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Beyond customer satisfaction: measuring service provision

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Market Equity; Flinders University; Passenger Transport Board

Abstract

One of the most important transport challenges facing the public transport regulator, is that of measuring service provision. Customer satisfaction measures are widely used in this regard, taking many forms from self-completion surveys and personal intercept interviews, to observational studies and self-reporting telephone hotlines.

However is customer satisfaction enough? Are customers more satisfied on those services that have increasing patronage? Are more complaints received on services that have less satisfied customers? What are the relationships between customer satisfaction and other measures of service provision, and is customer satisfaction a robust measure of the adequacy of public transport provision?

This paper discusses an approach that extends the customer satisfaction measure to a statistical modeling process involving the integration of data from three independent sources. Specifically these three data sources were a self-completion customer survey of some 22,000 Adelaide public transport passengers, observational on-board audits and data collected from passenger complaints and compliments over comparable time-periods. Patronage (expressed as total boardings from the Metropolitan Adelaide ticketing system) was used as the independent variable.

This paper outlines both the statistical modelling process and the uses of this valuable tool in determining the “best” and “worst” performing route groups in Adelaide, providing a solution to one of the many transport challenges facing the public transport regulator.

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Introduction

The Passenger Transport Board (PTB) is a Statutory Authority established by the South Australian State Government in July 1994, to plan, regulate and fund South Australia's land-based passenger transport services for the State.

The Passenger Transport Act 1994 requires the Board to conduct a range of functions from overseeing the creation and maintenance of an integrated network of services, administering fare subsidies, to accreditation, providing service information, and the establishment and audit of safety, service, equipment and comfort standards.

The Passenger Transport Board does not operate passenger transport services but has continued to deliver fundamental improvements to these services for the people of South Australia. The PTB is committed to providing safe, comfortable and reliable passenger transport to meet the travel needs of customers while delivering environmental and social benefits to the rest of the community.

Implementing customer satisfaction surveys aligns with the Functions and Charter of the Passenger Transport Board as defined in the *Passenger Transport Act; 1994*, viz

Section 20 (g) "to…audit…standards for passenger transport within the State;"

Section 20 (j) "…to establish appropriate procedures and mechanisms to enable members of the public to comment on those services;" and

Section 20 (l) "to initiate, carry out, support, or promote projects and programs for the development and improvement of passenger transport services."

Measuring customer satisfaction

Customer satisfaction, while simple to define:

"*the extent to which a product's perceived performance matches a buyer's expectations" – Kotler*[1]

is more complex to measure. There are many different approaches to measuring customer satisfaction, many incorporating scales, measures of importance and measures of expectations. However, whatever the format of the customer satisfaction measure, it is always subjective. Customer satisfaction is not an absolute concept, but a relative one, with improvements to customer satisfaction measure only achieved when customers both notice improvements, and then modify their attitude accordingly.

In March 2001, Market Equity undertook a customer satisfaction survey of Metropolitan Adelaide public transport users for the Passenger Transport Board (PTB). In general terms, the purpose of the research program was to measure customer satisfaction over a range of issues and performance criteria as required by the contracts entered into with service providers. The study captured the customer satisfaction of some 21,984 bus, train and tram passengers, and was conducted between the 9th and 23rd March 2001 (inclusive). This time-period was chosen to be outside of the school and university holidays, and any other extraordinary events, and to represent an "average" two-week period.

In recognition of the limitations of using a single measure of service provision, and with the need to verify some of the more subjective measures of service provision against hard-core objective data (patronage expressed as ticketed boardings), Market Equity and the PTB extended the customer satisfaction survey analysis to include statistical modeling to develop a quality score for each route group*.

Through the use of objective data (patronage performance) to verify the subjective customer satisfaction ratings, self-reported incidents, audit and complaints/compliments survey data, Market Equity was able to provide the PTB with a better indication of true service levels, which as suggested by De Vrye[2] is often, the missing link.

These quality scores enabled the route groups to be ranked in terms of the "best" and "worst" performing route groups, taking into account the series of subjective data. In developing the quality score, Market Equity provided the PTB with an enhanced knowledge of the relationships between these data sets, and answered the most frequently asked question: *"Which route group is the best performer?"* The following section describes the statistical modelling process used to derive the service quality scores.

The statistical modelling

Market Equity, in conjunction with Adrian Esterman undertook a three stage statistical modelling process. In the first instance, the distribution of each data set was analysed to establish the most appropriate statistical means of identifying the relationships between the data sets. Statistical testing was then conducted in order to measure these relationships. The final stage involved statistical modelling using factor analysis to develop the quality scores. A summary of the statistical modelling process undertaken is contained in Figure 1.

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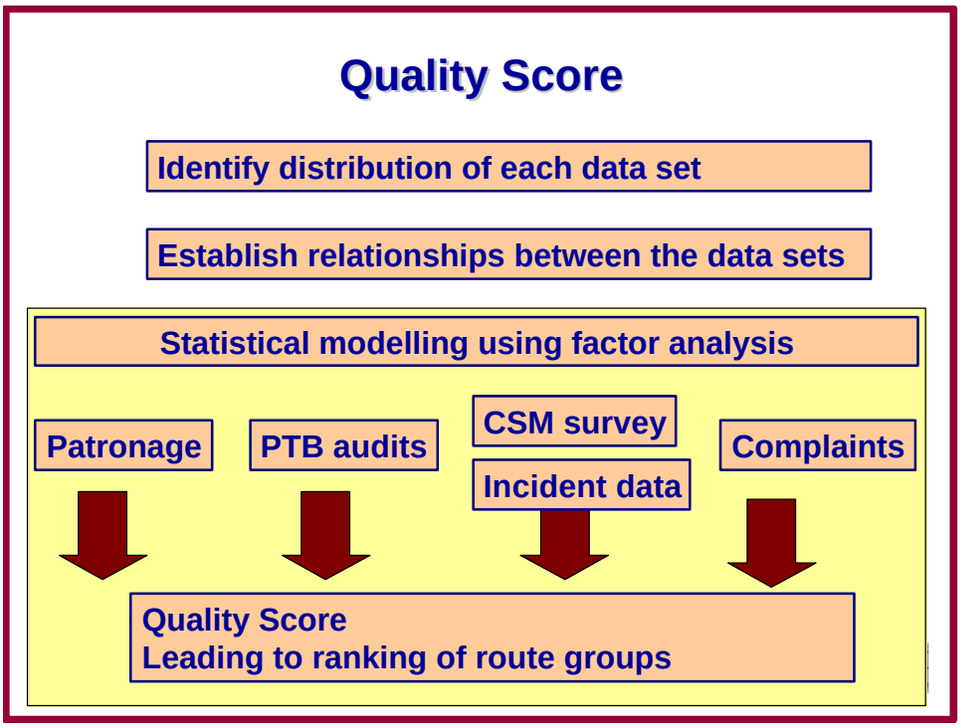
* A route group is a group of 2-8 routes that travel along a common path

Figure 1 Quality Score Research Methodology



The source data

The data for the quality score was derived from 24 variables across 61 route groups from the following data sets. Initially all 24 variables were included in the modelling, but through a series of statistical analytical processes 14 of these variables were excluded giving a quality score comprised of 10 variables.

Specifically the source data was:

Customer satisfaction

Self-reported satisfaction scores across 6 service features and one overall rating, that were scored as the proportion that were satisfied or very satisfied with a service feature derived from the customer satisfaction survey conducted in March 2001. The customer satisfaction data contributed 7 of the 24 variables used in the modelling.

Incident rates

Self-reported occurrence of problems with service features collected as part of the customer satisfaction survey in March 2001. The proportion of passengers who reported an incident was converted to the proportion of passengers who had experienced no incidents across the same 6 service features on which satisfaction scores were measured. The incident data contributed 6 of the 24 variables used in the statistical modelling.

Audit scores

Audit reported scores expressed as the percentage scoring excellent/good, or the proportion of "none" in the case of graffiti and scratched windows. The audit data was collected in May 2001, and contributed 8 of the 24 variables used in the statistical modelling.

Complaints data

Recorded complaints and compliments by route group standardised to number of complaints per 100,000 initial boardings for the month of March 2001. The complaints/compliment data contributed 2 of the 24 variables used in the statistical modelling.

Patronage

Patronage data expressed as the percentage change in initial boardings from March 2000 to March 2001, (with adjustments made for day type differences). This was used as an external measure of validity.

Exclusions

For the validity analysis involving patronage, the City Free, Southern Circuit (701-702) and 650-652 route groups were excluded – the first two because of timetable changes, and the latter due to the fact that it was an extreme outlier.

Assumptions and derivations

Customer satisfaction and self-reported incidents data was missing for the CityFree route group for punctuality. It was therefore set at 100% since buses on this route run so frequently (5 minute service) that it could be assumed they were never late or early.

The statistical modelling

The creation of a quality measure that stands the test of time is not trivial. This is because of the large number of potential items that might be included, and the need for the scale to have several desirable properties. In particular, the items that make up the scale should be:

- usable and fair over different modes of transport; and
- have sufficient variability between route groups in order to provide discrimination.

In addition, scales created should:

- cover most of the service quality areas of interest;
- be valid;
- be reliable (i.e. able to be consistently measured); and
- be simple (complex scales are less believable and less likely to be used).

A series of statistical analyses were therefore undertaken in order to remove variables from the data set with undesirable properties, and to utilise the remaining variables to create the formula for the service quality scores. These scores were then evaluated for all route groups and ranked to determine the "best" and "worst" performing route groups. The analysis was conducted in 3 stages:

Stage 1: Modal consistency

One of the main criteria of a service quality indicator was that it was suitable for all modes of transport. Therefore stage one tested that there was a valid value for each mode, and that the variable had the other desirable property of not differing substantially by mode of transport. Table 1 shows the mean score for each variable by mode of transport.

Table 1 Mean score by mode of transport

Variable	Mode of transport			Total (n=61)
	Buses (n=56)	Trams (n=1)	Trains (n=4)	
CSM onboard safety	90.714	88.200	85.975	90.362
CSM vehicle cleanliness	76.998	76.800	59.800	75.867
CSM punctuality	60.966	76.300	76.375	62.228
CSM politeness	65.241	77.500	69.800	65.741
CSM helpfulness	65.748	75.800	55.400	65.234
CSM seat availability	75.352	72.800	67.250	74.779
CSM overall satisfaction	83.493	85.300	80.200	83.307
No incidents onboard safety	91.800	92.000	88.075	91.559
No incidents vehicle cleanliness	90.330	91.400	83.775	89.918
No incidents punctuality	68.698	85.700	76.550	69.492
No incidents politeness	90.084	92.300	91.225	90.195
No incidents helpfulness	93.836	95.400	95.650	93.980
No incidents seat availability	81.918	85.400	75.125	81.530
Audit vehicle interior cleanliness	89.684	83.800	65.706	87.958
Audit interior wear & tear	60.183	38.300	88.134	61.707
Audit interior windows scratched	7.147	18.800	45.988	10.078
Audit interior graffiti	63.711	87.700	47.821	63.040
Audit interior graffiti	63.711	87.700	47.821	63.040
Audit interior other vandalism	63.203	64.300	1.200	59.018
Audit exterior cleanliness	91.754	81.800	41.578	88.184
Audit exterior graffiti	96.552	100.000	43.574	93.019
Audit smooth ride	89.355	-	-	89.355
Audit punctuality	74.580	89.600	85.515	75.576
Complaints per 100,000 initial boardings	27.578	4.762	4.044	25.661
Compliments per 100,000 initial boardings	1.041	.000	.009	.962

Some of the 24 variables shown in Table 1 were either not collected for trams and trains (e.g. smooth ride) or differed substantially in their average scores between modes (bus/train/tram).

At the conclusion of stage 1, the following 9 variables were eliminated using a qualitative approach, and eliminating those variables that were considered to be unusable and unfair across the modes.

- Audit smooth ride
- Audit interior windows scratched
- Compliments per 100,000 initial boardings
- Audit interior other vandalism
- Complaints per 100,000 initial boardings
- Audit interior wear & tear
- Audit interior graffiti
- Audit exterior graffiti
- Audit exterior cleanliness.

These variables were disregarded from the development of the quality scores for all route groups.

Stage 2: Discrimination between route groups

A desirable property of each item included is that it differs between route groups, otherwise it provides no discriminating power. Stage 2 tested for the desirable property of being able to discriminate at the route group level to provide a score that reflected the changes in patronage at the route group level. The Coefficient of Variation (CV) was derived for each variable against patronage to test the ability of each variable to discriminate. The higher the CV the better the discrimination power. Table 2 shows the variability between route groups for each of the remaining 15 variables as measured by the Coefficient of Variation (CV).

Table 2 Variability between route groups

Variable	CV (%)
Audit punctuality	17.3
CSM punctuality	16.4
Audit vehicle interior cleanliness	11.5
No incidents punctuality	10.6
CSM vehicle cleanliness	9.4
CSM helpfulness	9.1
CSM seat availability	9.1
CSM politeness	8.9
No incidents seat availability	5.9
CSM overall satisfaction	5.0
No incidents onboard safety	3.7
No incidents vehicle cleanliness	3.6
CSM onboard safety	3.5
No incidents politeness	2.6
No incidents helpfulness	2.5

The variables with the least discriminating power were dropped from the set. These variables were:

- No incidents of politeness
- No incidents of helpfulness.

Stage 3: Factor analysis

The next stage in the analysis was to see whether or not the remaining variables fell naturally into groups from which scales could be created. Confirmatory factor analysis was used for this purpose based on the correlations between variables. Correlation is a measure of the relationship between two variables, i.e. as one increases, so does the other.

Factor analysis is a statistical technique designed to reduce a large number of correlated variables into a smaller number of uncorrelated ones (factors). The new factors are made up from combinations of the original variables. There are no formal tests to decide how many factors could or should be created, but an accepted approach to decide on the number of factors is to use a “scree plot”. In

the case of the current data set, the scree plot showed that three factors provided the best solution.

The end product of the factor analysis is a rotated component matrix that shows how each factor should be derived. The component matrix shows the factor loading for each variable for each factor, and tells us how important that variable is in making up the factor. A factor loading of 1 is the highest possible importance. If the factor loading is low (about 0.7 or less), it is probably not worth including when creating the factor. In creating the factors, those variables that loaded at less than 0.7 were excluded from the factors. However, for pragmatic reasons, and in the interest of not limiting the factors solely to the customer satisfaction data set, the audit punctuality variable was included in the third factor.

Table 3 shows the rotated component matrix from the remaining 13 variables in the data set. The factor loadings have been sorted into size order within each factor. Factor loadings of less than 0.4 have been left blank for ease of interpretation.

Table 3 Results of factor analysis (Rotated Component Matrix)

Variable	Component		
	1	2	3
CSM seat availability	.859		
CSM helpfulness	.814		
No incidents seat availability	.796		
CSM overall satisfaction	.699		.484
CSM vehicle cleanliness	.646	.557	
Audit vehicle interior cleanliness	.480		-.454
No incidents onboard safety		.894	
No incidents vehicle cleanliness		.801	
CSM onboard safety		.782	
CSM punctuality			.879
No incidents punctuality			.806
CSM politeness			.660
Audit punctuality			.466

* Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

The first factor (component 1) reflected customer satisfaction, especially seat availability, and was named CUSTOMER SATISFACTION. It was mainly determined by four variables:

- CSM seat availability
- CSM helpfulness
- No incidents seat availability
- CSM overall satisfaction.

The second factor mainly reflected onboard safety, but also included an item on vehicle cleanliness, which was named ONBOARD SAFETY. It was mainly determined by three variables:

- No incidents onboard safety
- No incidents vehicle cleanliness
- CSM onboard safety.

The final factor was about punctuality, containing the customer satisfaction and incidents variables for this service feature, and to a lesser extent, the audit punctuality variable. This was named PUNCTUALITY. It was mainly determined by 3 variables:

- CSM punctuality
- No incidents punctuality
- Audit punctuality.

Overall Service Quality Score (OSQS)

The formula for the Overall Service Quality Score (OSQS) was derived as the additive scale of the factors defined in stage 3. The quality score developed was defined as:

SATISFACTION = [CSM seat availability + CSM helpfulness + No incidents seat availability + CSM overall satisfaction]/4.

SAFETY = [No incidents onboard safety + No incidents vehicle cleanliness + CSM onboard safety]/3.

PUNCTUALITY = [CSM punctuality + No incidents punctuality + Audit punctuality]/3.

OSQS = [SATISFACTION + SAFETY + PUNCTUALITY]/3.

The next step was to sum the three scales to form an overall measure of service quality. We have called this measure the Overall Service Quality Score (OSQS), and it ranged from 1-100.

Additive scales were used for simplicity, to provide the PTB with a methodology that was both easy to apply and straightforward to explain to the Service Contractors. No weighting was applied as the factor loadings of the variables were not too dissimilar within each of the 3 factors.

Using this formula, and applying it to all 61 route groups, the "best" (and "worst") route groups, defined by their overall service quality scores were identified.

Test for OSQS reliability

Each of the three scales was tested for reliability using a measure called Cronbach's alpha. A Cronbach's alpha greater than 0.80 means that the scale has very good reliability, and can be created as an additive score.

Cronbach's alpha for the three scales was: CUSTOMER SATISFACTION (0.87), SAFETY (0.81) and PUNCTUALITY (0.59). The lower value for punctuality was due to the lack of correlation between the audit punctuality measure and the other two punctuality measures. Despite this, it was felt worthwhile incorporating the audit measure in order to retain at least one item from this data set.

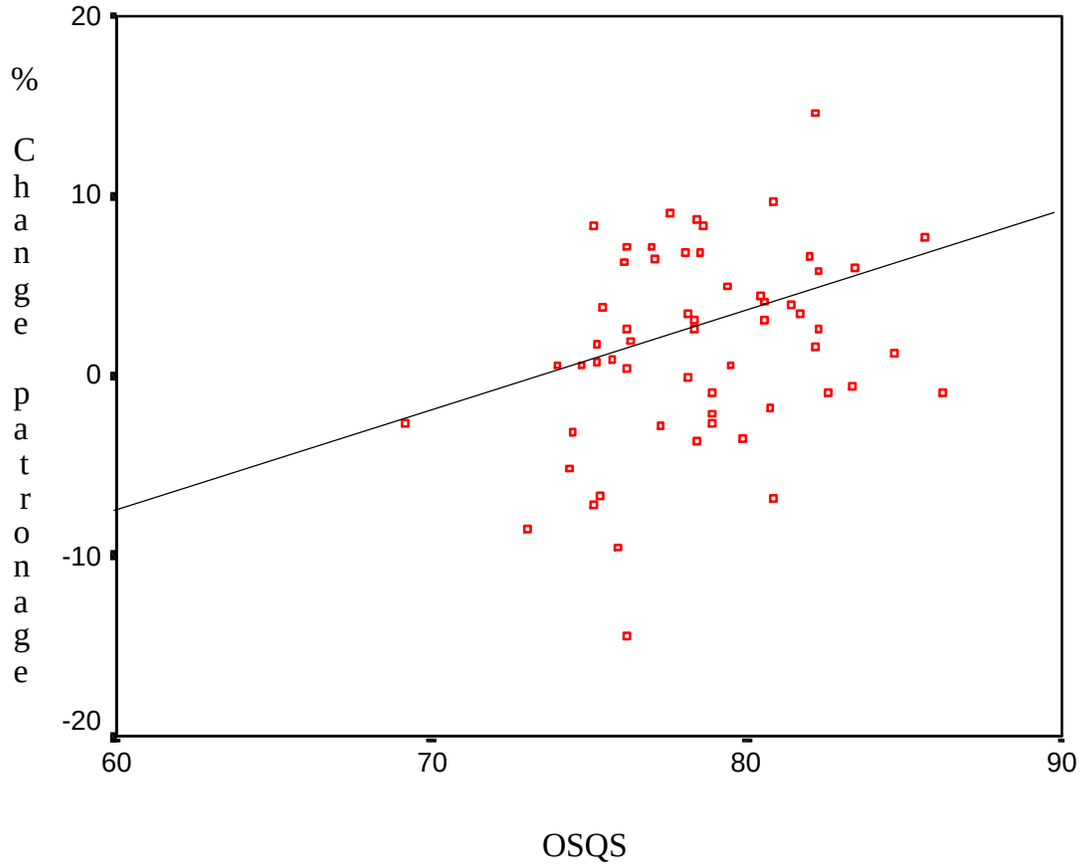
The usual method of testing the factor structure is by confirmatory factor analysis. The original intention was to carry this out using the results from 2002 customer satisfaction survey and the May 2002 audit. However, as the 2002 customer satisfaction survey was not conducted, this was not feasible.

OSQS validity check

The final step was to assess the validity of the OSQS by checking its relationship with change in patronage. Figure 2 shows that as the OSQS increases, patronage also increases, thus demonstrating validity. This relationship is confirmed by the statistically significant ($p=0.018$) correlation ($r=0.309$) between the OSQS and patronage.

Figure 2 OSQS by change in patronage

Based on the best fit line (derived using standard regression techniques) of the plot



of the OSQS against percentage change in patronage, it can be seen that for a positive change in patronage, a quality score of at least 72 is required.

Conclusions

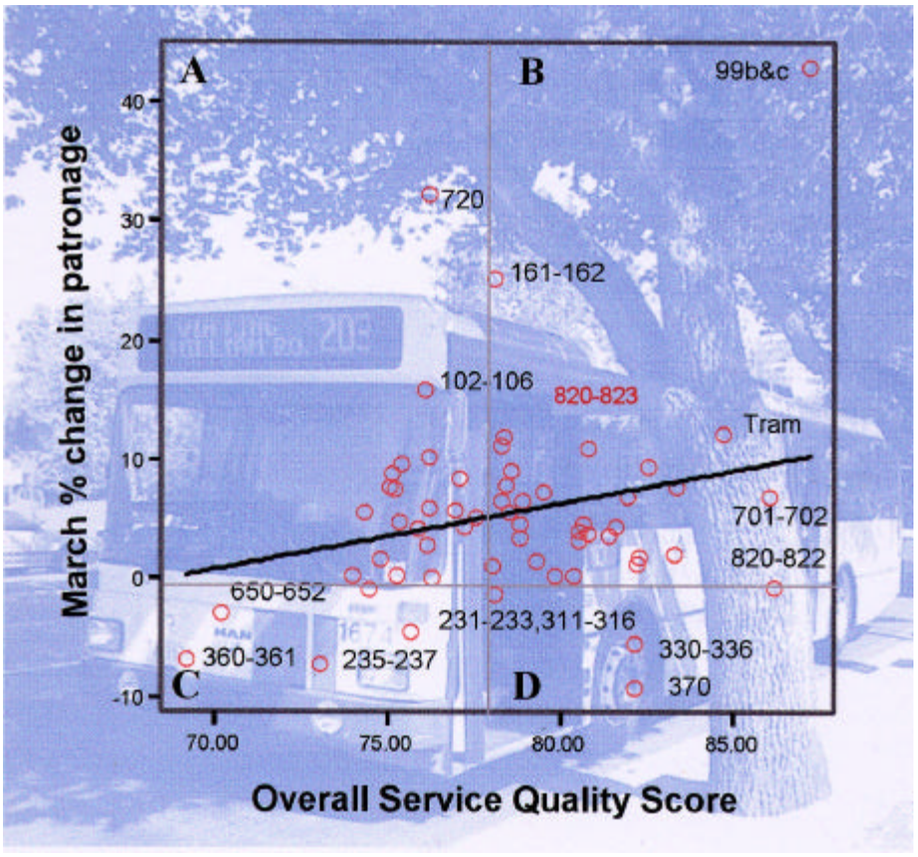
This analysis has developed a framework for the creation of an Overall Service Quality Score (OSQS). This score reflects customer satisfaction, reported incidents of problems associated with service features, and the punctuality measure from the PTB audits. Whilst other variables from the audit and complaints data were considered for inclusion, the final OSQS was derived from 10 variables.

PTB use of the OSQS

The Passenger Transport Board utilises the OSQS in its monthly performance reporting to Service Contractors to provide a more detailed analysis of performance.

As illustrated in Figure 3, the OSQS is reported as a plot against the month's change in patronage.

Figure 3



Route groups that appear in quadrant A are those that have had patronage increases, but also have a lower OSQS. It is pleasing to note that there are fewer route groups in this quadrant, and can be explained by external factors, such as the opening of a new school along the route, or significant favourable changes to the services since OSQS was measured. With the customer satisfaction survey scheduled for annual conduct, the OSQS can be updated to reflect such service changes.

Routes that appear in quadrant B are the best performers, in that they demonstrate not only a high OSQS, but also a corresponding increase in patronage. Further analysis of these routes, such as an investigation into routes 161-166 are conducted within the monthly reporting. In reporting the March data, the PTB also reported that the route group 161-166 had significant increases in Concessional passengers, particularly in the student category for the month of March 2002.

Routes that appear in quadrant C have declined in patronage, as well as having a poor OSQS. These route groups are highlighted in the PTB's reporting to identify areas for service improvements, such as the 360-361.

Routes that appear in quadrant D have a high OSQS, but have low patronage. Route groups that appear in this quadrant tend to be non-commuter style route groups, such as loop services, and "shopping services". Whilst patronage is not increasing significantly on these services, the customers have a favourable OSQS, highlighting that on some services, favourable service delivery ratings do not always result in increased patronage.

Using this analysis, the PTB are then able to recommend service improvements to the Service Contractors for their implementation.

Updating the OSQS

The OSQS is updated as new data for the model is acquired, which is largely dependent upon the conduct of the annual customer satisfaction survey. For monthly reporting, the change in patronage (as shown in Figure 3 as the y axis) is updated monthly, whilst the OSQS (shown in Figure 3 as the x axis) is static until the next customer satisfaction survey is conducted (next scheduled for March 2003). Whilst this is not ideal, it does give a monthly indication of changes in patronage relative to the service quality score. Ideally, we would like to see the points in Figure 3 moving into quadrants A and B (i.e. with positive changes in patronage), with more points in quadrant B than in quadrant A.

Discussion

With 8 out of the 10 variables comprising the OSQS derived from the customer satisfaction survey, it may be asked why the other 14 variables, predominantly audit scores did not score well for inclusion. The following rationale is provided:

The customer satisfaction data met the primary selection criteria of being usable and fair over different modes. This stage of the analysis process excluded 7 audit variables and 2 complaints/compliment variables.

The second selection criteria required that there had to be sufficient variability between route groups to provide discrimination. This led to the exclusion of 2 incident variables.

The final analysis phase led to the exclusion of 1 customer satisfaction variable, 1 incident variable and 1 audit variable based on a weaker association with the other variables in the derived factors.

The customer satisfaction survey was derived from an extremely robust sample, comprising of responses from some 22,000 passengers, with those trips surveyed selected using a rigorous sampling frame. This gave the variables derived from the customer satisfaction survey the desirable properties of:

- Covering most of the service quality areas of interest;
- Being a valid representation of passenger satisfaction and reported incidents through a rigorous sampling methodology and correct weighting procedures; and
- Providing reliability through consistency.

Recommendations

This paper contains a replicable methodology for the development of a quality score. As the data sets build or change, such as a change in scales or service features monitored, it is recommended that the quality score is reviewed and the statistical modelling process repeated.

References

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[2] DeVrye C. Good service is good business. The Quality Magazine Aug 1995 pp18 – 23.

[3] Alford G, Linking Customer Satisfaction Surveys, Employee Surveys and Organisational Performance Indicators – an Australian Case Study, MRSA National Conference, 1999.

[4] McDougall R, The Art of Listening, Customer Magazine, March 1999, pp21-24, 27

Appendix A – Overall service quality score by route group

Route group	% Change in patronage	Customer satisfaction scale	Onboard safety scale	Punctuality scale	Overall service quality score (OSQS)
99b & 99c	43.0	84.5	92.6	84.6	87.2
820-822	-1.0	81.4	94.0	83.2	86.2
701-702	-30.6	86.7	92.8	78.8	86.1
604-607	7.6	89.4	93.0	74.5	85.6
Tram	1.2	79.8	90.5	83.9	84.7
560	6.0	81.0	89.4	79.9	83.4
728-729, 738-739	-0.6	79.0	93.9	77.1	83.3
280-282	-1.0	82.3	92.2	73.4	82.6
505-509, 520, 522	2.7	78.7	93.3	75.0	82.3
576-7, 519	5.9	76.6	91.3	78.9	82.3
330-336	1.6	77.8	91.1	77.7	82.2
370	14.6	85.6	88.6	72.3	82.2
340-345	6.7	81.6	89.6	74.7	81.9
550-2, 518	3.5	79.8	93.7	71.5	81.7
511-513, 515-517, 521, 540-546	4.0	76.4	91.6	76.3	81.4
680-682	-6.9	76.7	92.7	73.1	80.8
680-682	-6.9	76.7	92.7	73.1	80.8
Outer Harbor	9.7	75.3	86.2	80.9	80.8
601, 602	-1.8	84.4	92.6	65.1	80.7
151-155	4.1	80.5	89.9	71.3	80.6
171-172	3.2	77.2	94.2	70.3	80.6
580-581	4.4	78.5	94.2	68.7	80.5
206	-3.4	78.0	89.6	72.0	79.9
141-145	0.6	77.8	92.9	67.9	79.5
741-2, 743-745, 747	5.0	75.7	86.9	75.5	79.4
243-248, 600	-0.9	77.1	92.7	67.1	78.9
500 & 530	-2.1	74.6	92.8	69.3	78.9
TL6-8,721, 722, 725, 711-716	-2.6	75.6	90.5	70.6	78.9
Belair	8.4	66.2	91.5	78.1	78.6
175-179	6.9	73.4	91.0	71.1	78.5
121-124	8.7	74.8	91.0	69.5	78.4

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Route group	% Change in patronage	Customer satisfaction scale	Onboard safety scale	Punctuality scale	Overall service quality score (OSQS)
275-278	-3.6	77.8	93.0	64.5	78.4
272-273	2.7	78.9	91.6	64.6	78.4
130-137	3.1	72.3	91.8	70.8	78.3
190-192, 195-198	-0.1	74.9	92.6	67.0	78.2
161-166, 828	3.5	74.8	93.5	66.1	78.1
253, 255, 301-307	6.8	78.0	88.3	68.0	78.1
Gawler	9.1	72.0	80.6	80.2	77.6
296-297	-2.8	75.2	92.3	64.3	77.3
723, 724,726, 727, 733, 734, 737	6.5	72.4	90.7	68.2	77.1
440-443, 450-455	7.2	76.2	88.4	66.3	77.0
400-405, 900, 411-415, 430	1.9	75.1	85.7	68.1	76.3
193-194	-14.4	75.6	90.5	62.7	76.2
Noarlunga	7.2	64.5	85.5	78.7	76.2
720	2.6	76.4	89.1	63.2	76.2
286-287	0.4	72.1	91.1	65.5	76.2
102-106	6.3	68.6	92.7	67.0	76.1
201-203	-9.5	72.0	93.8	62.0	75.9
231-233, 311-316	0.9	75.3	87.2	64.5	75.7
112-118	3.8	74.3	90.2	61.7	75.4
204, 207-209	-6.7	74.6	88.7	62.8	75.4
222, 224-229	0.7	73.3	90.7	61.8	75.3
100	1.7	73.0	86.8	65.9	75.2
181-182	-7.1	68.1	90.0	67.4	75.1
291-292	8.4	77.7	91.3	56.3	75.1
260-266	0.6	74.4	91.8	58.2	74.8
210-218, 618	-3.1	71.3	92.3	59.8	74.5
167-168	-5.2	73.4	90.7	58.9	74.3
235-237	0.6	76.7	87.9	57.5	74.0
241	-8.6	74.4	89.5	55.2	73.1
650-652	-31.2	69.5	89.7	51.4	70.2
360-361	-2.7	70.6	82.9	54.1	69.2