

Washington Metropolitan Area Transit Authority

Short Term Ridership Forecasting Model (Version 3.0)

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Presentation Outline

- *Background*
- Model Updates
- Findings
- Model Application
- Uncertainty Analysis

Background Purpose

- Update and refine the 1998 ridership forecasting model
- Apply ridership forecasting model in multi-year budget and planning analysis
- Identify regional and system factors influencing ridership
 - Since June 2000, there have been changes that have impacted both ridership and revenue
 - system expansion
 - fare changes
 - socioeconomic development
 - gas prices

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Background Update Process

- Perform a backcasting exercise to assess how well the existing model would have predicted ridership and revenue from 2002 to 2008
- Review previous model and assess the feasibility, utility, and advisability of adding or removing variables
- Assess the feasibility of adding more submarkets (e.g., weekday versus weekend)
- Estimate revised model(s)
- Add an uncertainty analysis component to the revised model(s)

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Model Updates Peer Review

- **TCRP Synthesis 66: 36 agencies surveyed, primarily use qualitative techniques relying on professional judgments**

Forecasting Technique	Number of Agencies Responding	Agencies Responding (Percentage)
Professional Judgment	29	83
Rules of Thumb/Similar Routes	28	80
Service Elasticities	22	63
Four-Step Travel Demand Model	18	51
Econometric Model	7	20
Regression Analysis	7	20
Other	7	20

- **Surveyed**
 - Bay Area Rapid Transit
 - Chicago Transit Authority
 - Los Angeles County MTA
 - MTA New York City

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Model Updates Variables Tested

- Several types of variables were considered as determinants of Metrorail and Metrobus
 - Demographic
 - Population and Employment
 - Tourism
 - Hotel Rooms Sold, Smithsonian Visitors
 - Service Related
 - Fare, Service Hours, Parking Supply
 - Special
 - Gas Price, Weather, Events
 - Seasonal and Month

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Model Updates Model Estimation

- Four monthly time-series regression models were developed
 - Metrorail (Weekday)
 - Metrorail (Weekend)
 - Metrobus (Weekday)
 - Metrobus (Weekend)
- All models were developed by testing many of the variables in a variety of functional forms
- Advanced statistical evaluation criteria and tests were used
- The final specifications are simple linear regression models

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Model Updates Metrorail (Weekday)

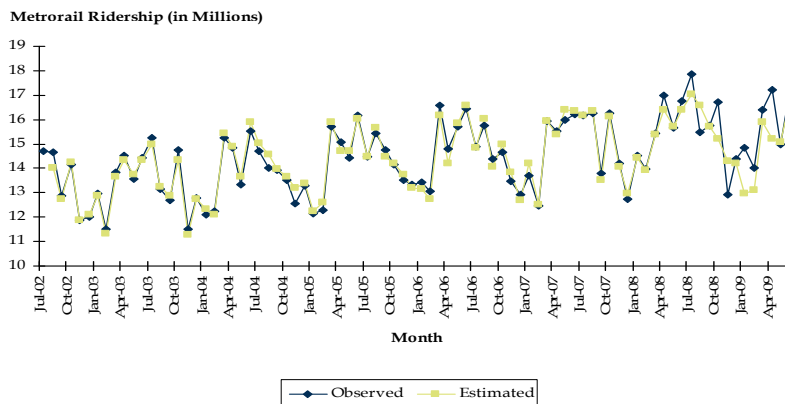
Metrorail Weekday Model

Variable	Coefficient	t Value
Constant	-9.104	-3.32
Natural Log of D.C. Employment	2.057	4.87
Natural Log of Hotel Rooms Sold	0.159	8.56
Natural Log of Gas Prices (lagged)	0.061	2.37
Natural Log of Metrorail Fare (lagged)	-0.117	-1.27
Severe Weather	-0.040	-3.37
July	0.046	4.70
June	0.048	5.23
December	-0.046	-4.45
Number of Observations	71	
RMSE	0.02	
Adjusted R-Square	0.925	

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Model Updates Metrorail (Weekday)

Metrorail Weekday Observed vs. Estimated



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Model Updates Metrorail (Weekend)

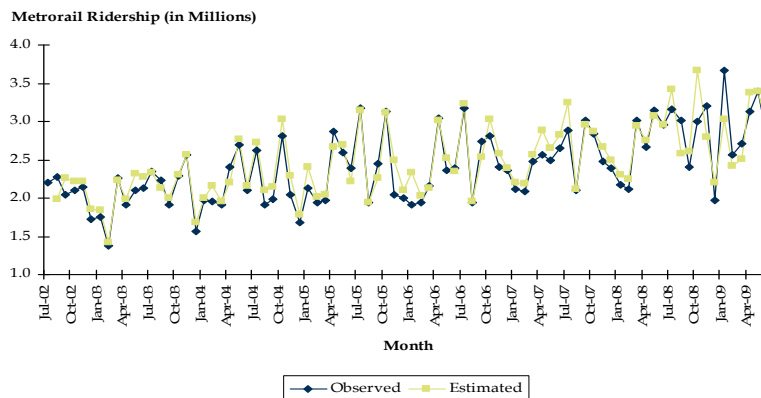
Metrorail Weekend Model

Variable	Coefficient	t Value
Constant	-64.285	-12.95
Natural Log of D.C. Population	9.846	12.5
Natural Log of Hotel Rooms Sold	0.555	12.08
Weekend Snowstorm	-0.219	-4.36
July	0.106	4.77
October	0.059	2.57
January	-0.057	-2.42
April	0.112	4.91
June	0.075	3.27
Number of Observations	71	
RMSE	0.048	
Adjusted R-Square	0.918	

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Model Updates Metrorail (Weekend)

Metrorail Weekend Observed vs. Estimated



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Model Updates Metrobus (Weekday)

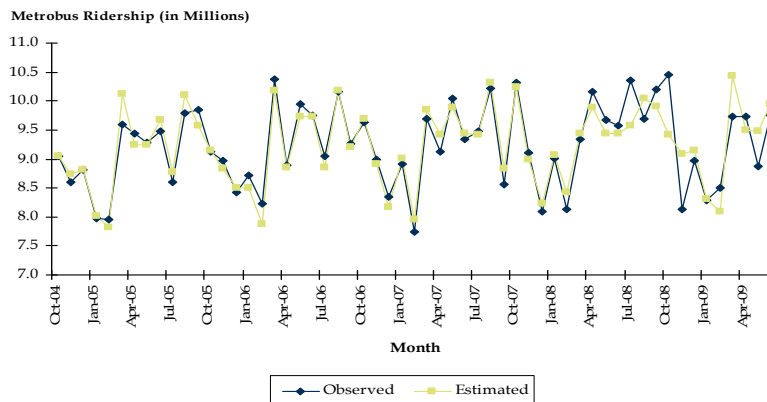
Metrobus Weekday Model

Variable	Coefficient	t Value
Constant	0.262	0.13
Natural Log of D.C. Employment	0.893	2.99
September	0.036	3.03
October	0.036	3.1
December	-0.089	-7.65
January	-0.039	-3.38
February	-0.065	-5.63
Number of Observations	45	
RMSE	0.022	
Adjusted R-Square	0.737	

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Model Updates Metrobus (Weekday)

Metrobus Weekday Observed vs. Estimated



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Model Updates Metrobus (Weekend)

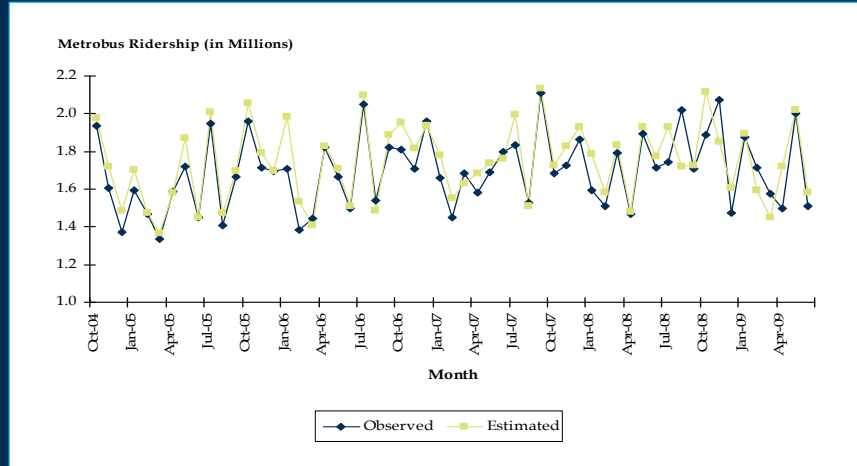
Metrobus Weekend Model

Variable	Coefficient	t Value
Constant	-4.846	-1.39
Natural Log of Smithsonian Visitation	0.068	4.97
Natural Log of Metrobus Fare (lagged)	-0.241	-2.41
Natural Log of D.C. Population	2.572	2.9
Presidential Inauguration	-0.152	-5.34
July	0.031	1.66
August	0.042	2.48
September	0.088	5.45
October	0.068	4.86
May	0.042	2.66
June	0.050	3.23
Number of Observations	45	
RMSE	0.026	
Adjusted R-Square	0.854	

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Model Updates Metrobus (Weekend)

Metrobus Weekend Observed vs. Estimated



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Findings Model Validity and Fit

- Model fit as measured by R-squared indicate:
 - Metrorail models have a high degree of fit
 - Metrobus models have an adequate degree of fit
- Mean absolute percentage error (MAPE) of the models (comparison of observed and model-predicted ridership for the model estimation periods) are in the same range as the previous modeling effort
 - Metrorail: 1.91% (previous model 1.46%)
 - Metrobus: 1.49% (previous model 1.95%)
- As noted in the previous model documentation, these ranges appear to be similar to other models, but not within the more-desirable 1.00%.

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Findings

Key Factors Impacting Ridership

- Employment and population are the determinants of transit ridership
 - Employment drives weekday ridership
 - Population drives weekend ridership
- Tourism strongly influences ridership
 - Hotel Rooms Sold is a new variable influencing Metrorail ridership
 - Smithsonian Visitation remains a good indicator
- Other variables
 - Service Variables - Fare, Parking Supply
 - Special Variables - Gas Price, Weather, Events
 - Seasonal and Month

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Findings

Impacts of Previous Fare Changes

- Difficult to isolate the effects of fare changes from other independent variables in the models because:
 - High level of correlation between fares and other variables
 - Very few fare changes in the estimation period
- Model specifications that include fare variables indicate a reasonable range of fare elasticities (percent change in ridership due to a one percent change in fare)
 - Metrorail fare elasticity: -0.12 to -0.18
 - Metrobus fare elasticity: -0.2 to -0.26
- Recent similar modeling efforts in similar cities have had rail fare elasticities in the -0.10 to -0.20 range and bus fare elasticities in the -0.20 to -0.43 range

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Findings

Impacts of Gasoline Price Changes

- Gas price changes had a small effect on WMATA ridership during the model estimation period
- Weekday model specifications that include gas prices indicate a reasonable range of gas price elasticities (percent change in ridership due to a one percent change in gas price)
 - Metrorail weekday gas price elasticity: +0.04 to +0.07
 - Metrobus weekday gas price elasticity: +0.05 to +0.07
- Weekend ridership did not appear to be related to gas prices
- Recent similar modeling efforts in similar cities have had gas price elasticities in the +0.05 to +0.15 range

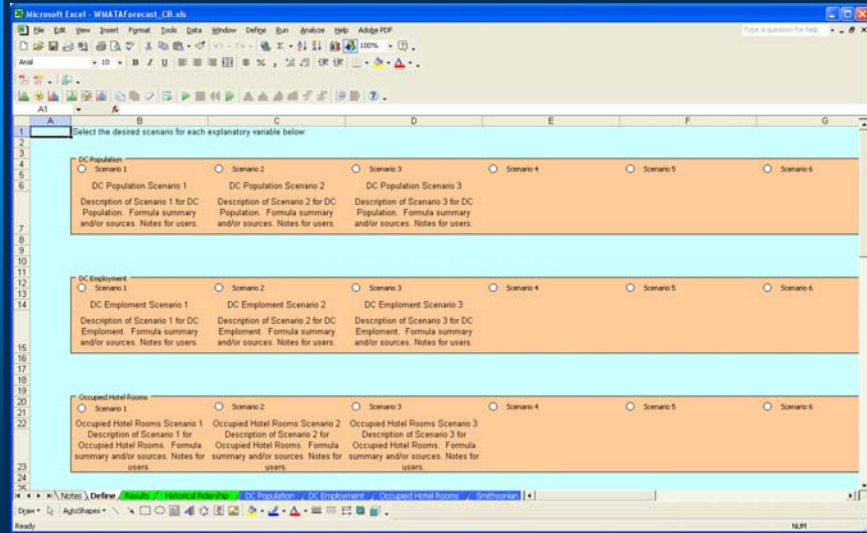
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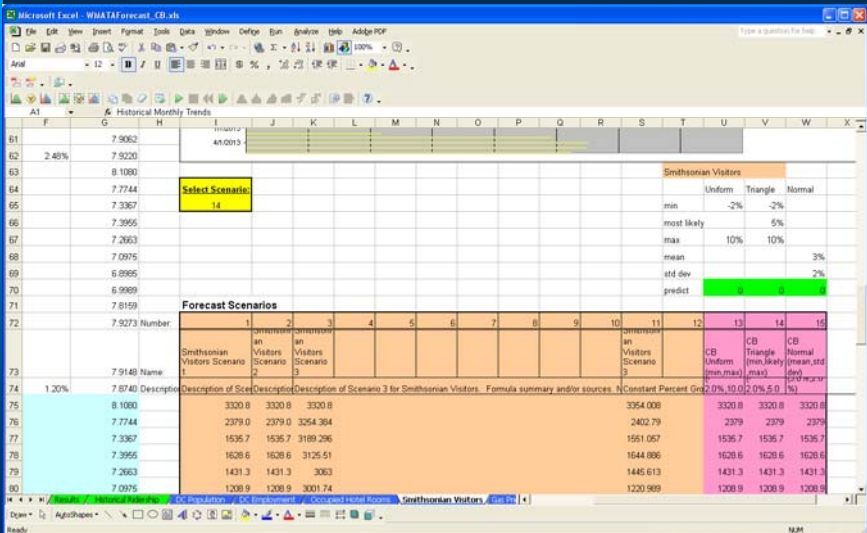
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Model Application Model Definition Tab



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Model Application Input Variable Tab



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Model Application Results Tab

Sequence	Month	Bus Passengers - Weekday	Bus Passengers - Weekend	Rail Passengers - Weekday	Rail Passengers - Weekend	Bus Ridership	Rail Ridership
72	94	Apr-08	452.0	367.0	772.0	668.1	
73	95	May-08	451.0	379.2	747.0	628.4	
74	96	Jun-08	456.3	359.7	798.5	671.8	
75	97	Jul-2008	444.7	396.3	788.1	638.1	
76	98	Aug-2008	438.0	365.2	726.6	593.9	
77	99	Sep-2008	453.3	371.8	730.4	552.2	
78	100	Oct-2008	463.8	391.3	748.1	641.0	
79	101	Nov-2008	448.0	370.1	717.9	526.5	
80	102	Dec-2008	436.3	351.5	666.7	451.3	
81	103	Jan-2009	423.8	301.1	704.6	463.4	
82	104	Feb-2009	428.2	347.8	710.8	497.9	
83	105	Mar-2009	446.1	379.3	747.5	594.5	
84	106	Apr-2009	449.3	368.1	766.4	681.0	
85	107	May-2009	446.7	391.4	763.7	621.4	
86	108	Jun-2009	446.9	386.6	759.4	638.8	
87	109	Jul-2009	444.7	410.5	807.6	656.5	
88	110	Aug-2009	438.0	391.9	738.8	576.2	
89	111	Sep-2009	453.3	361.7	746.4	567.2	
90	112	Oct-2009	463.8	401.7	764.2	658.4	
91	113	Nov-2009	448.0	379.9	733.4	548.8	
92	114	Dec-2009	436.3	364.0	680.0	463.6	
93	115	Jan-2010	423.8	372.6	717.5	476.0	
94	116	Feb-2010	428.2	367.0	728.7	511.4	
95	117	Mar-2010	446.1	389.4	763.6	610.7	
96	118	Apr-2010	449.3	402.0	782.9	699.5	
97	119	May-2010	446.7	398.3	777.6	638.3	
98	120	Jun-2010	446.9	407.1	778.2	656.1	
99	121	Jul-2010	444.7	421.4	825.0	674.4	
100	122	Aug-2010	438.0	402.4	765.7	591.9	
101	123	Sep-2010	453.3	379.4	751.6	572.6	
						Bus Ridership FY 2009	324,064.7
						Rail Ridership FY 2009	304,064.7
						Bus Ridership FY 2010	326,668.5
						Rail Ridership FY 2010	306,668.5

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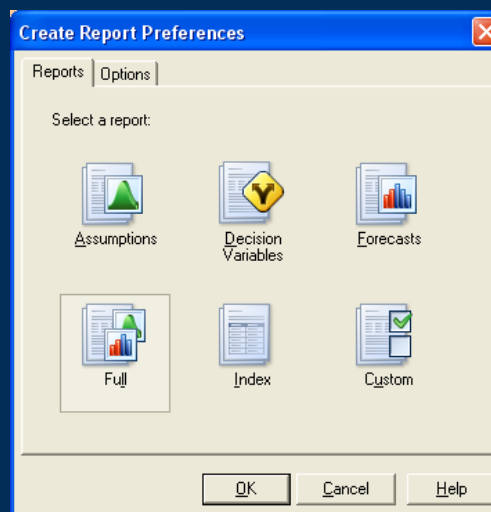
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Uncertainty Analysis

- Selected Oracle's Crystal Ball Excel add-on
- Provides a way to test the reliability of model predictions and explore alternative scenarios
- Avoids single point estimates of future values of input variables; permits specification and selection of distributions for each input variable
- Useful for looking at range of possible forecasts where more than one input variable is involved
- Provides the probability of each outcome and the relative contribution of each input to that outcome

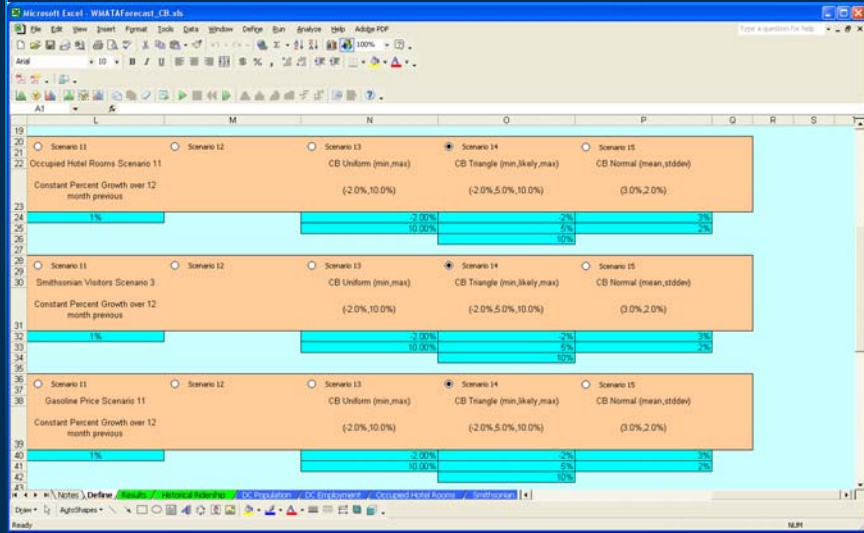
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Uncertainty Analysis Crystal Ball Application



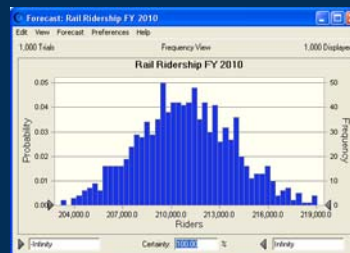
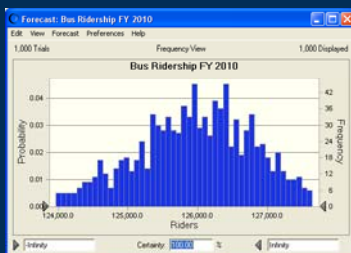
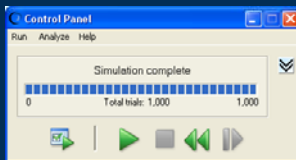
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Uncertainty Analysis Crystal Ball Inputs



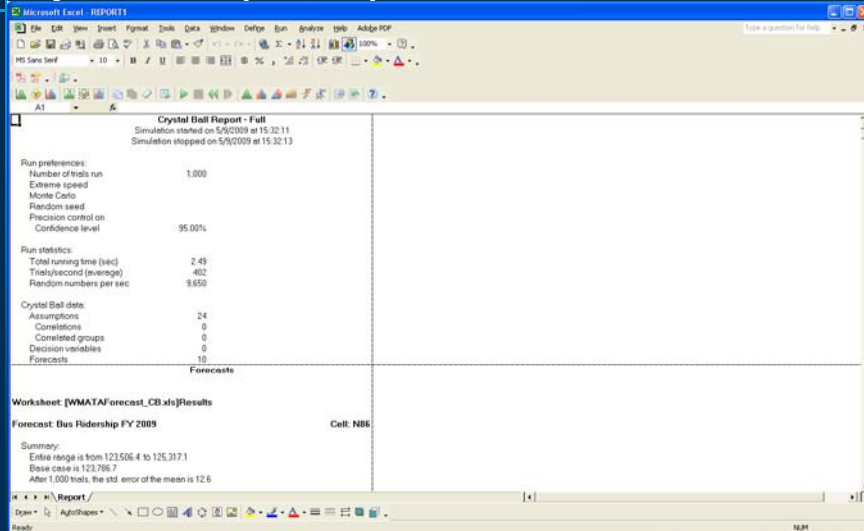
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Uncertainty Analysis Crystal Ball Toolbar, Control Panel, and Forecast View



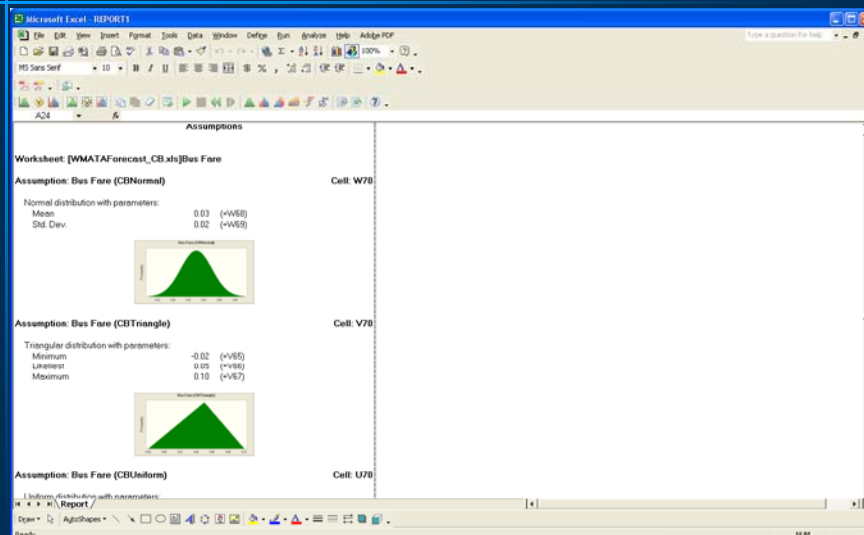
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Uncertainty Analysis Crystal Ball Report Output – Introduction Section



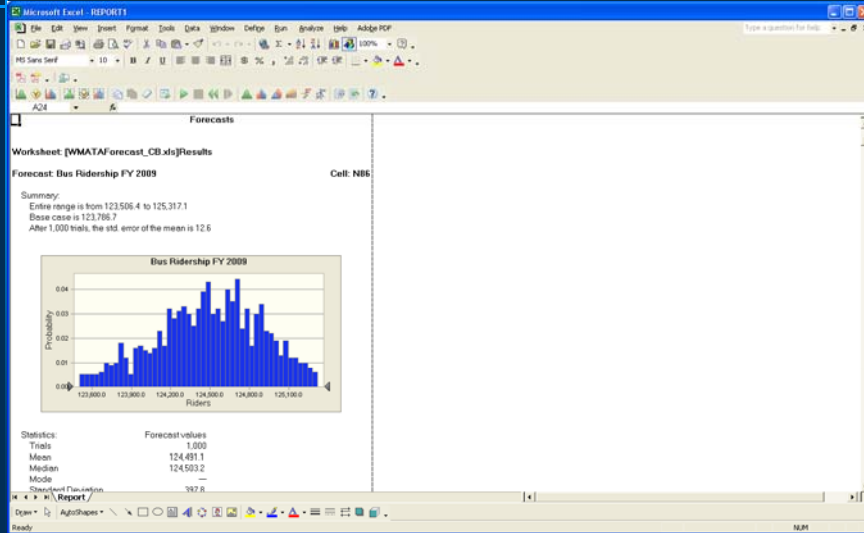
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Uncertainty Analysis Crystal Ball Report Output – Assumptions Section



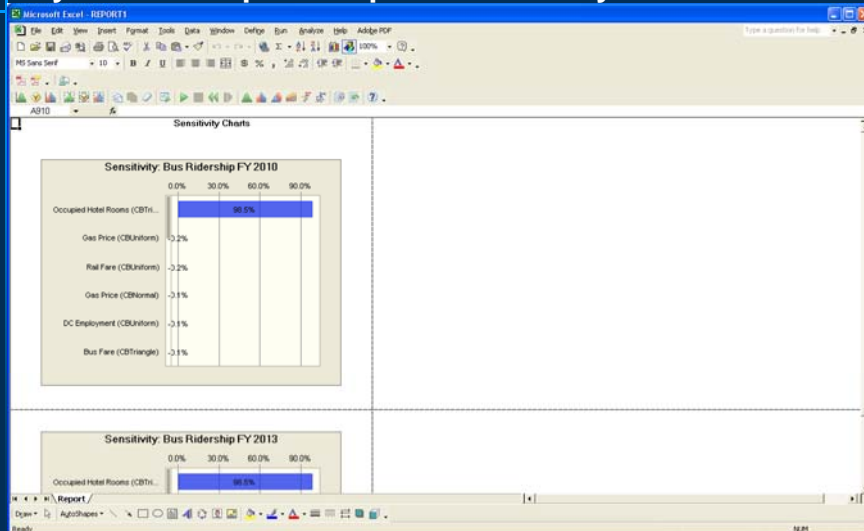
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Uncertainty Analysis Crystal Ball Report Output – Forecasts Section



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Uncertainty Analysis Crystal Ball Report Output – Sensitivity Section



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Contact Info

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