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Contents

Our troubled planet can no longer afford the luxury of pursuits confined to an ivory tower. Scholarship has to prove its worth, not on its own terms, but by service to the nation and the world.
— Oscar Handlin

Factor Analysis for the Study of Determinants of Public Transit Ridership

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Abstract

Behavioral studies based on attitude survey questionnaires with numerous variables may be tainted with repetitions and correlations. To overcome these deficiencies, a factor analysis approach is demonstrated that produces clusters of uncorrelated factors. From 47 observable variables contained in the Ottawa-Carleton Transportation Commission (OC Transpo) attitude survey, only 8 underlying factors have emerged. Bus information service is the most important factor. In addition to factor analysis, this article reports on a logistic regression model, based on key factors, for estimating the odds of ridership.

Introduction

Public transportation agencies undertake attitude surveys in order to identify the factors that affect public transit ridership. The questionnaires are designed to elicit responses on a large number of variables. However, analysis of data collected may be deficient due to repetitions and correlations. In order to obtain useable answers from a large number of survey responses, advanced statistical analyses are required.

In this research, a factor analysis approach was defined for removing anomalies and to produce clusters of uncorrelated factors using a large number of observed variables. The identification of the key factors that serve as determinants of public transit ridership would assist in developing policies, strategies, and tactical measures for attracting riders. This article describes the factor analysis methodology and reports its application to OC Transpo's attitudinal survey data. Additionally, the development of a logistic regression model is described that can explain ridership. The identified key factors are used as independent variables to estimate the odds of ridership.

Methodological Framework

The study methodology consists of six components. At the outset, the public transportation characteristics of the National Capital Region (Canada) are introduced. The attitude survey data collected for the OC Transpo are described next. The third section covers the theory of factor analysis and describes the rationale for its application to this research. Factor extraction and interpretation are noted next. The analysis of a large database and tests for reliability and validity are explained. In this part of the research, each individual variable was coded, missing values were discarded, and response-oriented variables were identified. This process yielded 47 variables. By use of factor analysis, these variables were reduced to a small number of individual entities called "factors" and were given labels to suit the current knowledge regarding bus service. The factor analysis results yielded the order of importance of these determinants of ridership.

In the fifth step, the newly labeled factors were used as independent variables for the study of the dependent variable of ridership. The logistic regression analysis enables the estimation of the odds of bus ridership and the relative importance of factors included in the model. In the final section, conclusions are reported and actions to be taken are described.

Public Transportation in the National Capital Area (Canada)

The National Capital Area (NCA) consists of the Regional Municipality of Ottawa-Carleton (RMOC) and the Outaouais Urban Community (OUC). In the RMOC, the OC Transpo provides public transit services for about 0.7 million persons (Figure 1). As compared to other transit agencies serving medium-size urban areas, OC Transpo ranks favorably in terms of transit trips per capita.

A bus rapid transit system is available based mainly on an exclusive bus roadway, the Transitway (Zargari and Khan 1998). In the central business district, exclusive bus lanes are provided in mixed-traffic environments. The Transitway is an access-controlled, grade-separated, two-way rapid transit facility. It enables travelers to minimize the number of transfers through the extensive use of suburban express services in peak periods. Stations are designed to provide a comfortable, sheltered, and secure environment for passengers while they are waiting for buses.

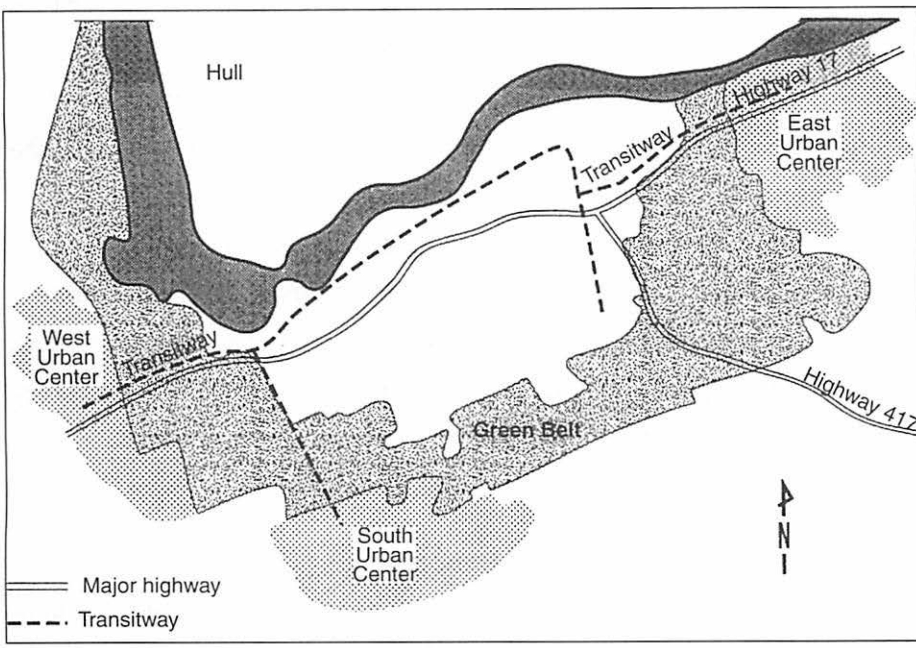

Figure 1. Transitway in the regional municipality of Ottawa-Carleton (Canada)

Bus information is provided through printed schedules and maps, video screens, and dial access to OC Transpo's public information office (Gault 1995). Bus arrival information provided to the public is based on scheduled times. Although in recent years, OC Transpo has installed an automatic vehicle location and control (AVLC) system on selected routes, the information provided by this system is not available to potential users through a state-of-the-art advanced traveler information system.

Attitude Survey Data

Surveys have been used by the OC Transpo since 1988 for tracking attitudes in support of policy formulation, planning, and marketing of services (OC Transpo 1995). The surveys feature questions designed to yield information on user characteristics and attitudes toward services and facilities provided by the transit authority. The OC Transpo's analyses produce weighted frequencies of responses. In this research, the 1995 Attitude Survey data were selected for detailed analysis based on advanced statistical methods.

The survey was designed and conducted by the Carleton University Survey Centre. Trained interviewers fluent in English and French were employed. The sample was extracted from telephone numbers. The survey design took into account representative samples across age groups (18 years and older), and care was taken to ensure proper representation from all parts of the RMOC. Prior to actual use, the English and French versions of the questionnaire were tested. A total of 2,000 telephone interviews were completed. According to the Survey Centre, the sample was representative of residents living in areas served by public transit and is accurate to 3 percent (19 times out of 20).

Factor Analysis: Technique and Rationale

Factor analysis as an advanced statistical technique was described by a number of authors. See, for example, Kim and Mueller (1981) and Harman (1976). It is an efficient performer of data analysis and achieves variable reduction by defining a set of factors extracted from the variables in the database. The principal component analysis was chosen for this purpose. Factor loadings are obtained by squaring the correlation coefficient of the variables concerned. In a factor model, the factor loadings and their signs are important items of information. The highly loaded factors provide a reliable basis to explain transit ridership. Therefore, factors with high loadings are retained in the model structure and the lightly loaded are discarded. The threshold for such retention or discarding depends on the percentage of variance explained by the respective indicators.

The attitude toward ridership of public transit is dependent on variables that in the original version may be tainted with shallow perception of the questions answered, indifference, or mere capitulation to a "sought-after" question clearly manipulated. Some of these questions and answers may simply be vague. Factor analysis is expected to overcome these anomalies by creating clusters of observed variables.

Factor Extraction and Interpretation

For factor extraction, Cattell's Scree Test was used. As shown in Figure 2, it is a plot of unrotated factors versus the proportion of total variance or eigenvalues. In the scree plot, there is a negative slope, decreasing from factor number 1 to 6 and then it seems to level off and slope further down and level off again. The point corresponding to the first scree may initially determine the number of factors that should emerge. However, subjective judgment is required to determine the level-off point. Details on factor extraction process are presented below.

Tables 1 through 8 show clusters for selected factors. The factors, their respective share of loading (variance), the original variables, and their factor loadings are also shown. In these tables, 35 out of 43 variables are accounted for by these factors.

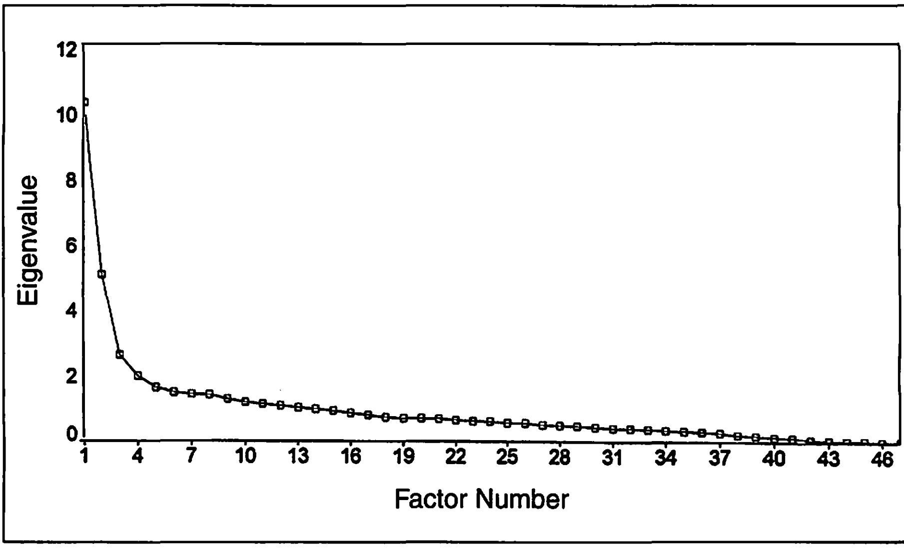

Figure 2. Factor scree plot

Table 1
Bus Information Cluster

Factor and % Loading	*Original Variable Descriptions*	*Factor Loading*
Bus information 22.1%[a]		
	Do you call customer service?	0.93805
	Do you use the timetable?	0.91546
	Called OC Transpo Information Centre	0.89160
	Drivers describe stops	0.88163
	Use TV screen	0.87487
	Have system map	0.87453
	Pick up other information	0.87021
	Heard of Easier Access Program	0.87012
	Use 560 telephone system	0.86284
	Use printed schedules at stops	0.85484
	Bus information	0.70452
	Information accurate	0.59465
	Yes—seen bus kneeling[b]	0.54846
	How often (560 telephone system)?	0.41828

a. Percentage of variance explained by the factor.
b. Kneeling is a hydraulics function whereby the bus is lowered down so that its first step lines up with the curb level for easier access.

Table 2
On-Street Service Cluster

Factor and % Loading	Original Variable Description	Factor Loading
On-street service 10.9%	Bus service unreliable	0.73673
	Bus frequency adequate	0.73021
	Bus routes well planned	0.58765
	Taking bus frustrating	0.58233
	Bus not easy to use	0.57367
	Transfers are convenient	0.46835

Table 3
Customer Service

Factor and % Loading	Original Variable Description	Factor Loading
Customer service 5.6%	Information accurate	0.87169
	Information courteous	0.86992
	Information Centre easy to get through	0.73616

Table 4
Cleanliness Cluster

Factor and % Loading	Original Variable Description	Factor Loading
Cleanliness 4.3%	Transitway stations are not kept clean	0.69639
	Bus shelters clean	-0.66766
	Buses not kept clean	0.74036

Table 5
General Attitude Cluster

Factor and % Loading	*Original Variable Description*	*Factor Loading*
General attitude 3.5%	Taking buses benefits the environment	0.80120
	It is reasonable for people to stand sometimes on rush-hour buses	0.59456
	No matter where I live, I will always avoid taking the bus	-0.5090
	The Transitway has improved bus service for me	0.42273

Table 6
Transitway Station Safety Cluster

Factor and % Loading	*Original Variable Description*	*Factor Loading*
Transitway station safety 3.2%	Transitway station safe	0.83010
	Why not use Transitway station	0.80022

Table 7
Security Cluster

Factor and % Loading	*Original Variable Description*	*Factor Loading*
Security 3.1%	Personal security at night in multistoried parking lots	0.66647
	Taking bus at night no threat to security	0.63321
	Personal security at night while walking in neighborhood	0.56441

Table 8
Reduced-Fare Cluster

Factor and % Loading	*Original Variable Description*	*Factor Loading*
Reduced fare		
2.6%	Peak-hour trip too expensive	0.75583
	Bus pass good buy	0.42952
	Good deal during off-peak hours	0.39000

Factor Extraction Process

By rule of thumb, the factors with eigenvalues equal to or greater than 1 are included in the factor model and their factor loadings are calculated. Another procedure to determine the number of factors for a factor model is by drawing a plot of eigenvalues as the ordinate with the respective variables as the abscissa. There will be a noticeable scree (i.e., a horizontal leveling off followed by another slope downwards). This corresponding number of factors is taken into the factor model.

Next, a factor matrix is created with all the variables sharing these factors. The coordinates are rotated orthogonally, say 45 degrees, for simplification of observation and interpretation. From the rotated table, if the loadings are sorted in order of magnitude and the lower values of loadings are blanked out, distinguishable clusters should emerge.

The premise of factor analysis is that the correlation between variables is due to a sharing of common factors. Factors may be orthogonal (i.e., they are located in an axis perpendicular to each other or they may be oblique, in which case their axes are not perpendicular with one another). In this research study, orthogonal analysis has been done using the Varimax rotation method.

The ridership index was analyzed for reliability. It shows an 89 percent scale reliability. Next, the underlying dimensions of ridership were examined. This process required the assessment of the correlation matrix of all 47 variables. To share common factors, the correlation between the observed variables must be high. Another step was a sample adequacy test. The Kaiser–Meyer–Olkin (KMO) measure of sample adequacy is derived from correlation information and shows if the data are suitable for factor analysis or not. Values of this measure above 0.7 can be regarded as acceptable. The following results were obtained in this analysis:

KMO Measure of Sampling Adequacy = 0.79589
Bartlett Test of Sphericity = 12835.64; significance = 0.00000

The Bartlett Test of Sphericity examines the hypothesis that the correlation matrix is an identity matrix with a diagonal as 1 and off-diagonal values as 0. In this case, this hypothesis is not true. Therefore, factor analysis is feasible with the 1995 database.

At this stage of analysis, the factor extraction procedure commences. As noted previously, there are several methods of this extraction. Here, the principal component analysis was chosen and each variable was standardized to have a mean of 0 and a standard deviation of 1 and therefore variance of 1. The factor loading was obtained by squaring the correlation coefficient of the variable concerned, which denotes the variance of the variable. In the case of principal component analysis, total variance was calculated. After factor extraction, the communalities have been recalculated for finding the actual variance.

In the next step for factor extraction, Cattell's Scree Test was used (Figure 2). The Varimax Orthogonal rotation was carried out. Compared to the unrotated matrix, this rotated matrix has resulted in a more interpretable set of constructs. This was made possible by means of Varimax rotation, which converged in 15 iterations. The Varimax rotation used maximization of variance of squared loadings for each factor.

The final step was to calculate the factor scores. This was done by studying the product of the standardized value of a variable and its factor score coefficient, and summing them up separately under each factor for each variable. Another test, the Direct Oblimin method, was used to determine if the fit between data and factor structure could be improved. However, no improvement occurred. In obtaining the structure, the lower magnitude (≤ 0.39) loadings were blocked out in the rotated matrix in order to show the clusters more distinctly.

Logistic Regression Analysis

A logistic regression model was developed to obtain the odds of ridership. This mathematical model for factor analysis is somewhat similar to a multiple regression equation. However, each variable is expressed as a linear combination of factors that are not actually observed (Pedhazur 1982).

In this model form, the dependent variable is binary in nature with two probable values (i.e., 1 = ridership occurring, 0 = not occurring); the multiple linear regression analysis and the discriminant analysis techniques pose difficulties (Norusis 1990). Therefore, logistic regression was chosen as the appropriate technique in this analysis.

A number of models were developed and tested through the likelihood ratio by introducing one factor at a time and noting the change in the log likelihood. The likelihood ratio tests the null hypothesis that the coefficient for the last variable added to the model is 0.

Table 9 shows the model that incorporates the top eight factors. The odds ratio is used to assess the effect of the independent variable on the dependent variable in terms of the likelihood of the event that is coded as 1 (in this case it is ridership). The value that is greater than 1 indicates a positive effect of an independent variable on the dependent variable. The value that is less than 1 indicates a negative effect. The maximum-likelihood method was used to find the coefficients for the factors included in the model.

The goodness of fit of the model was examined by deriving the Pseudo R^2 square and R_L^2. The change in Pseudo R^2, due to inclusion of a factor in the

Table 9
Logistic Regression Model (dependent variable: ridership)

Interpreted Factor Label	Odds Ratio
Bus information	91.221[a]
On-street service	2.1712[a]
Customer service	1.6885[b]
Cleanliness	1.0769
General attitude	0.7376
Safety: Transitway station	1.7356[b]
Safety: En route	1.0814
Reduced fare	1.3611
Pseudo R^2	0.800
R_L^2	0.523

a. $p < .05$; two-tailed-t test.
b. $p < .10$.

regression model, is an indicator of the unique information provided by that variable. These are used as indicators of relative importance of the respective factors as per their magnitudes (Table 9).

The high importance of a particular factor reflects respondents' perception of attributes of public transportation. The inclusion of questions on attributes is based on management's requirement for information. For example, bus information-related questions in the OC Transpo's attitude survey are due to the company's desire to learn about the impact of some of the new services provided by them. The high relative importance of that factor reflects attitudes of respondents. The combined results obtained from the factor and logistic models are mutually reinforcing in terms of establishing factor ranks.

Conclusions and Implications

This research has identified key factors on the basis of factor analysis for making urban transit bus ridership more attractive to RMOC residents. On the basis of percentage variance explained by various factors, the following is the hierarchy of factors:

- bus information, 22.1 percent;
- on-street service, 10.9 percent;
- customer service, 5.6 percent;
- cleanliness, 4.3 percent;
- general attitude, 3.5 percent;
- transitway station safety, 3.2 percent;
- personal security, 3.1 percent; and
- reduced fare, 2.6 percent.

On the other hand, the logistic regression results show a slightly modified order of importance: bus information, on-street service, station safety, customer service, safety en route, reduced fare, cleanliness, and general attitude. Taken together, a knowledge of these factors could be used to develop strategies, tactics, and operational measures to enhance ridership.

Bus information service is the most important factor cluster compared to others. The implication of this result is that all state-of-the-art user information systems that are not currently available in the Ottawa-Carleton region should be implemented on a priority basis. For example, real-time bus arrival information should be provided at stations, other locations such as shopping centers, and also through the telephone system (Eno Transportation Foundation 1998; *Urban Transport News* 1997; U.S. Department of Transportation 1996). This can be achieved by using Intelligent Transportation Systems (ITS) technologies, for example, based on Global Positioning Systems (GPS). Without a high-quality pervasive bus information system, it would be difficult even to keep regular bus users in the fold of bus transit.

On-street service is next in the order of relative importance. It includes reliability of service, adequate bus frequency, well-planned routes, convenience at transfers, level of service, etc. Potential riders, though unconsciously, will assess the conditions of the various components of this service before switching from cars to bus. To provide an excellent on-street service, the bus company should increase its fleet of buses so that adequate frequency of service can be maintained. All these new purchases should include a variety of buses to suit different demands at different times and places. Travel time should be within a threshold of tolerance, determined through surveys. Technological and institutional concerns, operational and environmental performance, financial performance, standard of service including passenger waiting time, walking distance to stops, the need to interchange between routes and services, passenger journey time, passenger travel expenditure, and affordability are to be incorporated in the on-street service planning. Expansion of the rapid transit service by building Transitway extensions and reduction of congestion in mixed-traffic environments in downtown would help in enhancing on-street service.

Safety and security concerns should be addressed in the Transitway stations, in the access and egress routes, and inside the bus itself, especially at night. This would improve ridership. Safety concerns in Transitway stations, inside buses, and in the neighborhoods can be further improved by implementing in full, measures such as emergency push-button telephones at all stations, vigilant security patrols at night in remote areas, and improved street as well as platform lighting at current sites as well as new ones.

Customer service improvements are necessary to make riders happy and to improve general attitudes toward bus transit service. Bus operators, ticket sellers, telephone operators, and others responsible for customer service should be courteous to passengers. Customer service should be given a high profile while planning strategies to enhance bus ridership.

According to the model, a reduced fare should improve ridership considerably. Although it is difficult to implement, given that public transit is a subsidized service, it deserves a closer examination. Keeping fares low through efficiency improvements is a worthwhile goal. Employers may offer transit fares as incentives instead of free parking. Fare reduction may also be achieved by transitioning to privately run, high-efficiency transit services.

The cleanliness factor has a number of implications. Riders prefer to travel in a bus that is sprightly clean. Also, the bus should be plying on roads that are kept clean from snow, dust, and dirt. Additionally, buses should be perceived as environmentally clean. This could be achieved by using low-pollution, alternative-fuel buses.

The general attitude can be positively influenced through carefully designed marketing means such as advertisements, which portray the numerous benefits of using public transit (Deka 1996). The benefit that comes to the forefront is the environmental one. The public's general attitude is also influenced by, among other things, comfort and convenience and other level-of-service (LOS) features. For example, if people perceive that using mass transit not only frees road space but also removes emissions, noise, and accident hazards, ridership should get a boost.

The public's general attitude cannot be changed easily. For this, direct intervention will be necessary. For example, advertising the benefits of using public transit can motivate people to use this mode. Also, information services can incorporate some advertisement features through ITS technologies. Imposing charges on single-occupancy-vehicle users can also turn around a negative attitude toward public transit.

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The Role of Information in the U.K. Passenger Rail Industry

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Abstract

In 1993, the U.K. passenger rail industry was privatized with expectations of greater investment, increased efficiency, and improved network performance. To date, progress has been mixed and the industry has been subject to a critical national press and passenger complaints that have reached record levels. The industry is continuing to develop a service that can do justice to its privatization. Passenger information is an important aspect of these improvements and national rail journey planning services are now heavily used. However, relatively little consideration has been given to understanding the role that information might play in assisting passengers who have already planned their journey but who encounter problems when they travel by train.

Failure to execute a journey as planned can be severely disruptive to rail passengers in terms of lost time, expense, anxiety, and frustration. This article charts the development of the privatized rail industry and defines a set of journey breakdown situations that can be encountered by passengers. Insights are gained from passenger complaint letters. Such letters typically provide detailed accounts of journey breakdowns, attempts to recover the situations, and the use made of available information. Inaccurate or misunderstood pre-trip information is found to be a factor in many journey breakdowns. Accessible, timely, and appropriate provision of en-route information can improve passengers' satisfaction by enabling completion of their immediate journey and might also be decisive in ensuring they have the confidence to use the rail network again in the future.

Introduction

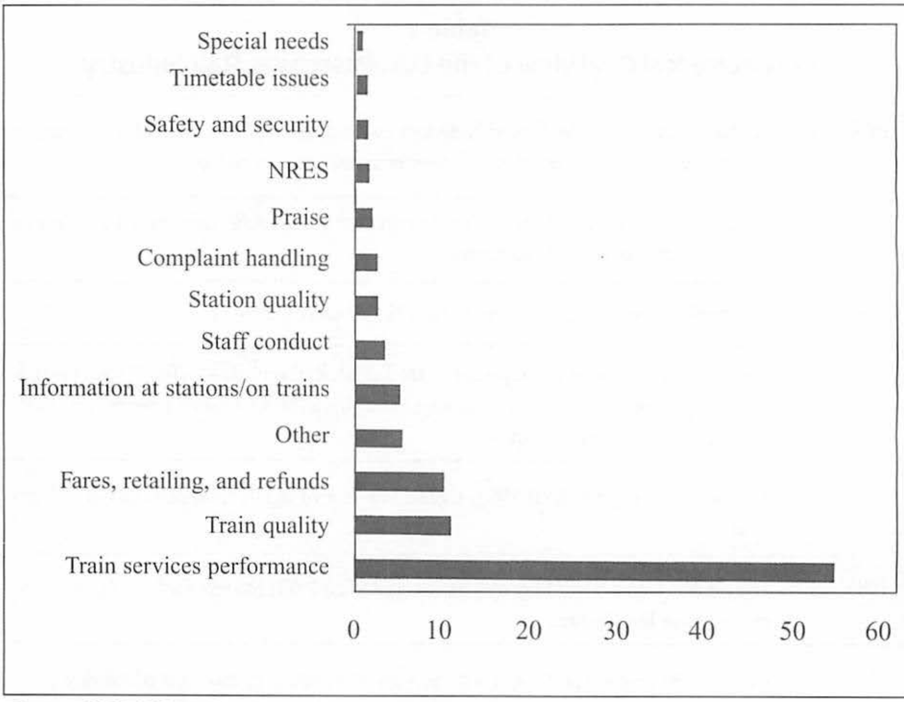
During the 1990s, the United Kingdom transitioned its passenger rail from a nationalized system to a privatized industry. Table 1 summarizes the history of the industry and highlights the key organizations that comprise today's provision of passenger rail in the United Kingdom. For further details concerning the privatization process, including economic impacts and a view on the restructured railway, see White (1998), Organization for Economic Cooperation and Development (1998), and Welsby and Nichols (1999).

Despite the technological advances made between Stephenson's rocket (1829) and the modern interurban trains operating in the United Kingdom, such advances are not reflected in current journey times and punctuality. For example, the current Great Britain Passenger Railway Timetable allows 44 minutes for the Portsmouth to Southampton train that, in 1898, took just 35 minutes (Leake and Macaskill 1998). This is not merely because there are now more stations, although it may be due to higher numbers of trains on the network.

A lack of investment in rail infrastructure has led to increased delays and unreliability (Department of the Environment, Transport [DETR] and the Regions 1998). According to the Shadow Strategic Rail Authority (SSRA 1999), only 8 out of 25 Train Operating Companies (TOCs) are achieving both 90 percent or higher punctuality and 99 percent or higher reliability. ("Punctual" is defined by the SSRA as being within 10 minutes of the stated arrival time for interurban routes, 5 minutes for local routes, and 30 minutes for sleeper trains. "Reliable" is defined as a train completing at least 50% of its scheduled route mileage.) From April 1, 1998, through March 31, 1999, the TOCs registered over 1 million complaints from passengers (737,331 written), an increase of 12 percent from the previous year. This represents 122 complaints per 100,000 journeys (Office of the Rail Regulator [ORR] 1999). Of these complaints, 55 percent concerned train service performance (Figure 1). The Rail Regulator considered that these figures did not fully reflect passenger dissatisfaction, but that they did depict a rail industry that was increasingly failing the customer. Yet there may be other reasons why

Table 1
Chronological Overview of the U.K. Passenger Rail Industry

Pre-1921	A railway system in the United Kingdom evolved. It was comprised of a plethora of independent railway companies with their own lines and procedures.
1921	By this date, amalgamation with a need to improve commercial viability led to a railway system comprised of four companies.
1948	Companies were nationalized and became the Railway Executive.
1962	The Railway Executive was replaced by the British Railways Board (BRB) with the railway component of the enterprise known as British Rail (BR). Central government grants provided for loss-making routes.
1963	The Beeching Report (BRB 1963) signaled closure of lightly used parts of the rail network.
1983	The Serpell Inquiry (Her Majesty's Stationery Office 1983) brought forth public outcry to prevent more line closures.
1988/89	Government grants total £700M with no sign of reduction in this level of subsidy.
1993	The Railways Act was passed bringing about privatization of the passenger rail industry with hopes of greater efficiency. BR was divided into its component parts: Railtrack (infrastructure), TOCs (passenger services), and Rolling Stock Companies (ROSCOs) providing/leasing passenger rolling stock to the TOCs. The ORR was created to oversee operation of the privatized industry.
1994	The Association of Train Operating Companies (ATOC) was formed to act as a trade organization for the 25 TOCs.
1997	ATOC began operation of a National Rail Enquiry Service (NRES) with telephone call centers providing timetable and fare information.
1998	A U.K. Transport White Paper was published with a policy emphasis on integrated transport. Establishment of a Strategic Rail Authority (SRA) was proposed to provide a focus for strategic planning with powers to influence the behavior of key industry players DETR (1998). This was established in shadow form prior to the necessary legislation being passed.
Post-2000	A transport bill is currently passing through Parliament with the necessary legislation for establishment of the SRA.



Source: ORR 1999.

Figure 1. Distributions of passenger complaints made to the TOCs by complaint category

complaints are rising. Individual train operators and government bodies have introduced complaint procedures. The Rail Regulator has encouraged complaint collection. Press coverage of complaints has brought complaining to peoples' attention, as has the prospect of compensatory payments to complainants. To encourage more people to use the rail network, rail companies will need to overcome the perception that rail travel is something about which to complain.

Passenger information represents a key means by which the extent of adverse reaction to rail travel might be redressed. The nature of public transport information and the role it can perform is summarized by Le Squeren (1991) as shown in Table 2.

Complementary to Table 2, Anderson (1993) identified six objectives for a passenger rail information system (stemming from similar objectives relating to the London Underground):

1. assist passengers in planning and during their journeys;
2. improve passengers' efficiency of movement through the system (leading to a reduction in travel time, or their perception of it);
3. provide reassurance and confidence to passengers (indicating that staff know what is happening and are in control);
4. advise passengers if changes in their route become necessary;
5. enhance the quality and range of services offered (with the aim of attracting more passengers); and
6. provide staff with a better picture of what is happening (to enable them to effectively respond to inquiries from passengers).

Table 2
Functions of Traveler Information

	Promotional Role
Mobility	Propose destinations and/or reasons for traveling
Presence	Tell people about public transport: include public transport in the range of options open to people
Image	Improve the image of public transport, highlight its advantages
	Teaching Role
Learning	Facilitate understanding of how to use public transport (tickets, fares, etc.)
Conforming	Familiarize patrons with the rules of conduct for a collective system
	Operational Role
Trip planning	Facilitate the preparation and planning of journeys on public transport (schedules, etc.)
Access	Facilitate access to the network (reductions)
Travel	Facilitate the journey itself (indications, identification, guidance)
Arrival	Facilitate the onward journey after arrival
Modification	Inform users of and explain reasons for modifications with respect to scheduled service
	Appropriation Role
Atmosphere	Participate in creating the physical and psychological atmosphere of the journey
Control	Give patrons more control over their journey and the various options available to them

Source: Le Squeren (1991).

Passenger information can improve understanding of what the passenger rail industry has to offer, enable journey planning, and provide travel itineraries that assist journey execution. It does not materially improve rail services, increase punctuality or frequency, or reduce service journey times or costs. However, it can empower the passenger to make confident and effective use of what is available. *Passengers value information.*

Availability of information is increasing and, in turn, passenger propensity to seek information and their expectation to find it available are both also increasing. Access to telephone- and Internet-based information systems predominantly concerns pre-trip journey planning. Yet information has considerable potential to assist passengers during their journey. The complaints statistics given above suggest that at least 1 million rail passengers a year suffer some disruption to their journey. In some cases, existing provision of information may have served to alleviate frustrations and instruct passengers on any changes necessary to complete their journey. However, in many cases, passengers will have suffered unnecessary delay, inconvenience, irritation, and possible expense because of an absence of information to enable them to address the disruptions to their journey.

This article offers an initial consideration of the opportunities for information provision in situations where a passenger's journey has "broken down" and where access to suitable information could assist in "recovery" of the journey. Complaint letters provide a useful insight into journey breakdowns encountered by passengers and typically include a detailed account of a passenger's experience and attempts to recover the journey including the use of information. Complaint letters received by the ATOC are examined and a classification of journey breakdown situations is developed.

U.K. Passenger Rail Information Systems

Under BR, local stations responded to local train inquiries; under postprivatization, stations do not pass on journey information by telephone. The NRES is provided on behalf of the TOCs by ATOC and is accessible from a single national telephone number, 24 hours a day, 7 days a week (ATOC 2000). The

NRES handled approximately 60 million calls in 1999, compared to 52 million in 1998 and 37 million in 1997. Recent (unpublished) research undertaken by ATOC demonstrated that the NRES is revenue generative and makes a valuable contribution to passenger services' finances.

This service uses the Great Britain Passenger Railway Timetable as its basis for timetable information, stored in electronic form in such a way that schedule information can be provided in response to inquiries. In the event that changes to the timetable occur, and with at least 36 hours' notice, these can be sent to the NRES and the timetable can be amended. In the event of an emergency or serious incident, each of the six call centers that operate the NRES are contacted. Call center operators are then expected to take account of this information where it affects routes relating to passenger inquiries. The NRES uses separate systems for fares and timetables. A new Rail Journey Information Service (RJIS) that combines information on fares, timetables, and reservations is currently working in preproduction mode. Real-time train running information will be an additional facility introduced in late 2000. It is expected to be able to handle 5 million queries a month—at least 70 queries a minute (*Computing* 1998). This system will be able to identify when a train has been delayed, and could then pass this information on to passengers, along with advice about alternative routes.

More than 94 percent of homes in the United Kingdom have a telephone (Office for National Statistics 2000) and hence have access to the NRES for pre-trip information. The 1999 Which? Annual Internet Survey (see http://www.which.net/) estimated that approximately 14 percent of Britons were using the Internet. More recent survey results suggest that at the end of 1999 this figure was closer to 20 percent (*Internet Magazine* 1999). Access is set to increase dramatically in the home and workplace and via mobile communications. The rail industry is responding to this trend with websites that offer information comparable to that from the NRES (Lyons 1999). Railtrack's website (http://www.railtrack.co.uk) provides a journey planner for national rail inquiries. (Railtrack has an obligation to make the Great Britain Passenger Railway Timetable available to the public.) In 1999, the site processed a similar number of journey planning inquiries to the number of calls handled by the NRES (Railtrack 2000). The TrainLine (http://www.thetrainline.com) is a commercial on-line service that is now being promoted by a strong marketing campaign. It provides both journey planning and fare information with the option of on-line booking and payment.

Access via telephone or Internet to information for pre-trip journey planning is generally very good. From the 60 million calls made to the NRES in 1999, the level of NRES-related complaints is 0.03 percent. Information is also available at stations via station staff, timetable boards and terminals, kiosks, and Help Points (providing intercom access on platforms to rail staff). Much of this information is historical rather than contemporary or predictive. Some kiosks have modem links, but others require manual updates.

Until all trains run precisely to schedule, there will be a need for collection and dissemination of real-time information. The U.K. rail industry is investigating ways to exploit information and communications technology to gather and distribute such information. For example, ScotRail has tested a Global Positioning System (GPS) to try to pinpoint trains and provide customers with more accurate information (Campbell 1998). This has led to a countdown and map display to provide passengers with arrival times within 25 seconds of accuracy.

There is a need to understand how rail information systems might be further developed and used in supporting passengers en route whose journeys have suffered a setback and who must replan the remainder of their journey. This may call for a more passenger-oriented rather than a systems approach to journey recovery as replanning may include the (partial) use of another (public transport) mode. Cooperation and partnership across the public transport industry is enabling the current development of a National Public Transport Information System that will be available via a single telephone number as with the NRES. The system is a goal set out in the government's Transport White Paper (DETR 1998). It will aim initially to provide a timetable-based journey inquiry service across public transport modes down to a bus-stop/street level of detail. The system is unlikely to offer relevant and sufficient information appropriate for unscheduled rail journey recovery situations, at least in the short term.

To explore the potential information needs for journey recovery, it is necessary to identify the types of journey breakdowns that can occur.

Journey Breakdowns

A journey breakdown can be defined as a failure to execute a journey as planned. In some cases, a breakdown will be the fault of the traveler either directly, or indirectly as a consequence of problems associated with the means of transport used to reach the station. In other cases, it will be the actual or perceived fault of the rail industry in terms of information provided or its interpretations, or through a lack of information to enable the traveler to complete the journey as planned. In further situations, a journey breakdown will be a direct result of a failing of the train service in terms of not operating according to the timetable. Consideration was given to the ways in which a journey might suffer a setback. This resulted in a set of journey breakdown scenarios as shown in Table 3 (see Adenso-Diaz et al. 1999 for another list of possible incidents leading to rescheduling, or Higgins and Kozan 1998 for different delay types). An interpretation of the likely consequences, recovery options, and information needs for each scenario is also given in Table 3.

The passenger rail industry is aware of the importance of information. However, it will need to be convinced of the merits of further investment in its information provision to specifically support passengers needing to establish recovery options following a journey breakdown. To accomplish this, the following steps are suggested:

1. Determine the frequency of occurrence nationally of each breakdown scenario over a given time period.
2. For each scenario, establish an estimate of the average "level" of recovery that is possible, given perfect information, in terms of delay saving and monetary cost. Other measures constituting generalized travel cost

Table 3
Rail Journey Breakdown Scenarios

No.	*Scenario*	*Consequences*	*Recovery Options/ Information Needs*
1	No problem	Journey completed as planned.	No recovery necessary.
2	Get to station, can't locate train	Will miss the train unless it can be located.	Signs, staff, and other passengers can give directions.
3	At station, train is different from that expected	Time cost if passenger must wait for another train.	Need to find if train is suitable, or change mode.
4	At station, find price is different from (recollected) quote	May miss train if not able or willing to pay. Possible anger and mistrust.	Can still use train, if able/prepared to pay new price, or could consider alternative travel options.
5	Get to station, imminent departure	Miss train or try to pay on board. Possible penalty.	If train caught, then no problem. If not, need information to proceed.
6	Get to station late, train has gone	Miss train, possibly cancel trip.	Catch up with the train, take a later one, change mode, or cancel trip.
7	Board wrong train	Probable time cost and potential additional monetary cost.	Return to origin, try to meet train, take an alternative route, or take an alternative mode.
8	Get to train, train doesn't depart	Delay, possibly cancel trip.	Find out what is happening, change train, mode, or cancel trip.
9	Train arrives late	Delay, possibly cancel trip.	Find out if train will arrive, or another option must be taken.
10	Train cancelled	Delay, possibly cancel trip.	Find alternatives or cancel trip.
11	Train departs late	May miss connections. Lost time may be recovered over journey distance.	Find out if the delay is sufficient to warrant changing plans.
12	Train stops outside station	Passengers must wait.	Begin to plan for when the train starts moving.
13	Train stops at intermediate station	Delay while waiting for action.	Need information to decide whether to stay with train, take alternatives, or abandon trip and return to origin.
14	Train doesn't stop at expected station	Delay, anxiety.	Get off at next suitable stop for return by appropriate mode.
15	Train runs behind schedule	Late to destination, may miss connections.	Remain with train or depart early to try alternatives.
16	Train runs ahead of schedule	Arrive early. Possible wait for collection or connection.	Phone ahead to inform of early arrival, catch other connections.
17	Passenger uses network suboptimally	Time and/or financial costs.	Use information to improve use of network.

might also be considered.

3. Establish the propensity of passengers, given the availability of the necessary information, to pursue the recovery options identified.
4. Estimate the collective value to passengers, over the given time period, of providing information that enables journey recovery options to be determined.
5. Conduct a cost-benefit analysis of the provision of suitable tailored information.

Such an approach is difficult to pursue. Categorizing the complaints received annually by the industry according to the scenarios could enable step 1 to be completed. However, the industry does not currently record all complaints in a form to enable this to be done. Further, not all passengers who suffer a journey breakdown will register a complaint. Nevertheless, analysis of written complaints does provide a useful preamble to the five-step approach or similar in terms of acquiring a better understanding of the breakdown situations people face and the consequences that ensue.

Analysis of Complaint Letters

ATOC gave permission for its complaints files to be examined.

Complaint Letters Held by ATOC

The vast majority of written complaints about the rail service are sent directly to the individual TOCs concerned. A minority of written complaints about TOCs or the NRES are lodged with ATOC. These are filed for a minimum two-year period. By the middle of February 1999, ATOC had 105 letters of complaint on file (from the beginning of January 1998 to the end of January 1999); the TOCs received a million written and oral complaints in this time period (ORR 1999).

Complaint letters are inevitably not written to a common format with subsequent analysis in mind. However, there is a substantial degree of overlap in terms of the information they contain. The letters were treated retrospectively as a set of survey responses. A "data entry" schema was devised and used to elicit salient information from each of the 105 letters.

Scenario Representation within Letters

The complaint letters represent an extremely biased sample of journey breakdowns experienced. They address situations that are the fault of the rail service, not those that are the fault of the traveler, such as arriving late at the departure station and missing the train. They also represent journey breakdowns that were sufficiently disruptive to warrant a written complaint (or individuals with a higher propensity to lodge complaints).

Table 4 shows the representation of the 17 scenarios from Table 3 among the 105 complaints. (While it may seem peculiar for people with no problem to complain, some felt that information provision was inadequate despite not experiencing any difficulty.) Nearly all the scenarios were found within this relatively small sample of complaints.

It became apparent when reading the complaint letters that many of the sce-

Table 4
Scenario Occurrences in Assessment of Complaint Letters

No./Scenario	*No. of Complaints*	*Scenario*	*No. of Complaints*
1. No problem	3	10. Train cancelled	22
2. Get to station, can't locate train	3	11. Train departs late	5
3. At station, train is different from that expected	14	12. Train stops outside station	1
4. At station, find price is different from (recollected) quote	22	13. Train stops at intermediate station	9
5. Get to station, imminent departure	2	14. Train doesn't stop at expected station	2
6. Get to station late, train has gone	2	15. Train runs behind schedule	16
7. Board wrong train	1	16. Train runs ahead of schedule	0
8. Get to train, train doesn't depart	0	17. Passenger uses network suboptimally	1
9. Train arrives late	2		

narios identified were interrelated. A late-arriving train (9) probably also departs late (11). If passengers "give up" on this train, it becomes a train that does not depart (8). Trains with imminent departure (5), or where passengers cannot find the train (2), may become trains that have gone (6). Trains making unanticipated stops at stations (13) or on the line (12) will run behind schedule (15). Many passengers had to take a different train from that expected (3) because their train had been cancelled (10). Based on such considerations, the 17 scenarios can be translated into 5 journey breakdown bundles in terms of the recovery options that will need to be considered. These are summarized in Table 5.

Journey Breakdown Bundles

There is a balanced distribution of complaints across bundles with the exception of the "no problem" bundle where, as expected, few complaints arise. Consideration of situations encountered within the complaint letters for each bundle provides some intriguing insights into the disruption suffered by rail passengers. It is only possible to provide a limited number of examples within this article.

No Train. The first bundle covers those cases where the passenger does not board the planned train at the origin. Pre-trip information, particularly station information, is available to these passengers. Several trips mentioned in the complaints to ATOC would have experienced no problem if the passenger had allowed more float time at the outset to catch an appropriate train. One passenger complained about missing the Barnham–Bognor train and being late for an interview. This train takes 6 minutes and runs every 10. In a further 14 cases, the journeys might not have needed to be recovered if people had been given the correct information to begin with: morning times were given instead of evening ones; summer schedules began, but passengers were not told about them. A passenger, who was advised by the NRES to take the 15:55 Banbury–London connecting with the Edinburgh train, noticed it was not on the departures board. Ticket staff then told him a special timetable was in operation during long-running engineering works. He was advised to take another train that only allowed

Table 5
Grouping of Journey Breakdown Scenarios into Journal Breakdown Bundles

Bundle Name	*Description*	*Scenarios*	*No. of Complaints*
No train	In fact, or in effect, there is no train. If the train is cancelled, does not depart, or has already gone, the prospective passenger must plan to do without this train.	2, 5, 6, 8, 10	29
Late train	Trains that will not get to the destination on time, stopping en route, or running behind schedule. Passengers need to know how they will be affected by falling behind the timetable.	9, 11, 12, 13, 15, 17	34
Unexpected train	Train ride is more expensive than anticipated, or on a different schedule. Passengers must find out if it is still worthwhile boarding.	3, 4, 7, 14	40
Incomplete journey	Train will not get to the desired destination. Passengers, or the train, miss the stop, if the train even goes there. Passengers have to find out how to get to the destination from a new starting point.	7, 10, 12, 13, 14	34
No problem	People who cannot find their train, or who have imminent departure, as long as they make it on board. Also includes trips ahead of schedule. This group does not need recovery information.	1, 2, 5, 16	8

2 minutes for a connection, which it missed. He then missed the last train to Edinburgh and had to stay in London overnight. This passenger had used the NRES, departure notices, and staff, but was still unable to complete the journey as planned. He could have waited until the next day to make the trip, at less cost. One passenger, given contradictory information during service disruptions, elected to "forgo the delights of the rail system for the enormous convenience and considerably reduced cost of [his] private car."

Late Train. The second bundle covers situations where a passenger boards a train that will not reach the destination by the expected time. Here the passenger is limited to en-route information to discover how to proceed. Unless the passenger has time at a connecting station, information sources are limited to fellow passengers, conductors, telephone, and Internet. One man whose train was "traveling at snail speed" toward London because of a crane on the line, disembarked the moment he was near enough to the Underground because he knew London well enough to change modes. Many people are not aware of other routes or modes they could use. Access to appropriate information provision could assist. Out of 62 complaints with sufficient journey descriptions to allow further investigation, 28 could have been completed with delay savings if the passenger had taken an alternative mode, or caught another train.

Unexpected Train. The third bundle covers situations where there is a train ready for departure, but it is different from the one the passenger expects. It may have a different price or schedule, or the passenger may board the wrong train. The passenger must decide whether or not to continue with the journey. One embarrassed teacher had to use his own money to pay for a school trip, having been allegedly misquoted on the fare. All stations have now been supplied with NRES complaint forms to try to differentiate between genuine complaints and cases where the NRES is unjustly blamed.

Incomplete Journey. The fourth bundle is for incomplete journeys, where the passengers cannot get to their desired destination(s) without adding new legs to the trip. Some situations will be the same as those for "late train" or "unexpected train," but there are some additions. Passengers have boarded trains that have then failed to get to the destination. One passenger specifically asked for a Waterloo–Trowbridge train that stopped at Warminster, as he wanted to deliver a package. His train did not stop. A member of Parliament traveling from Market Harborough to Essex was not happy when a coach was laid on in place of a train. He commented that if he had wanted a bus he would have gone to the bus stop.

No Problem. The fifth bundle covers journeys that are problem free once the passenger boards the train. No one complained that their train arrived ahead of schedule, although one passenger did query why he was able to find a quicker route than that provided by the NRES. The answer relates to the need for the NRES to allow certain lengths of time for connections, even though some passengers are able to cross platforms quicker, or catch different trains if theirs gets in early.

Letters assessed within each bundle highlighted, in some cases, the complexity of recovery options that people must endure, but also that, with appropriate information, recovery was possible (in at least 28 cases). They revealed an ability of some passengers to be effective in journey recovery, while others floundered with the added frustration of conflicting information. People do make use of available information sources, but their complaints clearly indicate a need for improvement in clarity, timeliness, and reliability.

Existing Information Provision

As mentioned, there is good access to pre-trip information. Prior to boarding a train, passengers can phone the NRES; use the Internet, information kiosks, paper timetables; or ask friends, station staff, or even people standing on the platform how to get from A to B. Once on board the train, access is more restricted. Here the primary source of information is the conductor, who can give out some information about how the train is expected to continue, but not about how to complete any particular journey. Passengers can still phone the NRES. It is estimated that 41 percent of the U.K. population have mobile phones (McIntosh 2000). Some handsets are now able to connect to the Internet and therefore offer access to Internet timetable services en route. However, if there is a problem with the information the NRES supplied, then passengers will not trust any new information, which may be out of date depending on the nature of the problem. From the complaints collected, 33 people tried to verify the information they were given. There were a number (n) of trips where the NRES did not give correct information because of confusion over travel time ($n = 9$), schedule confusion: changed with insufficient warning or was incorrect information in the NRES database ($n = 16$), or there was an incident where NRES was not informed ($n = 25$). Although the popularity of the NRES reflects its overall quality of service, the reliability of information provided or its interpretation could be improved. This should reduce the number of journey breakdowns and, by implication, remove the need for journey recovery support.

Railtrack is keen for people to use the Internet to obtain information. None of the complaints analyzed referred to Internet information. This may be due to several reasons:

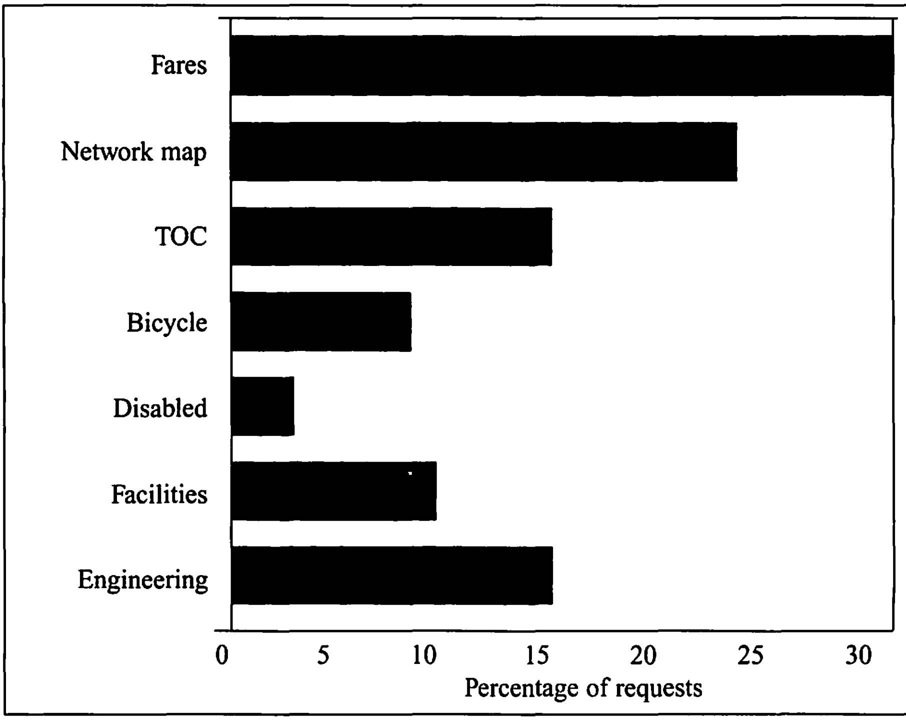
- none of the 105 complainants used this source of information;
- people complained directly to Railtrack;
- expectations concerning travel information from the Internet are not high enough to warrant complaining; or
- information from the Internet was accurate.

Railtrack surveyed website users for information they would like to see in addition to timetables (Figure 2). Nearly 15 percent of requests were for information on engineering works, (i.e., when the network was not expected to run normally). This was an issue that prompted 11 percent of the complaints to ATOC about actual journeys made.

Existing information system developments are at risk of being technology led. Assessment of complaint letters offers one means of gaining greater insight into how recovery information could be of greater benefit to passengers than scheduled timetable information, however well the latter might be presented across different media. Such insight can assist in promoting greater attention to user needs in future system developments.

Compensation

The complaints analysis shows that one-fourth of all complaints that ATOC received could have been avoided with more accurate information. ATOC paid £1,313 in compensation in response to the 105 complaints. Although only a crude approximation, if this figure is scaled up according to the total complaints to the



Source: Railtrack (2000)

Figure 2. Other types of information users would like to see on the Railtrack website

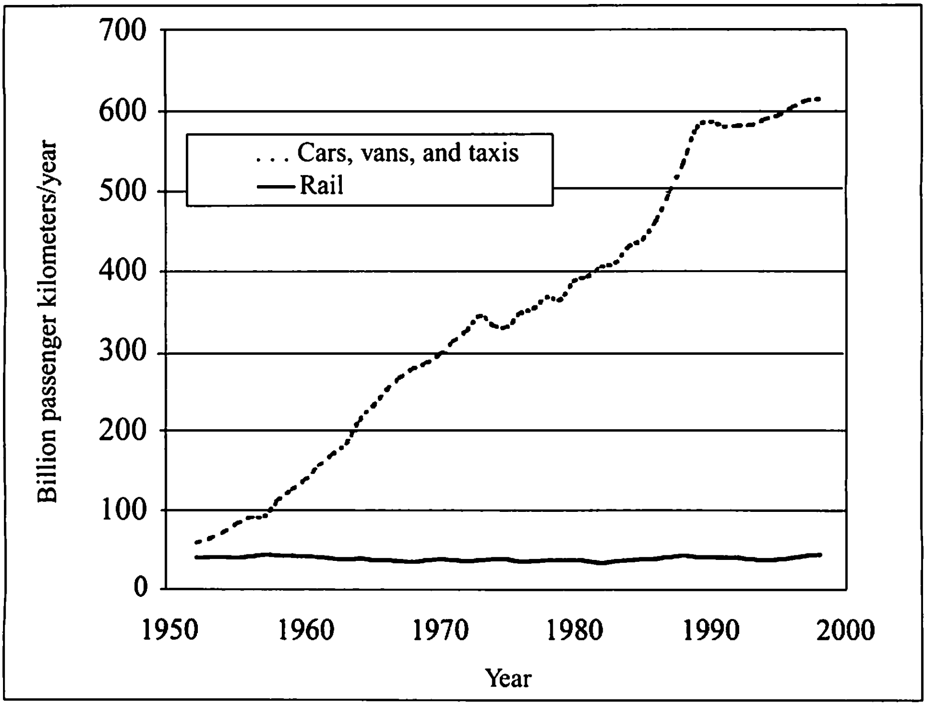
industry, compensation could be totaling approximately £13,000,000 per year.

The cost to the industry of journey breakdowns is likely to be much higher if other factors are taken into account. Not all breakdowns result in reported complaints. If passengers become discouraged by a bad experience, they may elect not to travel by rail in the future. Peoples' travel choices reflect their historical experience of the traveling environment (Adler and Blue 1998). Improved information provision has the potential to reduce the cost of journey breakdowns considerably.

Conclusions

This article has sought to illustrate the current and potential role of passenger information in supporting a rail industry that is still beleaguered by problems of train cancellations and punctuality. For long-distance journeys in the United Kingdom, the train has great potential as an alternative to the car. Yet in terms of passenger kilometers traveled per year, car travel has increased dramatically over the last 40 years while the level of rail travel has remained largely unchanged (Figure 3).

The government recognizes the importance of information in improving the awareness and attractiveness of public transport modes and in making journeys feel more seamless or easy to execute. The major complaint from passengers is about train service performance (Figure 1). There is scope for timely, accurate information to facilitate less disruptive progress of passengers through the rail network and alleviate some of the disruption resulting from poor performance.



Source: DETR (1999).

Figure 3. Billion passenger kilometers/year traveled by mode: 1952–1998

The passenger rail industry is evolving very good information systems for timetabled services and is beginning to address the need to take account of planned and unplanned deviations from the timetable. However, it appears that the specific value of information to passengers in journey breakdown situations is not being fully addressed.

This article has highlighted and conducted a preliminary examination of rail journey breakdown and recovery. The collective value of information to assist passengers in such situations has not yet been established. However, from the initial investigations of passenger complaints, there appears to be substantial potential for (enhanced) journey recovery information to improve both the plight of stranded passengers individually and the image of the passenger rail industry as a whole with the prospect of attracting higher levels of patronage.

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A Three-Year Comparison of Natural Gas and Diesel Transit Buses

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Abstract

This article details the experiences of two California public transit agencies, Sacramento Regional Transit District (RT) and SunLine Transit Agency, which replaced aging diesel buses with new compressed natural gas (CNG) buses in 1994. It compares the operating characteristics and costs of 170 CNG buses (with the same engine–chassis configuration) and 73 diesel buses in service at the same time. Equipment was tested over a three-year period for a total of 22.2 million miles.

The data indicate that labor, parts, and fuel for diesel equipment cost more than for CNG buses. Both agencies also achieved significant savings in hazardous waste disposal. The study indicates payback of the incremental costs of CNG equipment is realized in six to eight years, and that both communities benefit from public transit's clean air leadership.

Introduction

At the beginning of their respective transitions to alternative fuel, Sacramento RT and SunLine were operating aging fleets of diesel buses in need of replacement. Both public transit agencies began independent research into alternatives. Each decided CNG was the best choice at the time. It was mere coincidence that the agencies chose the same transit bus manufacturer, chassis, and engine configuration, albeit determined in great part by the availability of California Air Resources Board (CARB)-certified engine choices.

While the air quality advantages of CNG fuel have been well documented, prior to this research project, no large-sample study compared the maintenance costs of CNG with diesel in a head-to-head test. Reports at the onset of the alternative fuels movement featured small samples and/or short operating periods.

These figures were collected from two transit agencies over a three-year period. Buses operated in equal service and maintenance environments.

Background

RT began providing service in 1973 in the growing Sacramento, California, region. The agency currently operates in a 418-square-mile area. It serves a population of 1,060,000 with 60 bus routes and light rail. The transit fleet consists of 209 buses and 36 light rail vehicles. Combined ridership totals 24,802,000 unlinked trips per year. Overall, annual operating expense is $55 million for all agency functions.

RT's service area has been classified by the U.S. Environmental Protection Agency as a severe nonattainment zone for air quality. As a result, RT is committed to eventually replacing all diesel buses with lower emissions CNG vehicles.

SunLine began service in 1977 in the Coachella Valley in southern California. The valley, comprised of Palm Springs and eight other resort cities, has a population of more than 260,000. SunLine's service area is approximately 406 square miles.

Though it once had the dubious distinction of operating one of the oldest fleets in the country, in 1994 SunLine replaced its entire fleet with new CNG buses. Ridership now exceeds 3,500,000 per year. The agency's overall annual operating budget is $11 million.

Both CNG fleets surpass CARB's stringent 1994 emissions standards, primarily in reduction of particulate matter and NO_X emissions. Both agencies operate fueling stations on-site; both systems have experienced steadily increasing ridership over the last few years.

Profile of Fleets

RT operated 136 40-foot Orion V CNG buses built since 1993 in fixed-route service. The buses operated approximately 5.7 million miles per year, each averaging about 42,000 miles per year. The 73-bus diesel fleet operated approximately 50 percent less.

SunLine operated a 100 percent CNG fleet of 34 40-foot Orion V buses built in 1993 and 5 29-foot El Dorado buses in fixed-route service. This report includes data for the Orion buses only. Each SunLine vehicle averaged about 43,500 miles per year for a total of nearly 1.5 million miles. The study fleet composition is listed in Table 1.

Both agencies operated fully accessible fleets and complementary para-transit services according to the Americans with Disabilities Act. The common CNG fleet configurations studied in this report are model years 1993/94/96 Orion V buses powered by six-cylinder Cummins L10G engines, original equipment manufactured for dedicated CNG operation. All buses were equipped with bike racks to allow for multimodal travel, wheelchair lifts, and air-conditioning, due to extreme summer air temperatures.

The diesel buses analyzed were model years 1985/90 Gillig powered by Detroit Diesel 6V92 series engines. These two-stroke diesel engines are the most common source of bus power in the U.S. public transit system.

Methodology

This report was prepared by researching the maintenance records and databases of both agencies. RT and SunLine use different computer-based programs to track cost categories and have different philosophies on tracking the work order process as applied to cost allocations. Those differences were man-

Table 1
Study Fleet Composition

Fleet	*Quantity*		*Year*	*Manufacturer*	
	Diesel	*CNG*		*Chassis*	*Engine*
RT	48		1990	Gillig	Detroit Diesel 6V92TA
	25		1985	Gillig	Detroit Diesel V92TB
		41	1996	Orion	Cummins L10G/280
		20	1994	Orion	Cummins L10G/240
		75	1993	Orion	Cummins L10G/240
SunLine		34	1993	Orion	Cummins L10G/240
Total	73	170			

ually adjusted in the final analysis and cost breakdown so data could be collated into matching categorical descriptions. Final totals for CNG-to-CNG cost performance between the two agencies indicate the method was successful.

Assumption 1: New Buses versus Old

This study compared new CNG buses to old diesel equipment. As expected, it was difficult to quantify the maintenance advantage of a new bus compared to one aged in service. Certainly, a new diesel bus would show maintenance cost advantages over an old diesel bus. But an agency attempting to discontinue diesel purchases can still use the CNG cost data to make comparisons to similar vintage diesel.

All of the buses show increasing annual expense as each of the fleets age. But, the margin of cost reductions of CNG buses over diesel continues to grow, as explained in the Year-to-Year Costs section (below).

Assumption 2: Characterization of Operating Environments

Sacramento and the Coachella Valley have similar ambient temperatures, weather, and primarily flat service terrain. RT and SunLine have comparable transit duty demands on maintainability and reliability. Therefore, this factor was considered negligible in collating the cost data.

Assumption 3: Weight Disadvantages of CNG Buses

A CNG bus can weigh 2,500 pounds more than a diesel bus because of the necessary storage cylinders. Yet this presented no problem to either agency and operational cost savings were still substantial. (Tire wear was included in the "parts" category.)

The intuitive conclusion for increased brake wear due to the resulting increased inertial forces was actually found to have decreased by using state-of-the-art transmissions employing a speed retarder for additional deceleration assistance. This same property would apply to new diesel buses as well.

Assumption 4: Fuel Range Impacts

The potential need for interim, en-route fueling was not a problem for either agency; each has its own on-site fueling facility. There was no attribution to maintenance for a road call to provide refueling (or "rescue") service because planning strategies have eliminated that type of road call.

The fuel range on the Orion buses is specified to be at least 350 miles for equity to a diesel bus. Range can be less due to high ambient temperatures combined with CNG heat of compression and air-conditioning use.

Various management strategies were employed when routes were longer than the range. For example, rather than using a maintenance servicing truck, a coach operator may have driven out to the relief point in a fully fueled bus and had the relieved operator return to base in the bus that was lower on fuel. Or, coach operators may have exchanged buses mid-route when one was traveling back to base. These options would then be reflected in operating cost rather than maintenance cost.

It is crucial for management to think through the mileage and bus range of each line and plan dispatch strategy accordingly to avoid problems. Dispatchers surveyed for this study acknowledged it was an easy process to learn and soon became standard procedure.

Assumption 5: Training Maintenance Personnel

Training cost is not a factor of this report because of its many variances. The agencies shared the philosophy that training is part of "business as usual" and would apply to any fuel-bus configuration. Training is further discussed in the Additional Investment in Switch to CNG section (below).

Assumption 6: Special Projects

During the study period, SunLine actively assisted the clean fuels industry's efforts to advance developing technology by becoming a beta test site for commercialization via field demonstration. The labor involved in tracking those specific projects and any impact on parts have been deducted from the final analysis to remove the potential to skew results.

Assumption 7: Extrapolation of Capital Cost Recovery

The only portion of capital investment considered is the incremental cost of a CNG bus over a similar diesel bus. In calculating capital recovery periods, the cost of mid-life rebuild has been omitted since CNG substantially reduced engine wear.

Description of Cost Categories

As was shown in *Public Transportation Alternative Fuels...A Perspective for Small Transportation Operations* (Booz-Allen and Hamilton, Inc. 1992) use of:

> *gaseous fuels will potentially allow less maintenance and greater engine durability than operation with liquid fuels. This is because of the elimination of formation of deposits on the fuel injector tip, ring grooves, piston bowl, and other combustion chamber surfaces. Oil change frequency is longer because of the reduction of formation of acidic products of combustion. Gaseous fuels will not dilute the lubricating oil, accelerating ring, cylinder, and bearing wear.*

Both agencies found this to be true, as can be seen in the comparison of

CNG and diesel maintenance costs (Table 2 and Figure 1). After switching to a CNG fleet in 1994, SunLine had no diesel costs. RT, however, continued to operate diesel and CNG vehicles, thus enabling costs to be compared. Following is a discussion of 1997 statistics in Figure 1 and Table 2.

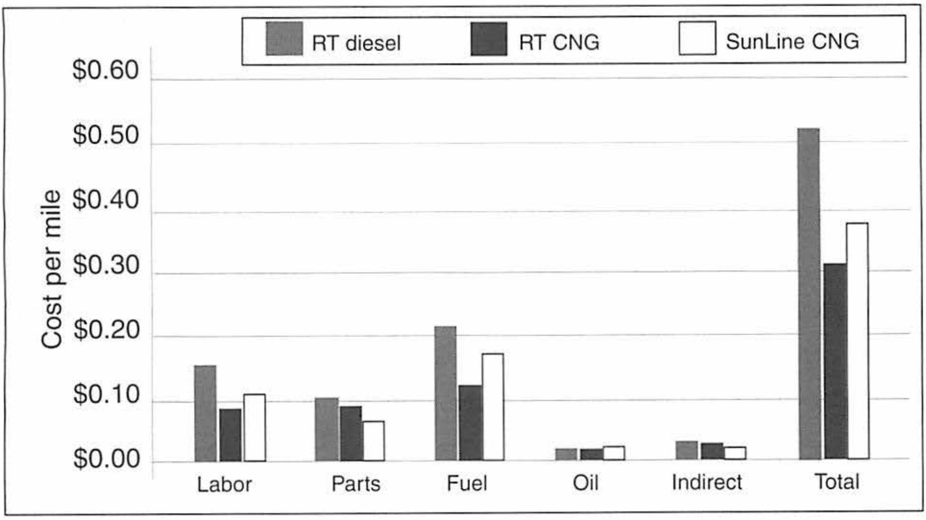

Figure 1. FY1997 CNG vs. diesel cost per mile

Table 2
FY1997 CNG vs. Diesel Cost per Mile

	CNG		*Diesel*
Cost Category	*RT*	*SunLine*	*RT*
Labor	$0.087	$0.111	$0.160
Parts	0.088	0.061	0.110
Fuel	0.122	0.178	0.223
Oil	0.006	0.012	0.007
Indirect	0.019	0.015	0.019
Total	$0.322	$0.377	$0.519

Maintenance Labor

Labor costs were computed for mechanics with chargeable time against a specific bus. Graffiti removal is included by SunLine in the "labor" and "parts" categories (body/glass). No administrative time is computed in this cost.

Maintenance Parts

Maintenance parts were consistent for both agencies, although coding for computer input varied somewhat. All parts chargeable to a specific bus were included. In general, categories included: heating/ventilation/air-conditioning, body/glass, head sign, wheelchair lift, fare box, brakes, suspension, tires, drive-line, cranking/charging, electrical, engine/transmission cooling, preventive maintenance, accident, and vandalism.

Fuel

The cost of compression (capital, electricity, and maintenance) was not included in Table 2 and Figure 1. RT owns 100 percent of its fueling facility; SunLine owns 25 percent of one facility and 90 percent of another facility. These percentages were used in fuel cost calculations. Table 3 is a listing of fuel prices for CNG and diesel over the years of the study. While RT's diesel buses averaged 3.51 miles per gallon, its most recent mileage for CNG buses was 3.07; SunLine's was 3.09 miles per equivalent gallon.

Table 3
Fuel Prices (per gallon equivalent)

	CNG		*Diesel*
Year	*RT*	*SunLine*	*RT*
1995	$0.283	$0.538	$0.692
1996	$0.380	$0.600	$0.735
1997	$0.402	$0.551	$0.599

Oil

This category included only the cost of oil, while other associated preventive maintenance costs (e.g., filters and labor) were allocated against parts and labor, respectively. Both agencies monitored oil quality through independent analysis and were able to significantly extend oil change intervals as compared to diesel.

Indirect Costs

Indirect costs included "bench stock," overhead, and minor parts such as bulbs, fuses, and hoses which are generally low cost and not charged to specific buses. Over several years, these costs can vary dramatically depending on opportunities for bulk purchases, fleet diversity, and specific fleet issues. Although these costs were a minor portion of the overall cost, sometimes varying accounting procedures can affect this type of line item.

Summary of Results

In 1997, CNG buses saved RT over $1 million in fuel, maintenance, parts, and hazardous waste disposal, a 38 percent per mile reduction over the cost of their diesel buses. This represented an approximate cost savings of $0.197 per mile over 5.7 million miles with 136 buses. That same year, SunLine saved approximately $213,000, or $0.142 per mile over 1.5 million miles with 34 CNG buses—a 27 percent reduction.

Maintenance Cost Savings Analysis

This section examines maintenance savings in the FY1997 category costs and year-to-year costs.

FY1997 Category Costs

RT's labor and fuel costs for the older diesel buses were nearly twice that for CNG buses; parts were 25 percent more. Indirect costs and oil remained approximately the same during the reporting period since RT had not yet decreased the frequency of oil changes for the CNG buses. Oil change frequency has since gone from 8,000 miles to 10,000 miles, compared to 6,000 miles for diesel.

Similar to RT, SunLine's cost savings were seen in fuel, maintenance, and parts. Oil changes occurred every 6,000 miles while the buses were under warranty. Oil changes are now performed every 12,000 miles and are carefully monitored by analysis.

The total cost-per-mile differences between the two transit agencies can be attributed to various factors. SunLine has a particularly aggressive preventive maintenance (PM) program due in large part to its desert climate. Blowing sand is a daily occurrence and vehicles must be cleaned thoroughly. As a result, SunLine's PM costs (labor and materials) account for 23 percent of the budget as opposed to 16 percent at RT. SunLine also uses each vehicle approximately 3 percent more than RT in revenue service.

Indirect costs were slightly higher for RT than for SunLine. The diversity of its fleet required more overhead in bench stock/small parts.

Year-to-Year Costs

Savings could be attributed, in part, to the newness of the CNG buses, especially while the manufacturer's warranty covered some maintenance costs.

As expected from the data shown in Table 4, all of the buses showed increasing annual expense as the fleets aged. Although there were expected cost savings in the first years on CNG due to warranty coverages, the margin of cost reductions continued to grow over diesel. Figure 2 represents the rate at which costs grew by comparing the slope of trending costs. Diesel expenses climbed 16 percent from 1995 to 1997, while CNG expenses went up 11 percent over the same period for RT. That is even more significant when considering RT reduced its diesel fleet by 36 percent, increased the new CNG fleet by 30 percent over the same time frame, and the diesel buses incurred about 50 percent less miles each year than the CNG buses.

Table 4
Year-to-Year Comparison Total Cost

		Dollars per 1,000 Miles		
Fuel Type	*Agency*	*FY1995*	*FY1996*	*FY1997*
Diesel	RT	447	466	519
CNG	RT	290	294	322
	SunLine	366	343	377

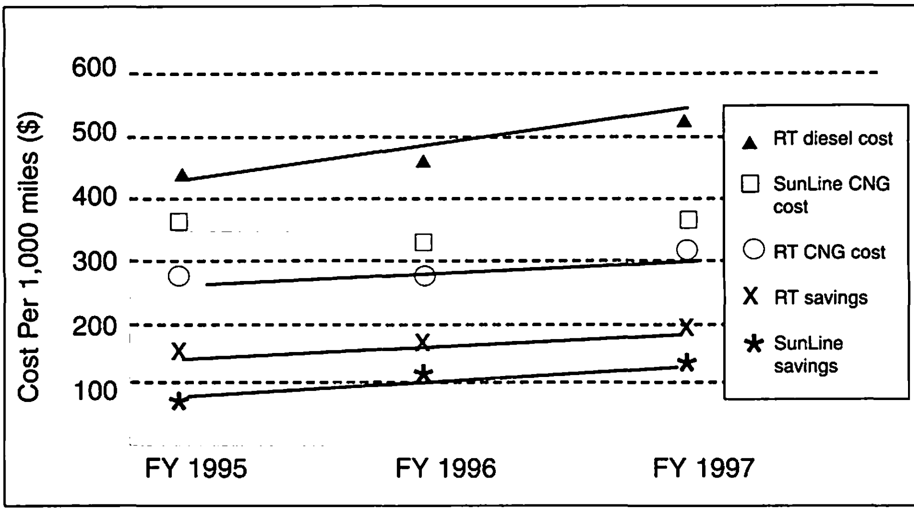

Figure 2. Trend comparisons of costs and savings

SunLine's higher expenses in FY1995 than in the next two years can be attributed to two situations. First, a pressure relief device (PRD) failure[1] in December 1994 required removal and replacement of PRDs for the total fleet. That event contributed a cost of vented fuel loss to depressurize the storage system and increased mechanic time to accomplish the upgrade to newer PRDs (RT upgraded in FY1997). Second, in January 1995, SunLine opened another operating division that required the additional expense of mobile fueling of the fleet until a fixed-site compressor station was installed.

The important conclusion depicted here is that the reduced rate of CNG cost growth may indeed be an indicator of lower life-cycle costs as addressed in the cost category descriptions and the increasing cost savings shown in Table 5.

Additional Savings

In California, hazardous waste must be carried away for disposal—a costly endeavor. Because four-stroke, spark-ignited engines remain cleaner in the absence of heavy particulate matter, they neither require steam cleaning as fre-

Table 5
Year-to-Year Comparison Cost Savings

	Dollars per 1,000 Miles		
Agency	*FY1995*	*FY1996*	*FY1997*
RT	157	172	197
SunLine	81	123	142

quently as diesel engines nor as many oil changes. As a result, both RT and SunLine experienced significant cost savings in hazardous waste disposal. Cleanup costs in the shop and parking areas were also substantially less.

SunLine's hazardous waste disposal costs decreased approximately 72 percent after removing diesel buses from the fleet. RT's hazardous waste costs decreased by one-third. That percentage is expected to increase as more diesel buses are replaced by CNG vehicles.

Road calls were not compared because of the diversity of reporting procedures between the two agencies. For example, the Federal Transit Administration (FTA) does not specify that a malfunctioning air conditioner is a road call, but both agencies count these as road calls because of climatic conditions. Still, neither agency experienced a significant number of CNG-system-related road calls.

The transit industry diesel average is approximately 4,000 miles between road calls for all categories. Even with variances in reporting between the two agencies, the differences are impressive. RT's most recent figures showed the CNG bus average exceeded 8,500 miles compared to 6,200 miles between road calls for its older diesel buses. SunLine's most recent average exceeded 11,000 miles. SunLine's advantage can be attributed to an innovative practice of a joint inspection by the operator and mechanic when the bus returns from service each day. This reduces the potential of unreported problems producing road calls.

Incremental Cost Payback

Until the manufacturing volume of CNG buses begins to match the volume of diesel buses, the incremental cost of a CNG-equipped bus will be higher (currently between $35,000 and $50,000 more per unit). At the rate of savings experienced during the first three years of operation, the payback of the incremental costs would occur midway through the life of the buses. Table 6 shows the payback calculated at a $50,000 incremental cost per unit without consideration of life-cycle cost factors.

Table 6
Payback of Incremental Costs

	Number of Buses	*Incremental Cost per Bus*	*Savings per Year*	*Payback[a]*		
				per Mile	*in Years*	*Miles per Bus*
RT	136	$50,000	$1,122,900	$0.197	6.1	253,807
SunLine	34	$50,000	$213,000	$0.142	8.0	352,113

a. FTA guideline for the planned life of a bus is 12 years or 500,000 miles.

All information indicated CNG will have a favorable reduction in life-cycle costs. RT sought to find out whether its fleet would need the $3,000 to $4,000 mid-life engine rebuild normally required for diesel engines at 250,000 miles. Cummins West, Inc., analyzed internal wear factors to assess engine durability during disassembly of an RT engine that had 296,628 miles. The engine was found to be in very good condition and no problems were discovered that would have prevented it from continuing to operate in the fleet. The internal wear report noted that the bearings could easily last double the mileage, the crankshaft was reusable without rework, the pistons were visually in "new" condition, and the oil pump was in excellent condition. No signs indicated the need for a mid-life rebuild.

Additional Investment in Switch to CNG

Both agencies experienced initial costs of fuel station installation, facility modifications, and training for both mechanics and operators. Other than the fuel station capital cost recovery in the price of fuel, these costs were not factored into the cost-per-mile comparisons.

Fueling and Maintenance Facilities

SunLine spent $1.47 million to design and construct its CNG fueling facility and adapt its maintenance facility. In partnership with Pickens Fuel Corp., SunLine operates a public access 1,200-standard cubic feet per minute (scfm) fuel station with two compressors. SunLine has a 25 percent ownership share and receives credits for all fuel sales; therefore, some of the capital costs are offset by the volume of sales to neighboring public and private fleets. Facility renovations included automated makeup air ventilation integrated into gas detection/alarm systems of 12 sensors for automatic activation of the new mechanical exhaust fans, explosion-proof electrical conduit, sealed sulfur lighting, and totally enclosed heaters.

RT spent $3.5 million to design and construct its CNG fueling facility and adapt its maintenance facility. This included three compressors, dehydrators, buffer vessels, dispenser/control units, control room, and emergency shutdown (ESD) system. RT's design, similar to SunLine's, incorporated 28 gas/fire sensors that detect the presence of gas, and increased shop airflow through the installation of several new ventilation systems, both electric and passive.

Many of these up-front facility modification costs were incurred for safety reasons, and a vast array of choices exists between regulatory jurisdictions in interpreting guidance for the acceptable level of mitigation versus the potential for a hazardous occurrence.

Mechanic Training

SunLine's mechanics attended 100 hours of training at College of the Desert, which cost approximately $84,000 in mechanic wages and benefits. RT invested between $27,000 and $30,000 in labor costs to retrain its mechanics.

As with any relatively new product, personnel needed to be trained for the introduction of the new technology to be successful. SunLine and RT firmly believe the positive results shown in this study are directly related to thorough training practices. For training to be effectively implemented, top management must be committed to the alternative fuel and accept lost productivity during the transition period.

Costs of New Technology and the Payback

As discussed in the Maintenance Cost Savings Analysis section, both agencies replaced PRDs, which affected expenses. Following this study, in 1998, RT began replacing its EDO brand cylinders because of a leakage problem, whereas cylinders usually last 15 years.

Because both agencies committed to procure more CNG vehicles over time, it would have been inaccurate to load the up-front infrastructure costs against the initial vehicles. So the up-front costs incurred in fueling and maintenance facilities were not calculated here in terms of payback. In SunLine's case, public access infrastructure supports paratransit and nonrevenue vehicles as well as a variety of local government vehicles and heavy-duty refuse trucks. RT's CNG bus fleet is growing each year and will be 100 percent CNG in the next few years. The greater the number of vehicles using the infrastructure, the lower those costs are per vehicle and per mile of operating costs over time.

However, if the infrastructure costs of fueling and maintenance facilities were charged against the original fleets of buses, payback in operational savings within the vehicle life expectancy would still occur. RT's payback would be extended to just over 9 years; SunLine's payback would be extended to just over 11 years.

Infrastructure is a substantial cost, but one that can be either offset by making the fueling facility a profit center (as SunLine has done) or avoided by fueling off-site. Another way to look at the cost is to determine the cost of a diesel fueling facility and the ongoing facility costs.

Policy Implications and Conclusions

The savings resulting from CNG buses help maintain an equitable pace with inflation, enabling both agencies to plan for vehicle replacements and possibly to add service as the stability of future funding allows.

Lower maintenance costs are attributable to thorough mechanic training. There also appears to be some longevity advantage for CNG life-cycle cost reduction because of reduced engine wear due to fewer engine deposits, absence of engine knock, better oil life, and longer life of reciprocating engine components. The FTA's standard 12-year replacement cycle could potentially be extended with maintenance practices concurrently improving chassis life expectancy (in favorable climatic environments). Particulate matter and other harmful emissions from CNG buses are greatly reduced over their diesel counterparts.

Prior studies have indicated the operating costs of CNG buses are generally higher or about the same as diesel, but the number of CNG buses compared was much smaller than the number of diesel vehicles. The cost to operate five CNG buses at Pierce Transit was $0.28/mile and five CNG buses at Metro-Dade was $0.55/mile, as reported in *Alternative Fuel Transit Buses, Final Results from a Vehicle Evaluation Program* (National Renewable Energy Laboratory 1996). The NREL study was closely matched with diesel controls. RT and SunLine's data fall within the best and worst range of that report but showed much better results over diesel, which could be partly attributed to the age of RT's diesel engines.

RT will continue to procure buses with CNG engines to meet the goal of replacing its entire fleet by 2003. SunLine will continue to purchase only CNG or new clean technology replacement vehicles for service operation and support. Both agencies will pursue all subsequent improvements to CNG technology, with the goal of providing more reliable vehicles in a cleaner environment.

Use of CNG technology also improves the image of mass transit. Transit buses are usually thought of as belching black smoke. No driver enjoys being behind a bus in slow-moving traffic. CNG buses emit no black smoke particulates (which stain the buses and make them appear unattractive), plus are also quieter to operate. This presents a more appealing perspective of bus riding; hopefully encouraging more individuals to use mass transit and take community pride in their transit systems.

In August 1998, California became the first state in the nation to name diesel exhaust as a toxic air contaminant—one that can cause cancer and other diseases. With growing environmental and health concerns over diesel, both agencies are sending strong messages to the citizens of their communities that alternative fuels help maintain a clean environment. Elected officials at both public agencies share a commitment to use alternative fuels and assist other local partners in using alternative fuels. As a result, area sanitation/refuse haulers, water districts, car rental agencies, shuttle services, and municipalities are now using CNG. Both agencies are active participants in their regions' U.S. Department of Energy Clean Cities programs.

CNG buses support the economies of Sacramento as the California state capital, and the Coachella Valley as an international resort destination. Air quality is an important destination criteria for tourists and visitors.

Both Sacramento RT and SunLine have found a win-win situation in CNG with significant maintenance savings and emission reductions. It is more economical to power buses on CNG than diesel and both communities take pride in transit's leadership in promoting cleaner air.

Acknowledgments

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Endnote

1. SunLine had a high-pressure PRD failure inside the maintenance garage leading to a burn of vented fuel, causing no harm to personnel or damage to buses, but minor facility damage. The extreme cost impact was due to hazardous material cleanup caused by fire suppression sprinkler flow into, and subsequent overflow of, waste oil reservoirs creating a massive oil spill on the property. For more details on this incident, see "Safety First: Lessons Learned from a Pressure Relief Device Failure," *Natural Gas Fuels Magazine,* November 1995.

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About the Authors

Chief Operating Officer **Cameron Beach** (cbeach@sacrt.com) is responsible for over 600 employees, a $52 million budget, and all rail and bus transportation at RT. In his 36-year transit career, Mr. Beach has worked for both public and private sector providers of public transportation.

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Assistant general manager for SunLine Transit Agency at the time the study was done, **Tracy Daly** (daly@scrra.net) was involved in nearly every aspect of the agency's conversion to CNG. In August 2000, she joined the staff of Metrolink in Los Angeles, California, as assistant executive officer.

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Niche Marketing Strategies: The Role of Special-Purpose Transportation Efforts in Attracting and Retaining Transit Users

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Abstract

This study evaluates the use of public transit niche strategies as an alternative marketing strategy designed to attract and retain new public transit riders. Four niche efforts, a university football shuttle, professional football shuttle, summer metropolitan park shuttle, and suburban subscription vanpool are the focus of the investigation. A total of 738 intercepts provide the data for the research. The researchers conclude that niche marketing efforts are an effective strategy, and therefore should be an important tool in the public transit industry's efforts to attract and retain new riders in order to offset the prolonged decline in public transit market share.

Introduction

The perception of public transit as a viable commuting option has steadily declined. Its overall share of the commuting market declined from 3.6 percent in 1969, to 2.6 percent in 1983, to 2.0 percent in 1990 (Khattak, Noeimi, and Al-Deek 1996; Pisarski 1992). The loss of market share is even more dramatic for work commutes where public transit's share declined from 12.6 percent in 1960 to 5.3 percent in 1990 (Khattak, Noeimi, and Al-Deek 1996; Ball 1994). However, the most dramatic evidence of the difficulty public transit has in attracting and retaining riders can be found in metropolitan areas (MSA) where its market share declined by 24.9 percent from 1980 to 1990 while the total number of commute trips made by MSA residents increased by 20.5 percent (Kemp et al. 1997).

In spite of the need for innovative marketing-based solutions, comparatively little attention has been directed to developing a better understanding of how consumer marketing approaches might be utilized by public transit agencies. For example, efforts to identify how to increase product awareness and encourage trial are traditional responses for organizations experiencing a small and declining market share (Jones 1990; Langlois 1986). With consumer products, this is typically done through sampling; that is, the delivery of free, or low-cost, product samples to potential customers. Examples of such strategies can be found almost daily in mailboxes or during trips to local retail stores. Sampling as a marketing strategy is obviously more difficult in the case of public transit. However, there is a lesson to be learned from consumer marketers.

As the cost of delivering product samples to consumers' homes has become almost prohibitive, marketers of consumer products have embraced in-store product sampling techniques (Blattberg and Neslin 1990; Boulding, Lee, and Staelin 1992). A visit to a local grocery store or warehouse club provides ample evidence of efforts *to bring the product to a central location* where large numbers of consumers can "sample" it. Niche market strategies are the public transit equivalent of these efforts. The intent of such strategies is to identify an event, or events, where a great number of people, particularly nontransit users, are in attendance and public transit is a visible, viable, and potentially attractive transportation alternative. Consumers in such situations are provided with an enticement to "sample" transit services, in that by using the service they can avoid long waits in traffic, difficult searches for parking, potential damage to their vehicles, and other problems. Transit providers are thereby afforded an opportunity to promote the quality of their services and to use entertainment-based tactics to elicit a level of satisfaction that will encourage "sample riders" to consider public transit services as an alternative in their day-to-day commutes. Moreover, these services do not have to be given away. Frequently, either the event sponsor or the riders themselves are only too happy to pay for the "convenience" of using such public transit services.

Niche Marketing Strategies

Niche transit marketing strategies are defined in this article simply as one-time, or infrequently occurring, transit services designed to offer access to a unique event or activity. Common examples include transportation to and from sports events, parades, holiday festivities and activities, seasonal recreational activities, and other similar events and occasions. The service may be offered using fixed or flexible routes, and regular or specially prepared vehicles. For instance, the Orioles' Train was a specially decorated railcar that ran on a fixed route from Washington D.C.'s Union Station to Baltimore's Camden Yards on Orioles' game days. In San Francisco and Chicago, regularly scheduled BART and CTA trains are promoted as a transit option for Oakland As' and Raiders' and Chicago White Sox's games. Many cities also use their transit systems to facilitate transportation to and from Fourth of July and New Year's Eve celebrations, Christmas or Thanksgiving Day parades, and other local festivities. Some also use such services seasonally to move local residents and tourists through parks or to and from other local attractions.

However, to date, the value of these efforts as marketing tools seems to have been largely overlooked by public transit properties. Too often, it appears that such transit services are offered as a "convenience" or "public service" with little consideration of their potential as a marketing tool. In fact, such efforts are often criticized as expensive and excessive or even as inappropriate because they appear to be subsidizing the operations of privately held organizations.

The objective of this study is to determine whether niche strategies are, in fact, an effective means to attract and retain new transit customers. That is:

1. Are the users of such services likely to be non- or infrequent public transit users?
2. If they are non- or infrequent public transit users, are they likely to increase their overall transit use as a result of their use of niche services?
3. If niche strategies are an effective means of attracting and retaining transit customers, what determines the service quality perceptions and satisfaction levels of niche transit customers?

The underlying theme investigated is that niche marketing efforts can be positively employed by public transit organizations if they are properly planned and executed as a promotional tactic rather than as a goodwill or community service project.

The Research

In order to better understand niche transit marketing strategies, four such efforts were investigated ($N = 738$):

1. college football shuttle service (sample 1; $n = 181$),
2. professional football shuttle service (sample 2; $n = 212$),
3. summer metropolitan park shuttle service (sample 3; $n = 231$), and
4. subscription vanpool service (sample 4; $n = 114$).

The four samples were drawn in separate metropolitan areas that have well-established public transit properties. Sample 1 is from a mid-sized southeastern city where the local economy is dominated by multiple state universities and government offices. Sample 2 is drawn from a second, and larger, southeastern city. The area's economy is dominated by service and military operations. Samples 3 and 4 are from different, very large, Midwestern cities that have diversified economies. The vanpool subscription service was identified as a niche strategy by the local public transit property based on the fact that it was the only one they operate, it serves a single employer, and was designed to encourage its users to utilize the property's rail and bus services.

Data for each of the samples were collected through personal intercepts at the events identified. Graduate students under the direction of the first author gathered the data in samples 1 and 2 and employees of the local public transit properties were responsible for that task in samples 3 and 4. The survey instrument utilized was identical for each location with minor variations to account for service differences. Specifically, the survey for sample 3 did not contain four questions that were deemed not applicable by the local transit agency. In addition, one question was added to reflect a unique characteristic of this system. In sample 4, four questions relative to staff performance were eliminated because no local agency staff had contact with users of the service.

Generally, the gender, income, and age distributions of the respondents are similar. The two exceptions are that sample 3 has proportionately more women (about 60% as compared to 50% in the other samples) and the college football shuttle program (sample 1) understandably exhibits a slightly younger mix of respondents.

Results

This section examines the results of the four public transit systems' niche strategies.

Who Uses Public Transit Niche Services?

The first focal research question is concerned with whether the users of niche services are likely to be non- or infrequent users of public transportation in general. Of the 738 total respondents, 265 (35.9%) either agree or strongly agree with the statement "I frequently use (*the transit agency name*) to commute to work." A total of 256 (34.7%) either agree or strongly agree with the statement "I frequently use *(the transit agency name)* for purposes other than work." The implication of these data is that approximately 65 percent of the niche service riders do represent new or infrequent transit users.

Do Niche Strategies Increase Overall Transit Use?

If 65 percent of the individuals reached by niche services are new or infrequent public transit users, these strategies are increasing the use of public transit in their own right. However, if niche strategies are to be truly effective, the investment in these efforts needs to be leveraged; that is, system operators want these new or infrequent users to become users of other public transit services. The results suggest such is the case. Of the 310 total respondents who indicated that they are new or infrequent users of public transit by not agreeing or strongly agreeing with the statements, "I frequently use *(name of local transit system)* to commute to work" and "I frequently use *(name of local transit system)* for purposes other than work," only 19.5 percent expressed a reluctance to "use other similar services."

In contrast, 62.2 percent strongly agreed or agreed that they would be willing to use other public transit services. Among the same group of respondents (i.e., new or infrequent transit users), only 6.5 percent indicated that they would not use the same service again, whereas 76.3 percent strongly agreed or agreed that they would use it again. Thus, the researchers found strong support for the use of niche marketing strategies as a means of attracting and retaining new or infrequent public transit users.

Unfortunately, space on the research instrument and the time available to question respondents limited the researchers' ability to identify what "other similar services" the non- or infrequent riders would use. In order to answer this question, a longitudinal study is needed to track the public transit usage of such individuals. One means to accomplish this is the use of a "diary" study. In this type of research, respondents keep a daily log of their transportation activities. An analysis of this information can identify what services are used, how often they are used, when they are used, and for what purpose. Public transit marketers can use such techniques as distributing smart cards that allow an individual's use of a transit system to be tracked. Casino- and airline-like frequency programs are examples of how this technique can be implemented.

What Are the Determinants of the Service Quality Perceptions and Customer Satisfaction of Public Transit Niche Marketing Strategies?

The success of niche marketing strategies is dependent on their ability to elicit three behaviors from customers. These behaviors are customers' willingness to (1) reuse the same service, (2) use other public transit services, and (3) recommend public transit services to other consumers. The mean response of the respondents relative to their willingness to engage in these three behaviors respectively was 4.56, 4.07, and 4.47 (where 1 = strongly disagree and 5 = strongly agree). This indicates a strong overall tendency among respondents to react to niche strategies in a manner beneficial to the transit provider. The attendant question is why? The model depicted in Figure 1 suggests the theory underlying the positive response to niche public transit strategies. That is, the high levels of perceived service qual-

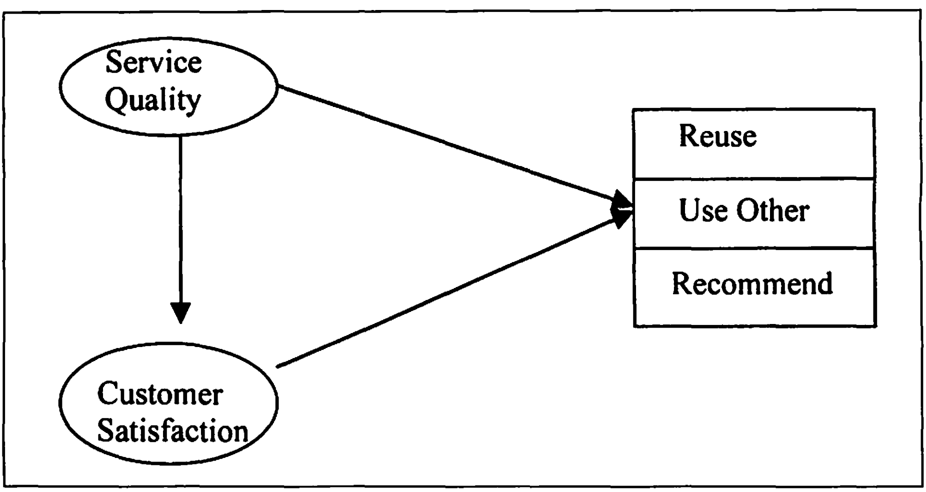

Figure 1. The research model

ity lead to customer satisfaction and willingness to engage in the desired behaviors—to use and/or recommend other public transit services.

The results identified in Table 1 validate the proposed relationship. Service quality and customer satisfaction exhibit a correlation of .914, indicative of the magnitude of the impact that transit users' perception of the quality of the service received has on their satisfaction with the transit provider. Additionally, these results point out the impact that service quality perceptions and customer satisfaction have on the success of niche marketing strategies by

Table 1
Perceived Service Quality and Customer Satisfaction Effects on Behavioral Outcomes

Variable	*Beta*	t-*value*	*Significance*
1. The quality of the service I received today was excellent (Perceived Service Quality)	.135	2.428	.015
2. I am very happy with this service (Customer Satisfaction)	.687	12.381	.000
DV. I would use this service again			Adj R^2 = .658
Variable	*Beta*	t-*value*	*Significance*
1. The quality of the service I received today was excellent (Perceived Service Quality)	.409	5.165	.000
2. I am very happy with this service (Customer Satisfaction)	.167	2.111	.035
DV. Because of this service, I would use other transit services			Adj R^2 = .319
Variable	*Beta*	t-*value*	Significance
1. The quality of the service I received today was excellent (Perceived Service Quality)	.222	4.168	.000
2. I am very happy with this service (Customer Satisfaction)	.621	11.676	.000
DV: I would strongly recommend this service to a good friend			Adj R^2 = . 686

public transit organizations. Both have a consistently strong, positive, and statistically significant influence on the willingness of consumers to reuse the specific niche service investigated, to use other transit services, and to recommend the public transit services to other consumers.

More specifically, although each has a significant impact on the three behavioral outcomes (see the beta and their respective significance values in Table 1), service quality appears to have a greater influence on transit users' willingness to try other transit services (i.e., its beta and associated *t*-value are greater than those for customer satisfaction). The more emotional-based satisfaction variable appears to have a greater influence on the focal niche service, specifically, in terms of the users' willingness to reuse and recommend the niche service (i.e., the betas and associated *t*-values for customer satisfaction are greater for these dependent variables [DVs]). The more cognitive, or evaluative, service quality assessment in contrast appears to have more influence in extending the impact of the niche marketing effort. That is, the better the perceived performance of a niche public transit strategy, the more likely patrons are to use other services offered by their local transit property. It also suggests that if public transit organizations want a niche marketing strategy to increase the use of their traditional services (i.e., fixed-route rail or bus services), they need to stress and deliver service excellence. Thus, promotions should also emphasize service excellence, and the best operators and equipment available should be utilized.

Impact of Service Quality Perceptions on Behavioral Outcomes

This study also investigated the effects of niche marketing strategies on three behaviors: customers' willingness to (1) reuse the niche service, (2) use other public transit services, and (3) recommend public transit services. A key assumption that underlies the use of niche strategies is that they help public transit organizations attract and retain users. As indicated above, the majority of the users of the niche transit services investigated are not regular public transit customers. Thus, if users indicate a willingness to reuse the service, evidence of the ability of these services to retain, as well as attract, new customers is identified.

The results identified in Table 2 suggest first that service quality perceptions are important as they explain 80.6, 66.6, 66.9, and 75.5 percent of the variation in the respondents' intentions to reuse the four investigated public transit services. Overall, the most obvious implication from Table 2 is that the niche public transit users prefer to reuse services that are more convenient than driving themselves (see samples 1, 2, and 3). Therefore, an emphasis on communicating the convenience of public transit services is needed in the providers' promotional efforts. More specific details are provided below.

Evaluating Specific Performance Dimensions

For the major university football shuttle, the respondents appear to prefer a clean, quick, not overly crowded, safe service where there is no waiting and parking is convenient. Users of the professional football shuttle service indicate a preference for quick, convenient service where tickets are easily purchased. The summer metropolitan park shuttle service users indicate that clean vehicles, convenient stops, and a friendly, helpful staff that is available when needed is what gets them to reuse this service. In contrast, the subscription vanpool users suggest that clean and comfortable vehicles, convenient stops, courteous, friendly drivers, and easy ticket availability are the factors that lead them to reuse this service. These factors thereby need to be incorporated into both the operational and marketing (i.e., promotional) efforts of public transit organizations.

Intentions to Use Other Transit Services

Table 3 identifies the impacts of service quality on the intentions of niche service users to expand their use to other transit services. This also is a test of a key assumption of the value of niche marketing strategies; that is, that they influence users to expand their product usage. The results identified in Table 3

Table 2
Influence of Individual Service Quality Perceptions on Intentions to Reuse the Service

Variable	Sample 1 Beta t-value Significance	Sample 2 Beta t-value Significance	Sample 3 Beta t-value Significance	Sample 4 Beta t-value Significance
1. Our buses were very clean	.124 1.749 .082	-.054 -.982 .328	.268 4.406 .000	.117 1.714 .091
2. Our buses were comfortable	.033 .507 .613	.023 .440 .660	.018 .252 .802	.126 1.690 .095
3. Our buses were not overly crowded	-.152 -3.041 .003	.001 .020 .984	.057 .872 .384	.074 1.067 .290
4. We got to our destination quickly	.225 3.766 .000	.125 2.330 .021	-.051 -.775 .440	.023 .318 .751
5. The ride was smooth	.015 .240 .811	-.012 -.227 .821	-.067 -1.029 .305	-.038 -.466 .643
6. I had no fear that I would be in an accident	.045 .835 .405	-.062 -1.164 .246	N/A	.011 .149 .882
7. I felt safe while on the bus	.139 1.970 .051	-.049 -.889 .375	.013 .216 .830	-.082 -.968 .337
8. The staff at the stops were courteous	.101 1.299 .196	.045 .760 .448	.026 .180 .858	N/A
9. The staff at the stops were friendly	.118 1.571 .118	.046 .820 .413	.429 4.212 .000	N/A
10. The staff at the stops were very willing to help riders	.127 1.569 .119	.079 1.351 .178	.244 1.889 .061	N/A
11. Staff were available at the stops when they were needed	.059 .765 .446	.085 1.484 .139	-.196 -2.030 .044	N/A
12. The locations of the stops were convenient	-.068 -1.042 .299	.167 3.158 .002	.169 2.538 .012	.554 7.929 .000
13. I felt safe at the stops	.127 1.461 .146	-.070 -1.098 .274	.049 .805 .422	.015 .145 .885
14. The waiting time was reasonable	-.094 -1.693 .093	.066 1.134 .258	.062 .906 .366	.005 .066 .948
15. The lines to get on buses were well organized	-.098 -1.573 .118	.077 1.418 .158	N/A	.124 1.533 .130
16. Convenient parking was available	.298 3.822 .000	.059 1.014 .312	-.066 -1.049 .296	-.101 -1.296 .199
17. The drivers were courteous	.018 .220 .826	-.009 -.147 .883	.045 .637 .525	.880 4.421 .000
18. The drivers were friendly	-.009 -.115 .909	.057 .988 .324	-.060 -.774 .440	-.641 -3.136 .003
19. The drivers were very willing to help riders	-.019 -.248 .804	.057 .981 .328	-.009 -.138 .890	.147 1.192 .237

Table 2 *(continued)*

Variable	*Sample 1* Beta t-value Significance	*Sample 2* Beta t-value Significance	*Sample 3* Beta t-value Significance	*Sample 4* Beta t-value Significance
20. It was easy to buy a ticket	-.030 -.432 .666	.367 6.384 .000	-.042 -.472 .638	.244 2.837 .006
21. We were well organized	-.010 -.127 .899	.081 1.117 .265	N/A	.168 1.628 .108
22. Enough information was available	-.086 -1.235 .219	-.028 -.392 .696	-.048 -.691 .491	.156 1.846 .069
23. Convenient parking was available	-.090 -1.088 .278	.002 .040 .968	N/A	-.057 -.637 .526
24. This service is more convenient than driving ourselves	.540 7.482 .000	.330 5.659 .000	.141 2.460 .015	.090 1.089 .280
25. The connection with ___ is convenient	N/A	N/A	.209 3.290 .001	N/A
DV: I would use this service again	Adj R^2 = .806	Adj R^2 = .665	Adj R^2 = .669	Adj R^2 = .755

support this assumption as service quality perceptions explain 36.5, 31.6, 45.1, and 33.0 percent of the variation in the respondents' intentions to use other transit services.

Individually, users of the university football shuttle service (sample 1) indicate that safety, organization, and convenience are the factors that encourage them to expand their use of transit services beyond the niche effort. Sample 2 users, the professional football shuttle service, suggest that a well-organized, smooth, uncrowded ride that is more convenient than driving and free of the fear of an accident enhances the probability that they will use other transit services. The summer metropolitan park shuttle service users (sample 3) indicate that clean vehicles, safe stops, convenient parking, and links to the local mass transit system will similarly motivate them. The subscription vanpool users (sample 4) suggest that reasonable waiting times, conveniently available tickets, and information availability are the factors that will lead them to expand their use of public transit services.

These results suggest that the factors that encourage niche riders to use other public transit services are not identical to those that lead to reuse of the

Table 3
Analysis of the Importance of Individual Service Quality Perceptions on Intentions to Use Other Similar Services

Variable	*Sample 1* *Beta* *t-value* *Significance*	*Sample 2* *Beta* *t-value* *Significance*	*Sample 3* *Beta* *t-value* *Significance*	*Sample 4* *Beta* *t-value* *Significance*
1. Our buses were very clean	.102 .479 .633	.121 1.119 .265	.480 5.096 .000	.129 .672 .505
2. Our buses were comfortable	.202 .980 .329	.137 1.319 .189	.120 1.090 .278	.134 .572 .570
3. Our buses were not overly crowded	.015 .136 .892	.195 2.538 .012	.067 .693 .489	.034 .180 .858
4. We got to our destination quickly	.031 .194 .846	.126 1.353 .178	.032 .304 .761	.061 .254 .801
5. The ride was smooth	.080 .513 .609	.283 2.370 .019	.097 .993 .323	.098 .366 .715
6. I had no fear that I would be in an accident	.174 1.150 .252	.219 1.835 .068	N/A	.262 .551 .584
7. I felt safe while on the bus	.371 1.808 .073	.175 1.224 .223	.063 .610 .543	.160 .357 .722
8. The staff at the stops were courteous	.121 .400 .690	.150 .780 .437	.309 1.415 .159	N/A
9. The staff at the stops were friendly	.181 .461 .646	.209 1.061 .290	.220 .942 .348	N/A
10. The staff at the stops were very willing to help riders	.035 .096 .924	.074 .474 .636	.104 .470 .639	N/A
11. Staff were available at the stops when they were needed	.208 .694 .489	.109 .745 .458	.062 .417 .677	N/A
12. The locations of the stops were convenient	.106 .672 .502	.122 1.195 .234	.194 1.532 .128	.026 .116 .908
13. I felt safe at the stops	.151 .654 .514	.080 .674 .502	.311 3.094 .002	.144 .663 .510
14. The waiting time was reasonable	.129 1.066 .288	.004 .040 .968	.047 .449 .654	.423 1.977 .053
15. The lines to get on buses were well organized	.201 .702 .484	.070 .512 .609	N/A	.399 1.178 .244
16. Convenient parking was available	.083 .355 .723	.058 .464 .643	215 2.119 .036	.038 .137 .891
17. The drivers were courteous	.245 .570 .569	.010 .050 .960	.009 .049 .961	.504 1.206 .233
18. The drivers were friendly	.276 .586	.125 .578	.301 1.485	.323 .783

Table 3 *(continued)*

Variable	*Sample 1* *Beta* *t-value* *Significance*	*Sample 2* *Beta* *t-value* *Significance*	*Sample 3* *Beta* *t-value* *Significance*	*Sample 4* *Beta* *t-value* *Significance*
19. The drivers were very willing to help riders	.572 1.590 .114	.001 .009 .993	.096 .649 .518	.177 .733 .467
20. It was easy to buy a ticket	.285 1.373 .172	.020 .166 .869	.157 1.045 .298	.423 1.649 .105
21. We were well organized	.301 4.575 .000	.163 4.716 .000	N/A	.010 .127 .899
22. Enough information was available	.127 .735 .463	.119 .819 .414	.120 1.037 .302	.574 1.644 .106
23. Convenient parking was available	.096 .390 .697	.192 1.296 .197	N/A	.218 .454 .652
24. This service is more convenient than driving ourselves	.318 1.666 .098	.034 .357 .721	.051 .669 .505	.198 .908 .368
25. The connection with ___ is convenient	N/A	N/A	.199 1.888 .061	N/A
DV: I intend to use other similar services	*Adj* R^2=*.365*	*Adj* R^2=*.316*	*Adj* R^2=*.451*	*Adj* R^2=*.330*

niche service. Thus, public transit marketers must employ different messages if this is their objective. Organization, safety, and security join convenience as factors that encourage niche riders to use other public transit services.

Willingness to Recommend Transit Services

Table 4 provides support for the notion that service quality perceptions play an important role in eliciting positive word-of-mouth, or recommendations, for their public transit properties as they explain 81.9, 69.7, 74.9, and 74.3 percent of the variation in the respondents' willingness to recommend the service to a good friend. Once again, services that consumers view as more convenient than driving themselves register strong support (see samples 1, 2, 3, and 4).

On a sample-to-sample basis, for the major university football shuttle, respondents express the greatest willingness to recommend the service when it is quick, safe, and convenient. For the professional football shuttle, the will-

Table 4
Influence of Individual Service Quality Perceptions on Willingness to Recommend this Service

Variable	*Sample 1* *Beta* *t-value* *Significance*	*Sample 2* *Beta* *t-value* *Significance*	*Sample 3* *Beta* *t-value* *Significance*	*Sample 4* *Beta* *t-value* *Significance*
1. Our buses were very clean	-.036 -.481 .631	-.018 -.335 .738	.153 2.770 .006	-.056 -.741 .461
2. Our buses were comfortable	-.106 -1.632 .105	.099 1.833 .068	.007 .102 .919	.132 1.719 .090
3. Our buses were not overly crowded	-.091 -1.859 .065	.033 .682 .496	.139 2.258 .025	.080 1.121 .266
4. We got to our destination quickly	.141 2.225 .026	.178 3.250 .001	-.005 -.073 .942	.094 1.308 .195
5. The ride was smooth	-.091 -1.319 .189	.155 3.062 .003	-.108 -1.793 .075	.082 .978 .331
6. I had no fear that I would be in an accident	-.130 -1.837 .068	.109 1.915 .057	N/A	.054 .658 .513
7. I felt safe while on the bus	.182 2.472 .015	-.087 -1.293 .198	.095 1.555 .122	.035 .399 .691
8. The staff at the stops were courteous	-.052 -.436 .663	.059 1.096 .274	-.011 -.084 .933	N/A
9. The staff at the stops were friendly	.037 .257 .797	.046 .843 .400	.645 5.371 3.073	N/A
10. The staff at the stops were very willing to help riders	.122 1.453 .148	.028 .503 .616	-.075 -.790 .431	N/A
11. Staff were available at the stops when they were needed	-.090 -.826 .410	.054 1.030 .305	.088 1.084 .280	N/A
12. The locations of the stops were convenient	-.162 -2.521 .013	.100 1.811 .072	.088 1.084 .280	.148 1.836 .071
13. I felt safe at the stops	.004 .040 .968	.111 1.763 .080	.197 3.190 .002	.101 1.178 .243
14. The waiting time was reasonable	-.023 -.425 .671	.014 .259 .796	.220 -3.334 .001	-.012 -.131 .896
15. The lines to get on buses were well organized	-.049 -.837 .404	.036 .664 .508	N/A	.169 1.956 .055
16. Convenient parking was available	.191 2.207 .029	.185 3.730 .000	-.118 -1.908 .058.	-.231 -2.009 .048
17. The drivers were courteous	-.029 -.352 .725	-.010 -.190 .850	.276 2.555 .012	-.136 -1.207 .232
18. The drivers were friendly	-.025 -.326 .745	-.027 -.502 .616	-.799 -6.440 .000	-.156 -1.303 .197
19. The drivers were very willing to help riders	-.030 -.403 .687	.058 1.072 .285	.046 .479 .633	.316 3.609 .001
20. It was easy to buy a ticket	-.071 -1.1016 .311	-.094 -1.415 .159	-.493 -5.221 .000	.062 .621 .537

Table 4 *(continued)*

Variable	*Sample 1* *Beta* *t-value* *Significance*	*Sample 2* *Beta* *t-value* *Significance*	*Sample 3* *Beta* *t-value* *Significance*	*Sample 4* *Beta* *t-value* *Significance*
21. We were well organized	-.055 -.669 .504	.134 2.288 .023	N/A	.459 3.750 .000
22. Enough information was available	-.003 -.049 .961	-.088 -1.310 .192	-.077 -1.011 .314	.002 .012 .991
23. Convenient parking was available	.002 .026 .979	.004 .053 .958	N/A	.050 .417 .678
24. This service is more convenient than driving ourselves	.482 6.330 .000	.401 7.242 .000	.164 3.179 .002	.399 3.944 .000
25. The connection with ____ is convenient	N/A	N/A	.209 3.29 .001	N/A
DV: I strongly recommend this service to a good Friend	*Adj* R^2 = *.819*	*Adj* R^2 = *.697*	*Adj* R^2 = *.749*	*Adj* R^2 = *.743*

ingness to recommend was strongly associated with a quick, convenient, and organized service that featured a smooth ride. For the summer metropolitan park shuttle service, a greater number of factors determined the willingness of users to recommend the service. Clean, convenient, and safe service that featured little waiting, no crowding, and courteous and friendly drivers were the specific factors identified as antecedents of the willingness to recommend the service to others. Users of the subscription vanpool indicated comfortable vehicles, convenient stops, organized service, and courteous and helpful drivers are the factors that lead them to recommend this service. Again, incorporating these implications into marketing efforts allows public transit organizations to leverage their investments in niche marketing strategies.

Impact of Service Quality Perceptions on Customer Satisfaction

Another important consideration is the impact of transit users' perceptions of the quality of the service they receive. The results identified in Table 5 indicate that much of the variation in customer satisfaction is explained by their perceptions of the quality of the service they receive; specifically, 94.5, 81.5, 74.9, and 82.1 percent, respectively, in the four individual research samples. Interestingly, the service factor that is most often significant across the four

Table 5
Influence of Individual Service Quality on Satisfaction with Service

Variable	*Sample 1* *Beta* *t-value* *Significance*	*Sample 2* *Beta* *t-value* *Significance*	*Sample 3* *Beta* *t-value* *Significance*	*Sample 4* *Beta* *t-value* *Significance*
1. Our buses were very clean	.127 3.170 .002	-.027 -.618 .537	.076 1.450 .149	.010 .155 .877
2. Our buses were comfortable	-.031 -.712 .478	.042 .969 .334	-.093 -1.599 .112	.083 1.111 .270
3. Our buses were not overly crowded	-.026 -.952 .343	.008 .209 .835	-.087 -1.491 .138	.024 .386 .701
4. We got to our destination quickly	.078 2.170 .031	.108 2.447 .015	-.160 -2.700 .008	.006 .102 .919
5. The ride was smooth	.000 .002 .999	.003 .061 .952	-.034 -.596 .552	.025 .345 .731
6. I had no fear that I would be in an accident	.022 .553 .581	.086 2.064 .040	N/A	.102 1.083 .283
7. I felt safe while on the bus	.114 2.860 .005	-.102 -1.668 .097	.290 4.883 .000	-.153 -2.148 .035
8. The staff at the stops were courteous	-.039 -.857 .393	.182 3.003 .003	-.094 -1.267 .207	N/A
9. The staff at the stops were friendly	-.048 -1.035 .302	.006 .069 .945	-.026 -.341 .734	N/A
10. The staff at the stops were very willing to help riders	-.026 -.527 .599	-.134 -2.163 .032	-.020 -.283 .778	N/A
11. Staff were available at the stops when they were needed	-.009 -.195 .846	.046 .636 .526	-.079 -1.223 .223	N/A
12. The locations of the stops were convenient	-.018 -.509 .612	.044 .941 .348	.192 3.251 .001	.089 1.233 .222
13. I felt safe at the stops	-.097 -1.950 .053	-.070 -1.392 .166	.104 1.859 .065	-.049 -.626 .534
14. The waiting time was reasonable	-.049 -1.691 .093	.131 3.079 .002	.015 .248 .804	-.122 -1.607 .113
15. The lines to get on buses were well organized	-.012 -.364 .716	.028 .522 .602	N/A	.243 3.340 .001
16. Convenient parking was available	.157 3.612 .000	.120 2.276 .024	-.037 -.639 .524	-.096 -1.248 .216
17. The drivers were courteous	-.001 -.012 .990	.010 .140 .889	.257 4.626 .000	.083 .880 .382
18. The drivers were friendly	-.033 -.724 .470	.002 .027 .978	-.044 -.410 .682	.090 .920 .361
19. The drivers were very willing to help riders	.029 .633 .528	146 2.993 .003	.001 .009 .992	.269 3.447 .001
20. It was easy to buy a ticket	-.014 -.258 .797	.030 .510 .611	.075 1.015 .312	.139 1.754 .084

Table 5 *(continued)*

Variable	*Sample 1* *Beta* t-*value* *Significance*	*Sample 2* *Beta* t-*value* *Significance*	*Sample 3* *Beta* t-*value* *Significance*	*Sample 4* *Beta* t-*value* *Significance*
21. We were well organized	.125 2.565 .011	.169 2.838 .005	N/A	.402 4.082 .000
22. Enough information was available	.104 2.448 .015	169 2.838 .005	.097 1.621 .107	-.001 -.008 .994
23. Convenient parking was available	-.006 -.110 .913	.159 2.612 .010	N/A	-.088 -.893 .375
24. This service is more convenient than driving ourselves	.347 7.410 .000	.030 .510 .611	.142 2.803 .006	.252 3.357 .001
25. The connection with ____ is convenient	N/A	N/A	.293 5.229 .000	N/A
DV: I am very happy with this service	*Adj* R^2 = *.945*	*Adj* R^2 = *.815*	Adj R^2 = .749	*Adj* R^2 = *.821*

samples is personal safety while on the transit vehicle. This is logical, as satisfaction represents a user's emotional reaction to the service they receive, and safety elicits a strongly emotional reaction in all service experiences. This directly underscores the importance of sending the message in the marketing efforts of public transit organizations. Specifically, it suggests that to be effective, the safety of niche marketing strategies must be communicated to potential users.

Analyzing the individual niche services, the university football shuttle users' satisfaction is enhanced if the service is perceived to be safe, clean, quick, and organized, enough information is provided about the service, convenient parking is available, and waiting time is minimal. The professional football shuttle users exhibit a similar pattern, except their satisfaction is less dependent on the cleanliness of the vehicle and more impacted by staff courtesy and staff and driver helpfulness. The summer metropolitan park shuttle service users also were more satisfied if they perceived the service to be safe, quick, and convenient; have adequate information available; have convenient parking; and if they felt the service was more convenient than driving. A unique consideration for this service was the connection with the area's mass transit system. Users who believed that connection to be convenient tended to be more satisfied. Users of the subscription vanpool were more satisfied if they perceived the service to be safe and well organized, the drivers helpful, tickets easy to buy, and if the service was perceived to be more convenient than driving.

Importance of Individual Service Quality Perceptions

A second consideration of note is the importance of the individual components of service quality perceptions. Given the influence of the service quality perceptions of the users of niche transit services, knowing the relative impact of each quality component allows more effective positioning and promotion decisions to be made. The results identified in Table 6 indicate that much of the variation in service quality perception is explained by the set of quality factors identified. In fact, 94.0, 79.0, 70.5, and 90.1 percent of the variation in the overall measure of performance excellence is explained by the composite set of factors in the four individual research samples.

For the university football shuttle users, service quality perceptions are most impacted by their evaluation of the cleanliness of vehicles, friendliness of staff, safety, freedom from fear of accidents, convenience of the service and parking, provision of information, and the organization of lines and the service in general. The professional football shuttle users equate service excellence with getting to destinations quickly, freedom from the fear of an accident, friendly staff, reasonable waiting times, organized services, good information, and convenient parking. The summer metropolitan park shuttle service riders use safety, the friendliness and courtesy of staff and drivers, and convenience to judge the quality of the service. Users of the subscription vanpool associated getting to destinations quickly, freedom of fear from accidents, organization of the service, friendliness and helpfulness of drivers, and convenience of the service with service quality excellence.

Table 6
Analysis of the Importance of Individual Service Quality Perceptions

Variable	*Sample 1* *Beta* *t-value* *Significance*	*Sample 2* *Beta* *t-value* *Significance*	*Sample 3* *Beta* *t-value* *Significance*	*Sample 4* *Beta* *t-value* *Significance*
1. Our buses were very clean	.108 2.544 .012	.045 1.006 .316	.034 .603 .547	.143 2.779 .007
2. Our buses were comfortable	.022 .440 .661	.063 1.442 .151	.001 .017 .987	.155 2.602 .011
3. Our buses were not overly crowded	.047 1.522 .130	.003 .071 .944	.001 .024 .981	.055 .972 .335
4. We got to our destination quickly	.063 1.578 .130	.132 2.845 .005	.029 .467 .641	.181 3.195 .002
5. The ride was smooth	.042 1.042 .299	.003 .063 .950	.005 .075 .941	.224 3.241 .002
6. I had no fear that I would be in an accident	.067 1.553 .123	.072 1.654 .100	N/A	.096 1.452 .151
7. I felt safe while on the bus	.173 4.137 .000	.014 .310 .757	.243 3.844 .000	.051 .778 .439
8. The staff at the stops were courteous	.098 1.230 .221	.012 .229 .819	.262 4.377 .000	N/A
9. The staff at the stops were friendly	.269 3.742 .000	.093 1.707 .090	.158 2.011 .046	N/A
10. The staff at the stops were very willing to help riders	.097 .988 .325	.018 .351 .726	.001 .005 .996	N/A
11. Staff were available at the stops when they were needed	.396 5.663 .000	.062 1.264 .208	.027 .293 .770	N/A
12. The locations of the stops were convenient	.034 .830 .408	.000 .005 .996	.045 .662 .509	.084 1.515 .134
13. I felt safe at the stops	.145 2.653 .009	.026 .490 .625	.135 2.382 .018	.032 .555 .581
14. The waiting time was reasonable	.086 2.217 .028	.242 5.404 .000	.051 .742 .459	.008 .125 .901
15. The lines to get on buses were well organized	.125 2.921 .004	.054 .980 .329	N/A	.246 4.329 .000
16. Convenient parking was available	.194 3.758 .000	.036 .596 .552	.001 .009 .993	.044 .739 .463
17. The drivers were courteous	.035 .660 .510	.170 3.849 .000	.575 5.094 .000	.016 .215 .830
18. The drivers were friendly	.052 1.054 .294	.114 1.239 .217	.458 3.768 .000	.123 1.642 .105
19. The drivers were very willing to help riders	.071 1.447 .150	.100 1.463 .145	.023 .226 .882	.243 4.295 .000
20. It was easy to buy a ticket	.151 2.706 .008	.089 1.483 .140	.028 .362 .718	.082 1.285 .203
21. We were well organized	.322 4.365 .000	.266 5.002 .000	N/A	.173 2.158 .035
22. Enough information was available	.327 6.910 .000	.109 1.709 .089	.076 1.197 .233	.056 .598 .552

Table 6 *(continued)*

Variable	Sample 1 Beta t-value Significance	Sample 2 Beta t-value Significance	Sample 3 Beta t-value Significance	Sample 4 Beta t-value Significance
23. Convenient parking was available	.107 1.624 .107	.173 3.630 .000	N/A	.013 .162 .872
24. This service is more convenient than driving ourselves	.419 7.758 .000	.141 3.101 .002	.167 3.040 .003	.386 6.859 .000
25. The connection with ___ is convenient	N/A	N/A	.043 .321 .748	N/A
DV: The quality of the service I received today was excellent	Adj R^2 =.940	Adj R^2 = .790	Adj R^2 = .705	Adj R^2 = .901

Conclusions and Implications

The study presented clearly suggests that niche public transit marketing strategies can be effective tools in public transit's efforts to attract and retain new riders. Whereas some might look at niche efforts, such as the ones investigated, as extravagant and superfluous, they, in fact, are one of the most effective ways to reach new markets. Much of today's consumer decision making is emotionally derived from individuals' satisfaction with their purchase experiences. Sporting events, holiday celebrations, and vacation excursions are occasions packed with positive emotions. If public transit is able to tap into these emotions by providing convenient and attractive alternatives to dull commutes and harried searches for parking, these experiences can place public transit in the evoked set for other day-to-day work and pleasure commutes. As such, niche strategies can represent a marketing investment; albeit, one that often is also profitable in its own right.

Interestingly, the results of this investigation suggest that consumers' decisions relative to the use of public transit move beyond the role of clean, attractive, and safe vehicles and friendly, courteous staff and drivers. They also move beyond issues of personal safety, either while on vehicles or at stops. This is not to suggest that these issues are not important determinants of public transit users' service quality perceptions; satisfaction with the service; or their intention to reuse the niche service, use other transit services, or to recommend the transit agency to a friend. They are important considerations in each of these areas. However, the transit industry has known that for years.

Equally interesting is the important role in these decisions assigned by niche public transit users to the organization of the service, the provision of information about the service, and the ease of gaining access to the service (i.e., buying tickets, waiting time, and parking). Study respondents were largely nontransit users. One might surmise from the results that they are more likely to use a service if it appears organized, if they have sufficient information to make its use convenient, and if access to the service is assured. These aspects should be incorporated into the design and promotion of transit services intended to attract and retain new users.

In conclusion, the declining trend in public transit's share of riders does not reflect a decaying market for the industry's services. Rather it appears to be signaling a need for a redirection of public transit product planning. Gone are the days when a significant number of U.S. consumers had no other means of transportation. The public transit market in the United States is now a discretionary market. The potential public transit users today have options available to them. While it is true that traditional transportation patterns have been altered and many commutes now represent multiple-purpose trips, this does not alter the fact that there is still a legitimate need for public transit services in this market. It is the responsibility of the transit industry to identify that role and to adjust its product offerings to reflect the market's needs. The market will not change.

In order for public transit to gain a larger share of the people-moving market, its marketers need to gain a better understanding of what motivates individuals to make specific transit choices. Niche markets are one area where public transit has many documented successes. Perhaps, in this industry, learning from one's positive experiences is as important, if not more so, than learning from its mistakes.

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The Public Land Transport Sector in Lebanon

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Abstract

Lebanon is one of the few countries in the world that allows public transport vehicles to move freely in the country without any regulation or planning. As a result, the present status of the public land transport sector in Lebanon has reached a critical state that must be reformed and organized.

This article identifies the problems facing the public land transport sector. It examines the plan that has been recently endorsed by the Council of Ministers to mitigate the current situation. The plan identifies a new role for the government: It would cease being just a losing service provider and it would become the planner and regulator of the sector. This strategy is intended to ensure the existence of sufficient, affordable, and efficient transport services, provided by several private sector operators functioning under competitive conditions. Thus, the existing autonomous Railway and Public Transport Authority (RPTA) would be restructured to serve as the effective regulator, its bus operations would be corporatized (for possible eventual privatization), and all existing private sector service providers would be regulated. The article also reviews the recommendation that the government carry out two prototype projects before the entire reform plan is implemented nationwide.

Introduction

The public land transport sector in Lebanon is in a critical situation. Unsustainable conditions have resulted from the simultaneous occurrence of:

1. a threefold increase in the number of taxis and service vehicles (shared taxis) from 10,650 in 1996 to 33,300 in 1998;
2. the operation of 225 buses of the RPTA on 22 routes in Beirut;
3. a tripling in the number of privately owned buses (to reach 2,400 buses); and
4. the issuance of up to 4,000 plates of a new category of public transport vehicles, the "minibus" (Baaj 1999c).

The presence of this huge public transport vehicular capacity and 800,000 private passenger cars (in a country whose total population is 3.5 million) utilizing an insufficient road network, causes daily traffic congestion that impacts the economy because it increases transport costs as well as air pollution. Poor transport revenues lead to dangerous competition, with repercussions on the offered service levels, especially on traffic safety. The lack of an annual and effective mechanical inspection program and the absence of liability insurance along with poor vehicular repair and maintenance have negative effects on traffic safety and air pollution levels. Therefore, it was imperative to set up an efficient and comprehensive reform and regulatory plan for the public land transport sector in Lebanon.

This article presents the components of the reform and organization plan. It identifies the elements of the public land transport sector (the players) and the share of each sector element in meeting transit demand. The article also examines the problems of the sectors and the proposed reform and organization policies, including the new role of government. It discusses the three components of the reform plan: identification of the new regulatory body (the restructured RPTA), corporatization of RPTA's bus operations, and regulation for all private sector service providers. The article concludes with ongoing research into the plan's implementation since it was formally endorsed by the Council of Ministers in April 2000.

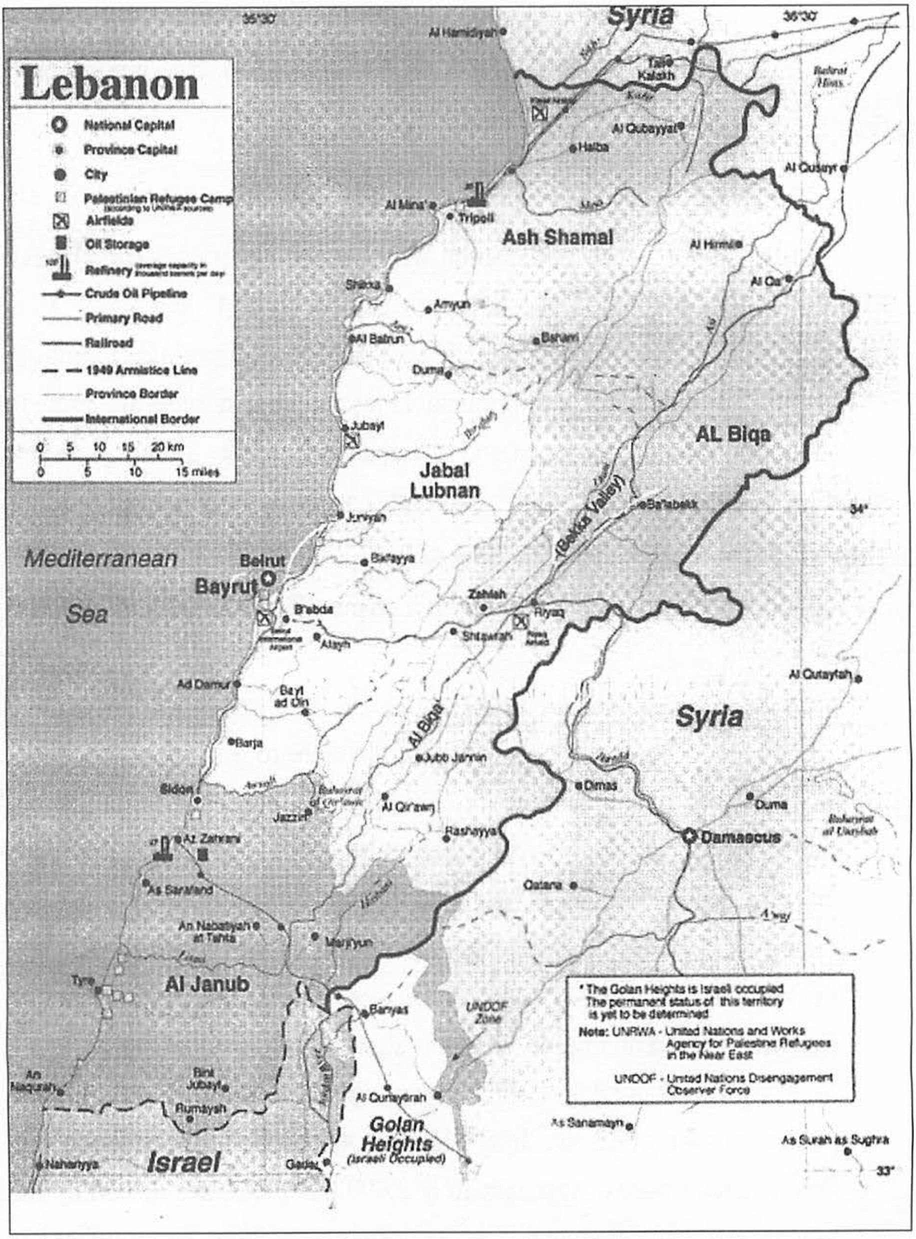
Status of the Public Land Transport Sector

Figure 1 shows a map of Lebanon with its five governates (provinces). RPTA presently operates in the country's capital (Beirut) and in Al Biqa Governate, while plans are being prepared for service in Tripoli (the capital of Ash Shamal Governate). The two principal cities and their suburbs are home to almost half the country's population. In Lebanon, intercity public transport demand is met by privately owned buses and shared taxis.

Elements of the Public Land Transport Sector

The public land transport sector in Lebanon consists of these service providers:

- Service vehicles (shared taxis) and taxis. Presently, there are about 33,300 red plates whose owners have the right to provide service anywhere in the Lebanese republic. This fleet size represents a threefold increase over the last two years (there were only 11,000 red plates by the end of 1996). Of the 33,300 red plates, 1,300 were licensed to taxis (with meters) and 32,000 to service vehicles. Furthermore, preliminary statistics estimate that 20,000 to 25,000 service vehicles and taxis operate in Beirut while the number in Tripoli is about 4,000.
- Minivans (minibuses). In 1996, this new class of vehicles was allowed into public transport operation. Today there are 4,000 minibuses in service.
- Private sector buses. Approximately 2,400 bus plates are owned by the private sector and operate within major Lebanese cities. This number has increased about four times, from about 600 buses at the end of 1996.
- RPTA buses. Of the total 302 buses in operation, 50 are older Berliets (PR 100-Renault), 200 are newer Karusas (B731-Renault) (purchased in



Source: MAGELLAN Geographix℠, Santa Barbara, CA, 1992.

Figure1. Lebanon and its five governates

1996 through a 21 million USD [U.S. dollars] Lebanese government loan), 12 are Elbas (locally assembled), and 40 are Mitsubishi (Rosa) midibuses (received as a grant to the government). The Elba and Mitsubishi buses have not yet been deployed in service; they will be used in the implementation of future service expansion plans.

Sector Element Share

A 1995 study (Team International-Iaurif-Sofretu) estimated that the transport demand is about 1.75 million daily motorized trips within the greater Beirut area. Such demand is expected to increase to 3 million and 5 million daily motorized trips in 2005 and 2015, respectively. As for Tripoli, there were 0.5 million daily motorized trips in 1998. As shown in Table 1, the shares of the different transport providers in the greater Beirut area were: 68 percent for private cars; 15 percent, service and taxi vehicles; 14 percent, private sector buses; and 3 percent, RPTA buses.

Table 2 shows a comparison between the public land transport means in Lebanon and Jordan (Pricewaterhouse Coopers 1999). It clearly demonstrates the existence of a large number of service and taxi vehicles in the Lebanese cities, which exceeds the real transport demand.

Problems of the Public Land Transport Sector

This section examines the main problems faced by the land transport sector.

Lack of Organization

The key problem is the sector's lack of organization. A large number of transport providers compete to serve a demand that is less than the existing available capacity. Meanwhile, several Lebanese regions suffer from a shortage of public transport service providers. Shared taxis, minibuses, and buses compete on the same lines, resulting in poor financial returns. Consequently, many drivers and owners of service vehicles are compelled not to replace, repair, or maintain their vehicles properly. (The average age of the fleet of service vehi-

Table 1
1998 Demand Distribution by Vehicle Classification

Region	*Greater Beirut*	*Tripoli*
Population	1,300,000	400,000
Daily motorized trips	1,750,000	500,000
Transport share:		
1. Service and taxi vehicles	15%	21%
2. Private sector buses	14%	12%
3. RPTA buses	3%	0%
4. Private passenger cars	68%	67%
2 + 3: Trips by bus	297,500	60,000

Table 2
Comparison between Lebanon and Jordan (1998)

City	*Greater Beirut*	*Tripoli*	*Amman*
Population	1,300,000	400,000	1,100,000
Service and taxi vehicles	20,000	4,000	9,900
Buses and minibuses	4,100	800	810
Private passenger cars	280,000	100,000	90,000

cles is about 20 years old.) The Council of Ministers recently authorized service vehicle owners to import replacement vehicles duty-free, provided that the age of each replacement vehicle is less than 5 years and that it runs on gasoline only.

Furthermore, some operators have been illegally modifying their vehicle engines to run on industrial diesel fuel, which contains extremely high levels of sulfur. The latter's cost, being subsidized by the government, is about half that of unleaded gasoline. In addition, diesel fuel yields a fuel efficiency (as measured in miles per gallon) double that of unleaded gasoline. Hence, it is imperative to prepare a scientific and subjective study of the transport demand patterns within and between Lebanese regions and to distribute the service providers' supply rationally. If there still is a surplus of transport providers, then several actions could be considered including repurchasing some surplus red plates.

Deterioration of Service Levels

The actual distribution of transport providers as well as the number of private passenger cars (about 800,000 in actual operation) lead to high transport costs and poor service levels. In fact, traffic congestion on greater Beirut area roads results in long trip times relative to trip lengths and a high consumption of gasoline, creating a harmful air pollution problem. The negative impact on the Lebanese economy is multifaceted: a high gasoline import bill, additional costs to export goods (which harm their competitiveness), and extra transport times for passengers and goods (which translate into low economic productivity and efficiency). Furthermore, the driving pattern of service providers, particularly operators of service vehicles and minivans, is one of roaming, which increases traffic congestion. Thousands of service vehicles roam in search of limited ridership while usurping an unacceptable share of the road capacity.

Traffic congestion is one main reason preventing RPTA buses from attracting passengers and encouraging them to use its buses. The authority's unreliable service, especially during peak hours, makes it difficult for buses to abide by a timetable. Both the RPTA and the privately owned buses operate without any announced schedules. This is one major reason why potential passengers, distrusting the reliability of the bus timetables, prefer to drive their own cars. This action is encouraged by the lack of deterring factors such as high costs of gasoline and parking and high customs duties on automobile acquisition and registration. Therefore, despite the costly subsidy from the Lebanese Treasury, RPTA buses do not carry more than 3 percent of the daily motorized trips and 10 percent of the daily motorized nonpassenger automobile trips.

Annual Government Subsidy

RPTA transported 14 million passengers in 1998 and collected ridership revenues of about 4.7 million USD (Baaj 1999c). In order to fulfill its responsibilities, RPTA was granted a 9.0 million USD subsidy from the Lebanese Treasury. The same subsidy was requested by RPTA in the 1999 budget, while for the 2000 budget, RPTA requested 13.3 million USD. A simple calculation shows how costly this subsidy is. If we consider that 14 million annual RPTA bus trips cost the government a 13.3 million USD subsidy, then each trip is subsidized by about 0.95 USD. Given that the bus trip fare is 0.33 USD, the real cost for each trip is 1.28 USD. This is almost double the present trip fare charged by service vehicles (0.67 USD). Thus, if the government chooses to stop providing the subsidy (with RPTA consequently ceasing its bus operation) and gives each bus passenger 0.33 USD in cash, then each passenger would be able to travel in service vehicles and the government would save 8.7 million USD annually. This is the difference between the requested 13.3 million USD subsidy and the 4.6 million USD in cash payments paid directly to bus patronage.[1]

It is also essential to compare the performance of RPTA's bus operation with that of the private sector. The Lebanese Commuting Corporation (LCC), a major bus competitor to RPTA, operates a fleet of 185 Mercedes buses on 12 routes (6 of which are also served by RPTA buses). LCC transported 18 million passengers in 1998 (29% more than RPTA), generating a revenue of about 6.0 million USD. Its 1998 route mileage was 12.8 million bus-km—22 percent more than RPTA, whose fleet traveled 10.5 million bus-km. LCC's cost per bus-km was 54 percent less than RPTA's (0.61 USD/bus-km for LCC versus 1.33 USD/bus-km for RPTA). Table 3 presents the comparison between RPTA and LCC. (While RPTA's numbers have been validated by an independent auditor, LCC's results have not.)

Table 3
Comparison between RPTA and LCC (1998)

Bus Company	*Railway and Public Transport Authority (RPTA)*	*Lebanese Commuting Company (LCC)*
Fleet size in operation	164 buses in Beirut 20 buses in Al Biqa Governate	185 buses 12
Routes in operation	24 in Beirut and its suburbs 15 in Al Biqa Governate	
Number of passengers transported annually	14.0 million	18.0 million
Annual travel distance	10.5 million bus-km	12.8 million bus-km
Annual revenue	4.7 million USD	6.0 million USD
Annual cost	11.7 million USD	7.7 million USD
Cost/bus-km	1.33 USD	0.61 USD
Annual deficit	9.0 million USD	1.7 million USD
Ratio of employees to operational fleet size	3.8 employees/bus	2.4 employees/bus

Excludes nonridership revenues, such as advertising revenues.
Sources: Baaj, 1999c; Mourtada, 1999.

Traffic Safety and Environmental Pollution

Traffic safety has become a serious issue in Lebanon. Competition between RPTA buses, private sector buses, minivans, and shared taxis leads to daily conflicts, often reaching fistfights. Many operators try to reach the passenger first, often at serious risk to other pedestrians and passenger car occupants. In addition, most service vehicles operate without mandatory insurance and do not undergo any mechanical and emissions inspection programs. A consortium of insurance companies has proposed to subsidize the cost of the mechanical inspection for each car (especially testing the balance alignment, brakes, and tires) if such a program is mandated. The number of accidents caused by the lack of mandatory mechanical inspection is very high and inflicts heavy losses on the entire insurance sector. Furthermore, no emissions inspection programs exist and, as a result, vehicles illegally utilize diesel fuel, while others use leaded gasoline, thus releasing excessive emissions that pose environmental and health hazards (Fadel and Hashisho 1999).

Proposed Reform and Organization Policies

In July 1999, for the first time since its establishment in 1993, the Ministry of Transport (MOT) organized an international workshop on land transport policy for Lebanon. The workshop was attended by local and international experts, specialists from the International Bank for Reconstruction and Development (IBRD), and representatives of leading foreign and local transport firms. Problems facing the public land transport sector were presented and policy recommendations were formulated to resolve these issues. One principal recommendation addressed the strategic role of government in reforming the sector (Baaj 1999b).

Strategic Role of Government

The workshop participants suggested revising the role of the Lebanese government. They noted that the government should not be both regulator/planner and service provider. They agreed that the government should be in charge of planning and reforming the sector, while emphasizing its economic interests in addition to its social and environmental concerns. The participants also noted that the government should simultaneously create enabling conditions that allow the private sector to play a more significant role in the production and financing of transport services in a free and competitive environment. The participants recommended that in order for the MOT to meet its regulatory role, the government must take immediate actions to create appropriate technical capacities within the MOT (Baaj 1999b). Thus, MOT, in coordination with the IBRD, established the Transport Regulatory Unit (TRU) within the ministry. The TRU, which has been operating since September 1999, consists of local experts working with leading international consulting firms to implement the reform and organization plan.

The government must create the enabling environment and conditions that allow and ensure the existence of sufficient, affordable, and efficient transport services provided by several private sector operators functioning under competitive conditions. By reforming and organizing the transport sector (including restructuring and privatizing the RPTA bus operation) the government will be able to meet its objectives of:

- Achieving a balanced and sustainable transport system that is economically efficient; enables safer travel with the least environmental harm; and which takes advantage of the private sector's competitive nature, flexibility, and continuous capital investment programs.
- Providing improved transportation services that are affordable, costing no more than 10 percent of the disposable income of the majority of the population.
- Reducing the government's annual subsidy to RPTA gradually in order to enable the Lebanese treasury to save 13.3 million USD annually, starting with the 2000 budget. The comparison between the performance of RPTA's bus operation and a leading private sector company leads to the same conclusion reached by experts attending the MOT workshop; namely, the Lebanese government should cease its role as service provider.

Role of the Private Sector

The public land transport sector in Lebanon is essentially privatized because the fleets of service vehicles, minivans, and buses are all owned by the private sector, except for the RPTA buses. The latter transports less than 3 percent of the total daily motorized trips (including private cars) and about 10 percent of the total daily motorized trips using the public transport service providers' fleets. The percentages for the private sector service providers are 29 percent and 90 percent, respectively. Both the taxi and service owners and drivers and bus owners have urged the government to reform and organize the public land transport sector in Lebanon. All three private sector syndicates have offered to fully support the regulatory role of the government and to cooperate with it to ensure a successful implementation.

Reform and Organization Plan

Costa (1996) examined the structural changes in urban public transport of Western European metropolitan areas using a broad topology of organizations, and explored related changes in public transport conduct and performance. The proposed organization for Lebanon would broadly follow the "third model" implemented in London, Copenhagen, and Gothenburg. This model embraces clear separation between the policy-setting authority and the operation of the public transport system by public and private operators under contract to the authority. The fare system remains integrated across the modes and among the different operators, but the operation of public bus services is contracted to different operators through a tendering process. The authority is responsible for coordination of the system. A key feature of this model is the introduction of competition in access to the business—competition "for the market" versus "in the market."

The reform and organization plan for Lebanon consists of three components: identifying and establishing the regulatory authority (a restructured RPTA), developing the regulatory plan, and the corporatization of RPTA's existing bus operation business.

Identifying and Establishing the Regulatory Authority

A restructured RPTA would become the new transport regulatory authority. The MOT would set the necessary implementing rules accordingly. These functions would be performed by the restructured RPTA:

- Plan the development of the public land transport sector in Lebanon.
- Generate contracts for service to be provided by the private sector and tender them in a competitive, fair process.
- Develop and implement a program for the continuous enhancement of service levels provided by the private sector.
- Supervise and monitor contractor compliance with the regulations and contract provisions in collaboration with the enforcement agencies of the Ministry of Interior and relevant municipalities.
- Set tariffs on routes of service.
- Identify routes where service is important from a social perspective (poor, isolated, and/or deprived areas) and contract with the private sector to provide service.
- Resolve conflicts between private sector contractors.
- Ensure a suitable platform that enables private sector contractors and passenger representatives to participate in negotiations pertaining to private sector performance and service improvement measures.
- Provide comprehensive and up-to-date data on the public land transport network.

These functions can be met if RPTA is restructured in accordance with the organization chart shown in Figure 2. In addition to the Legal Services Office and the Information Technology Office (a minimum of two employees in each), there would be four divisions:

1. Planning and Regulatory Division (minimum 3 employees).
2. Execution and Monitoring Division (minimum 4 employees, as well as 15 to 30 line controllers).
3. Public Relations and Communications Division (minimum 4 employees).
4. Finance and Management Division (minimum 10 employees).

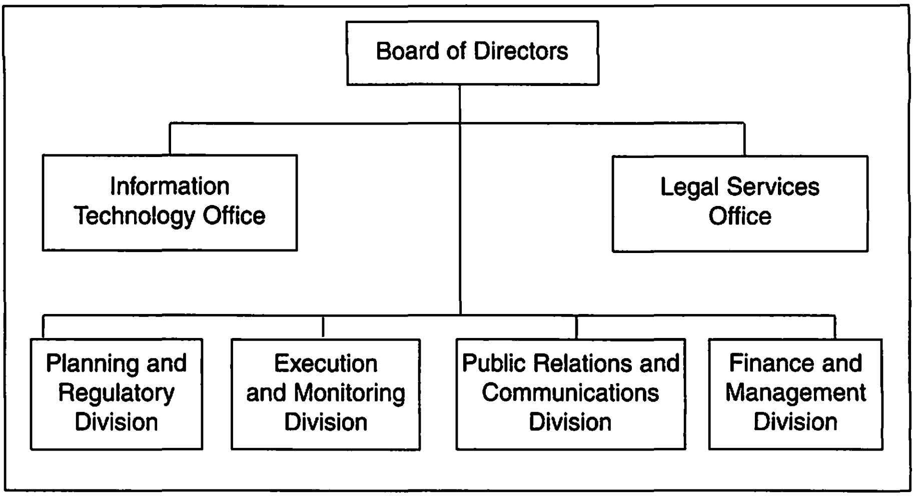


Figure 2. Proposed organization chart for the restructured RPTA

Developing the Regulatory Plan

In order to improve and meet the real demand for transport service, it is necessary to develop and implement the plan. The following sections describe how this should be done.

Identifying Routes. The routes as well as their layouts and capacities of operation within and between the Lebanese cities and governates must be identified. Following a rational methodology, bus service areas would be designated for contracting with service operators (a single scheduled service operator is contracted to provide scheduled service in each service area). The contracting must be carried out via an established competitive tendering process. The success of such a process has been proven in several cities and is well documented (Cox and Love 1989; Cox, Love, and Newton 1997). A limited number of service vehicles would be allowed to compete on the single operator's bus routes. Usually, the service area is defined by selecting homogeneous areas or by identifying passenger travel patterns. As for tendering routes, the authority may auction each route individually or may auction bundles of profitable and losing routes. The actual network in Beirut and one planned for Tripoli appear more appropriate for tendering bundles of routes because bundling:

- Is more practical and cost effective for the authority to monitor a network of routes than to monitor each route individually.
- Provides the operator flexibility in allocating vehicles among routes to better match the requirements of peak and off-peak travel patterns.
- Permits the sale of multitrip tickets, which in turn attracts more passengers, facilitating the transfer from one route to another.
- Allows the profit of some routes to offset the losses of other routes within the same service area.

This option, however, has a major disadvantage: It tends to exclude operators with small fleets who are unable to operate several routes in one service area. Following the identification of the allowable competing number of service vehicles and taxis on the bus lines, routes dedicated to service vehicles and taxis (layouts and capacities) must be identified. Any excess number of service vehicles and buses should be reallocated to new routes and/or repurchased by the government.

Developing the Framework. The rules, principles, and methodology must be established for contracting out service by competitive tendering with the private sector and procedures for monitoring operator performance and compliance with contract provisions. The success of the reform and organization process requires the transport regulatory authority to develop an effective monitoring plan that ensures that private sector operators comply with the contract provisions. This requires the regulatory authority (through its line controllers) to continuously check and evaluate service provider performance. For example, the authority would need to determine that:

- the daily number of trips provided by the operator is as stipulated in the contract;

- the operator is providing service on the full routes; and
- the operator is implementing an effective marketing program aimed at attracting more passenger ridership.

The contract would generally be established for two years, after which the authority would evaluate the service and subject the service area (which may be amended if necessary) to a new tender to identify a new operator.

Carrying Out Two Prototype Projects. Before implementing the complete plan, the RPTA should operate two prototype demonstration projects. The first project would expand the bus public transport service to cover Tripoli and its suburbs by contracting out with the private sector to operate RPTA buses. In return, the MOT would receive an annual fee determined by the tender. The second project would allocate service vehicles and taxis to dedicated routes in the greater Beirut area. Both syndicates of taxi and service vehicle owners and drivers have submitted to MOT a heuristic draft plan that constitutes a positive start. This plan would be evaluated and amended according to a study based on a sound technical approach.

Construction of New Bus Terminals. Beirut's Charles Helou transit terminal, which is used by buses and service vehicles, is adequate for organizing travel in the northern entrances of greater Beirut. A second bus terminal is necessary in the eastern entrances and a third one in the southern entrances. In Tripoli, RPTA has prepared a study for a multimodal bus–service–rail terminal station in Bahsas, south of the city. The proposed station is expected to cost 10 million USD and includes major commercial spaces in order to enhance the project's financial feasibility. It has been suggested that this project be executed on a BOT basis, whereby the private sector will *build* the station, *operate* the facility for a determined duration, then *transfer* it (after an agreed-on number of years) to RPTA.

Ongoing Studies and Programs. The RPTA should develop and implement programs to improve the service levels, starting with enhancing the skills of public transport vehicle drivers and training them in an institution specially established for this purpose.

Corporatizing RPTA's Existing Bus Business

At present, RPTA functions solely as a service provider, operating 37 routes (22 in greater Beirut and 15 in Al Biqa Governate) with 250 buses in service, while 52 medium-sized buses have not yet been deployed. RPTA's figures reveal that only 6 out of 22 routes in greater Beirut are profitable. The authority's routes suffer from low ridership (poor load factors) and an operating and maintenance cost per km that is almost double that of private sector buses. Furthermore, the excessive number of employees adds to the operating deficit. Since RPTA will be restructured to become the planner and regulator of the sector, it must withdraw from competition with the private sector. This is essential for the restructured RPTA to successfully regulate the sector without any conflicts of interest.

Thus, a two-phase plan should be implemented to phase out RPTA's bus operation activity. During the first phase, the bus operation division of RPTA would be converted into a new commercial company. The new company would concentrate (over an agreed-on limited time period) on upgrading its performance and reducing the operating costs and consequently improving the company's profitability. From a financial standpoint, one of the advantages enjoyed by the new commercial company is that it would not be burdened by any financial loans because RPTA does not have either accumulated losses or outstanding debts.

In the second phase, the company would be partially or fully privatized and then required to compete with other private sector companies to provide the best service at a reasonable cost. Then, after say, a three-year period, the government will be able to stop offering a 13.3 million USD annual subsidy to the RPTA.

Financing and Implementation of the Plan

In April 1999, the MOT, in collaboration with IBRD, identified areas of cooperation in the transport industry. In response to the minister's request, IBRD awarded Lebanon a 100,000 USD grant to fund a mission to Lebanon by three leading experts in the land, maritime, and aviation subsectors. The team's main assignment was to evaluate and report on privatization opportunities in the three subsectors. In July 1999, the experts attended the Workshop on Land Transport Policy for Lebanon and made brief presentations on the results of their mission. Several meetings followed between representatives of the World Bank and the MOT. These meetings led to approval for allocating 632,000 USD to MOT. The allocated funds aimed at establishing the TRU with the MOT. TRU's objectives and tasks were identified in a project document agreed on by the MOT and the World Bank. Its main objective is to provide technical assistance (from local specialists in the land, maritime, and aviation subsectors who cooperate with international consultants) to enable the MOT to develop the reform and implementation plans within one year. The execution of all developed plans would be discussed by the MOT and the World Bank during their upcoming negotiations on the financing of the prospective Beirut Urban Transport Project (BUTP). If approved, the loan for the BUTP would be approximately 105 million USD. The loan would be divided into four components:

1. 70 million USD to be spent over five years for constructing grade separations (bridges or tunnels) at 16 intersections;
2. 25 million USD to set up and equip the greater Beirut area Traffic Control Center (which will control traffic through 220 intersections during the first phase);
3. 5 million USD for parking (developing regulations and installing meters); and
4. 5 million USD in technical assistance to the MOT to finance the implementation of TRU's plans and other MOT projects (including the reform and organization plan of the land public transport sector).

Conclusions and Directions for Further Study

This article has reported on a plan for the reform and organization of the public land transport sector in Lebanon. The plan consists of three components:

1. restructuring the RPTA to become the planner and regulator of the sector;
2. allocating private sector service providers into service areas by concessioning service via competitive tendering; and
3. corporatizing RPTA's bus operation.

The Council of Ministers has formally endorsed this plan and authorized the MOT to proceed immediately with its implementation.

Presently, options regarding the corporatization of RPTA's bus operation are being studied. Establishing the new corporate bus business constitutes a necessary first step toward a possible eventual privatization of such a company. The company would be put up for sale (partially or fully) to the private sector. This would allow expanded growth opportunities and ensure that the company is capable of competing with other existing private sector providers. It is possible to delay the privatization process until the rules and regulations of this reform and organization plan have been completed and implemented.

The second option calls for full RPTA ownership of the corporatized bus company, but ceding its management to a competent private sector company. Such a company would be selected through tendering and would be hired in accordance with a well-formulated management contract. The company would be paid an annual amount while RPTA would retain all revenues from the bus operation. This option constitutes a minor financial risk for the investor (smaller investment is needed compared to buying the company). However, it may not be an attractive option for RPTA because sale proceedings would not be there and RPTA would still incur the costs of monitoring the performance of the private management along with the full ridership revenue risks.

A third option calls for full RPTA ownership of the new corporate bus business, but leasing its assets to a private company in return for a fixed annual payment. This option is the easiest to implement because it ensures fixed revenue for RPTA's commercial company with full RPTA ownership. It is the most appealing option for the Lebanese legislature and public opinion.

The restructuring of RPTA, including the corporatization of its bus business, would be completed in two to three years and necessitates the completion of these steps:

1. Establish the necessary rules and regulations for the restructured RPTA.
2. Identify the essential assets that should be transferred from RPTA to the new corporate bus business.
3. Identify the unessential assets in order to sell them in the future.
4. Conduct an accurate evaluation of the profitability of all existing routes.
5. Set the organizational structure of the new corporate bus business, including the employment, financial, and jurisdictional regulations.
6. Develop a new balance sheet and an annual budget for the first three years of operation for the new corporate bus business.

Endnote

1. The author does not endorse such a solution, but presents this example to demonstrate how costly the treasury's subsidy is.

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