unison
Cost Engineering

25th ISBSG anniversary
IT Confidence 2022

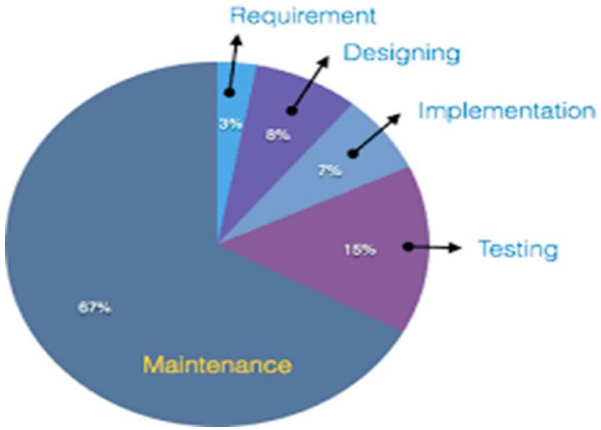
Lessons Learned from ISBSG Software Maintenance and Support Datasets

IT Confidence

Arlene Minkiewicz

Lessons Learned from ISBSG M&S Dataset

- Introduction
- Lessons to be Learned
- Learning Process
- Results and Lessons Learned

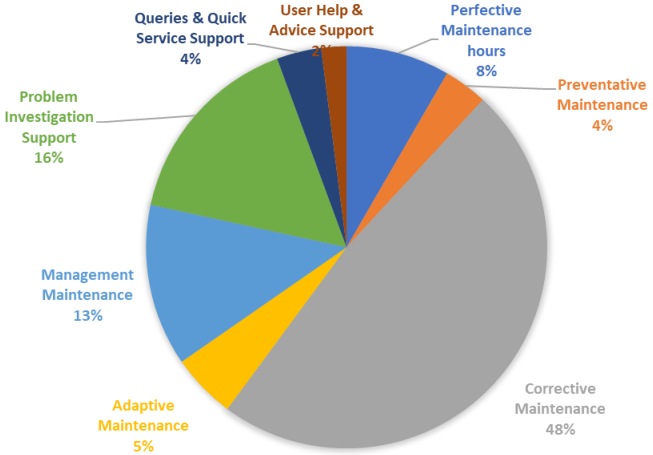


Introduction

- Software sustainment is an increasingly important part of the operation of a complex systems (65-75%)
- Software estimates continue to focus primarily on development costs, light on the sustainment costs
- Limited data exists to support software sustainment estimates, especially in the public domain
- This study uses the ISBSG M&S Dataset - August 2020 Version 7
  - 226 datapoints
    - Filter on IFPUG and NESMA
    - Filter for missing hours
    - Other filters (listed in paper available from author)

Software Sustain

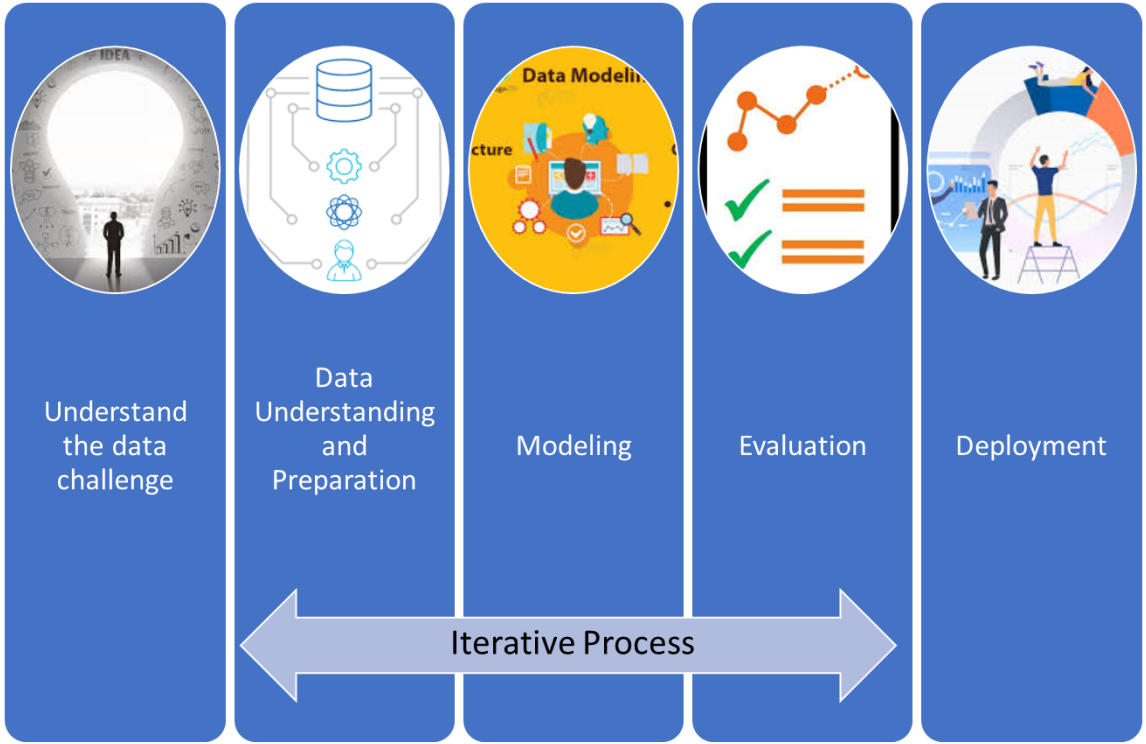
- Software sustainment is generally considered to be all activities associated with a software application after it is release to the public
- The context of this software sustainment study is aligned to the maintenance and support activities covered by the ISBSG M&S Data Set



The Questions to be Answered

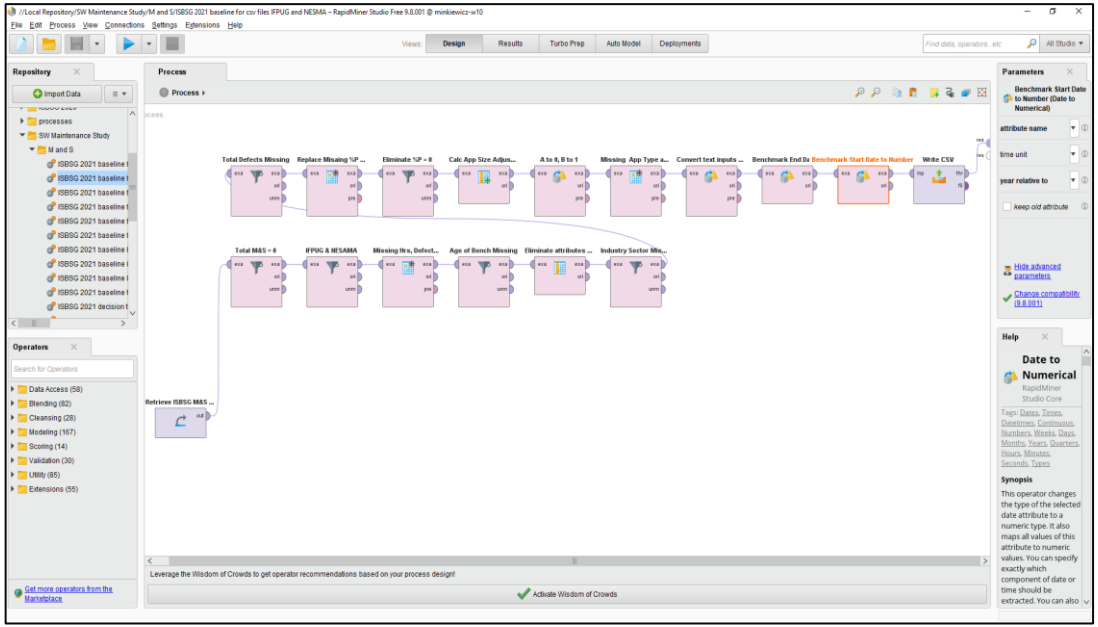
- What can we learn from the M&S Dataset?
- How can what we learn provide software sustainment guidance to the cost community?
- What useful benchmarks can we find to support estimation?
- Are there any useful Cost Estimating Relationships(CER) we can derive?

Data Collection and Analysis



Data Understanding and Preparation

- Following Steps were taken to prepare the data for analysis
  - Filter for IFPUG and NESMA records only
  - Replace missing value with 0 where it made sense
  - Remove Records based on age of Benchmark
  - Eliminate attributes not needed for the study
  - Digitized qualitative attributes where it made sense

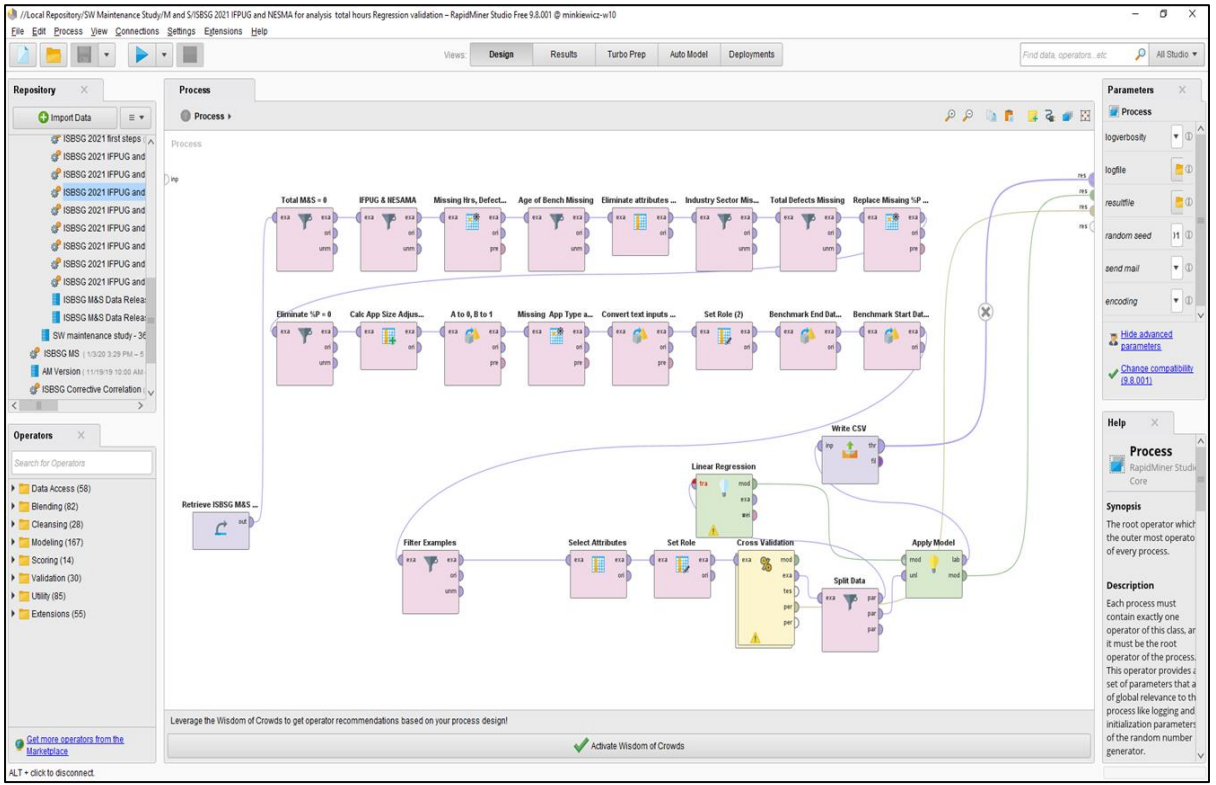


Modeling and Evaluation

- Correlation Matrix was used to identify suspects for analysis
- Operators were added to the RM process to perform analysis – primarily regression analysis

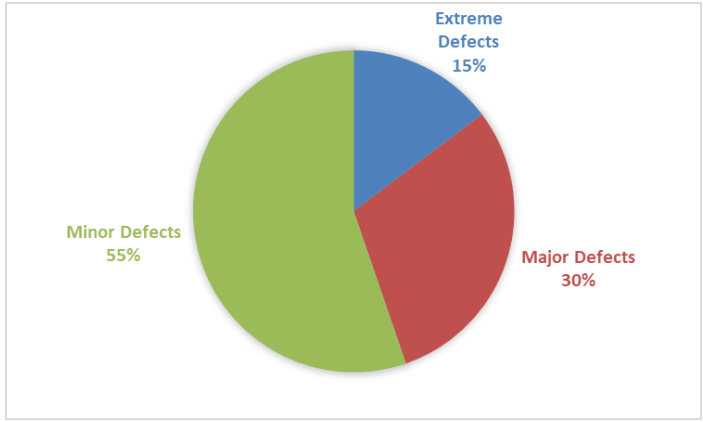
Attributes	Total M...	Perfecti...	Prevent...	Correcti...	Adaptiv...	Manage...	Total Su...	Proble...	Queries...	User He...	Manage...	Extrem...	Major D...	Minor D...	Age at ...	Total M...	Applicat...	Total De...	CalcAp...
Total Maintenance hours	1	0.140	0.152	0.253	0.045	0.661	0.810	0.129	0.002	0.101	-0.033	0.538	0.383	0.457	0.144	0.835	0.708	0.495	0.708
Perfective Maintenance hours	0.140	1	0.782	0.555	0.454	-0.140	-0.025	0.441	0.198	0.392	0.164	-0.115	-0.113	-0.009	-0.033	0.054	0.053	-0.037	0.052
Preventative Maintenance hours	0.152	0.782	1	0.625	0.522	-0.159	-0.034	0.550	0.175	0.513	-0.025	-0.138	-0.133	-0.024	-0.103	0.054	0.026	-0.055	0.027
Corrective Maintenance hours	0.253	0.555	0.625	1	0.102	-0.094	0.023	0.577	0.152	0.501	0.005	-0.057	-0.044	0.129	-0.027	0.137	0.144	0.079	0.142
Adaptive Maintenance hours	0.045	0.454	0.522	0.102	1	-0.140	-0.058	0.217	0.155	0.351	0.075	-0.132	-0.131	-0.116	-0.091	-0.011	-0.071	-0.112	-0.069
Management Maintenance hours	0.661	-0.140	-0.159	-0.094	-0.140	1	0.910	-0.105	-0.083	-0.127	-0.055	0.798	0.586	0.610	0.263	0.692	0.907	0.672	0.914
Total Support hours	0.810	-0.025	-0.034	0.023	-0.058	0.910	1	0.083	0.213	0.053	-0.058	0.768	0.674	0.642	0.230	0.807	0.890	0.720	0.884
Problem Investigation Support hours	0.129	0.441	0.550	0.577	0.217	-0.105	0.083	1	0.219	0.855	-0.005	-0.071	-0.098	-0.058	-0.096	0.094	-0.033	-0.068	-0.034
Queries & Quick Service Support hours	0.002	0.198	0.175	0.152	0.155	-0.083	0.213	0.219	1	0.209	-0.011	0.014	0.452	0.244	0.022	0.081	0.034	0.297	-0.007
User Help & Advice Support hours	0.101	0.392	0.513	0.501	0.351	-0.127	0.053	0.855	0.209	1	-0.001	-0.096	-0.119	-0.080	-0.111	0.065	-0.046	-0.089	-0.046
Management Support Hours	-0.033	0.164	-0.025	0.005	0.075	-0.055	-0.058	-0.005	-0.011	-0.001	1	-0.029	-0.012	-0.038	-0.068	-0.046	-0.024	-0.035	-0.027
Extreme Defects	0.538	-0.115	-0.138	-0.057	-0.132	0.798	0.768	-0.071	0.014	-0.096	-0.029	1	0.759	0.638	0.119	0.572	0.851	0.758	0.851
Major Defects	0.383	-0.113	-0.133	-0.044	-0.131	0.586	0.674	-0.098	0.452	-0.119	-0.012	0.759	1	0.724	0.117	0.509	0.682	0.854	0.656
Minor Defects	0.457	-0.009	-0.024	0.129	-0.116	0.610	0.642	-0.058	0.244	-0.080	-0.038	0.638	0.724	1	0.168	0.712	0.733	0.973	0.703
Age at Benchmark	0.144	-0.033	-0.103	-0.027	-0.091	0.263	0.230	-0.096	0.022	-0.111	-0.068	0.119	0.117	0.168	1	0.194	0.198	0.161	0.195
Total Maintenance & Support hours	0.835	0.054	0.054	0.137	-0.011	0.692	0.807	0.094	0.081	0.065	-0.046	0.572	0.509	0.712	0.194	1	0.752	0.712	0.735
Application size	0.708	0.053	0.026	0.144	-0.071	0.907	0.890	-0.033	0.034	-0.046	-0.024	0.851	0.682	0.733	0.198	0.752	1	0.795	0.998
Total Defects	0.495	-0.037	-0.055	0.079	-0.112	0.672	0.720	-0.068	0.297	-0.089	-0.035	0.758	0.854	0.973	0.161	0.712	0.795	1	0.767
CalcApplicationSize	0.708	0.052	0.027	0.142	-0.069	0.914	0.884	-0.034	-0.007	-0.046	-0.027	0.851	0.656	0.703	0.195	0.735	0.998	0.767	1

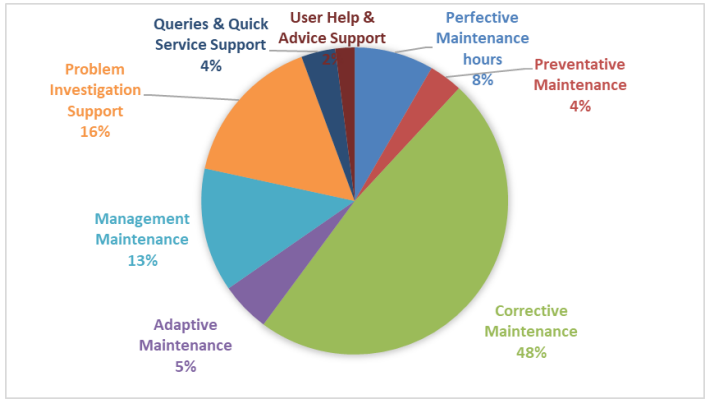
Modeling and Evaluation



Results - Benchmarks

- Benchmarks were compiled for:
  - Application Size
  - Hours
  - Hours Per Size
  - Defect Counts
- Benchmarks include:
  - Sample Size
  - Min., Max
  - 25%,75%
  - Median
  - Mode
  - Standard Deviation
  - Coefficient of Variation



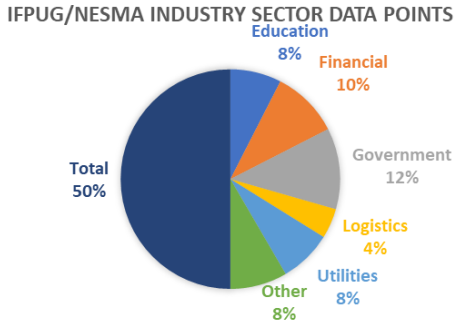


Comprehensive Benchmarks

Attribute	Sample Size	Min	Max	25%	75%	Mean	Median	Mode	Standard Deviation	Coefficient of Variation
Age at Benchmark	226	1	31	4	12	8.85	8	3	6.018	0.68
Adaptive Hours Per FP	30	0.002	3.894	0.055	0.423	0.44	0.197	0.002	0.768	1.746
Adaptive Hours	30	6	1032	21.75	388.75	235	69	18	304.77	1.297
Application Size	226	24	55312	459	3477.8	2931.24	1261.5	234	4893.831	1.67
Corrective FP Rate	41	0.002	4.292	0.038	0.327	0.356	0.095	0.002	0.742	2.083
Corrective Maintenance Hours	41	2	4224	24	132	320.707	48	6	843.871	2.631
Extreme Defects per FP	183	1.43E-04	0.066	0.002	0.006	0.005	0.004	0.002	0.005	1.12
Extreme Defects	183	1	152	2	15.5	12.778	5	2	18.525	1.45
Maintenance FP Rate	208	0.1	6.3	0.2	0.411	0.414	0.307	0.2	0.624	1.506
Major Defect FP Rate	185	3.10E-04	1	0.006	0.012	0.024	0.008	0.008	0.111	4.58
Major Defects	185	1	326.51	5	32	27.4	14	3	41.697	1.522
Management Maintenance Hours	172	2	3139	66.25	283.5	215.326	149	52	291.266	1.353
Minor Defects Per FP	193	3.10E-04	0.667	0.016	0.036	0.037	0.022	0.05	0.065	1.729
Minor Defects	193	1	954	19	82	69.658	41	12	121.581	1.745
Perfective Hours per FP	26	0.006	0.43	0.03	0.094	0.078	0.065	0.086	0.084	1.076
Preventive Maintenance Hours	34	1	240	6.75	76.5	60.853	31	6	71.711	1.178
Preventive FP Rate	34	0.002	0.747	0.034	0.113	0.116	0.068	0.1	0.16	1.377
Problem Investiageion FP Rate	31	0.003	2.113	0.041	0.234	0.226	0.098	0.003	0.408	1.802
Problem Imvestigation Hours	31	8	1237	23.5	106.5	112.258	60	13	220.839	1.967
Queries & Quick Service Support Hours	33	1	3752	13	132	243.909	67	13	656.753	2.693
Queries and Quick Service FP Rate	33	0.003	1.1	0.055	0.271	0.222	0.12	0.003	0.274	1.233
Support FP Rate	204	0.1	3.3	0.186	0.378	0.339	0.3	0.2	0.337	0.992
total Defects FP Rate	219	0.001	1.667	0.023	0.05	0.059	0.034	0.043	0.157	2.647
Total Defects	219	1	1311	22.5	111.5	96.831	51	32	159.462	1.647
Total Maintenance and Support Hours	226	11	22423	329.3	1759	1511.04	881.5	52	2457.856	1.627
Total Maintenance Hours	219	6	13182	181	936.5	780.174	452	126	1327.703	1.702
Total Support Hours	208	8	11212	170.8	841.25	687.611	453.5	40	1021.549	1.486
User Help and Advise Support Hours	27	3	495	12.5	99.5	72.074	33	13	100.605	1.396
User Help and Advice FP Rate	27	0.004	1.1	0.027	0.147	0.128	0.051	0.004	0.22	1.72

Additional Benchmark Scenarios

- More detailed studies for categories with enough data
- Categories studied include choices in the following categories:
  - Primary Language
  - Application Type
  - Industry Sector
  - Organization Type



Government

Attribute	Sample Size	Min	Max	25%	75%	Mean	Median	Mode	Standard Deviation	Coefficient of Variation
Age at Benchmark	54	1	31	6	12	9.981	9	6	6.299	0.631
Application Size	54	24	18500	444.75	3542	2724.5	871.5	453	3578.376	1.313
Maintenance FP Rate	45	0.1	2.1	0.206	0.374	0.383	0.287	0.2	0.357	0.931
Support FP Rate	38	0.112	0.732	0.197	0.363	0.307	0.29	0.112	0.142	0.462
Total Defects FP Rate	54	0.003	1.667	0.022	0.071	0.122	0.037	0.043	0.305	2.499
Total Defects	54	5.415	1037	28.25	121.3	101.194	48.5	32	155.578	1.537
Total Maintenance & Support Hours	54	13	15338	273.5	1824	1515.13	809	13	2385.777	1.575
Total Maintenance Hours	52	13	4657	137.5	941	718.635	364.5	225	926.848	1.29
Total Maintenance & Support FP Rate	54	0.038	4.75	0.367	0.759	0.728	0.606	0.038	0.732	1.005
Total Support Hours	38	91	3153	235.25	967.5	734.579	495.5	91	662.119	0.901

Modeling and Evaluation

- Within RM for the Regression analysis – the following Operators were used
  - Cross Validation – returns Linear Regression on the entire data set and returns performance parameters
  - Split Data Operator – separate data into a training (75%) and scoring set (25%)
  - Linear regression operator creates a model and sends it to the Apply Model score the model

Modeling and Evaluation

				Training Results			Scoring Results			
Dependent Variable	Independent Variable 1	Independent Variable 2	Independent Variable 3	Equation	R2 (equation)	Training Count	Scoring Count	R2 (prediction)	Pred(30)	Pred(50)
Total Maintenance Hours	Application Size(app)	Extreme Defects (exd)	Major Defects (mad)	165.806+0.2469*app-12.171*exd-2.604*mad	0.949	134	45	0.888	62%	89%
Total Mainenance & Support Hours	Application Size(app)	Extreme Defects (exd)	Major Defects (mad)	226.824+0.3977*app-0.54477*exd-3.6202*mad	0.927	135	45	0.483	58%	76%
Total Support Hours	Total Maintenance Hours(totMaint)			202.89+0.621*totMaint	0.910	152	51	0.959	47%	76%
Total Support Hours	Application Size(app)	Extreme Defects (exd)	Major Defects (mad)	125.929 +0.2366*app-5.015*exd-5.125*mad	0.879	117	39	0.879	60%	88%
Total Support Hours	Application Size(app)			85.746+0.193*app	0.855	164	55	0.528	56%	78%
Extreme Defects	Application Size(app)			2.81+0.0029*app	0.723	137	46	0.792	30%	52%
Total Support Hours	Total Defects (td)			181.055+5.759*td	0.700	151	50	0.571	30%	54%
Total Maintenance Hours	Total Defects (td)			383.085 + 4.828*td	0.660	158	53	0.593	22%	45%
Total Support Hours	Extreme Defects (exd)	Major Defects (mad)		90.07+10.798*exd+20.812*mad	0.659	131	43	0.684	28%	65%
Total Defects	Application Size(app)			314.571+31.084	0.632	164	55	0.643	40%	64%
Support Hours	Major Defects (mad)			89.802+26.7155*mad	0.614	131	43	0.674	27%	60%
Total Maintenance & Support Hours	Application Size(app)			451.95+0.382*app	0.570	170	56	0.796	43%	70%
Total Maintenance Hours	Extreme Defects (exd)	Major Defects (mad)		160.733+52.734*exd-1.757*mad	0.569	134	45	0.388	42%	51%
Total Maintenance Hours	Extreme Defects (exd)			187.36+46.755*exd	0.537	135	45	0.239	22%	56%
Total Support Hours	Extreme Defects (exd)			263.9+32.074*exd	0.528	131	44	0.740	25%	41%
Maintenance Hours	Application Size(app)			285.4212+0.173*app	0.510	164	55	0.988	41%	41%
Total Maintenance & Support Hours	Total Defects (td)			565.86+11.33*td	0.510	164	55	0.825	35%	51%
Major Defects	Application Size(app)			10.00+0.0054*APP	0.446	139	46	0.393	19%	50%

Lessons Learned

- Lessons Learned to support estimation
  - Similar domains and projects support:
    - Industry specific benchmarks
    - Programming Language benchmarks
    - Organizational benchmarks
    - Rules of thumb to allocate maintenance & support through lifecycle
    - Rules of thumb for predicting defect types
  - Resulting CERs provide potential predictors for
    - Software Support
    - Software Maintenance
    - Program Defects
  - The relationships around Size and Defects better for Support than Maintenance

- Observations about ISBSG and data collection
  - Conflicts between Total Hours (for Support and Maintenance) and sum of sub-categories
  - Free form fields are hard to work with
  - Application Set information would be more useful if assigned (anonymous) project and companies
  - Enhancement percent might be better if replaced with discrimination between baseline and new
  - Latent defects would be a good attribute to collect

Contact:

Arlene.minkiewicz@unisonglobal.com