g., grid to radial), planning major capital facilities, and introducing new transportation modes. Analyses of these options are usually in the domain of long range planning and programming. Another option which is usually outside the domain of SRTP is change in fare level or structure. In general, fare changes are initiated, designed, and resolved at the highest level of the transit agency. Often the only role for planners in fare changes is to predict the impacts on systemwide and route level ridership and to decide what, if any, service adjustments are appropriate.

The remaining types of system modifications, those suitable for consideration in the SRTP activity, can be grouped at various levels: the system coverage level, the route structure level, and the scheduling level (see Table 2.1). At each level a distinction can be made between actions tending to increase cost and ridership and those tending to decrease cost and ridership. The actions taken in a transit system may be predominantly of one type or the other depending on changes in the budget or in other resources of the system. In some cases, the actions taken may be a mixture, in which case the system is being "fine tuned" to improve attainment of the objectives of the system.

At the highest level, the system coverage level (Table 2.1), feasible actions include adding a new route, extending an existing route, replacing a small set of routes with a new set, discontinuing service on a route, shortening a route, or making minor modifications in route alignment. Actions at this level are the most disruptive for the public and so merit the closest scrutiny. Consequently, many of these actions are among the most time-consuming to plan and implement within the short range planning process.

Actions at the route structure level include splitting a route into two nonoverlapping segments, splitting a route into zones or express and local segments, and linking two existing routes to form one new one. While these

TABLE 2.1

SUMMARY OF GENERIC ACTIONS BY LEVEL

A. Area Coverage Level

1. New route
2. Route extension
3. A small set of routes replaced by a new set
4. Route abandonment
5. Shortening a route
6. Route realignment

B. Route Structure Level

1. Route splitting
2. Zonal service
3. Express/local service
4. Linking two routes

C. Scheduling Level

1. Changes in route frequency
2. Changes in departure times of individual trips
3. Changes in layover time, positioning time, etc.
4. Modify running times
5. Partial deadheading

actions are generally less disruptive than changes in system coverage, they do require some reeducation of the public and careful planning because some riding patterns may be changed.

At the scheduling level more or less service can be provided on a given route at a specific time of day; specific trip departure times can be changed, as can the running time allowed for a route segment or the layover time. Typically these actions will affect the waiting times and schedule adherence on an affected route.

This set of system changes describes general types of modifications that can be applied to any part of the network during any time period. Because of their generality, these changes are called generic actions. An alternative is defined as the application of a generic action to a part of the transit system. For example, an alternative may consist of changing the frequency (a generic action) on a specific route during the morning peak (for example, reducing service on Route 1 from five to four buses per hour).

Based on the definitions given above, the following operational description of SRTP can be developed: SRTP is the process of determining which, if any, generic actions should be takin in the short run for each route to produce the most effective system, i.e. identifying the most effective alternatives.

While the number of generic actions is quite small, a very large set of alternatives can be generated because of the frequently large number of elements (routes and time periods) of the transit system to which each generic action can be applied and the number of distinct alternatives accociated with a specific generic action and route. This requires that SRTP, like most complex planning problems, be structured around the following set of basic, sequential activities:

1. Problem identification
2. Design of alternatives
3. Analysis of each alternative
4. Selection of the most effective alternative.

Problem identification involves gathering and reviewing data on individual services to determine whether or not a problem exists. The existence of a problem implies that the objectives in providing the service are not being well met and that some change in the service may be warranted. Problem identification is an ongoing process which must be supported by data collection and analysis.

Once a problem has been found, there may be one or more generic actions which could be taken to alleviate it. The design of alternative actions may be straightforward in the case of some problems or difficult in the case of others. For example, a route which exhibits extreme crowding would obviously be considered for increased service frequency with the only design question being the extent of the increase in frequency. On the other hand, reliable service might be a candidate for several different generic actions, such as splitting into two shorter routes or modifying the running time or layover time; and for each possible action, alternative designs may be possible.

After the design of alternatives, each alternative is subject to some form of analysis to predict the associated impacts. This analysis process is often largely judgmental, but it may include one or more models to predict impacts. The planner will be concerned about impacts such as:

--changes in operating costs based on driver and vehicle requirements,
--changes in ridership, and
--changes in revenue

or, more generally, the extent to which the initial problem would be corrected and the degree to which underlying transit objectives would be furthered.

With the predicted impacts associated with each alternative, the most suitable alternative is selected. Often this selection is based on a review of the alternatives by different departments within the authority. In many cases this review also encompasses some external groups. The extent of internal and external review and negotiation generally depends, of course, on the generic action being considered. Typically a lengthier process is involved in determination of the best action of a service reduction type in which the public is adversely affected than for a service expansion type of action.

With this definition of the scope of short range transit planning and the identification of the basic elements comprising any planning process, the next chapter describes current planning practice in the transit industry.

CHAPTER 3: CURRENT PRACTICE

It is difficult to characterize current transit planning practice in the U.S. transit industry. The diversity of planning activities is very great even among properties of similar size and general geographic location. Given the limited resources available for this research, it was possible only to identify common elements and differences among the systems considered. To maximize the value of the available resources, a two-phase approach was taken to examine current planning practices.

The first phase consisted of a telephone survey and personal interviews with service planners, schedulers, and general managers from a dozen transit systems. An equal number of small, medium, and large public transport systems across the country were contacted (see Table 3.1). The interviews were informally structured but focussed on the main elements of the planning process described in Chapter 2. Results of these interviews are summarized in this chapter.

The second phase consisted of a more detailed analysis of the planning process used by the Massachusetts Bay Transportation Authority in 1981 to identify service reductions necessary to meet an imminent reduction in the operating budget. This analysis was undertaken to shed more light on some of the weaknesses in current practice identified in the first phase. For the sake of brevity, results of this analysis are not included in this chapter because they supported the survey results described here. This detailed analysis of the Massachusetts Bay Transportation Authority is described in Shriver (1981).

The discussion of current practice is organized around the following four elements which reflect the process as structured by many systems:

1. Data Collection and Analysis
2. Identification of Key Issues
3. Problem Identification
4. Problem Resolution

Compared with the more traditional problem solving process laid out in Chapter 2, this structure shows the much greater stress currently placed on the problem definition phase which incorporates data collection and analysis. Relatively little weight is given to resolving the problem effectively once it has been identified.

TABLE 3.1

TRANSIT AUTHORITIES SURVEYED

CITY	TRANSIT AUTHORITY
Boston, MA	Massachusetts Bay Transportation Authority
Bridgeport, CT	Greater Bridgeport Transit Authority
Cincinnati, OH	Queen City Metro
Des Moines, IO	Metropolitan Transit Authority
Houston, TX	Metropolitan Transit Authority
Los Angeles, CA	Southern California Rapid Transit District
Newport News, VA	Peninsula Transit District
New York City, NY	MTA - (MABSTOA)
Orange County, CA	Orange County Transit District
Portland, OR	Tri-Met
Springfield, MA	Pioneer Valley Transit District

3.1 Data Collection and Analysis

Of all the factors which influence short range transit planning, the data available to planners for analysis varies most widely among transit systems. There are vast differences in the types of data collected, level of aggregation, frequency and amount of data collected, and perceived data quality. This diversity in data collection can be partially attributed to the differences in size, equipment characteristics, and location of the transit agencies surveyed. However, much of the variability in the data collection procedures is due to historical precedents and current contexts, both political and operational, within which the transit systems operate.

Over half the transit systems contacted were either in the midst of, or had just completed, a reorganization of their data collection and/or data analysis procedures. These changes were due to the Section 15 data collection and reporting requirements, changes in personnel affiliated with the Planning and Scheduling Department(s), agency reorganizations, and/or crises, either operational or financial.

Almost all transit systems regularly collect data using one or more of the following methods: Driver Trip Counts, Farebox Readings, Peak Load Counts (Point Checks), and On-Board Counts (Ride Checks). However, the amount of information recorded, frequency of collection, and the employees assigned to collect data vary greatly and influence the use of the data and the planner's belief in its accuracy.

In driver trip counts, the driver uses a hand held or fixed counter to count passengers as they board. Typically the driver records the total number of passengers at the end of each one-way trip. The frequency of the driver trip counts ranges from every day for every trip on all routes to quarterly for a week's duration. Where available, driver count data are considered by planners to be both highly accurate and very detailed since they consist of disaggregate revenue and ridership information by time period, day of week, and direction. The method works best on low volume routes where the driver has ample time to collect the data. Depending on the desired level of aggregation, trip counts are sometimes cumbersome to analyze because of the sheer volume of data. In some larger systems, driver trip counts are also politically infeasible, contractually illegal, or simply untrustworthy.

Farebox readings are collected by most transit systems and are predominantly used for systemwide financial control. Where revenue is recorded by route, it is usually aggregated over a long time period, either at the end of a driver run or vehicle block. Farebox readings by trip are rare, and where they are made, planners characterize the data as being highly suspect and of little value in the planning process. This lack of confidence in farebox data comes from two sources--inaccurate or undependable fareboxes and distrust of the driver's recordings. These problems have caused a number of transit systems to stop collecting these data at least until reliability and accuracy have imporved. Problems were reported with both the older fareboxes and newer, more sophisticated fareboxes. Older boxes were constructed when fares were much smaller, and they often have difficulty handling the constant stream of cash, differentiating among fare categories, and accepting dollar bills or transfers. Newer fare boxes, which were designed for existing operating conditions, have had a number of technical problems including high mechanical and electrical failure rates. They require considerable maintenance, at a time when there is a shortage of qualified repair personnel. If the reliability of fare boxes can be improved, they will undoubtedly be better integrated into data collection programs.

Farebox readings produce the same type of data as driver trip counts and have many of the same drawbacks. The most serious of these is the lack of information on passenger loading along the route--for example, whether there is crowding and if so, over what portion of the trip and at which times of day.

Peak load counts are conducted by half the transit systems contacted, principally the larger systems having few checkers and restrictive labor agreements. Peak load counts are collected by stationing a checker at the point along the route where the passenger load is expected to be highest. As each bus goes by, the checker records the time and makes an estimate of the number of passengers on board. Peak load data is used most often for minor changes in frequency by the scheduling department, which regarded the data as accurate enough for adding and removing buses.

Peak loads were collected as often as every day for certain routes (data collected by supervisors) to four to ten times per year for each route to as needed. In general, the more often the data is collected, the less it is used by the planning department.

Many properties reported thay they did not have complete faith in the data for planning purposes. Peak load data is considered unreliable because it is based on the checker's estimates, which vary in accuracy among checkers. Data collected by supervisors or dispatchers are most suspect since they may be more interested in schedule adherence than loading. Similarly, if the checkers are in the same union or grouping with the drivers, the data may be biased as well as inaccurate.

On-board counts are collected by a checker who rides the bus and records at each stop the number of passengers boarding and alighting and often the arrival time at selected points along the route. These data provide information on loading patterns, activity patterns, and schedule adherence along the route. While on-board counts are conducted occasionally by almost all the transit systems surveyed, few regularly collect this type of data on every route. Despite the value of on-board counts, many agencies do not make extensive use of this method because of a lack of checkers.

Other data collection efforts that are undertaken infrequently are cordon counts, corridor counts, and passenger surveys. These are, in most cases, initially used for systemwide information rather than route planning. However, when these data are available, they are used to examine a group of routes for changes, such as route path changes and reallocation of vehicles among routes in a sector, which may not be suggested by standard data collection methods.

Many planners feel that they do not get the type and quality of data they need to make sound decisions principally because of a lack of money and personnel available to collect, process, and analyze the data. The larger transit systems perceive more problems in their data collection and service monitoring programs, citing the problems of restrictive labor contracts and poor information flow among departments. Some agencies reported that there was a lack of trust between the operations staff and the planning department, while others complained of tension between scheduling and planning.

The methods of data analysis currently being used in short range transit planning vary from handing the planner essentially raw data, to manual data summaries, to extensive computer analysis. In general, most planners feel that a minimal level of computer processing is necessary to transform the data into serviceable information. Peak load counts are an exception to this, since manual summaries of loadings or schedule adherence, may be sufficient for problem identification. Similarly, if small amounts of data, such as on-board counts, are being examined, it is often more informative to scan the raw data than to summarize.

Manual analysis techniques are most often used by transit authorities that could be characterized as firefighting or often in crisis and by those agencies that rarely make changes in the schedule. In these cases, the data is scanned to ascertain that nothing is seriously wrong, i.e. no overcrowded or empty buses are observed. If problems are evident, then additional data is collected, or the original data is analyzed in detail. This appears to work effectively for static routes where there is little variation over time and where planners are quite familiar with the routes. It does not work well, however, when urgent actions are required; it can be quite difficult to bring disparate types of data gathered at different times to bear effectively in an analysis of a particular route or set or routes.

3.2 Identification of Key Issues

The key issues which focus the priorities for reviewing data when it has been collected depend on the operational circumstances and the political climate within which the agency functions. Important planning issues often include ridership and revenue levels, efficiency or productivity of service, level of service, and reliability. A transit system's ability to deal effectively with any of these issues depends upon the data collected, the methods of analysis employed, the operating climate, the level of cooperation among different departments within the agency, in particular the scheduling and planning sections, and the freedom planners are given in identifying problems and implementing solutions or improvements.

All of the transit systems surveyed identified revenue and ridership as their top long term priorities. Efficiency was mentioned by only two transit systems as being of great importance to the planning department; in general, productivity problems are dealt with by the operations department. Similarly level of service was not cited as a high priority, except in the case of unreliability due to vehicle maintenance problems.

While each transit system is interested in the same basic issues, the level of attention and ability to focus on an issue varies depending on the current state of operations. Planning issues are often enunciated as loose goals such as becoming more self-sufficient, getting more buses out on the street, eliminating bad routes, and cutting down on overloading. Sometimes these planning issues are brought up as a reaction to serious systemwide problems such as bus shortages or escalating costs.

A dichotomy in planning style exists based on the ability of a transit authority to deal efficiently and directly with systemwide and route level problems. The agencies surveyed can be roughly divided into two groups-- those that are stable and those that are unstable or in a state of flux. The more stable group included the medium and smaller agencies that were not in crisis, while the unstable or firefighting group included most of the larger transit authorities and a few smaller ones.

In general, agencies in the firefighting group implement more changes than stable agencies; however, they also reverse changes and satisfice more often than other agencies. The unstable transit authorities are characterized by frequent system and route problems that keep them in a "firefighting" mode of operation. The larger systems face problems caused by bus shortages, crush level ridership, and financial crises.

In contrast, the stable agencies are more concerned with route level problems. While they enact more route path changes and service extensions than the larger agencies, they make fewer changes overall. The most serious problem these agencies face is growing peak ridership. The rate of growth is substantially larger in these systems because of the relatively low levels of service provided to the small proportion of total travelers who use transit. In these systems, a minor shift from auto to transit can cause a significant increase in transit use. These transit agencies are unable to expand as much as they would like because of both the larger operating deficits they would incur by expansion and the possible instability of their new ridership.

Both the stable and unstable authorities mentioned the same basic set of service changes consisting of reallocation of buses, increasing or decreasing frequency, changing the running time, changing a route path, and extending or cutting back a route. Joining or splitting routes and having buses make short turns are not usually considered by most transit systems. Major cutbacks in service, such as abandoning a route, are not implemented unless absolutely necessary. Similarly, unless there is an articulate demand and the resources are available to meet it, new services are not added.

Many planners feel that incremental changes in service are easier to implement and more effective than major changes. For service reductions it was agrued that minor changes do not alienate current ridership. For service increases, it was argued that resources are often better used to improve the current services rather than to add new services. Only when the time is felt to be right, both financially and politically, are new services added.

Apart from the stability of the transit authority's operations, there are two additional factors that appear to influence the planner's ability to focus on the key planning issues. These are the degree of trust and cooperation among different departments within the transit authority, notably between planning and scheduling, and the informal information available to the planner.

Most service changes depend on participation by both the scheduling and planning departments. In general for minor changes, the planner suggests a change and takes it to the scheduler to see if it can be implemented. Planners and schedulers are required to work together more closely on the development of more substantial changes.

The extent of cooperation between the scheduling and planning departments varies greatly among agencies. About half the planners contacted in both small and large transit authorities reported that there was a level of distrust between scheduling and planning which adversely affected the planning process. This was most pronounced in the agencies where scheduling and planning were quite separate (sometimes being physically remote), and schedulers had little direct input into the planning process. To avoid planner frustration and to maximize the efficiency of the planning process, it is essential to foster easy and clear communication between scheduling and planning and to include the scheduling group early in the process.

In addition to scheduling/planning conflicts, data availability also affects the planners ability to focus on planning issues. The type and magnitude of the problems that come to the planner's attention depend upon the information available to the planner. Almost all planners have access to some route data, although it is often dated and incomplete. However, there is other, less formal information which can help to identify and define problems. These include passenger complaints and suggestions; the checker's informal observations while collecting data; and input from supervisors, dispatchers, and drivers. The ability to obtain this information depends upon management's relationship with labor and the flow of information in that hierarchy, both of which are related to organizational style and structure.

Larger organizations, which get less of this type of informal information, tend not to postpone dealing with problems until they are critical. Larger organizations are also less able to respond to this type of information partly because the planners are often fully occupied with crisis resolution. When an agency is operating in crisis mode, it is hard to shift to a more rational and efficient planning process without an external impetus.

The smaller transit authorities rely more heavily on supervisor and driver input for both finding problems and identifying solutions. Not surprisingly, the problems that are most often brought up by drivers are crush loading and insufficient running time rather than empty buses and slack running time. The drivers' knowledge of the route can be invaluable when route changes are being considered because they often know more than the planners about specific route characteristics such as ridership patterns and activity generators.

Informal data is needed because of the limitations in amount, accuracy, and type of data which is typically obtained through formal techniques, but its value lies in its ability to complement and supplement formal data, rather than to replace it. Informal data itself is often particularly susceptible to limitations in the form of bias and inaccuracy.

3.3 Problem Identification

Problem identification is the third element of current planning practice. This analysis process typically looks for deterioriating levels of service, such as crush level riderhsip or reliability problems, or inefficient services as indicated by low ridership levels, as a way to identify problems requiring attention.

One way that is used to identify problems is through the use of service standards. Service measures and service standards are used by almost all transit authorities either as the basis for decisions or as indicators of problems. There is a major distinction between service measures and service standards or guidelines. Service measures are statistical summaries of route data, such as passengers/bus hour, revenue/bus mile, or percent of buses on time. A service standard is a critical level for a particular service measure which indicates poor performance--for example, a transit agency may have a minimum standard of 15 for the service measure passengers/bus hour. Service standards are used as a general indication of a problem or as evidence that some action must be taken.

Different transit agencies use different service measrues in route planning, but few, including those who compute many measures, regularly use more than three for the following reasons:

1) they are only interested in a few problems, such as overcrowding and underutilization, and a few measures can identify these problems,

2) the planning staff does not have time to deal with more than a few measures, and

3) the data are limited or suspect and can only be meaningfully used to compute a few measures.

The service measures used depend upon the type of data collected and the key planning issues. Since the key concerns are with ridership (and revenue), the vast majority are ridership oriented--passengers/hour, passengers/mile, passengers/bus trip, and peak load factor.[1] If the data collection is revenue rather than ridership based, the first three measures are often used with revenue substituted for ridership. Other service measures that are frequently used are subsidy per passenger, revenue/cost ratio, and the percent of buses on time. There is no uniformity in the exact definition of these service measures; some transit authorities define them by time period, others by bus trip or driver run.

Many of the transit authorities that use service measures have poorly defined standards that may change depending upon the planner's backlog of problems and the agency's bus availability and budgetary situation. While about a third of the agencies have formal written service standards, they are often used more as guidelines and are flexible depending on the situation.

Service measures can be used to identify problems in three ways: 1) to compare performance with an established standard, 2) to compare performance

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[1] Peak load factor is the ratio of passengers on board at the maximum load point on the route divided by the seated capacity of the vehicle. The ratio is expressed as a percentage.

across rotues to identify the poorest performers, and 3) to look at the change in performance over time to see if important trends are present.

Many of the systems that use service measures have at least poorly defined service standards which may not have been formalized. Service standards were defined by one or more properties for passenger/hour, passenger/mile, passenger/trip, load factor, revenue/direct cost, and percent of buses on time. The standards vary by time period, bus trip or driver run as well as by system and route characteristics such as express or local, crosstown or radial. Load factor standards are the most uniform, ranging between 80 and 100% in the off peak and 120 to 150% during the peak. Percent buses on time is usually cited as a goal rather than a standard with both the definition and the target levels differing among agencies. While standards for passengers/trip, percent of buses on time, and revenue to direct cost ratio are infrequently used during the problem identification process, these service measures are often used as general indicators of ineffective or inefficient service.

A quarter of the transit authorities reported that they rank routes according to one service measure and then look at the routes that have the lowest measures. The measures used for ranking were passengers/bus hour, annual revenue, and average daily passengers. No formal standards, such as bottom 10% or below system average, were reported for these service measures.

No formal time series analyses are normally conducted, but measures were sometimes compared for a route in between data collection cycles to see whether changes in the route had occurred. Analysis based on service measures and service standards are generally used to find problems which can be alleviated by scheduling changes. These problems--crush loading, empty buses, reliability, and schedule adherence--are usually dealt with by adjusting the running time and adding or removing buses or trips. Service measure analysis is rarely used for route path changes or for adding or removing service except during crises when the overriding priority is a speedy decision.

Suggestions are another method that is used to identify problems, particularly route path changes and new services. These problems are usually suggested by riders, community groups, and on occasion, business groups. Frequently planners will have a portfolio of such suggested changes which they would like to see implemented or at least analyzed more fully under suitable circumstances. Typical reasons for not pursuing these suggestions further are resource constraints or the political environment.

3.4 Problem Resolution

The process for resolving problems usually consists of four steps:

1) developing solutions
2) making a recommendation
3) obtaining approval
4) implementation

Solutions are developed in one of two ways. The first, which is standard in many of the larger transit agencies, is to have one planner take responsibility for developing one or more solutions to the problem. For scheduling changes there is generally only one suggestion, but for route path changes, there may be several alternatives from which to choose. It is the planner's responsibility to insure that each change is feasible and to estimate cost, ridership, and revenue impacts of the change.

The second method is to have round table discussions with palnners and schedulers performing the same analysis as the single planner would in the process described above. This group method is often used when resources are tight, when a proposed change may be controversial, or when a number of changes are being considered together.

During the process of trying to find feasible solutions to a problem, the planner(s) may require additional input or data. It is not uncommon to collect additional data either when the original data were cursorily collected or when the problem was brought to light by complaints or suggestions. Similarly, it is not unusual to talk to drivers, supervisors, or community groups about route path changes and new services.

There are a number of factors which eliminate potential solutions. If a change will entail increased deficits, planners may confer with the budget department to determine if adequate financial resources are available. If extra vehciles are required, planners may check with the garages or operations department on the number of spare vehciles available. Other factors which often constrain the range of solutions are policy headways (e.g. offpeak headways should be less than 60 minutes) and geographic accessibility guidelines (e.g. 95 percent of the area's residents should be within 1/4 mile of a bus route). Planners in all systems reported that they prefer to weed out early in the problem resolution process service changes which are likely to meet serious political or community resistance unless these changes are essential. This is because of fear that a recommendation to implement such a change will not gain final approval, resulting in loss of credibility for the planners and wasted effort.

If more than one feasible change emerges from this process, the planner will select one for proposed implementation based on the impacts predicted and the probability of final approval.

The third step in resolving a problem is obtaining approval for the suggested change. Transit planning problems may be divided into two groups: minor ones, which do not require a public hearing before implementation and major ones, which do require hearings. Minor changes, such as changing the running time or adding (removing) buses to a route typically require internal approval from the head of scheduling or planning and can be implemented at the next driver pick as long as no financial or other constraints intervene.

The methods used for large change vary according to the type of change being implemented and the policies of the transit authority. While Federal regulations require public hearings on major service changes, less than half the transit authorities contacted held public hearings strictly according to the regulations. Many planners feel that public hearings are not generally productive, particularly if they felt that the cutbacks were absolutely necessary. A few planners reported holding hearings which no residents attended.

Several transit authorities employed procedures that were in technical compliance with the public hearing regulations but which effectively disregarded public opinion. For example, one property which has its Board of Directors approve service changes has open Board meetings which the public can attend but which makes serious public participation unlikely. Another routinely institutes each change on an experimental basis for 6 months, which is allowed by the regulations, and then holds a public hearing. This strategy is often used to dissipate public opposition to the service change. Incrementalism is another strategy to avoid public review. In this case the transit agency cuts back a little at a time so that each change affects less than 25% of the riders and buses, so that a hearing does not have to be held.

Public hearings are used to obtain public input, but planners felt that they do not usually affect whether or not a service change is implemented. Final approval is usually given by one or more of the following: the General Manager, Director of Operations, an internal planning group, and the Board of Directors. Approval is almost always perfunctory because the agency's staff have weeded out changes thay they felt would be rejected. When the Board of Directors does occasionally stop changes from being implemented, it is usually for political or financial reasons and not because of design flaws.

Depending on the composition of the approving body and its relationship with the planners, certain strategies are used to ease the passage of service changes. One strategy is to present a portfolio of service changes that can be implemented concurrently. This strategy is often used in bus reallocation changes where service must be cut on one route so that it can be increased on another.

Planners generally know what will go through easily and what they may have trouble with, and it is not uncommon to compromise a change before presenting it to avoid the opposition of Board members. For example, suppose a route receives more service than the ridership appears to warrant, and a reduction in frequency is felt appropriate by the planners. However, because of political concerns, it is known that it is infeasible to cut back as much as the planner suggests. A lesser cutback which is felt likely to be acceptable to the Board is agreed upon by the planning group and is submitted for Board approval.

The final step in problem resolution is implementation: the net contribution of planning as it affects service on the street. In the year before this survey, the transit authorities implemented service changes, major and minor, on between 10 and 35 percent of all their routes. The low end represents the more stable systems, the high end some systems that were in the process of overhauling their services. There were also a few cases of expansion and contraction of services on all routes--for example, adding evening or weekend service.

Minor changes, as defined by the transit authority, represented between 50% and 90% of all changes. These were scheduling changes including bus reallocation, changes in running time, and frequency increases in the expanding systems and decreases in the contracting systems. The major route changes were predominantly service increases, either new routes or large increases in frequency, although there were some route path changes and route cutbacks. Many of these changes were attributed to the pressures applied by residents, institutions, and the business community. A large number of new services were to shopping malls and new residential developments, while most route path changes were initiated to provide transportation to service agencies, hospitals, and community centers.

A majority of planners cited political pressure as a formidable constraint in the overall problem resolution process. Political pressure was cited frequently when discussing "dog" routes--routes which are significantly less cost-effective than the system average according to conventional measures such as passengers per hour or revenue to direct cost ratio. Planners claimed that they were unable to cut service on these routes because they are patronized or supported by influential people, such as the General Manager or a City Council member. Between five and fifteen percent of all routes were characterized as dog routes, with the higher percentages in transit authorities whose Board of Directors of elected officials had to approve major changes. The planners were frustrated by retention of these routes and hoped that in the future, as transportation authorities are subject to greater public scrutiny, they would be freer to plan without these political constraints.

3.5 Overall Assessment

In terms of an overall assessment of current short range transit planning practice, the following five problems were noted as frequently having a negative effect on the outcome of the process:

a) unavailability of adequate, reliable data
b) lack of intra-agency cooperation
c) difficulty in adhering to stated goals and standards
d) political pressure
e) limited set of feasible solutions.

The most frequently cited problem was that the data and information available are insufficient and unreliable. Data was sometimes disregarded because it was collected too long ago to reflect the current state of the route. In some of the larger agencies, planners felt the wrong type of data was being collected--for example, peak load counts where either driver trip counts or on-board counts would have been more useful. Some planners claimed the data was collected for too short a period of time so that it was not representative of typical conditions. Data was also suspect when it was collected by a driver, street supervisor, or dispatcher, instead of by a traffic checker. When data is distrusted by the planner, the planning is implicitly or explicitly changed to rely more heavily upon either informal information or judgment, despite their limitations.

In a surprising number of systems, distrust or lack of coordination and cooperation between scheduling and planning units interfere with the effectiveness and efficiency of the planning process. Any effort to improve planning must include a strategy for coordination between the unit planning the change and the units responsible for operations and implementation.

Most of the transit authorities that had formulated a set of planning and service guidelines reported that they could not meet the established standards or goals. This failure was due to changes in the operating or planning constraints since the guidelines were drafted. Planning guidelines usually mandated levels of service including geographic coverage and policy headways which could not be met because of changes in the operating environment, such as vehicle shortages or budget cuts. For example, service cutbacks required for financial reasons may result in peak load standards being constantly violated or affect routes on which productivity is above the minimum standard. Several planners felt that better decisions resulted when they ignored their service guidelines and used judgment. These agencies are in a position where they could not possibly meet all their standards and policies, and rather than choose which standards to adhere to or how to change the standards, they prefer to evaluate route performance on a more judgmental level.

A few planners mentioned that they felt planning guidelines were a poor basis for setting service levels because they did not take into account local characteristics such as income levels and activity center locations. These factors, they felt, influenced the success of a bus route as much as population density and the other standard route planning criteria.

Political pressure, implicit or explicit, is an integral part of the planning process and influences its results often against the will of the planners themselves. These problems often surface in the context of new services or route abandonments or clear inconsistencies in the levels of service provided. Clearly not all planners are comfortable with this heavily political environment and would like to see a more rational planning process.

A number of planners felt that their choice of solution strategies was unnecessarily constrained, resulting in an inability to institute some changes that might use resources more efficiently or provide service more effectively. These limitations are predominantly implicit; only one planner reported an unsuccessful attempt to implement nonstandard changes. Other planners mentioned that they did not feel they could suggest changes such as short-turns or express/local service combinations because they would be negatively received by the affected riders and the Board of Directors.

Short range transit planning has been characterized as a problem identification and solution process which focuses on the single route or corridor. This is an adequate description of routine service planning activities. However, the planner must also be able to deal with more radical changes in policy or operating constraints, which might affect the whole system. In this case, the objective may be to minimize the negative impact of a significant budget cut. The major distinctions here are in the planner's control over the problem, the way the problem is identified and defined, and the actions that can be taken to remedy it.

Many agencies that were previously described as "firefighters" have been subject to either rapid expansion or severe cutbacks in their budget. Increases or reductions in available resources are largely beyond the planner's control, but the planner must respond by altering the services provided so as to meet the new resource constraint. Since the change in constraint occurs at the system level, the route analysis framework that was previously described cannot be directly applied. None of the agencies contacted had planning guidelines which were helpful in tackling these systemwide environmental changes. New criteria for system planning cannot be developed quickly enough to affect the process and so decisions on where to change are based on the planner's judgment modified by internal and external input. This procedure can result in arbitrary decisions under pressure of time and when the data required to make informed choices are unavailable.

CHAPTER 4: PROPOSED FRAMEWORK FOR IMPROVED TRANSIT PLANNING

As described in the preceding chapter, the typical transit planning process as it evolved during the 1970's was not severely tested because of the increasing resources available for transit operations. More recently though, the process has been tested in the context of tightening constraints on transit funding, and important weaknesses have been found. The framework for improved transit planning which is described in this chapter includes modifications to the current process which address these weaknesses.

Before describing the framework itself, some of the more important characteristics of transit systems which govern the relevance and probability of acceptance of new planning methods in the industry are articulated. It is argued that many past failures in adoption of "improved planning methods" are due more to lack of recognition of these realities on the part of researchers than to conservatism or simply inertia on the part of practioners.

4.1 Constraining Characteristics of Transit Properties

Short range transit planning occurs in a very constrained and quite complex organizational setting and cannot be considered to be a strictly technical and analytical activity. Recognition of these nontechnical characteristics of the function is essential early in the development of any change in the process to avoid wasting effort on a technical approach which is unlikely to be accepted in the industry. The operations research and transportation science literature abounds with sophisticated mathematical models of various elements of the transit planning process. Unfortunately there is a wide gap between this theoretical research and even the best of planning practice. Much of the research is based on abstractions of the actual problem which assume away what are in fact important characteristics of the real system. While these characteristics are extremely difficult, if not impossible, to deal with mathematically, it is not responsive to ignore them or assume they are dealt with externally. In this research the approach taken is to work within these constraints even though the resulting process may be less satisfying from theoretical and analytical persepctives in the hope that they will have a real impact on improving the current process.

Thus the following characteristics of transit operating agencies are incorporated, either implicitly or explicitly, in the proposed approach.

1. Multiple Goals

The SRTP process must recognize that properties have multiple goals usually including providing mobility for those without autos, reducing traffic congestion, and reducing energy consumption. Different goals are often associated with different routes (serving specific markets) and periods of the day (for example, congestion occurs principally during peak periods). Thus analysis must be structured at a detailed level in terms of the performance of the route with respect to each objective during each period of operation.

2. Coordination with Related Activities in the Agency

Short range planning is only one activity within a transit agency, and its effectiveness depends on the interrelationships with other parts of the organization. For example, after approval, actions recommended by a planner must be implemented by the schedulers. Only by considering the interdependencies between SRTP and other activities can it be ensured that actions recommended by planning will be acceptable to the total organization.

3. Constraints in Planning Resources

Since it is clear that planning resources available for SRTP (principally time and manpower) are now, and will remain, tightly constrained, it is important to focus on services with high potential for positive payoff. Since detailed analysis of all alternatives changes for all services is impossible, a screening procedure is essential. Constraints on the scheduling end also imply that large scale changes which require extensive analysis and run-cutting cannot usually be undertaken, particularly in a manual scheduling process.

4. Changes in the Agency's Environment

SRTP has to be able to respond quickly and effectively to changes in the operating situation of the agency, such as sudden changes in budget of shifts in policy direction by the Board of Directors.

5. Limitations of Technical Analysis

Since the state of the art in transit technical analysis is far from perfect, quantitative methods should be used to supplement rather than replace the planner's judgment and experience. It's very unlikely that any "black box" type of model will ever be accepted in the transit industry because the planner would be faced with a "take it or leave it" proposition in which judgment and experience would not affect the outcome.

Even recognizing all these constraints, there is still room for significant change in the short range planning process. It is believed that the development of the revised process should be based on evolutionary growth of the existing process, rather than creating a new process from whole cloth. This incremental change is described in the next section which presents the proposed framework.

4.2 Proposed Planning Framework

The presentation of the proposed short range transit planning process is structured around the central steps in SRTP: problem identification and the design of alternatives. In transit, the problem identification step usually includes a preliminary design of alternatives because solutions (or generic actions) are often directly associated with the problem definition. This combined problem identification and preliminary design is discussed in the problem identification section. The section on design of alternatives deals with more detailed design.

For each of these steps, modifications to current practice are proposed, both in terms of the processes followed and the required data and analytical support. Finally, a brief discussion about the corrdination of SRTP with other related activities of the transit agency is presented. Throughout this section emphasis is given to the general approach to planning; in the next section, a specified step-by-step process is proposed.

4.2.1 Problem Identification

Problem identification as it is carried out in current practice has two basic limitations. First, the term problem is often used as a synonym for substandard performance. This narrow definition usually excludes routes, which although currently performing satisfactorily, could be significantly improved. The second limitation is that the multiple objectives of the transit agency are usually not incorporated in the problem identification step. For example, routes with low revenue to cost ratio are usually considered substandard; however, this low ratio may be caused by a large number of elderly passengers, who pay a reduced fare; and the route may be fulfilling an important role in the provision of mobility for the elderly. In the next two sections, ways to overcome these limitations are presented.

Defining Problems in SRTP

In dealing with the first limitation, a better definition of "problem" is required, and it is useful to build on the concept of generic action which was introduced earlier. These actions are the control variables available to the agency to modify its system in order to improve its performance (see Table 1.1). With this in mind, a problem route is defined as one whose performance could be significantly improved with the application of one of the generic actions. This definition encompasses both types of routes of interest: those that are "substandard," for example, in terms of schedule adherence or productivity, and those whose efficiency in providing a given service could simply be improved. Both types need to be identified; and while different methods are required for each, they are both based on relationships between generic actions and types of problems.

The method for identifying "substandard" routes, referred to as the problem centered approach, is similar to current practice. The major difference is the recognition that the generic actions that are applicable to a specific problem are a small subset of all the possible actions. To narrow the set of all possible changes to this small subset, performance measures are needed that will indicate the existence of a problem on any given route.

Table 4.1 presents the starting point for the (traditional) problem centered approach. This table presents performance indicators, which identify common problems and their typical solutions.

Table 4.1

THE PROBLEM-CENTERED APPROACH

	Problem	Indicators	Possible Actions
A.	Poor Productivity	Rev/cost Pass/veh. hour Load	Decrease frequency Eliminate route segments Modify schedule
B.	Overcrowding	Load	Increase frequency
C.	Schedule Adherence Problem	% of trips late	Increase allowed time Modify route

This table does not directly incorporate the multiple objectives of transit operators; this issue and methods to deal with it are discussed later.

While three types of problems are defined in Table 4.1, the great majority of changes made are due to poor productivity or overcrowding, and the most common actions are simply to decrease or increase frequency. This underlines the narrowness of much current SRTP activity and the dominance of scheduling problems with scheduling solutions. This conservative approach to planning should result in few errors but is not likely to be effective in achieving system objectives under tight resource constraints.

The second approach to problem identification is most appropriate for improving parts of the system in which heavy pressure for change does not currently exist, i.e. for routes with no obvious problems. The key to this approach is that the potential of any generic action to improve the performance of a route depends on a favorable set of conditions existing on that route. The problem then is to define the set of conditions that indicate the potential for each generic action and find measures for these conditions. Since this approach to problem identification is structured around the generic actions, it is referred to as the action centered approach.

This approach has two principal advantages which are closely related to each other. First, actions which are usually in appropriate for substandard routes will be included directly in the set of potential service improvements. For example, many problem routes are characterized by low ridership and/or policy headways, and actions such as express or zonal routing will never be feasible. Such actions would lie outside the domain of interest to planners relying on the problem centered appr ch and would probably not be considered for any route in the system. Second, some routes which are not substandard will be subject to planner review and subsequent change which might either free resources to tackle substandard routes or improve overall service quality.

Table 4.2 presents the starting point for the action centered approach to problem identification by listing each generic action and the set of conditions favoring it. Several of the actions listed in Table 1.1 at the area coverage level have not been included in this table because they are too complex to be effectively characterized by a small number of conditions. This is particularly true where significant new ridership might be generated from offering new services.

TABLE 4.2

THE ACTION-CENTERED APPROACH

Generic Action	Favorable Route Conditions
A. Area Coverage Level	
1. Eliminate Route Segment	Low ridership generation on segment Vehicle savings possible from elimination Higher frequency possible from elimination
B. Route Structure Level	
1. Split Route	Low productivity Uneven load profile Long route
2. Zonal	Tapering load profile Long route High Ridership
3. Express/Local	High ridership Tapering load profile Long route Large time differential local/express
C. Scheduling	
1. Increase Frequency	Overcrowding Moderate rather than high ridership Even load profile
2. Decrease Frequency	Low productivity and loads Headways below policy levels
3. Eliminate Trips	Low ridership on trips High cost savings from elimination
4. Increase Running/ Layover Time	Poor Schedule adherence High loads
5. Partial Deadheading	Large imbalance in flows Large time differential in service/deadhead High frequencies

To measure these conditions, several types of indicators may be required. For example, schedule adherence can be characterized by a numerical indicator such as percentage of trips late. For identifying ridership, either at a point or associated with a route segment, a graphical load profile similar to the one shown in Figure 4.1 may be most appropriate. For measuring the potential for a route extension, a map on which new residential and commerical development and possible traffic generators are marked may be most useful. Locations of possible bus turn around points, which are important for route extensions and splitting may also be plotted on a map. Verbal indicators may consist of comments from planners, supervisors, and drivers which could later be supplemented with data.

Of course, the choice of which measures or indicators to use for both the problem and action centered approaches will depend on the cost, accuracy, and the reliability of each type of information as well as on the data currently available to the operator. For example, suggestions or comments from drivers cost very little, but their reliability may be suspect and may depend on the availability of mechanisms and incentives to transmit the information accurately. Performance measures based on an ongoing data collection program, on the other hand, may provide the most reliable information but at a higher cost.

Multiple Objectives and Search

The second limitation of the current problem identification process is that it does not recognize the multiple, and often conflicting objectives of the transit agency. With multiple objectives, it is not possible to find a single measure that indicates goal attainment; usually different measures will be required for each goal. For example, a measure such as the number of elderly riders could be used to evaluate the performance of a route with respect to the goal of serving the elderly. For the goal of cost efficiency of service, however, the traditional revenue to cost ratio could be used.

Since some goals are conflicting, attaining an acceptable level in one will sometimes result in failure to meet another. For example, a route serving many elderly will often have a low revenue to cost ratio because of low elderly fares. To deal with this problem, a ranking of all the routes in terms of the performance measures selected for each goal is proposed. It is

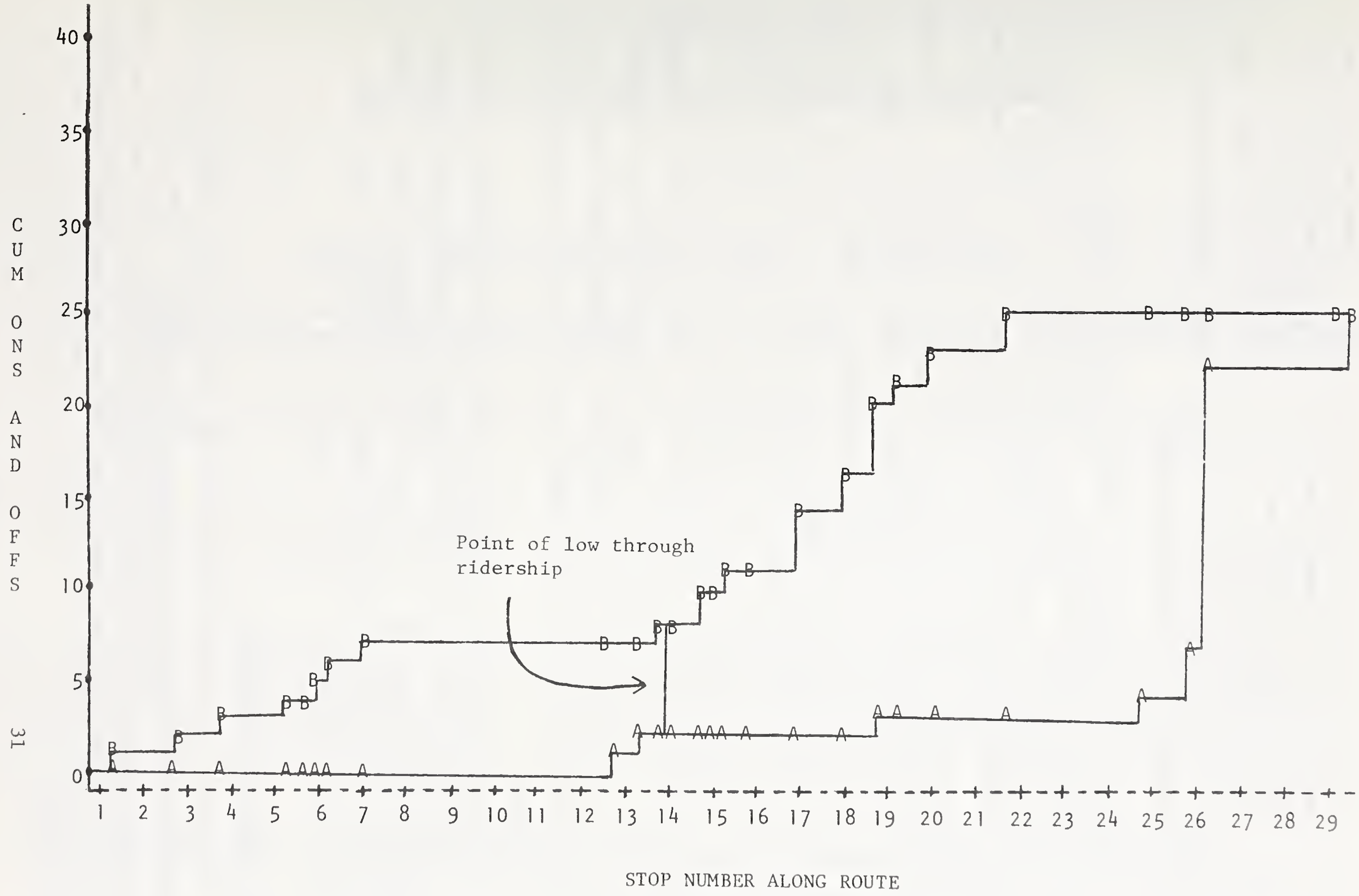

FIGURE 4.1: CUMULATIVE BOARDINGS AND ALIGHTINGS BY STOP

important to do this ranking by type of route (or area) served and time period so that similar services are compared and spatial and temporal equity can be considered. These rankings can then be used as a screening mechanism. For example, for the goal of cost efficiency, the routes in the lowest 10% revenue to cost ratios and which are not in the upper 25% of the rankings for other goals could be screened for further analysis.

To demonstrate this approach, a computer program to summarize the required information has been developed. A sample output of this program is shown in Table 4.3 with the variables passengers per trip for different fare categories, total passengers per trip, and revenue per trip. The report shows the ranking and values of the measures for each route in the system. Two summary variables which indicate the number of measures for which a route falls in the top and bottom 15% are also included and used to categorize routes. The top group consists of those routes that perform very well with respect to some measures and not badly with respect to any measures. The bottom group are routes which are the worst performers in some categories and do not perform well in any category. These are prime candidates for remedial action. It is interesting to look at Routes 4 and 13 in the table. Using traditional ranking schemes based on revenue/cost and other economic performance measures, these routes would probably have been flagged for remedial action. However, as this analysis points out, they are excellent performers with respect to other objectives. This, of course, should be considered when recommending any service changes.

The analysis presented in Table 4.3 could be based on different types of data. In this particular case, monthly revenue by route was used, together with judgmental estimates for each route of the percentage of riders of each fare category. If fare classification counts were available, these would have been used to provide more accurate input to the program.

4.2.2 Design of Alternatives

The output of the problem identification step is a small subset of routes with potential for improvement by the application of one or more generic actions. The purpose of the design of alternatives step is to develop detailed alternative changes for these routes which can then be evaluated for possible implementation.

TABLE 4.3

MULTIPLE OBJECTIVE RANKING TABLE FOR PROBLEM IDENTIFICATION

ROUTE	DAILY SCHEDULED TRIPS	THE VARIABLES BELOW ARE, FOR EACH CATEGORY, THE AVERAGE PER TRIP AND THE RANK																NO. OF CATEGORIES IN TOP 15%	NO. OF CATEGORIES IN BOTTOM 15%
		REVENUE		TOTAL PASSENGERS		REGULAR		TRANSFER		STUDENT		ELDERLY		HANDICAP		CHILDREN			
		AVG	RANK	AVG	RANK	AVG	RANK	AVG	RANK	AVG	RANK	AVG	RANK	AVG	RANK	AVG	RANK		
NOTE: THE ROUTES THAT FOLLOW ARE IN THE TOP 15% FOR AT LEAST ONE CATEGORY WITHOUT BEING IN THE BOTTOM 15% OF ANY CATEGORY																			
1	104	$15.26	2	52.72	1	26.36	1	13.18	1	2.11	2	5.27	2	0.53	3	5.27	1	7	0
2	54	15.53	1	49.54	2	26.25	2	11.89	2	0.99	6	7.43	1	0.99	1	1.98	3	6	0
3	78	6.95	6	23.97	4	10.55	7	5.99	3	2.40	1	3.59	7	0.24	10	1.20	5	1	0
4	30	6.84	7	19.83	7	9.72	9	1.98	8	1.98	3	4.96	3	0.59	2	0.59	8	1	0
13	25	7.27	5	22.60	6	11.52	6	3.39	6	1.81	4	3.39	8	0.45	5	2.03	2	1	0
NOTE: THE ROUTES THAT FOLLOW ARE NEITHER IN THE TOP OR BOTTOM 15% IN ANY CATEGORY																			
5	68	8.91	3	24.00	3	15.60	3	3.60	5	0.48	10	3.60	6	0.24	9	0.48	10	0	0
8	66	7.75	4	23.86	5	12.17	5	4.77	4	1.19	5	4.77	4	0.48	4	0.48	11	0	0
9	24	6.79	8	16.82	10	12.45	4	1.68	10	0.34	12	1.68	10	0.17	12	0.50	9	0	0
10	24	5.98	9	16.90	9	9.47	10	1.69	9	0.34	11	4.23	5	0.34	7	0.85	6	0	0
12	42	5.93	10	17.17	8	10.30	8	2.58	7	0.86	7	1.72	9	0.34	6	1.37	4	0	0
NOTE: THE ROUTES THAT FOLLOW ARE IN THE BOTTOM 15% FOR AT LEAST ONE CATEGORY WITHOUT BEING IN THE TOP 15% OF ANY CATEGORY																			
6	46	4.76	11	12.18	11	8.28	11	1.22	12	0.85	8	1.22	11	0.24	8	0.37	13	0	1
7	26	3.87	12	9.48	12	7.40	12	1.04	13	0.19	13	0.38	14	0.09	13	0.38	12	0	4
11	26	3.22	14	8.74	14	6.03	14	1.31	11	0.17	14	0.44	13	0.17	11	0.61	7	0	5

The analyses required for this design stage are more detailed, since specific decisions about whether, where and when to implement each generic action have to be made. As an example, with the problem centered approach assume that a schedule adherence problem has been identified on a route. Several different types of actions could be taken to alleviate the problem including modifying the running time and the layover (recovery) time, and for each type of action in the size of the change must be determined. To select the appropriate action, route segment level information on running times may be required to pinpoint the cause of the problem--a prerequisite to finding a solution. To resolve the problem of a low productivity route, segment level ridership data by passenger type may be needed to determine whether a route segment could be eliminated or specific trips cut.

Considering the action centered approach it is quite likely that a particular route will have been identified as a promising candidate for different generic actions, and in the design stage, each possible action must be defined in detail, and a selection among them made. In general, some detailed information will be required in the design stage, and it will usually include riding checks to clarify current ridership patterns.

A somewhat different process is required at the design stage to deal with changes in the priorities or in the constraints under which the agency operates. Perhaps the clearest example of this is where the operating budget or the vehicle fleet size changes significantly. In these cases it is important to be able to identify for each route (or set of interacting routes) the action which would be most appropriate should available resources be increased, or decreased by, perhaps, ten percent. This design process involves analysis of each route and the development of contingency plans for changes which could be relatively quickly implemented should cirumstances so dictate.

4.2.3 Interface of SRTP with Other Agency Activities

Short range transit planning is only one of many functions within a transit agency. Other functions which are strongly related to service planning are:

1. Scheduling - runcutting, driver assignment, etc.
2. Operations - field supervision, etc.
3. Marketing and Community Relations - communication between the agency and the public.

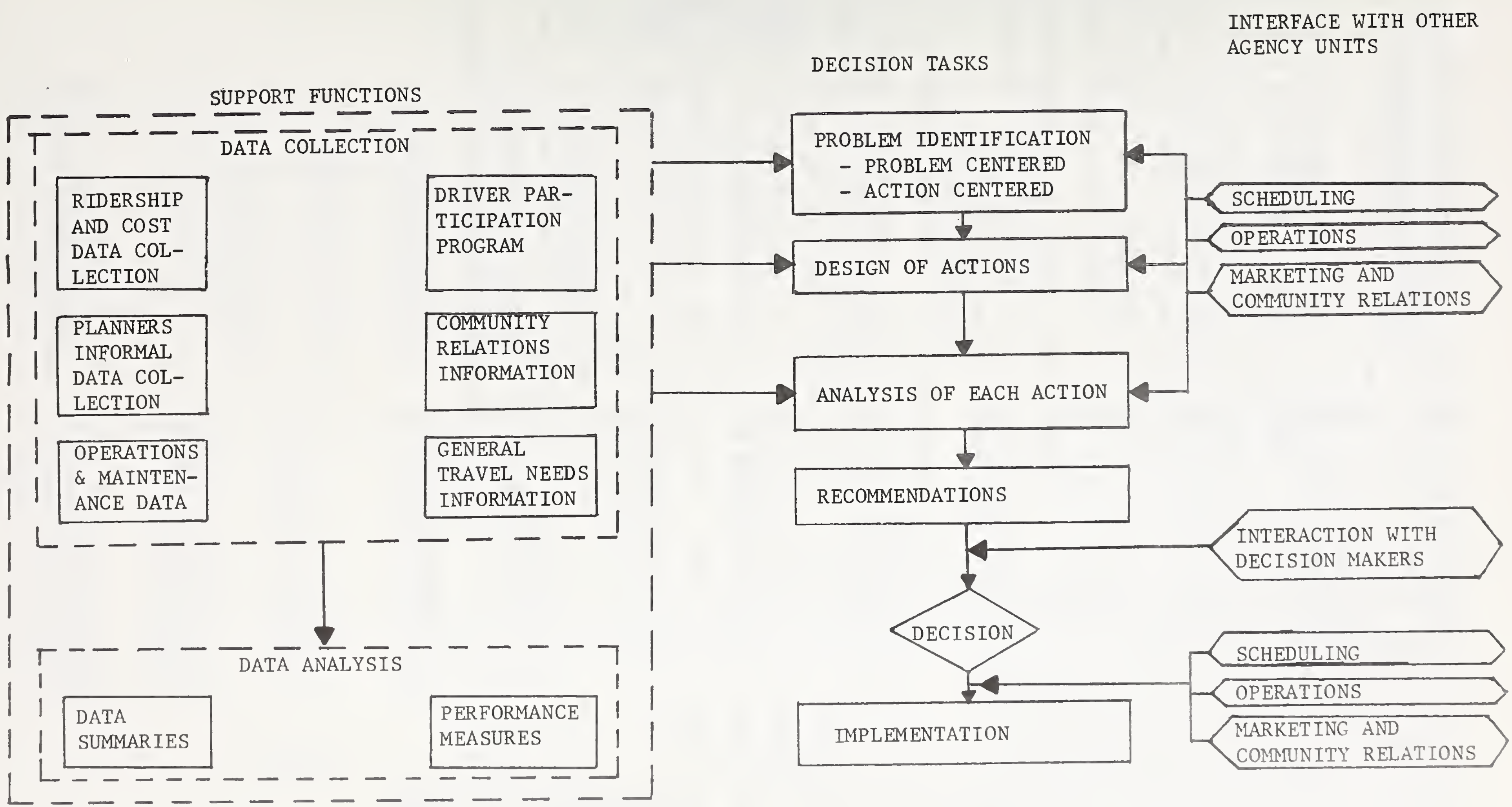

FIGURE 4.2: PROPOSED SHORT-RANGE TRANSIT PLANNING PROCESS

It is important that a good relationship exists between service planning and these functions so that service changes developed in the planning process have a good chance of being successfully implemented.

The scheduling function affects planning in at least two important respects. First the effect of a service change on the cost of operation is critically dependent on the runcutting process, and the planner must understand the way in which the change will affect driver runs if costs are to be predicted accurately. Second, the runcutting process itself often represents a significant barrier to the implementation of a proposed service change, since it is still a costly and time-consuming activity. Finally, the marketing and community relations group should be providing input both early in the process about the types of changes needed, and later in the process in the evaluation of specific changes and notification of the change to the pbulic.

It is difficult to prescribe the processes that will ensure that there are good relationships with these functions. The best approach will depend on the characteristics of the specific transit organization. However, the steps in the proposed STRP approach where input from other parts of the agency is needed can be identified. As shown in Figure 4.2, the central decision tasks in the planning process must be supported by a set of complementary data collection and analysis activities. While several of these lie under the direct control of the planning unit, others require input from the other units mentioned above. It is clear from the diagram that this input from other agency units is necessary throughout the planning process, not just at a single point. It may well be that failure to overcome these organizational barriers to effective cooperation underlies many of the problems with existing SRTP described in the previous chapter, and any improvements which do not encompass organizational factors are severely limited.

TABLE 4.4

SEGMENT ANALYSIS

TRIPNO	DIR	AVGON	AVGON1	PON1	AVGON2	PON2	AVGON3	PON3	AVGON4	PON4	AVGON5	PON5	AVGON6	PON6	AVGOFF
301	1	14.67	6.00	0.41	6.33	0.43	0.33	0.02	2.00	0.14	.	.	.	.	22.00
301	2	25.00	19.00	0.76	0.00	0.00	1.67	0.07	3.33	0.13	1.00	0.04	0.00	0.00	21.33
302	1	7.33	2.00	0.27	3.67	0.50	0.33	0.05	1.33	0.18	.	.	.	.	7.67
302	2	34.00	22.33	0.66	0.33	0.01	5.00	0.15	5.67	0.17	0.33	0.01	0.33	0.01	23.67
303	1	8.33	5.67	0.68	1.33	0.16	1	.	1.33	0.16	.	.	.	.	11.67
303	2	28.00	23.33	0.83	0.00	0.00	0.67	0.02	3.00	0.11	1.00	0.04	0.00	0.00	24.00
401	1	0.67	0.33	0.50	0.33	0.50	.	.	0.00	0.00	.	.	.	.	6.00
401	2	7.33	4.33	0.59	.	.	1.33	0.18	1.67	0.23	.	.	0.00	0.00	4.33
402	1	0.67	0.67	1.00	0.00	0.00	.	.	0.00	0.00	.	.	.	.	2.00

TRIPNO	AVGOFF1	POFF1	AVGOFF2	POFF2	AVGOFF3	POFF3	AVGOFF4	POFF4	AVGOFF5	POFF5	AVGOFF6	POFF6
301	2.00	0.09	5.67	0.26	0.00	0.00	14.33	0.65	.	.	.	.
301	0.00	0.00	0.33	0.02	5.00	0.23	6.67	0.31	5.00	0.23	4.33	0.20
302	0.67	0.09	1.00	0.13	0.00	0.00	6.00	0.78	.	.	.	.
302	0.00	0.00	0.00	0.00	7.00	0.30	13.33	0.56	1.33	0.06	2.00	0.08
303	1.67	0.14	2.00	0.17	.	.	8.00	0.69	.	.	.	.
303	0.00	0.00	0.67	0.03	9.33	0.39	10.33	0.43	2.00	0.08	1.67	0.07
401	2.67	0.44	1.00	0.17	.	.	2.33	0.39	.	.	.	.
401	0.00	0.00	.	.	3.00	0.69	0.00	0.00	.	.	1.33	0.31
402	0.67	0.33	1.00	0.50	.	.	0.33	0.17	.	.	.	.

WHERE:

TRIPNO - trip number
DIR - direction
AVGON - daily average boardings for trip
AVGONi - daily average boradings for trip on segment i
PONi - percentage of daily boardings occuring on segment i
AVGOFF - daily average alightings for trip
AVGOFFi - daily average alightings for trip on segment i
POFFi - percentage of daily alightings occuring on segment i

TABLE 4.5

ELDERLY PASSENGER RIDERSHIP

TIME PERIOD	DIRECTION	DAYS SAMPLED	DAILY SCHEDULED TRIPS	EXPANDED TOTAL	PERCENT OF TOTAL	AVERAGE PER TRIP	90% CL LOWER BOUND	90% CL UPPER BOUND	BETWEEN DAY VARIANCE	BETWEEN DAY COEFF. OF VARIATION	WITHIN PERIOD VARIANCE	WITHIN PERIOD COEFF. OF VARIATION	90% CL ACCURACY
1	1	2	6	14.0	9.5	2.3	1.0	3.6	0.444	0.2857	1.333	0.4949	0.5546
1	0	2	6	12.0	3.9	2.0	0.1	3.9	1.000	0.5000	3.000	0.8660	0.9705
2	1	2	11	133.0	30.9	12.1	10.1	14.1	0.159	0.0330	27.236	0.4316	0.1633
2	0	2	11	63.00	20.9	5.7	4.1	7.4	0.754	0.1516	12.800	0.6247	0.2888
3	1	2	6	18.9	11.2	3.1	1.3	5.0	0.983	0.3155	10.667	1.0392	0.5842
3	0	2	7	22.0	13.3	3.1	1.6	4.6	0.412	0.2041	7.619	0.8783	0.4790
4	1	2	4	0.0	0.0	0.0	0.0	0.0	0.000	.	0.000	.	.
4	0	2	4	0.0	0.0	0.0	0.0	0.0	0.000	.	0.000	.	.

AVERAGE DAILY PASSENGERS OF FARE CATEGORY = 262.9 or 16.4 PERCENT OF TOTAL

PASSENGERS OF FARE CATEGORY FOR FIRST DAY = 275.5 OR 17.5 PERCENT OF TOTAL

PASSENGERS OF FARE CATEGORY FOR SECOND DAY = 250.7 OR 15.1 PERCENT OF TOTAL

4.3 Suggested Step-by-Step Planning Process

An analysis cycle in short range transit planning can be initiated in any of the following ways:

a) Standard analysis of routinely collected data
b) Complaint or suggestion from employee (e.g. operator, supervisor or checker)
c) Passenger or community complaint or suggestion
d) Special study
e) Mandate from management regarding changes in budget, vehicle, or operator constraints

In the first four cases a single step-by-step analysis process can be followed consisting of identification and resolution phases, while in the final case, the mandate identifies the problem and the analysis process focuses directly on resolution.

4.3.1 Identification

Once an analysis cycle is initiated by any of the activities defined above, the identification phase of the analysis is entered to define the situation more clearly. Thus the identification phase focuses on the collection and analysis of data and other information, typically at the single route level. Completion of the identification pahse of an analysis results in one of the following conclusions:

- there is no problem (opportunity) worth further analysis
- there is a problem (opportunity) which warrants further analysis

In the latter case the analysis cycle moves into the resolution phase, otherwise the analysis ends.

Identification typically involves the following three steps:

1. Obtain information
2. Is the information sufficient to assess problem?
3. Is there an important problem?

The complete identification process is shown in Figure 4.3 and each of the steps is described below.

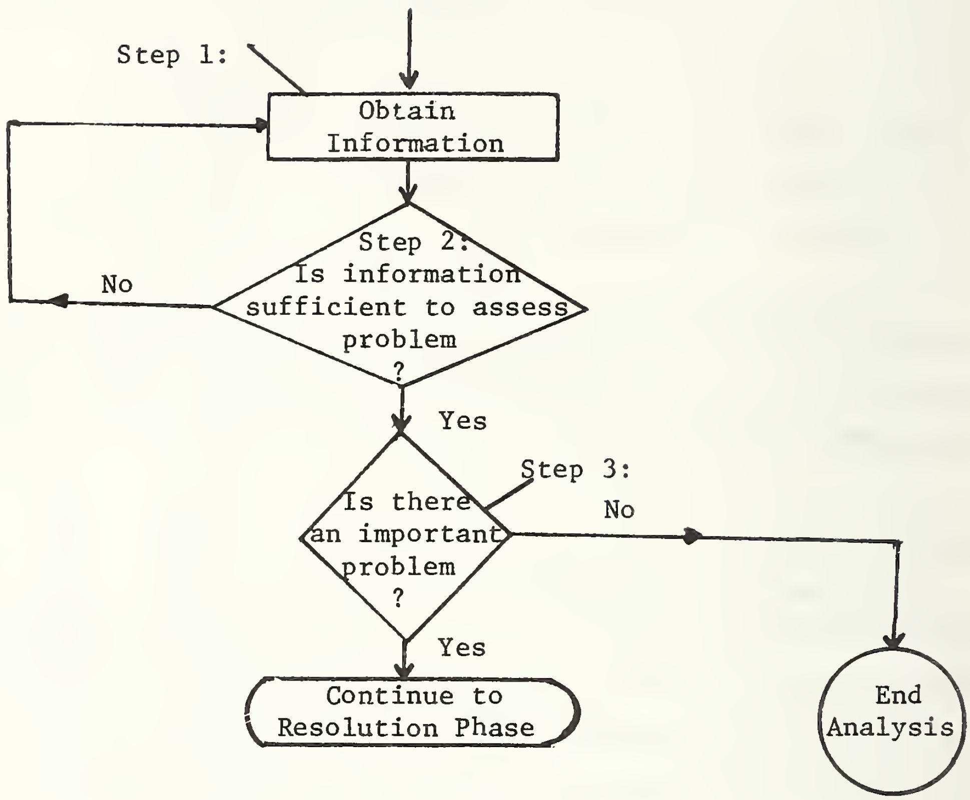

FIGURE 4.3: IDENTIFICATION PHASE

Step 1: Obtain Information

The main task in the identification phase is to collect, organize and analyze data and other information. Each of the actions which can initiate an analysis cycle will have some information directly associated with it, however the characteristics of the information will vary greatly. Table 4.7 summarizes the information contained in each possible initiative action in terms of its reliability and completeness for analysis purposes. Each stimulus will require a different response in this first step of the analysis process.

In a standard analysis of routinely collected data the data collection activity should provide the basic information for the identification analysis but often complementary data which exists in the agency must be combined to form a full picture of route operations. For example a monitoring program based on a single point count will allow a determination to be made about the existence of overcrowding, but if there has been a recent ride count this will help in the assessment of the significance of the problem. So this step would entail diverse sources of information which may be pertinent to the problem.

In the cases of complaints or suggestions originating from inside or outside the agency the level of completeness and reliability of the information is likely to be highly variable. In this step of the analysis, apart from bringing together any relevant data which may exist, an effort would usually be made to see if similar complaints or suggestions had been made previously and if they had whether any analysis and action had been undertaken.

In the case of special studies the information obtained is usually quite complete and reliable since such studies are designed with specific problems or opportunities already in mind. In some cases a special study may suggest a specific situation which was unanticipated and in those cases further information may need to be obtained.

In dealing with a management mandate it will be necessary to pull together all information pertinent to developing an appropriate response, but the type of information needed will vary greatly depending on the type of mandate.

TABLE 4.7

INFORMATION QUALITY

Initial Stimulus	Reliability	Completeness
Routine data	Generally high reliability. Some types of data are more trusted than others.	Usually covers the time period in question but may not adequately describe problem.
Employee Complaint (Suggestion)	Variable; the higher up the employee the more trusted.	Complete in both describing problem and when/where it occurs; lacks detail.
Passenger or Community Complaint (Suggestion)	Low reliability for individual complaints. More reliable when multiple complaints are received.	Incomplete; gives user view of problem which may not correspond to actual problem.
Special Study	High reliability	Complete description of problem.
Management Mandate	High reliability	Generally incomplete, may mandate net impact, but not type of actions.

At this stage, and throughout the analysis cycle, it is critically important that the raw data gathered in the field is summarized and easily accessible. For this purpose the use of computer data bases with convenient and powerful data base management systems is strongly recommended. It is also important however to retain the raw data because in later stages of analysis, after a problem (opportunity) has been identified, this detailed information may well be central to resolution.

Step 2: Is the Information Sufficient to Assess Problem

This stage in the identification process determines whether the information available from Step 1 is sufficient to assess whether an important problem (opportunity) exists. Again the actions taken here will depend on the initial stimulus for analysis.

For the routine data collection cycle there will be many cases in which sufficient information exists to assess the existence of and importance of a problem (opportunity). In other cases however the initial data will either not be accurate enough, or not be detailed enough to make this assessment. For example the productivity on a route may have dropped to a critical level, but in order to determine whether a full analysis is in order it may be appropritate to gather additional ride checks to increase the confidence in the true productivity. For other routes with higher productivity, this second round of checks will be unnecessary. In another case point counts on a heavy ridership route may be high enough to suggest introducing zonal, or express service, but ride checks or multiple point checks are then needed to ascertain where high potential exists.

For complaint or suggestion initiated analyses it will often be necessary to conduct some additional field data collection activity or a special study to obtain sufficient information for a definitive assessment. Complaints and suggestions are difficult to use to identify real problems (opportunities) since considerable staff time can be involved in each investigation. Consequently at this stage the planner may want to screen the cases to see which should be pursued. If there are more pressing problems to tackle or staff time is at a premium, it may make sense not to gather further information immediately, but to wait for a future opportunity to pursue it further.

Whether or not additional information is required, eventually sufficient information is obtained to move to the final step in the identification process.

Step 3: Is there an Important Problem?

In this step the decision is made whether to terminate the analysis or to pursue it to the resolution phase of the analysis cycle. At this stage there is no strong link back to the initial stimulus for the analysis, rather there are a set of situations, each of which is defined well enough to determine whether a problem (opportunity) really exists and if so whether it is worth pursuing at the current time.

Clearly if there is nothing to indicate a problem, then the analysis is complete; and no action is taken. For example, a peak load count on a route may show an average load factor of 90% during the offpeak hours, when the acceptable range is defined as from 50% to 125%. In many situations, however, the decision will not be so clear cut.

There are two methods that can be used to make this decision--service measures or service standards and judgment (by an individual planner or through roundtable discussion). Service measures and standards are best suited for numerical data but may be used for other types of information, e.g. if more than X complaints are received about a problem, then action should be taken. Intuition and judgement may also be applied to numerical data, as well as to complaints, suggestions, and recommendations. In some cases, such as a systemwide crisis, this step may be perfunctory, i.e. action is mandated, but in most cases, the final decision on whether or not there is a serious problem rests upon the judgment of the planner supplemented by data and service standards. The more simple the problem, the easier it is to apply service measures or rules of thumb based on informal standards.

Clearly, thinking of the complete analysis cycle, the set of cases which move into the resolution phase will be strongly influenced by the financial environment in which the planner is functioning. If budget cuts are needed the resolution will focus on those problem routes on which resource savings should be possible while an expanding budget would lead to consideration of opportunities for improving service. In general separate sets of routes where savings and service improvements should be possible should emerge from this identification phase.

4.3.2 Resolution

Just as there were five possible stimuli which could initiate the identification phase of the analysis cycle, there are four general scenarios for the resolution phase:

A. Simple or Obvious Solution - typically the change is a small one and is easy to implement. A classic example would be the addition of a bus to peak hour service on a route with unreasonably high load factors. Such solutions will usually be associated with straight-forward problems identified by either routine data collection activities or by complaints.

B. Single Pre-specified Solution - typically a suggestion has been made for a service change and the resolution process considers only this, perhaps with minor alterations, and no others. For example a suggestion has been made to detour an existing route to serve a new apartment complex. The resolution phase will focus on the desirability of this specific suggestion.

C. No Obvious Solution - several potential solutions must be developed and evaluated before a judgment is made to change service. For example a community requests service to a suburban mall but there are several routes which could be modified to provide the service and each potential solution must be developed and analyzed to select the best modification. This resolution scenario is often associated with complaints, suggestions and special studies and is often the case when a problem has been identified but its root cause remains uncertain.

D. Mandate - corresponding to the mandate which initiates the analysis, the net effect to be achieved is specified but the resolution phase focuses on what set of actions are best suited to achieve this impact. For example the bus availability will be decreasing due to major maintenance required on the complete fleet; the resolution process will focus on where the required peak hour cuts in service should be made.

Resolution begins with the problem definition and ends with either implementing a solution, submitting a proposal for change to upper management for approval or deciding that no change in service is appropriate. While the resolution process differs among the scenarios defined above, in its most general form it encompasses the following four steps (see Figure 4.4):

4. Conceptualize Options
5. Sketch Options
6. Evaluate Options
7. Detailed Design of Selected Option

The first two steps in the resolution process may be considered the alternatives generation part of the planning process. Option conceptualization should occur only once during an analysis cycle, but depending on the complexity of the problem, it may be necessary to iterate through the next two steps, sketching and evaluating options. More typically though all ideas will be sketched out initially, and a selection made among them in the evaluation step of the resolution process. Each of the four main steps is described below.

Step 4: Conceptualize Options

Depending upon the problem at hand, the distinction between the last step of Identification, deciding whether a situation is important enough for further analysis, and the first part of Resolution, conceptualizing options, may be blurred, particularly if the same person handles both steps. The distinction between the two is that deciding whether the case is worth pursuing is primarily concerned with the priorities of the agency and the impact of the problem, while conceptualizing the options is concerned first with understanding the root causes of the problem and the promising strategies for its resolution.

This task includes a clear definition of the situation itself, the constraints which will affect the resolution process (political and financial), and the priorities in seeking a solution. Defining the situation and the constraints is rather straightforward and is based on the available information, the planner's general knowledge about the route, and the general situation of the transit authority. Setting priorities is often more difficult, particularly with complex situations which may not be addressed in the service policy, even if such a document exists. These priorities often involve tradeoffs among different aspects of service quality, for example consolidating two

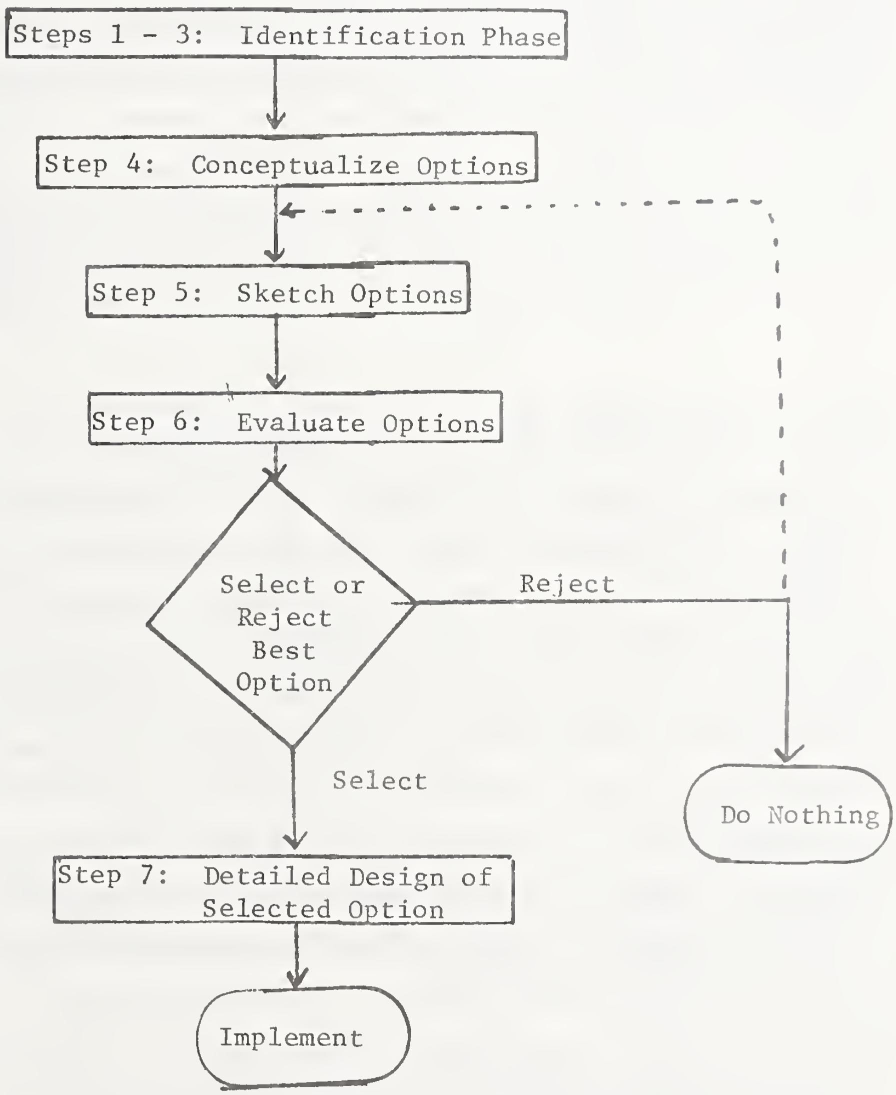

FIGURE 4.4: THE RESOLUTION PROCESS

parallel routes into one will involve greater walking distances for many passengers but shorter average wait times; in developing options how should walk distance and wait time be traded off? Tradeoffs between operator cost and passenger service quality also have to be established for use later in the elimination of infeasible or undesirable options and to ensure consistent decisions.

This step also involves considering the range of possible options and eliminating those which are unlikely to be feasible, i.e. an initial screening of options. The result of this conceptualization is a set of potentially feasible ideas that are ready to be sketched out. Referring back to the scenarios defined at the start of this section, this conceptualization step is most important under scenarios C and D where a complex situation exists with no clear strategy. One good example would be a high ridership corridor which might be suitable for express service or any of several types of zonal or restricted service; option conceptualization would determine which options are worth serious investigation given the specific corridor characteristics.

Step 5: Sketch Options

In this step each of the options identified in the preceding step would be defined in sufficient detail to allow a full evaluation. Typically this will entail specification of route alignment, service frequency, running time and change in number of buses and in bus-hours associated with the service change. Depending on the option being considered this step might be quite elaborate, as in the case of restricted zonal service, or straightforward, as in the case of a service frequency change. Again depending on the resolution scenario a single option might be developed or several options for each of several different concepts. For example in the high ridership corridor case the two concepts of restricted zonal and overlapping zonal might be developed with two alternative zone structures for each concepts - making four options which would be defined in this step.

Step 6: Evaluate Options

This is the analysis step in the resolution process which focuses on the elimination of undesirable options and the selection of rejection or the best option. In this evaluation it will ususally be necessary to estimate the changes in both operating cost and revenue associated with each option. Typically causal factor models will be used to make the cost estimates but demand, and hence revenue, changes will often be estimated by judgment.

Some options may be rejected at this point because they would violate adopted policies or priorities or are undesirable in terms of impacts on either operating cost or passenger service quality. The best of the remaining options is then selected, typically based on a subjective comparison of the impacts associated with each. Finally the best option is either accepted or rejected as a change from the status quo using the same sort of subjective evaluation, but incorporating the "transaction costs" associated with implementing the change, which may include scheduling effort, public information and public hearings.

If the best option is rejected then either the analysis cycle terminates or an attempt is made to sketch out new options. If the best option is accepted then the detailed design step is begun.

Step 7: Detailed Design of Selected Option

When a resolution option has been selected, the final task is to develop it to the point of implementation. This entails building a new schedule with associated driver runs and making sure that no technical barriers exist. Meetings with the affected communities or a formal public hearing may be needed to review the change before implementation. This step serves two purposes: to catch any flaws before implementation so that the strategy can be altered if necessary, and to have it ready for implementation without undue delay upon final approval.

Clearly the effort required for resolution is a function of the problem complexity and magnitude. At the route frequency level, most problems are clearly defined by the information which identified the problem, and the resolution process is straightforward. For more complex problems at the route structure, area coverage, or system levels, typically all four steps in the resolution process are required, and there may well be a need for formal design and impact prediction models in Steps 5 - 7 of the process.

CHAPTER 5: SUMMARY AND CONCLUSIONS

Transit authorities in the 1980's face many difficult problems, including changing ridership patterns, spiraling costs of providing service, new Federal regulations, and changing sources and amounts of funding. It is essential that a transit authority be able to respond to these changes and that it operate as efficiently and effectively as possible given the external environment. To do this, an agency must be able to respond quickly and effectively to both internal and external changes. It must be able to assess rescurce utilization and outstanding needs and be able equitably to allocate available resources accordingly. This requires that a transit authority have a short range planning process to identify which problems should be dealt with and which strategies should be implemented to resolve them.

The research described in this report explored the service and operations planning process in the transit industry in a two-phase approach. In the first phase a detailed assessment of current short range transit planning practice was undertaken through a survey of a dozen transit properties and a detailed investigation of two properties. This phase of the research provided a fuller understanding of the existing process, the constraints which any changes in the process should satisfy, and the weaknesses both as recognized by the planners themselves and as identified by disinterested observers. From this base, the second phase suggested a framework for structuring improvements to the planning process to deal with some of the more significant deficiencies.

The survey of current practice identified five critical weaknesses which frequently were perceived to have a negative impact on the outcome of the planning process:

a) unavailability of adequate and reliable information on current performance
b) difficulty in adhering to the agency's goals and standards
c) internal and external political pressures
d) lack of inter- and intra-agency cooperation
e) an artificially limited set of feasible options

In the development of the proposed modifications to the short range transit planning process, the existing process was used as a starting point. Modifications were suggested to deal with some of the above weaknesses, in recognition of the following characteristics of the planning context:

1. Properties are pursuing multiple goals, and often different goals are associated with different routes and periods of the day. Analysis must be structured at a detailed enough level to allow performance to be assessed against each objective for each period of operation.

2. Short range planning is only one (typically rather small) activity within a property, and its effectiveness depends on the interfaces with other elements of the organizaiton. Only by considering these interdependencies can it be ensured that actions recommended by planning will be acceptable to the organization as a whole.

3. Planning resources are and will remain tightly constrained, so it is important to focus on services with high potential for positive payoff.

4. Planners must be able to respond quickly and effectively to changes in the operating situation of the property, such as unexpected changes in budget.

5. Since the state of the art in transportation systems analysis is far from perfect, quantitative methods should be used to supplement the planner's judgment and experience, not replace it.

Perhaps the most important change suggested in the planning process is to move away from an exclusive reliance on problem centered screening of services requiring study and possible change. This reliance, which is tied to the widely accepted practice of setting service standards and flagging "substandard" routes, may mean that the planner does not consider opportunities which may exist for improvement on routes with "acceptable" performance. For example, strategies such as segmenting service on a route into express and local portions, establishing service zones, or having some vehicles deadhead in the lightly travelled direction to improve productivity are never likely to be viable on "problem" routes, yet they may be quite useful on high ridership corridors. By improving productivity on such routes, resources might be made available to better tackle the true problem routes. Thus a second focus of attention to be added to the problem-centered approach would be an action-centered screening to identify opportunities for improvement on routes where no problems exist. Modifications were also proposed to recognize the multiple objectives that transit operators are striving to achieve and to deal with the problem of the presentation of data in forms more directly useful in planning.

A general seven-step planning process was suggested incorporating the findings of the survey of current practice and the proposed modifications. This process was organized around the two major elements of problem identification and problem resolution. The suggested Short Range Transit Planning Process can be applied to most transit authorities because it draws its structure from current planning practice, but is designed to ameliorate problems in that process.

By adopting the approaches outlined in this report, it is possible both to examine critically a transit authority's planning process and to formulate a new, or restructure an existing, planning process. The strength of the approach comes from a knowledge of the component tasks and decisions of the planning process and an understanding of the factors that influence and shape it--notably, what data and information are available, what methods of analysis may be employed, and what are the relevant constraints. A change in the structure of a transit authority's planning process will rarely be effective unless it is accompanied by changes in the planning tools and how they are used. Similarly, it is ineffective to introduce new planning tools into the process unless there is a thorough understanding of their strengths and weaknesses and how they can best be used within the planning process. In summary, the structure of the planning process provides a solid basis for effectively and efficiently using a transit authority's planning resources.

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