An Evaluation of the SMART Paratransit Phone Reservation System

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ABSTRACT

The Suburban Mobility Authority for Regional Transportation (SMART) operates a paratransit service, called Community Transit, throughout Macomb County and in portions of Wayne and Oakland counties in Southeast Michigan. Community Transit offers both same day service and advance reservation service, i.e., request for trips other than for the day the call was placed. For advance reservation trips, customers request service by placing a phone call to a SMART Customer Service Operator (CSO). During 1995 and 1996, SMART implemented the Quo Vadis (QV) automated scheduling and dispatch system for the Community Transit service. Quo Vadis includes a user-friendly software interface to help CSOs accommodate customer advance reservation trip requests.

This report documents a "before-after Quo Vadis" evaluation of the telephone archives related to the Wayne county portion of the Community Transit reservation system. The goal of the evaluation is to determine the effects of Quo Vadis 1) on the productivity of CSOs (primarily in terms of the average time required to serve a customer) and 2) on the objective quality of the reservation service (in terms of shorter wait for service and faster response when being served).

Analysis of archival data for the trip reservation telephone system of SMART Community Transit service in Wayne County indicates that the implementation of the Quo Vadis (QV) automated scheduling and dispatch system had a positive effect on both objective service quality and CSO productivity. In comparison to pre-Quo Vadis conditions, post-Quo Vadis data show a significant decrease in the average amount of time customers wait for a CSO and in the average time it takes for a CSO to take a trip reservation. Moreover, the data show a decrease in the number of calls abandoned.

OBSERVATIONS & ANALYSIS

The daily value for a number of phone reservation system parameters was collected and segmented into two periods: before and after Quo Vadis implementation. In addition to the standard practice of "data cleaning", the data was pruned in two fashions. First, CSOs needed time to learn the Quo Vadis system and concern was raised that the learning period immediately after Quo Vadis implementation might introduce potentially spurious effects to service quality and operator productivity. Therefore, the first two months of post-Quo Vadis data were excluded from the analysis. Second, concern was raised that the millage to obtain support for SMART paratransit, which municipalities throughout the SMART service area considered during the period of the study, might also introduce spurious effects. The potential for these effects is evident from the fact that the job security of a number of SMART employees was uncertain just prior to the millage. Moreover, several communities decided to discontinue support for SMART Community Transit and thus lost access to the service in their area. Therefore, data for one month before and one month after the millage were excluded from the analysis.

After organizing the data in the aforementioned manner, simple linear regression with a before-and-after component was used to form a model for each parameter of interest. Two factors intuitively affect the values for parameters describing service quality and CSO productivity: the number of agent hours of staffing and the number of calls received. The analysis "controlled for" these factors so that observed differences can more likely be attributed to the implementation of Quo Vadis.

RESULTS

For the purposes of this study, the parameters in Table 1a were selected. The relationships among several of these parameters are shown in Figure 1. The parameters in Table 1b were derived from those in Table 1a to provide additional insight. Other interesting parameters exist, e.g., the percentage of time or tries that a busy signal is encountered, however, these parameters are not available in the existing data.

The phone archive data were segmented into before-after periods, as shown in Figure 2, where it is evident that a significant amount of data was not available. The figure also shows, as noted previously, that the data was pruned to avoid potentially spurious affects: one month before and after the millage date was excluded and data for two months following the Quo Vadis implementation date were excluded.

Table 2 shows the mean values of the parameters both before and after Quo Vadis. For example, as seen in the table, the average number of agent hours of service prior to implementation of Quo Vadis was 24.5; the number increased to 30.3 after Quo Vadis. Similarly, the number of calls answered increased from 231 to 324 from the before Quo Vadis to after Quo Vadis periods. The purpose of presenting the mean parameter values is to give the reader a feel for the absolute and relative magnitudes of the various parameters. Direct statistical comparison of mean values is not productive, however, because, intuitively, the number of calls received in relation to the number of agent hours worked will have an impact on many, if not all, of the other parameters. Thus, for example, if the number of agent hours decreased and/or number of calls received increased, the post-Quo Vadis mean customer wait time could be higher than the pre-Quo Vadis mean even if Quo Vadis reduces wait time. In this example, the mean wait time would have been even worse had Quo Vadis not been implemented. Nevertheless, the parameter means shown should give the reader a good idea of system operation during the period of the study.

Two simple linear regressions were performed to determine the affect of Quo Vadis on each parameter. The first regression ascertained the effect in terms of a step function, i.e., the gross before/after change due to Quo Vadis implementation. The second regression evaluated the effect of Quo Vadis in terms of a before and after trend in the parameters.

Statistical differences from before Quo Vadis to after Quo Vadis potentially reflect differences in operation due to the millage and/or the Quo Vadis system and/or other temporal trends not explicitly accounted for in the study. In this study, the assumption is made that the data pruning excluded any short-term effects of the millage, as well as short-term spurious effects of adopting Quo Vadis. Any long-term effect of the millage vote would most likely be a change in the number of calls received and/or agent hours. Even if there were no millage or service area additions, it is clear that the parameters describing what happens to a call once it has been received are dependent on the number of calls received in relation to the number of agent hours of operation. Therefore, the these two parameters were controlled for in the analysis by including them in each regression model. Seasonal affects could potentially remain undetected, however, the data is over an extended period of time and bias in the results due to seasonal effects is considered unlikely. In sum, the data pruning and controlling for confounding parameters give support to the assumption that any differences evident in the before-after Quo Vadis implementation data were due to Quo Vadis.

The results of the analysis of gross change and trends are shown in Tables 3a and 3b. Each table shows the parameters, the mean daily values for the parameters, either the regression

model coefficients for the gross before-after Quo Vadis change in the parameter data (Table 3a) or the before/after Quo Vadis trend in the parameter data (Table 3b), the effect of the agent hours of operation, the effect of the number of calls received, the Adjusted R Square, and the Significance of the F statistic. As evident from the Tables, a separate regression model was determined for each parameter.

Again, the goal of the study is to gain insight into whether or not Quo Vadis implementation had an effect on service quality and CSO productivity. Interpretation of the differences evident in Tables 3a and 3b, however, could potentially be somewhat problematic as these differences are based on "happenstance" data, i.e., because the range of the effects have likely been limited by efforts to keep system operation within preset limits by changing staffing level, etc. In other words, this study did not perform a controlled experiment and thus the outcome could be biased yet give no indication of bias. Nevertheless, as previously mentioned, the two effects of most concern regarding this potential problem, namely agent hours and calls received, were controlled for and so the results are believed to be accurate.

A brief look at the analysis reported in Tables 3a and 3b indicates that Quo Vadis did have a positive effect on phone reservation system quality and CSO productivity. For example, as evident from the highlighted cells in Table 3a, the average amount of time that a customer waits for a CSO decreased by about one minute from the pre- to post-Quo Vadis periods. The average amount of time a CSO talks with a customer similarly decreased by about one minute. The effects are summarized in Table 4, which describes the changes in mean daily parameter values from the pre-Quo Vadis to post-Quo Vadis time frame. Clearly, in comparison to the pre-Quo Vadis data, the post-Quo Vadis data show improvements in Community Transit phone reservation system by almost any measure. The trend analysis shown in Table 3b supports these observations with the after trend either reversing a negative before trend or accelerating a positive before trend.

CONCLUSIONS

The analysis in this report indicates that the Quo Vadis automated scheduling and dispatch system implemented by SMART during 1995 and 1996 had a positive effect on both objective service quality and Customer Service Operator (CSO) productivity. Specifically, in comparison to pre-Quo Vadis conditions, post-Quo Vadis data show a significant decrease in the average amount of time customers wait for a CSO and in the average time it takes for a CSO to take a trip reservation. Moreover, the data show a decrease in the number of calls abandoned.

Study conclusions are, of course, valid only within the range of the data. That is, the analysis can not support extrapolating the Quo Vadis effect far beyond the current operating conditions of the Community Transit. Consideration must also be given to the fact that approximately one fourth of the advance service requests are standing orders where the customer does not need to call the CSO and schedule a specific trip. The remaining advance service requests do require the customer to call and reserve each trip that they wish to take and would thus be more affected by Quo Vadis.

The nature of the analysis also provides input to policy decisions regarding staffing levels. Tables 3a and 3b show the effect on the various parameters of adding an additional hour of CSO time. For example, post-Quo Vadis an additional hour of CSO effort during a day reduces the number of calls abandoned after a wait of at least 60 seconds by 1.7 and also reduces customer wait time by 6 seconds, as evident from the highlighted cells in the "# Agent hours"

column in Table 3b. This information can be used in conjunction with the cost (savings) of adding (reducing) staffing and the number of customers affected to determine the wisdom of changing the staffing level. Of course, the assumption must be made that the distribution of added/subtracted agent hours is analogous to the distribution in the original data.

Finally, this study has shown that the telephone archives represent an enormous and rich source of objectively collected system performance data. Therefore, subsequent stages of the SMART APTS implementation should include a dedicated effort to continue and collect, code, clean, and analyze this data. This is especially true given the upcoming inclusion of AVL on the Community Transit and line haul vehicles. Continued data collection would enable assessment of the interaction between the AVL and the Quo Vadis system and the associated implications for service quality.

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Table 1a: Parameters of Interest Obtainable from the Telephone Reservation System Archive [1]

Parameter [2]	Variable Name	Notes
The calendar date associated with the data record.	DATE	All of the parameters listed here are in terms of a given date.
The total number of agent hours of service.	AGENTH	
The number of calls received by the phone system.	CLRCVD	A call is considered received if the caller remains on the line at least 60 seconds before abandoning the call or if the call is answered by a CSO. CLRCVD = CLANSW + CLABNG60
The number of calls abandoned after a wait of less than 60 seconds.	CLABNL60	
The number of calls abandoned after a wait of 60 seconds or more.	CLABNG60	
The total number of calls answered by CSOs.	CLANSW	This includes all calls answered; those answered directly and those answered after a customer has waited on one or both answering machines.
The number of calls transferred by a CSO to another SMART employee.	CLTRAN	Transfers could be to a supervisor (indicating the CSO had difficulty in meeting the customer's request), to a dispatcher (indicating that the customer wanted to schedule a same-day trip instead of making a reservation), or to a CSO in another county (indicating the customer called the wrong number or needed to make a transfer).
The sum of minutes that customers waited for CSOs, after the phone system picks up a call.	DLYTMM	This is the sum of time spent waiting on each of two sequential answering machines.
The sum of minutes that CSOs and customers spent talking to each other.	TLKTMM	

[1] The parameter names given here do not always directly match those given in the telephone system archives because SMART updated the phone system during the study. However, the system update had no effect on study: the same parameters were obtainable from both systems (under different names) and the two systems performed essentially the same functions.

[2] The data are the value of each parameter for a given date.

TABLES

Table 1b: Parameters of Interest Derived from the Telephone Reservation System Archive

Parameter [1]		Description
The percentage of calls abandoned after a wait of less than 60 seconds.	CLABNL6P	CLABNL6P = 100 * CLABNL60 / (CLRCVD + CLABNL60)
The percentage of calls abandoned after a wait of 60 seconds or more.	CLABNG6P	CLABNG6P = 100 * CLABNG60 / CLRCVD
The percentage of calls answered by CSOs.	CLANSWP	CLANSWP = 100 * CLANSW / CLRCVD
The percentage of calls transferred by a CSO.	CLTRANP	CLTRANP = 100 * CLTRAN / CLANSW
The average seconds a CSO and a customer spend talking per answered call.	AVTLKS	AVTLKS = (TLKTMM*60) / CLANSW
The average seconds that customers are delayed, i.e., spend waiting for a CSO, per received call. [2]	AVDLYRS	AVDLYRS = (DLYTMM*60) / CLRCVD. The time customers spend "on hold" is included in talk time, not wait time.
The average seconds taken to handle each received call. [2]	AVHDLRS	AVHDLRS = AVDLYRS + AVTLKS
The percentage of customer call time spent talking to a CSO.	CSTLKTMP	CSTLKTMP = 100 * TLKTMM / (TLKTMM + DLYTMM)
The percentage of CSO work time spent talking to customers.	AGTLKTMP	AGTLKTMP = 100 * TLKTMM / (AGENTH*60)

[1] The data are the value of each parameter for a given date.

[2] It would be desirable to have a parameter describing the average delay and average handling time experienced by answered calls as well. However, the archives do not parse the delay for calls received into delay for calls abandoned and for calls answered.

Table 2: Mean Daily Values of the Telephone Archive Parameters in Wayne County [1]

Parameter	Pre-QV Mean	Std Dev	Post-QV Mean	Std Dev
# Agent hours	24.50	5.32	30.30	5.59
# Calls received	262.35	41.75	355.31	65.45
# Calls abandoned < 60 sec	3.13	2.45	2.36	1.86
% Calls abandoned < 60 sec	1.15	0.87	0.66	0.52
# Calls abandoned ≥ 60 sec	31.75	22.40	30.88	18.99
% Calls abandoned ≥ 60 sec	11.55	6.88	8.37	4.57
# Calls answered	230.60	32.18	324.44	56.33
% Calls answered	88.45	6.88	91.63	4.58
# Calls transferred	32.86	8.08	45.77	13.58
% Calls transferred	14.47	3.99	14.24	4.14
Average seconds a customer waits for a CSO	120.10	86.99	72.36	50.14
Average seconds a CSO talks to a customer	220.35	31.16	168.10	25.77
Average seconds to handle a call (wait plus talk)	314.41	85.23	225.87	59.63
% call time a customer talks to a CSO	65.33	15.99	70.62	12.86
% work time a CSO talks to a customer	59.22	12.55	51.15	12.83

[1] Pre-QV n = 147 and Post-QV n = 124.

Table 3a: Overall Quo Vadis Effect on Mean Daily Parameters in Wayne County [1]

Parameter	Pre-QV Mean	Post-QV Mean	QV Effect	# Agent hours	# Calls received	Adjusted R Square	Sig F
# Agent hours [2]	25	30	———	——	———	———	——
# Calls received [2]	262	355	———	——	———	———	——
# Calls abandoned < 60 sec	3	2	-1.35	—	0.01	0.081	0.000
% Calls abandoned < 60 sec	1	1	-0.46	—	—	0.103	0.000
# Calls abandoned ≥ 60 sec	32	31	-12.41	-1.69	0.23	0.535	0.000
% Calls abandoned ≥ 60 sec	12	8	-4.10	-0.57	0.05	0.476	0.000
# Calls answered	231	324	12.41	1.69	0.77	0.952	0.000
% Calls answered	88	92	4.10	0.57	-0.05	0.476	0.000
# Calls transferred	33	46	8.12	—	0.05	0.304	0.000
% Calls transferred	14	14	2.57	-0.10	-0.02	0.110	0.000
Average seconds a customer waits for a CSO	120	72	-59.05	-6.21	0.51	0.416	0.000
Average seconds a CSO talks to a customer	220	168	-58.62	1.11	—	0.469	0.000
Average seconds to handle a call (wait plus talk time)	314	226	-103.53	-4.04	0.41	0.383	0.000
% call time a customer talks to a CSO	65	71	8.20	1.62	-0.13	0.605	0.000
% work time a CSO talks to a customer	59	51	-11.36	-1.45	0.13	0.698	0.000

[1] Coefficients shown have a T statistic significant at the .05 level, those not significant have been replaced with "—". The Adjusted R Square and F statistic are for the regression model. The R Square is an indication of the percentage of variability in the data that is explained by the model. R Square ranges from 0 to 1, where 0 means no variability has been explained and 1 means that all of the variability has been explained. The better the model fits the data, the higher the R Square. The Significance of the F statistic is a description of the probability that, given the data, the model is a random result, in contrast to being a true result. The Significance of the F Statistic ranges from 0 to 1, where 0 means that, with the given data, the probability that the model could have arisen simply as a random occurrence is 0, and 1 means that the model is a result of random processes. It is common to accept models that have an F Statistics with a significance of .05 or less.

[2] The number of agent hours and number of calls received were not regressed as dependent variables, but are included in the parameter list to show the mean daily values.

Table 3b: Trend of Quo Vadis Effect on Mean Daily Parameters in Wayne County [1]

Parameter	Pre-QV Mean	Post-QV Mean	Pre-QV Trend	Post-QV Trend	# Agent hours	# Calls received	Adjusted R Square	Sig F
# Agent hours [2]	25	30	———	———	——	———	———	——
# Calls received [2]	262	355	———	———	——	———	———	——
# Calls abandoned < 60 sec	3	2	0.00	-0.01	-0.06	0.01	0.132	0.000
% Calls abandoned < 60 sec	1	1	0.00	0.00	-0.02	—	0.144	0.000
# Calls abandoned ≥ 60 sec	32	31	—	-0.07	-1.73	0.25	0.569	0.000
% Calls abandoned ≥ 60 sec	12	8	—	-0.03	-0.59	0.05	0.520	0.000
# Calls answered	231	324	—	0.07	1.73	0.75	0.955	0.000
% Calls answered	88	92	—	0.03	0.59	-0.05	0.520	0.000
# Calls transferred	33	46	-0.02	0.08	—	0.05	0.395	0.000
% Calls transferred	14	14	-0.01	0.03	-0.08	-0.02	0.225	0.000
Average seconds a customer waits for a CSO	120	72	—	-0.41	-6.60	0.55	0.466	0.000
Average seconds a CSO talks to a customer	220	168	-0.10	-0.16	0.76	0.06	0.556	0.000
Average seconds to handle a call (wait plus talk time)	314	226	—	-0.50	-4.71	0.50	0.441	0.000
% call time a customer talks to a CSO	65	71	-0.01	0.07	1.66	-0.14	0.654	0.000
% work time a CSO talks to a customer	59	51	-0.01	-0.04	-1.52	0.14	0.722	0.000

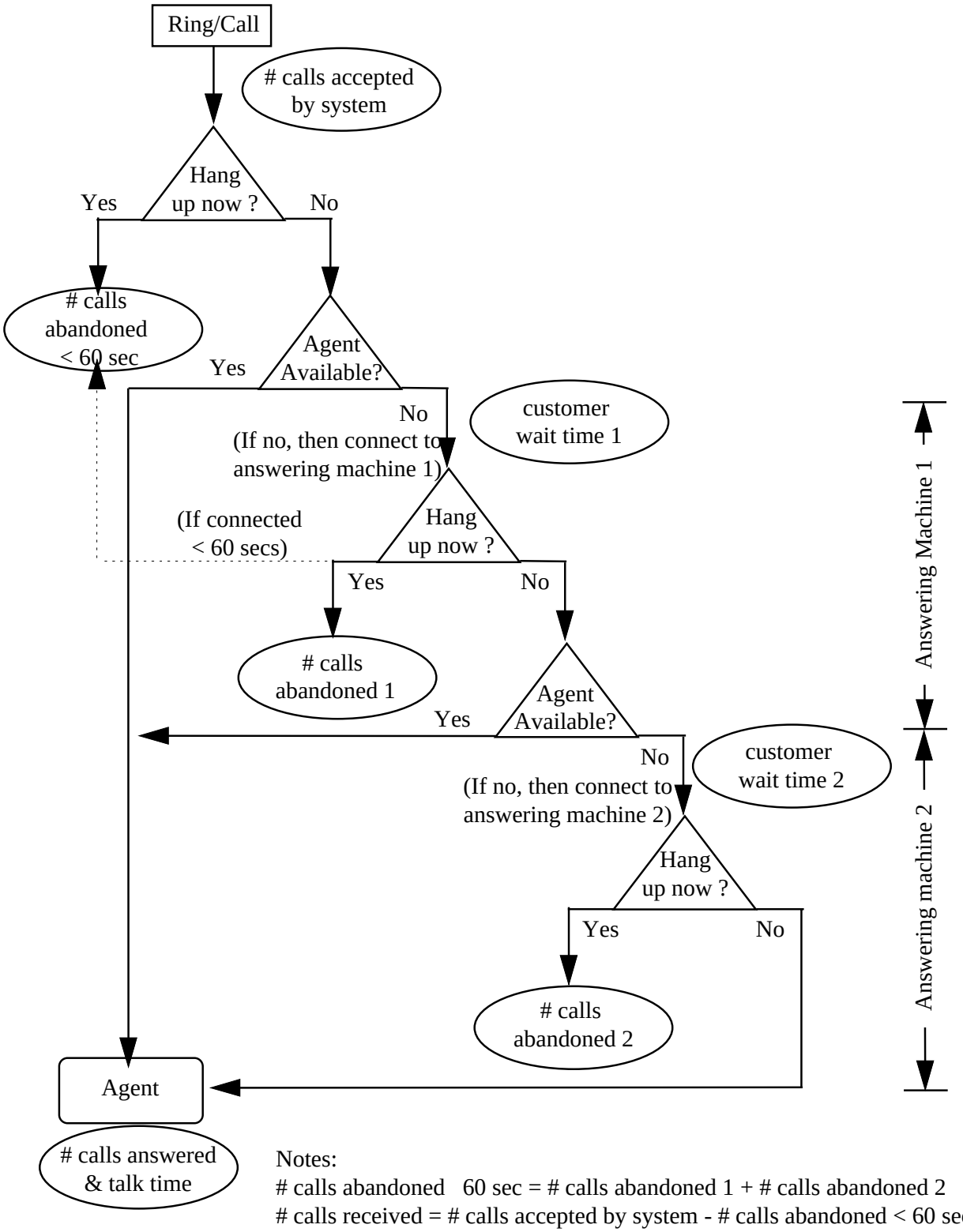
[1] Coefficients shown have a T statistic significant at the .05 level, those not significant have been replaced with "—". The Adjusted R Square and F statistic are for the regression model. The R Square is an indication of the percentage of variability in the data that is explained by the model. R Square ranges from 0 to 1, where 0 means no variability has been explained and 1 means that all of the variability has been explained. The better the model fits the data, the higher the R Square. The Significance of the F statistic is a description of the probability that, given the data, the model is a random result, in contrast to being a true result. The Significance of the F Statistic ranges from 0 to 1, where 0 means that, with the given data, the probability that the model could have arisen simply as a random occurrence is 0, and 1 means that the model is a result of random processes. It is common to accept models that have an F Statistics with a significance of .05 or less.

[2] The number of agent hours and number of calls received were not regressed as dependent variables, but are included in the parameter list to show the mean daily values.

Table 4: Pre-QV to Post-QV Changes in Mean Daily Value of Reservation System Parameters for Wayne County

Parameter	Pre-QV Mean	Post-QV Change
number of calls abandoned within 60 seconds	3	-1
number of calls abandoned after 60 seconds or more	32	-12
number of calls answered	231	+12
number of calls transferred	33	+8
average time that a customer must wait for a CSO	120 sec	-59 sec
average time a CSO needs to take a reservation	220 sec	-58 sec
average total time it takes a customer to reserve a trip	314 sec	-104 sec
average percentage of the call time that a customer is talking to a CSO	65%	+8 points
average percentage of the work day that a CSO is talking to a customer	59%	-11 points

FIGURES



Notes:
calls abandoned 60 sec = # calls abandoned 1 + # calls abandoned 2
calls received = # calls accepted by system - # calls abandoned < 60 sec
customer wait time = customer wait time 1 + customer wait time 2

Figure 1: Relationship Between Parameters

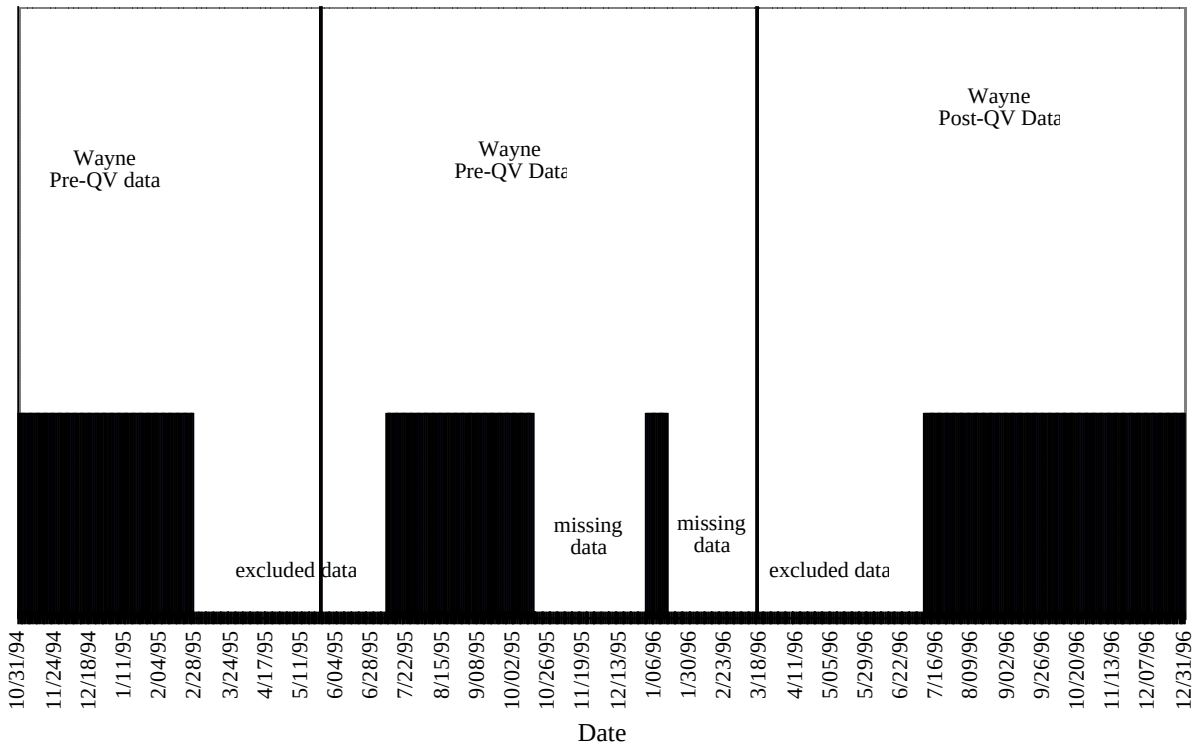


Figure 2: Data Timeline/Segmentation

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