Appendix: Stochastic disruption duration case test results

Table A1. Performance comparisons under stochastic disruption duration – demand pattern: uniform

Model	Optimal model objective values			Evaluation results		Comments
	User cost	Operator cost	Total cost	Expected user cost	Total cost	
demand pattern:	**uniform**			**duration distribution:**		**uniform**
LLA	82417.5	0.0	82417.5	82417.5	82417.5	
BB	80698.8	1200.0	81898.8	80698.8	81898.8	# BU bus = 1
BM	77317.8	2254.9	79572.6*	77317.8	79572.6	
ITM	77660.1	2031.3	79691.4*	77641.5	79672.8	**z = 0*****
demand pattern:	**uniform**			**duration distribution:**		**normal-like**
LLA	82512.0	0.0	82512.0	82539.3	82539.3	
BB	80752.0	1200.0	81952.0	80767.4	81967.4	# BU bus = 1
BM	77185.3	2271.4	79456.7*	77161.1	79432.5	
ITM	77424.2	2232.2	79656.4*	77424.2	79656.4	**z = 0*****
demand pattern:	**uniform**			**duration distribution:**		**exponential-like**
LLA	79551.0	0.0	79551.0	79580.1	79580.1	
BB	79551.0	0.0	79551.0	79580.1	79580.1	# BU bus = 0
BM	78944.9	510.7	79455.6*	78957.6	79468.3	
ITM	79077.2	356.0	79433.2*	79215.7	79571.7	**z = 0*****
demand pattern:	**uniform**			**duration distribution:**		**bi-Dirac**
LLA	82417.5	0.0	82417.5	82417.5	82417.5	
BB	80698.8	1200.0	81898.8	80698.8	81898.8	# BU bus = 1
BM	77317.8	2254.9	79572.6*	77317.8	**79572.6****	
ITM	77468.5	1241.5	78710.0*	77468.5	**78710.0****	z = 10

** Run time of 5 minutes reached without convergence;*
*** ITM is significantly better than BM;*
**** Duration distribution is not bi-Dirac, then ITM delay z's are zero.*

Table A2. Performance comparisons under stochastic disruption duration – demand pattern: increasing

Model	Optimal model objective values			Evaluation results		Comments
	User cost	Operator cost	Total cost	Expected user cost	Total cost	
demand pattern:		**increasing**		**duration distribution:**		**uniform**
LLA	81674.1	0.0	81674.1	81911.6	81911.6	
BB	79955.4	1200.0	81155.4	80243.5	81443.5	# BU bus = 1
BM	78641.9	2235.8	80877.7*	78659.0	80894.9	
ITM	77297.1	2228.8	79525.9*	77297.2	79525.9	z = 0
demand pattern:		**increasing**		**duration distribution:**		**normal-like**
LLA	81770.2	0.0	81770.2	81934.3	81934.3	
BB	80010.2	1200.0	81210.2	80230.1	81430.1	# BU bus = 1
BM	77494.5	2010.1	79504.7*	77455.9	79466.1	
ITM	77213.5	2378.2	79591.6*	77213.5	79591.6	z = 0
demand pattern:		**increasing**		**duration distribution:**		**exponential-like**
LLA	79134.1	0.0	79134.1	79193.9	79193.9	
BB	79134.1	0.0	79134.1	79193.9	79193.9	# BU bus = 0
BM	79134.1	0.0	79134.1*	79193.9	79193.9	
ITM	78977.3	194.3	79171.5*	78988.1	79182.4	**z = 20****
demand pattern:		**increasing**		**duration distribution:**		**bi-Dirac**
LLA	81674.1	0.0	81674.1	82358.1	82358.1	
BB	79955.4	1200.0	81155.4	80588.6	81788.6	# BU bus = 1
BM	78641.9	2235.8	80877.7*	78689.3	80925.1	
ITM	77428.1	1247.8	78675.9*	77428.1	78675.9	**z = 20****

** Run time of 5 minutes reached without convergence;*

*** When the demand pattern is increasing, it is advantageous to postpone the resource relocation decision.*

Table A3. Performance comparisons under stochastic disruption duration – demand pattern: decreasing

Model	Optimal model objective values			Evaluation results		Comments
	User cost	Operator cost	Total cost	Expected user cost	Total cost	
demand pattern:		**decreasing**		**duration distribution:**		**uniform**
LLA	83310.9	0.0	83310.9	83147.4	83147.4	
BB	79895.3	2400.0	82295.3	79835.4	82235.4	# BU bus = 2
BM	77063.7	2341.4	79405.1*	77133.6	79475.0	
ITM	77320.2	2187.2	79507.4*	77320.2	79507.4	z = 0
demand pattern:		**decreasing**		**duration distribution:**		**normal-like**
LLA	83394.6	0.0	83394.6	83367.4	83367.4	
BB	79921.8	2400.0	82321.8	79894.7	82294.7	**# BU bus = 2****
BM	77271.2	2790.5	80061.7*	77410.9	80201.4	
ITM	76967.9	2583.0	79550.9*	76968.0	79551.0	z = 0
demand pattern:		**decreasing**		**duration distribution:**		**exponential-like**
LLA	80111.8	0.0	80111.8	80089.0	80089.0	
BB	80111.8	0.0	80111.8	80089.0	80089.0	# BU bus = 0
BM	79102.4	622.3	79724.7*	79109.8	79732.1	
ITM	79417.0	326.6	79743.6*	79666.0	79992.6	z = 0
demand pattern:		**decreasing**		**duration distribution:**		**bi-Dirac**
LLA	83310.9	0.0	83310.9	82715.4	82715.4	
BB	79895.3	2400.0	82295.3	79729.9	82129.9	**# BU bus = 2****
BM	77063.7	2341.4	79405.1*	77256.7	79598.1	
ITM	77937.8	1252.7	79190.5*	77937.8	79190.5	z = 10

** Run time of 5 minutes reached without convergence*

*** Backup buses are heavily used when the demand pattern is concave.*

Table A4. Performance comparisons under stochastic disruption duration – demand pattern: convex

Model	Optimal model objective values			Evaluation results		Comments
	User cost	Operator cost	Total cost	Expected user cost	Total cost	
demand pattern:		**convex**		**duration distribution:**		**uniform**
LLA	73225.1	0.0	73225.1	73318.6	73318.6	
BB	71506.3	1200.0	72706.3	71655.8	72855.8	# BU bus = 1
BM	68824.2	2114.5	70938.8*	68814.8	70929.3	
ITM	68684.5	2255.5	70940.0*	68684.5	70940.0	z = 0
demand pattern:		**convex**		**duration distribution:**		**normal-like**
LLA	73288.2	0.0	73288.2	73396.4	73396.4	
BB	71528.2	1200.0	72728.2	71690.1	72890.1	# BU bus = 1
BM	68781.1	2087.2	70868.3*	68766.9	70854.1	
ITM	68902.4	2015.3	70917.7*	68902.4	70917.7	z = 0
demand pattern:		**convex**		**duration distribution:**		**exponential-like**
LLA	71046.6	0.0	71046.6	71003.0	71003.0	
BB	71046.6	0.0	71046.6	71003.0	71003.0	# BU bus = 0
BM	70248.5	571.7	70820.2*	70253.2	70824.9	
ITM	70367.5	384.7	70752.1*	70533.0	70917.6	z = 0
demand pattern:		**convex**		**duration distribution:**		**bi-Dirac**
LLA	73225.1	0.0	73225.1	73398.0	73398.0	
BB	71506.3	1200.0	72706.3	71712.7	72912.7	# BU bus = 1
BM	68824.2	2114.5	70938.8*	68798.2	70912.7	
ITM	69231.1	1150.2	70381.3*	69231.1	70381.3	z = 10

** Run time of 5 minutes reached without convergence*

Table A5. Performance comparisons under stochastic disruption duration – demand pattern: concave

Model	Optimal model objective values			Evaluation results		Comments
	User cost	Operator cost	Total cost	Expected user cost	Total cost	
demand pattern:		**concave**		**duration distribution:**		**uniform**
LLA	91636.6	0.0	91636.6	91831.6	91831.6	
BB	88460.0	2400.0	90860.0	88450.0	90850.0	**# BU bus = 2*** **
BM	85651.1	2361.2	88012.3*	85663.4	88024.5	
ITM	85704.6	2327.4	88032.0*	85704.6	88032.0	z = 0
demand pattern:		**concave**		**duration distribution:**		**normal-like**
LLA	91778.2	0.0	91778.2	92013.7	92013.7	
BB	88495.9	2400.0	90895.9	88497.0	90897.0	# BU bus = 2***
BM	85631.2	2344.0	87975.2*	85629.9	87974.0	
ITM	86421.6	2225.5	88647.1*	86420.8	88646.2	z = 30
demand pattern:		**concave**		**duration distribution:**		**exponential-like**
LLA	88097.2	0.0	88097.2	88226.1	88226.1	
BB	88097.2	0.0	88097.2	88226.1	88226.1	# BU bus = 0
BM	87642.6	402.1	88044.7*	87766.2	88168.4	
ITM	87833.6	269.8	88103.4*	87919.9	88189.7	**z = 10****
demand pattern:		**concave**		**duration distribution:**		**bi-Dirac**
LLA	91636.6	0.0	91636.6	91759.8	91759.8	
BB	88460.0	2400.0	90860.0	88432.4	90832.4	**# BU bus = 2*** **
BM	85651.1	2361.2	88012.3*	85685.0	88046.1	
ITM	86008.0	1206.0	87214.0*	86008.0	87214.0	**z = 10****

** Run time of 5 minutes reached without convergence;*

*** When duration distribution is bi-Dirac/exponential-like, it is advantageous to postpone the resource relocation decision.*

**** Backup buses are heavily used when the demand pattern is concave.*