Interim Report on Heuristics about Inspection Parameters:
Updates to heuristics resulting from refinement on projects

Project Deliverable for
Full Life-cycle Defect Management Assessment

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Overview

This memo serves as an update to a previously submitted report entitled "Preliminary Report on Heuristics about Inspection Parameters", submitted in December of 2007. The 2007 report included results from an initial analysis of the appropriateness of current NASA inspection heuristics, and a comparison of those heuristics as applied to sets of historical and contemporary projects. This interim report contains an accounting of further analysis done to validate and refine the inspection heuristics. Please refer to the 2007 report for a detailed explanation of the research goals and background of this study, which are only summarized here.

Research Goals

Our overall goal in this research is to provide assistance to NASA teams in planning and conducting software inspections on their projects. In particular, we have focused on validating and refining the NASA inspection guidelines based on the "moderator's three points of control," that is, the three parameters over which the inspection planner has direct influence and which are believed to affect the outcome of a given inspection. These three parameters are:

- The *team size*, the number of reviewers involved in the inspection;
- The *meeting length*, the amount of time that the reviewers meet as a team to walk through the document under inspection and discuss possible issues related to the document's quality;
- The *page rate*, the number of document pages that the inspectors examine per hour of the inspection meeting.

The inspection heuristics currently in place at NASA give recommended ranges for each of these parameters. These recommended ranges are based on analysis of inspection data across NASA in the early 1990s. One focus of our work in 2007 was to examine whether the recommended ranges of parameters still hold on contemporary NASA projects. As we reported at the end of 2007, our analysis showed that the heuristics concerning number of inspection participants and page rate do in fact hold up in both historical and contemporary projects. That is, inspections that complied with the recommended ranges for number of inspection participants and page rate did in fact detect more defects than those inspections that did not comply. However, the comparison did not hold up for the meeting length parameter. Since the recommended range for meeting length is simply that it be less than 2 hours, this result means that inspections lasting longer than 2 hours

found significantly more defects than those lasting less than 2 hours (i.e. that complied with the heuristic). However, this latter finding may be affected by the fact that a number of inspections in our dataset were actually split up over multiple meetings, each lasting less than 2 hours, but only the total meeting time is reported. Investigating this anomaly in the data is one focus of the continued analysis we have conducted in 2008.

In 2008, we have continued analyzing the inspection data in an effort to better understand the applicability and effect of the inspection heuristics on inspection outcomes. Our research goals during this period are:

1. Investigate the effect of anomalies in the dataset (e.g. the very large meeting length values for some inspections) on our results
2. Investigate the effect of the heuristics on other inspection outcome variables (e.g. effort)
3. Investigate whether the recommended ranges can be modified to give inspection planners more flexibility without sacrificing effectiveness
4. Investigate possible refinements or modifications to the heuristics for specific subdomains (partitioned, e.g., by size, domain, or Center)

This memo reports our results to date towards addressing these goals. In the next section, the first goal is addressed by describing the types of anomalies we have found in our dataset, how we have addressed them, and the effect of these changes on our previously reported results. In the following section, on "methodology", we describe the analyses we have conducted to address the other three goals and the results of these analyses are described in the "results" section. Finally, we conclude with future plans for continuing our investigation.

Data Used in This Analysis

Our SARP initiative over the last two years has so far collected data from 2,529 inspections across NASA, including inspections of requirements, design, code, test plans, and other artifacts (e.g. websites and hardware). These inspections come from 81 projects across 5 Centers. For each inspection, the data includes values for all three of the control metrics, as well as the date of the inspection meeting, the number of defects detected, the effort spent on various inspection activities, the types of defects found by the inspection, etc. Not all of these items were provided by all of our data sources so we analyzed the parameters both separately and together and used the maximum possible amount of data in each analysis.

As mentioned previously, our results concerning meeting length prompted us to take a closer look at the data. This led us to discover two major anomalies. First, we found that a number of inspections reported values for total inspection effort that were lower than the product of meeting length and number of participants (i.e. meeting effort). Since it is assumed that total effort should be at least as great as meeting effort (since the meeting is only one activity consuming effort in an inspection), the effort data for these inspections was suspect. On closer examination, it was determined that the reported "meeting length" for all inspections from certain Centers was actually meeting effort (i.e. meeting length

multiplied by number of participants). For data from these Centers, the reported meeting length was divided by the number of participants to yield the true meeting length.

Making this correction had the side effect of removing many of the records with very high report meeting length, which was the anomaly that originally prompted us to clean the data. However, there were still a fairly small number of inspections reporting a very high meeting length, in some cases upwards of 50 hours. Assuming that many of these were inspections that were split up over several meetings, but having no information as to how they were split up, or how many defects were found in each separate meeting, we decided to remove meeting length data for those inspections reporting a meeting length greater than 4 hours.

Methodology

Goal 1

Once we made the changes described above to the dataset, it was necessary to re-run the analysis we reported in our December 2007 deliverable, to make sure our results had not changed. This analysis, which was conducted once for historical inspections and once for contemporary inspections (using the cutoff date of January 1, 1995), compared inspections that complied with the heuristics with those that did not, in terms of the numbers of defects found. Another difference between the re-analysis reported here and the analysis reported in our December 2007 report is that the re-analysis used a non-parametric statistical test, the Mann-Whitney test, to test for significant differences between the defect-finding success of inspections that conformed to the guidelines and those that did not. In the original 2007 analysis, the standard t-test was used. We switched to the Mann-Whitney test because we found that none of our variables were normally distributed, which is one of the prerequisites for the appropriate use of the t-test.

Once we had conducted the above re-analysis, we also performed all the comparisons (for the three different parameters) on the combined dataset (historical plus contemporary).

Goal 2

In order to investigate the effect of the heuristics on other outcomes of an inspection, we defined three additional dependent variables:

- **total inspection effort** – total reported effort, including meeting effort (meeting length * number of participants) and preparation effort. This does not include rework effort (which was reported for very few inspection)
- **normalized defects** – the total number of defects reported, divided by the number of pages inspected; similar to the concept of defect density
- **defect detection rate** – the total number of defects reported, divided by the total inspection effort; this can be seen as a measure of productivity

Mann-Whitney tests were used on the combined dataset (historical + contemporary) to test for differences in these outcomes between inspections that complied with the heuristics vs. those that did not.

Goal 3

Our third goal is to investigate the possibility of relaxing some of the ranges in the heuristics, to give inspection planners more flexibility, while still preserving the effects on inspection outcomes. Our first step in this investigation was to chart simple scatter plots between all pairs of independent (i.e. the three parameters) and dependent (i.e. outcome) variables. Then we used a visual inspection of these scatter plots to see if there were "natural" thresholds for the independent variables corresponding to favorable values of the dependent variables. This was not entirely successful, as most of the scatter plots were not well shaped and such "threshold" values were not obvious. Our next step in this investigation will be to run a classification tree analysis on our dataset, as described later.

Goal 4

Finally, our last research goal this year has been to investigate the possibly differing effects of the heuristics on different subsets of our dataset. Some, but not all, of our data provides values for Center, project size, in-house vs. contracted development, software type, programming language, safety criticality, class of software, and maintenance vs. development. Segmenting the data by all possible values of all of these characteristics would yield many subsets too small for analysis. However, we did identify several significant subsets large enough to test for differences between those inspections in the subset that complied with the heuristics and those that did not. These subsets (numbers of inspections in parentheses) are:

- attitude software (180)
- orbit software (87)
- flight software (15)
- class C, or mission support, software as defined by NPR 7150.2 (66)
- small projects comprising 10,000 to 99,999 lines of code (51)
- medium-sized projects comprising 100,000 to 499,999 lines of code (78)
- maintenance projects (97)

In addition, several Centers provided enough data to run this analysis specifically for that Center. The analyses by Center and by artifact inspected (i.e. requirements, design, etc.) have not yet been conducted.

Results

Goal 1

The results of the re-analysis (run to see if our original results have changed due to the "cleaning" of the data) are shown in Table 1. Unfortunately, even after modifying the meeting length data values to be more accurate, we find that the meeting length heuristic still has an effect counter to expectations. That is, in both the contemporary and historical datasets, inspections that conformed to the meeting length guideline (i.e. less than 2 hours) found fewer defects than those that exceeded the guideline. Note also that there is a difference in the results of the page rate results for the contemporary dataset. Remember that the definition of page rate is the number of pages inspected divided by

the meeting length, so our changes to the meeting length values in the dataset had an effect on the values for page rate as well. We now see in the contemporary dataset that the page rate heuristic does not have a significant effect on the number of defects found.

CONTEMPORARY DATA SET (1995 and later)					
	Inspections that conform with heuristics		Inspections out of conformance with heuristics		Inspections following heuristics significantly better?
	# of inspections	Avg. # of resulting defects	# of inspections	Avg. # of resulting defects	
# of participants	23	38.7	206	6.5	YES (p<0.0005)
Meeting length	184	3.7	7	27.6	NO
Page rate	23	4.4	134	4.1	NO (p=0.5)
HISTORICAL DATA SET (1994 and earlier)					
	Inspections that conform with heuristics		Inspections out of conformance with heuristics		Inspections following heuristics significantly better?
	# of inspections	Avg. # of resulting defects	# of inspections	Avg. # of resulting defects	
# of participants	253	11.7	239	7.3	YES (p<0.0001)
Meeting length	460	8.5	29	22.7	NO
Page rate	115	15.6	355	7.4	YES (p<0.0001)

Table 1: Summary of results from re-testing historical inspection guidelines, on data from both contemporary and historical NASA projects. The p-value in the rightmost column shows the results of a statistical test of whether the inspections that conform to guidelines have significantly better results than those that don't. P-values of less than 0.05 represent a significant difference.

The results of the analysis on the combined dataset are shown in Table 2. In this dataset, it appears that the significant difference related to the page rate heuristic in the historical dataset outweighs the non-significance in the contemporary dataset, yielding a significant benefit of conforming to the page rate heuristic in the combined dataset.

COMBINED DATA SET (both historical and contemporary)					
	Inspections that conform with heuristics		Inspections out of conformance with heuristics		Inspections following heuristics significantly better?
	# of inspections	Avg. # of resulting defects	# of inspections	Avg. # of resulting defects	
# of participants	276	14.0	445	7.0	YES ($p<0.0005$)
Meeting length	644	7.1	36	23.6	NO
Page rate	138	13.8	489	6.5	YES ($p<0.0005$)

Table 2: Summary of results from testing historical inspection guidelines, on all inspection data available. The p-value in the rightmost column shows the results of a statistical test of whether the inspections that conform to guidelines have significantly better results than those that don't. P-values of less than 0.05 represent a significant difference.

Given that our results for the combined dataset are consistent, for the most part, with the results of the two separate datasets, all analyses from this point forward were conducted on the combined dataset (including both historical and contemporary inspections).

Goal 2

In this analysis, we investigated the question of whether or not compliance with the heuristics had an effect on total time spent, normalized defects, or defect detection rate. The results of these analyses, using the Mann-Whitney test, are summarized in Table 3.

COMBINED DATA SET (effect of heuristics on four outcome variables)				
	Do inspections conforming to the heuristics perform better or worse than those that don't with respect to:			
	Total effort?	Total defects?	Normalized defects?	Defect detection rate?
# of participants	worse	better	worse	worse
Meeting length	better	worse	worse	better
Page rate	worse	better	better	worse

Table 3: Summary of results from testing historical inspection guidelines, on all inspection data available, with respect to several different dependent variables. All results are significantly significant, according to the Mann-Whitney test, with p-values less than 0.05.

The results show a much more complicated picture than that presented by the results on total defects alone. The first two columns of Table 3 show that two of the heuristics (for number of participants and page rate) result in more effective but more expensive

inspections. The heuristic for meeting length has an opposite effect. When one examines the effectiveness of an inspection more closely (i.e. by normalizing the number of defects found, as in the last two columns of Table 3), the picture becomes yet more cloudy. For example, what appears to be a benefit of complying with the number-of-participants heuristic (more total defects found) evaporates when we look more closely at normalized defects or defect detection rate.

An overall message from this analysis seems to be that it will be difficult, if not impossible, to develop heuristics that optimize both effectiveness and efficiency of an inspection. Thus, one of our next steps is to characterize the cost-benefit ratio of complying with the heuristics. Basically, the question to be addressed is, how much does it cost to find more defects? This question will be addressed in our future analysis plans.

Goal 3

Our visual examination of scatterplots to find "natural" thresholds was intended to investigate whether or not the ranges in the current inspection heuristics could be modified and still include the most effective sets of parameters. An example of such a plot, in Figure 1, shows the relationship between the total number of defects found in an inspection (on the Y axis) and the meeting length in hours (the X axis). Although the chart does, in a rather obscure way, show that the number of defects found does increase with the meeting length, there does not appear any "natural" range of meeting length that encompasses a maximum number of defects found.

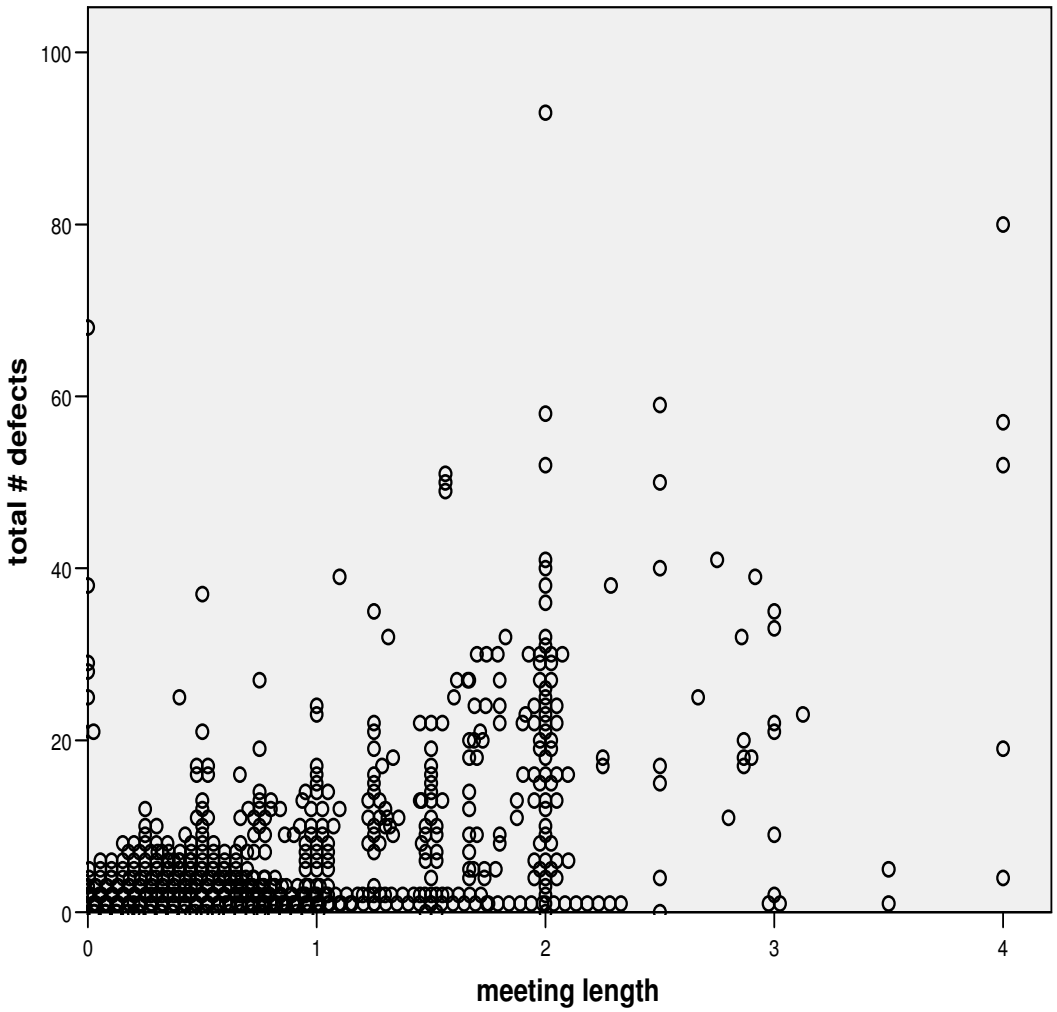


Figure 1: Over all inspections in the dataset, meeting length is plotted against total number of defects found in the inspection.

We created plots like the one in Figure 1 for all combinations of the three inspection parameters and the four dependent variables in Table 3. Some showed some potential for relaxing the current heuristics, but the optimal ranges varied depending on the outcome variable being considered. For example, a range of 6-8 inspection participants appears to maximize the number of defects found, but a range of 1-4 participants minimizes the total inspection effort. This reinforces our earlier conclusion that a single set of heuristics cannot optimize both efficiency and effectiveness of inspections, and leads us to our planned follow-on work on characterizing the cost-benefit ratios related to the inspection parameters.

Goal 4

Our work thus far on our fourth goal (determining the applicability of the heuristics for certain subsets of inspections) has involved running the same comparison analyses (as shown in Table 3, for example) but limited to specific subsets of the data. These subsets are defined based on various characteristics of the projects from which the inspections

come, as explained earlier. Our results have mostly been consistent with those presented in Table 3 for the entire dataset, with the following exceptions:

- All of the inspections in all of the subsets we tested conformed to the meeting length heuristic. This might imply that the 36 inspections that did not conform to this heuristic (see Table 2) were either "unusual" in some way or did not have the data on project characteristics, which might further explain our results concerning this heuristic. This bears further investigation.
- Medium-sized projects appear to benefit across the board (in terms of effectiveness) from the number of participants and the page rate heuristics. That is, total defects, normalized defects, and defect detection rate were all higher for medium-sized inspections that conformed to these two heuristics. However, effort was higher for conforming inspections in this subset. The same is true for small projects, but only for the number of participants heuristic.
- The number of participants heuristics seems to apply especially strongly to class C software, again in terms of effectiveness. The benefit of applying this heuristic to class C software inspections is strong and significant in terms of total defects found, normalized defects, and defect detection rate.
- Flight software appears to be the only subset that we tested for which the heuristics apply not only to effectiveness, but also efficiency. Inspections of flight software that conformed to the heuristics had better outcomes in terms of total defects, normalized defects, and defect detection rate, and also had lower total effort. However, these results were not statistically significant.

Discussion and Next Steps

We emphasize that the results reported here are preliminary and will be further examined going forward on the project. There are several further analyses we plan to conduct. One major area of investigation we envision over the next year is a characterization of the costs and benefits of the heuristics. It appears, in most cases, that there is a cost (in terms of effort) and a benefit (in terms of greater defect finding capability) to complying with the heuristics. Characterizing this tradeoff more precisely, with the aim of helping inspection planners in decision-making, will be a focus of our ongoing work.

We will continue to try to refine the heuristics, searching for ranges that optimize both effectiveness and efficiency (although maybe not at the same time). One approach that we plan to try is the use of classification trees. Classification tree analysis is an automatic technique for segmenting a dataset using values of various input variables (in our case the project and inspection characteristics, as well as the three points of control parameters) based on their effect on the outcome variables (efficiency and effectiveness). This technique is applied iteratively, producing a set of attribute/value pairs that serve as thresholds indicating the optimal ranges of the attributes.

Other analysis tasks left to be done include

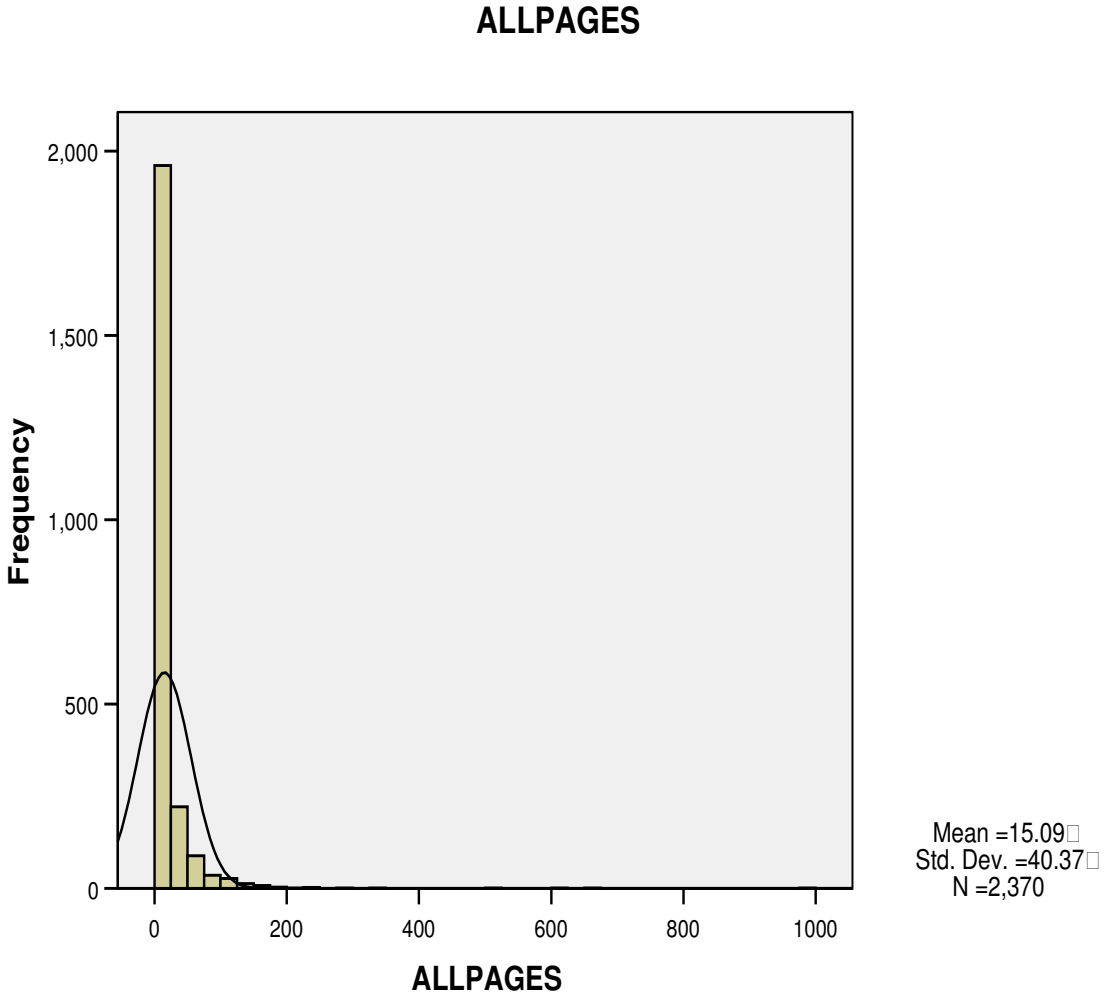
- Segmenting the data by Center and by artifact being inspected to determine if these subsets of the data behave differently with respect to the heuristics than the rest of the dataset

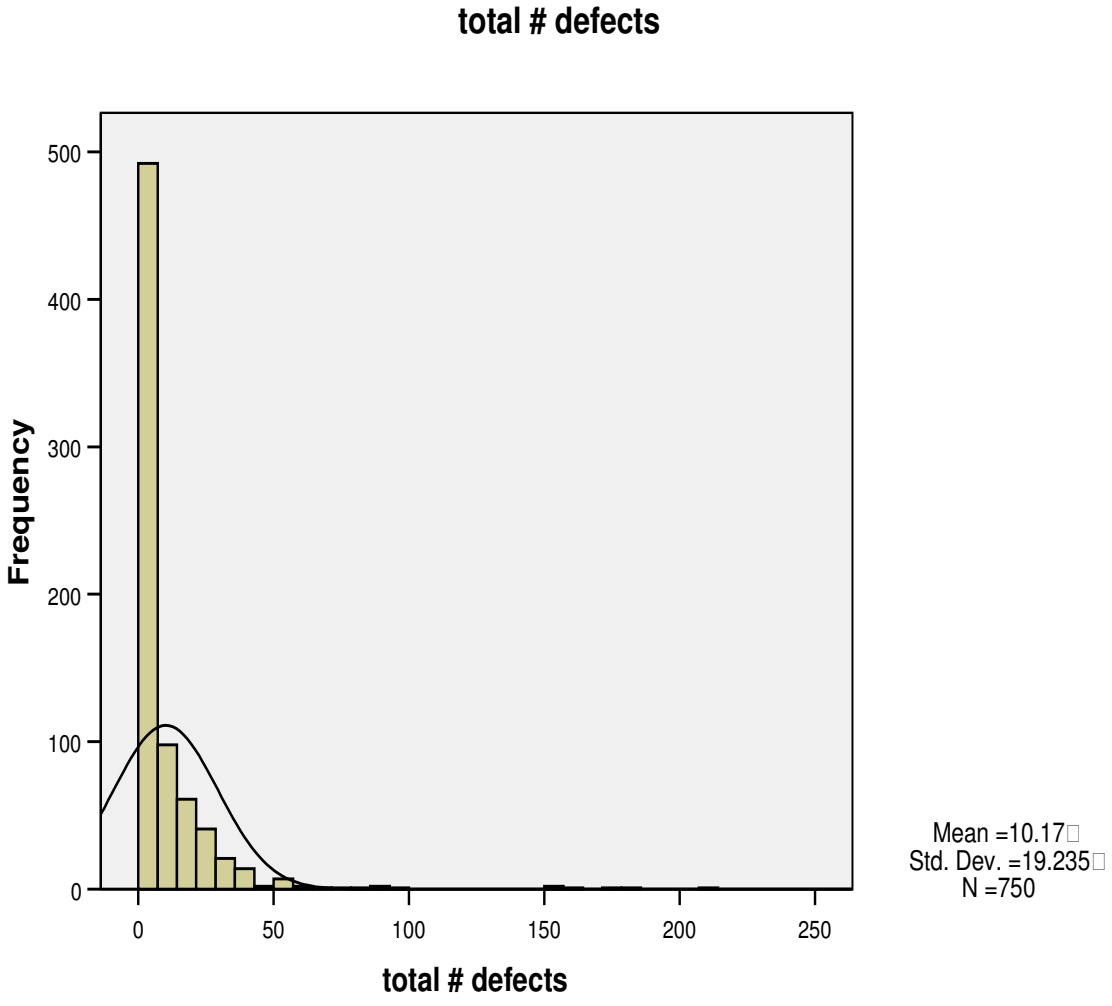
- Examining separately the two “tails” of the distributions of the three inspection parameters, i.e. for those heuristics that specify a lower boundary greater than 0, we would like to examine the inspections that fall below the recommended range separately from those that lie above the range to see if they are different in some way
- Taking a closer look at the few inspections in the dataset that do not comply with the meeting length heuristic to determine if there is some reason for their non-compliance, or for the differences in outcome variables.

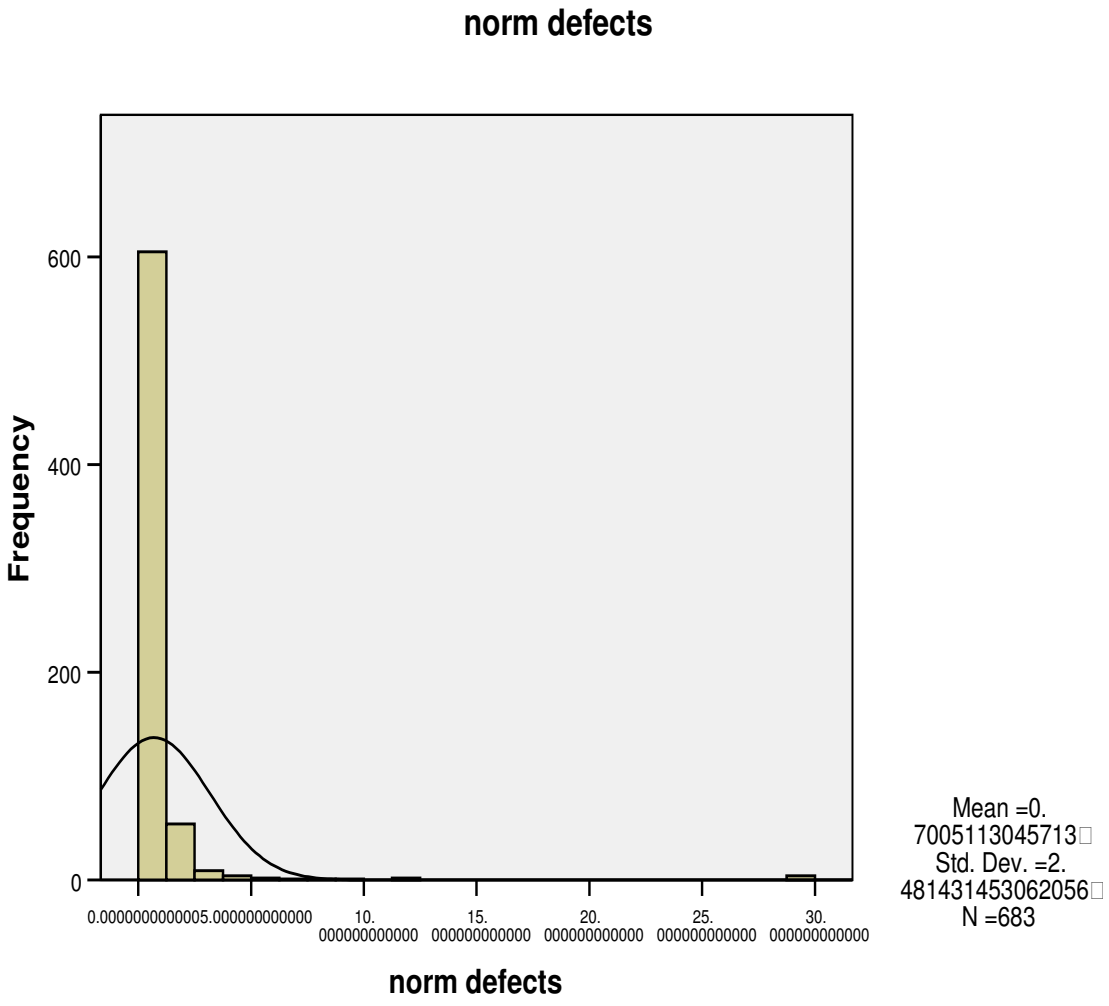
This analysis has so far very strongly demonstrated the usefulness of project characteristic data (e.g. project size, type of software, etc.). Although our characteristic data was limited (i.e. many inspections in our dataset did not include characteristic data), we were able to gain valuable insights, and expect to learn much more as our analysis continues. For example, we are beginning to understand how the inspection heuristics apply to different sub-classes of inspections, which will then allow us to tailor the heuristics for different situations, giving inspection planners finer-grained guidance in making their inspections as effective and efficient as possible. Going forward, if such characteristic data were collected more consistently, our models and heuristics would become increasingly tailored and useful.

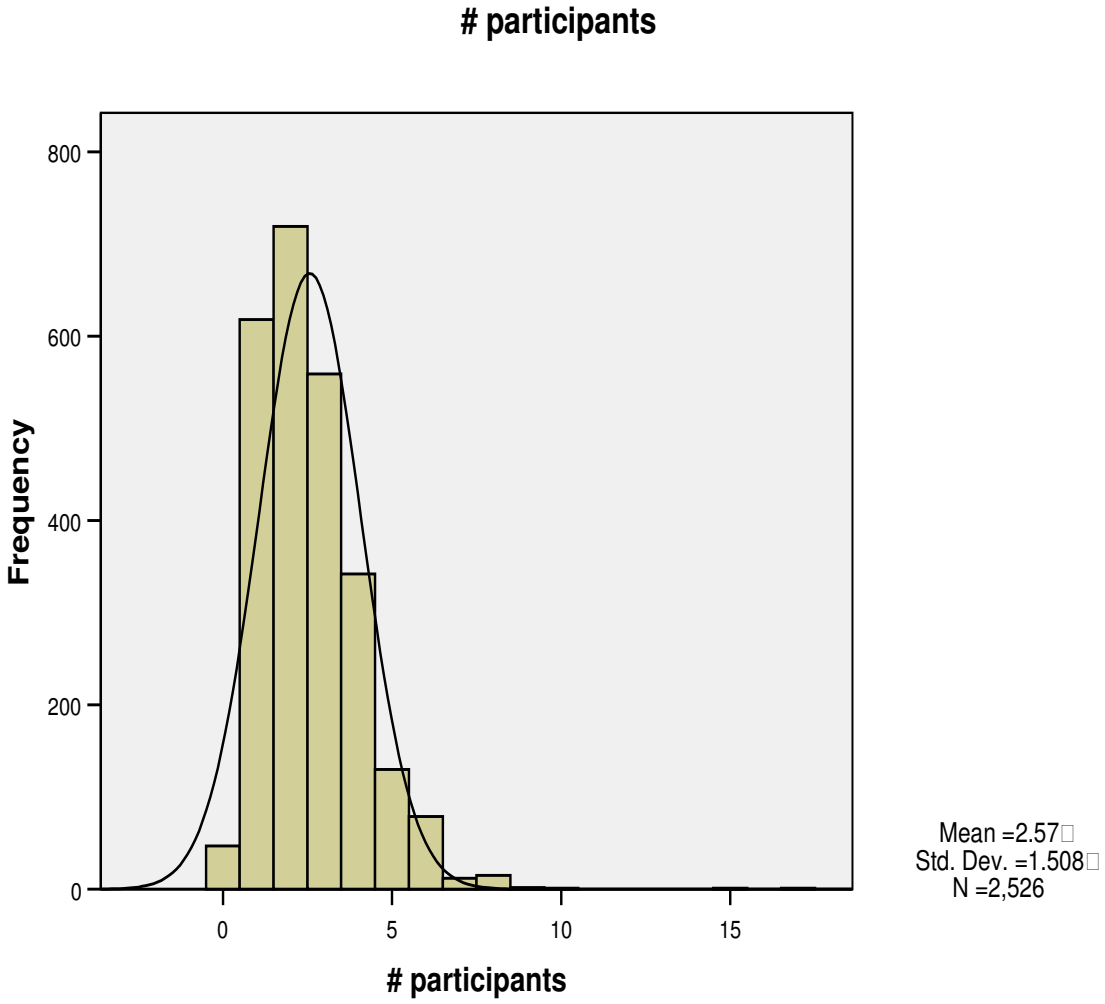
Appendix
Output of SPSS analyses

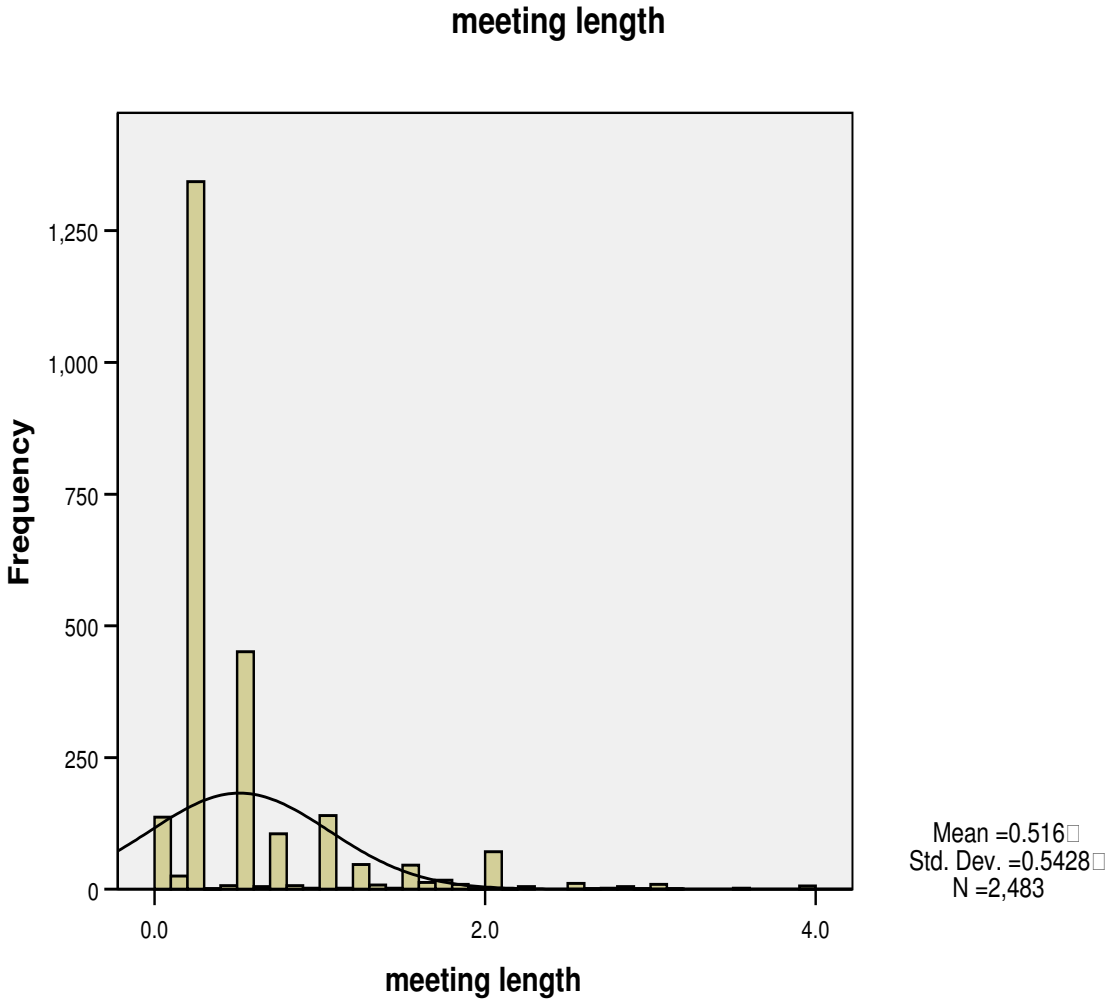
1. Distributions of some of the study variables

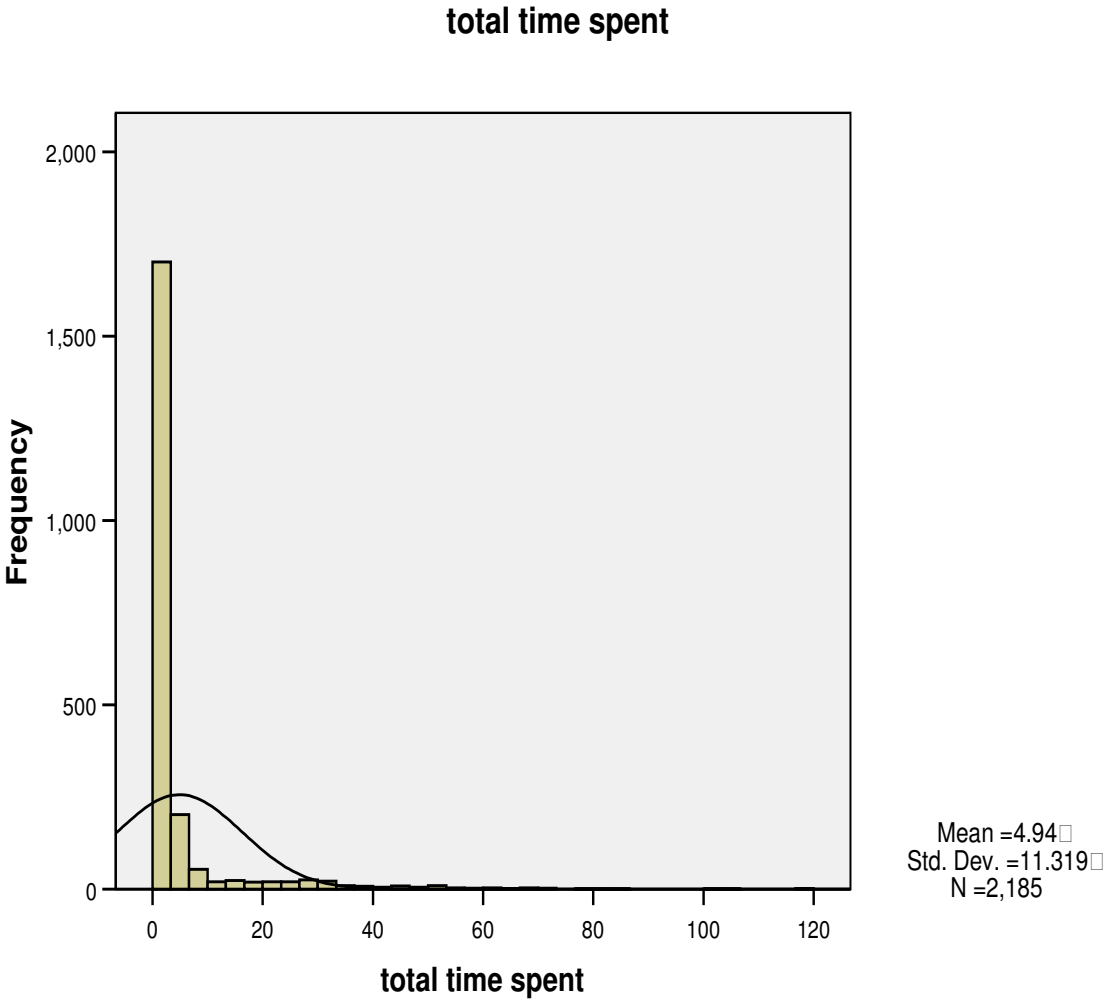



total # defects
Frequency
500
400
300
200
100
0
0
50
100
150
200
250
total # defects
Mean =10.17
Std. Dev. =19.235
N =750


norm defects
Frequency
600
400
200
0
0.0000000000005.000000000000
10.
000000000000
15.
000000000000
20.
000000000000
25.
000000000000
30.
000000000000
norm defects
Mean =0.
7005113045713
Std. Dev. =2.
481431453062056
N =683


participants
800
600
400
200
0
Frequency
0
5
10
15
# participants
Mean =2.57
Std. Dev. =1.508
N =2,526


meeting length
Frequency
1,250
1,000
750
500
250
0
0.0
2.0
4.0
meeting length
Mean =0.516
Std. Dev. =0.5428
N =2,483



2. Results of Mann-Whitney tests on whole dataset

Ranks

	Ptps in range	N	Mean Rank	Sum of Ranks
total # defects	0	445	297.38	132332.50
	1	276	463.58	127948.50
	Total	721		
norm defects	0	393	284.48	111800.00
	1	262	393.28	103040.00
	Total	655		
# major defects	0	65	122.78	7980.50
	1	159	108.30	17219.50
	Total	224		
norm major	0	55	115.45	6349.50
	1	151	99.15	14971.50
	Total	206		
# minor defects	0	65	125.57	8162.00
	1	160	107.89	17263.00
	Total	225		
norm minor	0	55	114.18	6280.00
	1	151	99.61	15041.00
	Total	206		
total time spent	0	1739	938.40	1631873.50
	1	402	1644.62	661137.50
	Total	2141		

Test Statistics(a)

	total # defects	norm defects	# major defects	norm major	# minor defects	norm minor	total time spent
Mann-Whitney U	33097.500	34379.000	4499.500	3495.500	4383.000	3565.000	118943.500
Wilcoxon W	132332.500	111800.000	17219.500	14971.500	17263.000	15041.000	1631873.500
Z	-10.476	-7.210	-1.529	-1.744	-1.848	-1.552	-20.751
Asymp. Sig. (2-tailed)	.000	.000	.126	.081	.065	.121	.000

a Grouping Variable: Ptps in range

Ranks

	Mtg in range	N	Mean Rank	Sum of Ranks
total # defects	0	36	525.08	18903.00
	1	644	330.18	212637.00
	Total	680		
norm defects	0	30	431.67	12950.00
	1	597	308.09	183928.00
	Total	627		
# major defects	0	29	128.50	3726.50
	1	172	96.36	16574.50
	Total	201		
norm major	0	23	103.30	2376.00
	1	167	94.43	15769.00
	Total	190		
# minor defects	0	29	132.22	3834.50
	1	173	96.35	16668.50
	Total	202		
norm minor	0	23	94.63	2176.50
	1	167	95.62	15968.50
	Total	190		
total time spent	0	29	1895.97	54983.00
	1	1981	992.46	1966072.00
	Total	2010		

Test Statistics(a)

	total # defects	norm defects	# major defects	norm major	# minor defects	norm minor	total time spent
Mann-Whitney U	4947.000	5425.000	1696.500	1741.000	1617.500	1900.500	2901.000
Wilcoxon W	212637.000	183928.000	16574.500	15769.000	16668.500	2176.500	196607 2.000
Z	-5.830	-3.646	-2.776	-.730	-3.062	-.081	-8.368
Asymp. Sig. (2-tailed)	.000	.000	.005	.465	.002	.936	.000

a Grouping Variable: Mtg in range

Ranks

	PgRate in range	N	Mean Rank	Sum of Ranks
total # defects	0	489	288.77	141208.00
	1	138	403.41	55670.00
	Total	627		
norm defects	0	489	263.37	128787.50
	1	138	493.41	68090.50
	Total	627		
# major defects	0	110	84.63	9309.00
	1	80	110.45	8836.00
	Total	190		
norm major	0	110	78.62	8648.50
	1	80	118.71	9496.50
	Total	190		
# minor defects	0	110	90.22	9924.50
	1	80	102.76	8220.50
	Total	190		
norm minor	0	110	75.59	8315.00
	1	80	122.88	9830.00
	Total	190		
total time spent	0	770	453.14	348915.50
	1	171	551.44	94295.50
	Total	941		

Test Statistics(a)

	total # defects	norm defects	# major defects	norm major	# minor defects	norm minor	total time spent
Mann-Whitney U	21403.000	8982.500	3204.000	2543.500	3819.500	2210.000	52080.500
Wilcoxon W	141208.000	128787.500	9309.000	8648.500	9924.500	8315.000	348915.500
Z	-6.606	-13.176	-3.221	-4.988	-1.553	-5.852	-4.292
Asymp. Sig. (2-tailed)	.000	.000	.001	.000	.120	.000	.000

a Grouping Variable: PgRate in range

Ranks

	AllParams in range	N	Mean Rank	Sum of Ranks
total # defects	0	559	294.51	164633.50
	1	65	467.18	30366.50
	Total	624		
norm defects	0	559	289.33	161735.00
	1	65	511.77	33265.00
	Total	624		
# major defects	0	137	91.16	12488.50
	1	53	106.73	5656.50
	Total	190		
norm major	0	137	86.20	11809.00
	1	53	119.55	6336.00
	Total	190		
# minor defects	0	137	95.70	13111.00
	1	53	94.98	5034.00
	Total	190		
norm minor	0	137	83.97	11503.50
	1	53	125.31	6641.50
	Total	190		
total time spent	0	876	446.07	390753.00
	1	60	796.05	47763.00
	Total	936		

Test Statistics(a)

	total # defects	norm defects	# major defects	norm major	# minor defects	norm minor	total time spent
Mann-Whitney U	8113.500	5215.000	3035.500	2356.000	3603.000	2050.500	6627.000
Wilcoxon W	164633.500	161735.000	12488.500	11809.000	5034.000	11503.500	390753.000
Z	-7.353	-9.416	-1.764	-3.770	-.081	-4.648	-9.731
Asymp. Sig. (2-tailed)	.000	.000	.078	.000	.935	.000	.000

a Grouping Variable: AllParams in range

Ranks

	Ptps in range	N	Mean Rank	Sum of Ranks
defect rate	0	342	336.76	115171.50
	1	235	219.50	51581.50
	Total	577		

Test Statistics(a)

	defect rate
Mann-Whitney U	23851.500
Wilcoxon W	51581.500
Z	-8.304
Asymp. Sig. (2-tailed)	.000

a Grouping Variable: Ptps in range

Ranks

	Mtg in range	N	Mean Rank	Sum of Ranks
defect rate	0	26	173.69	4516.00
	1	528	282.61	149219.00
	Total	554		

Test Statistics(a)

	defect rate
Mann-Whitney U	4165.000
Wilcoxon W	4516.000
Z	-3.388
Asymp. Sig. (2-tailed)	.001

a Grouping Variable: Mtg in range

Ranks

	PgRate in range	N	Mean Rank	Sum of Ranks
defect rate	0	415	276.80	114872.50
	1	109	208.05	22677.50
	Total	524		

Test Statistics(a)

	defect rate
Mann-Whitney U	16682.500
Wilcoxon W	22677.500
Z	-4.220
Asymp. Sig. (2-tailed)	.000

a Grouping Variable: PgRate in range

Ranks

	AllParams in range	N	Mean Rank	Sum of Ranks
defect rate	0	467	273.23	127597.50
	1	54	155.25	8383.50
	Total	521		

Test Statistics(a)

	defect rate
Mann-Whitney U	6898.500
Wilcoxon W	8383.500
Z	-5.454
Asymp. Sig. (2-tailed)	.000

a Grouping Variable: AllParams in range

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * Ptps in range	2141	84.7%	387	15.3%	2528	100.0%
total # defects * Ptps in range	721	28.5%	1807	71.5%	2528	100.0%
norm defects * Ptps in range	655	25.9%	1873	74.1%	2528	100.0%
defect rate * Ptps in range	577	22.8%	1951	77.2%	2528	100.0%
total time spent * Mtg in range	2010	79.5%	518	20.5%	2528	100.0%
total # defects * Mtg in range	680	26.9%	1848	73.1%	2528	100.0%
norm defects * Mtg in range	627	24.8%	1901	75.2%	2528	100.0%
defect rate * Mtg in range	554	21.9%	1974	78.1%	2528	100.0%
total time spent * PgRate in range	941	37.2%	1587	62.8%	2528	100.0%
total # defects * PgRate in range	627	24.8%	1901	75.2%	2528	100.0%
norm defects * PgRate in range	627	24.8%	1901	75.2%	2528	100.0%
defect rate * PgRate in range	524	20.7%	2004	79.3%	2528	100.0%
total time spent * AllParams in range	936	37.0%	1592	63.0%	2528	100.0%
total # defects * AllParams in range	624	24.7%	1904	75.3%	2528	100.0%
norm defects * AllParams in range	624	24.7%	1904	75.3%	2528	100.0%
defect rate * AllParams in range	521	20.6%	2007	79.4%	2528	100.0%

total time spent total # defects norm defects defect rate * Ptps in range

Ptps in range		total time spent	total # defects	norm defects	defect rate
0	Mean	2.600	6.9303	.72	2.195
	N	1739	445	393	342
	Std. Deviation	6.5018	17.61812	3.156	2.3434
1	Mean	13.560	13.9638	.64	1.155
	N	402	276	262	235
	Std. Deviation	18.3134	20.25399	1.017	1.1403
Total	Mean	4.657	9.6227	.69	1.772
	N	2141	721	655	577
	Std. Deviation	10.7474	18.96837	2.527	2.0102

total time spent total # defects norm defects defect rate * Mtg in range

Mtg in range		total time spent	total # defects	norm defects	defect rate
0	Mean	32.455	23.6111	.88	.814
	N	29	36	30	26
	Std. Deviation	19.0718	19.31288	1.026	.6278
1	Mean	4.057	7.0854	.62	1.704
	N	1981	644	597	528
	Std. Deviation	8.9898	9.43475	2.339	1.8266
Total	Mean	4.467	7.9603	.64	1.663
	N	2010	680	627	554
	Std. Deviation	9.8078	10.82747	2.293	1.7981

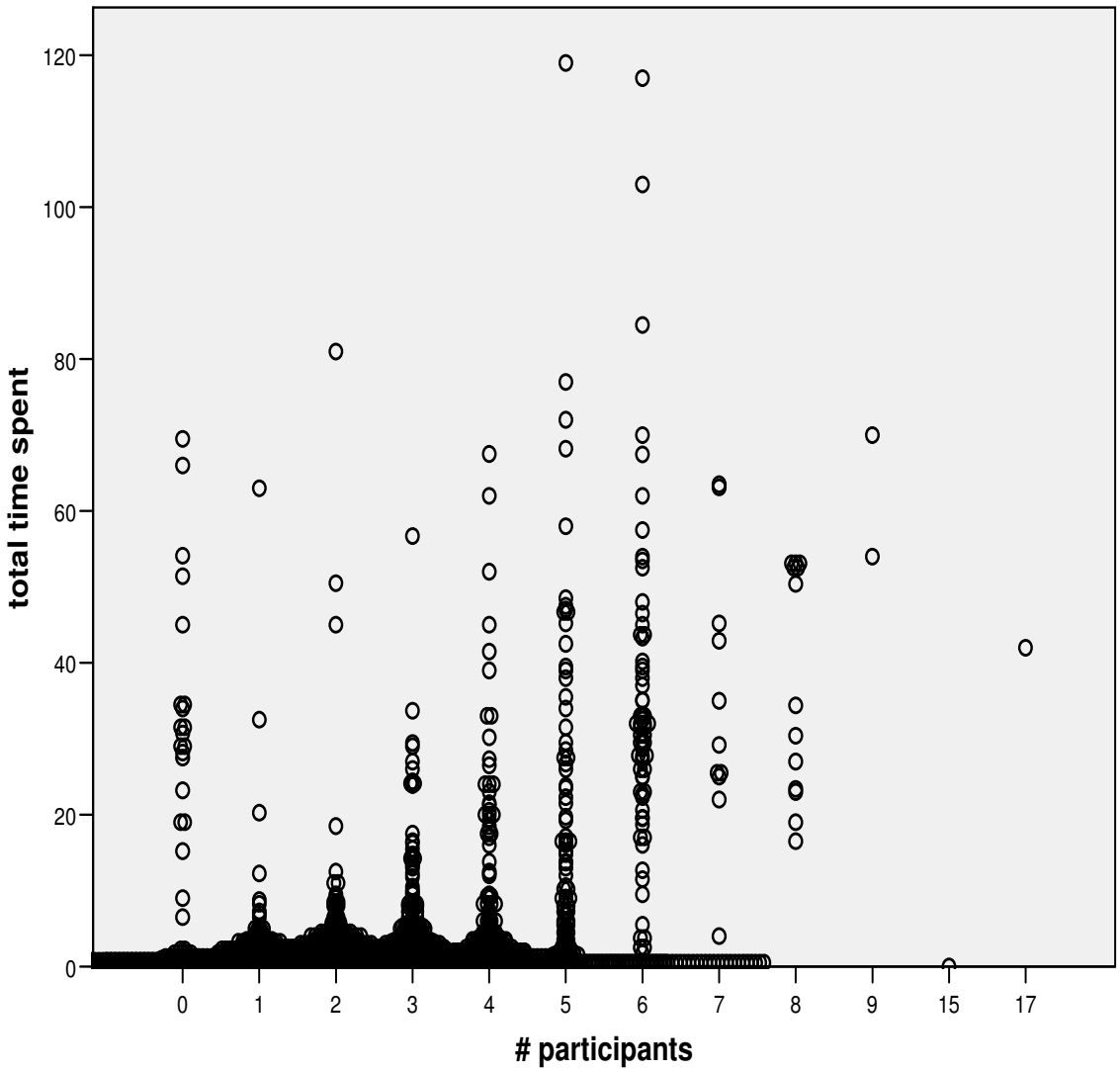
total time spent total # defects norm defects defect rate * PgRate in range

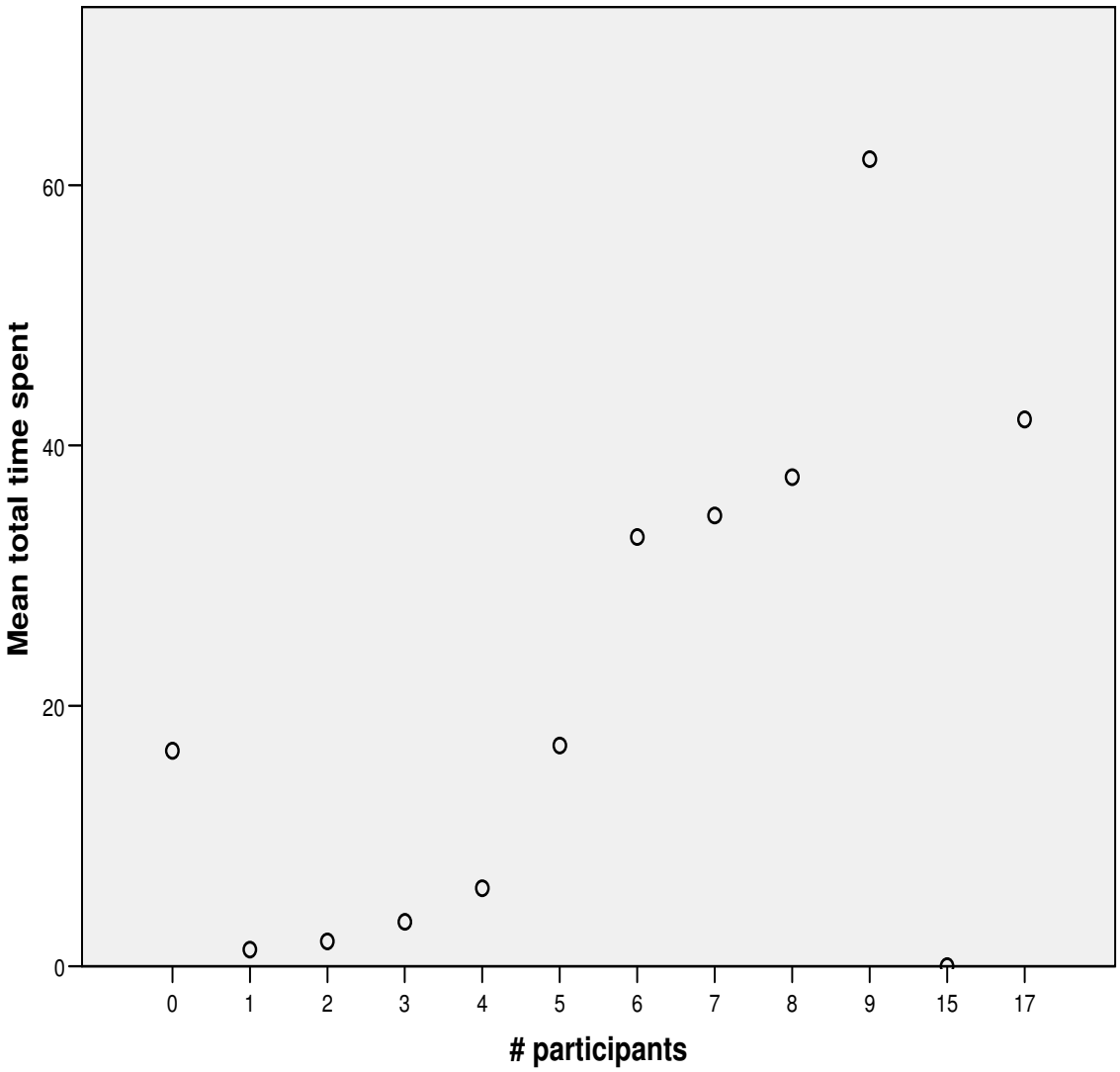
PgRate in range		total time spent	total # defects	norm defects	defect rate
0	Mean	5.448	6.5051	.30	1.754
	N	770	489	489	415
	Std. Deviation	11.5382	9.18662	.600	1.8985
1	Mean	15.335	13.7681	1.84	1.084
	N	171	138	138	109
	Std. Deviation	18.1783	13.07100	4.568	1.0478
Total	Mean	7.245	8.1037	.64	1.614
	N	941	627	627	524
	Std. Deviation	13.5361	10.59479	2.293	1.7759

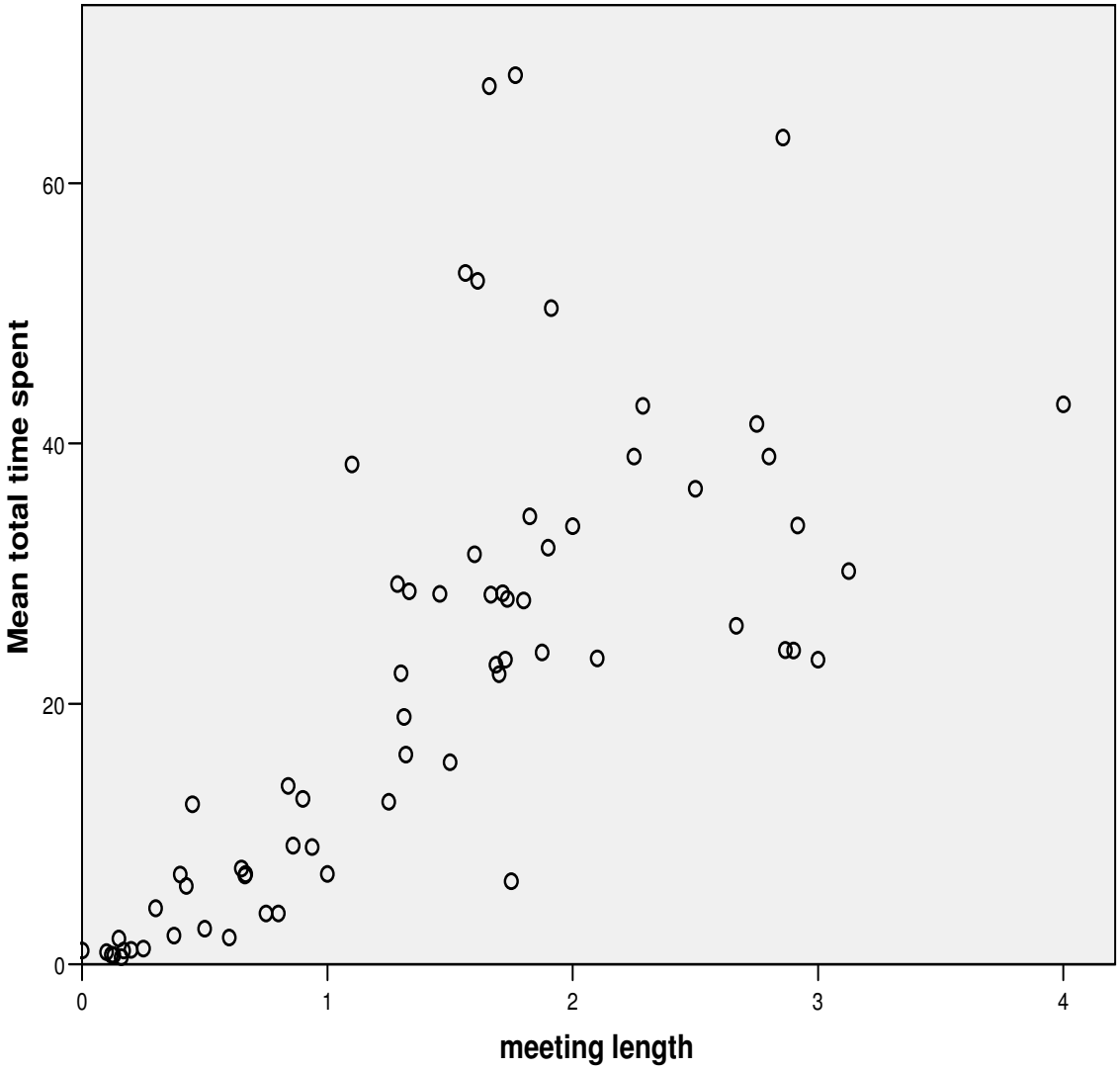
total time spent total # defects norm defects defect rate * AllParams in range

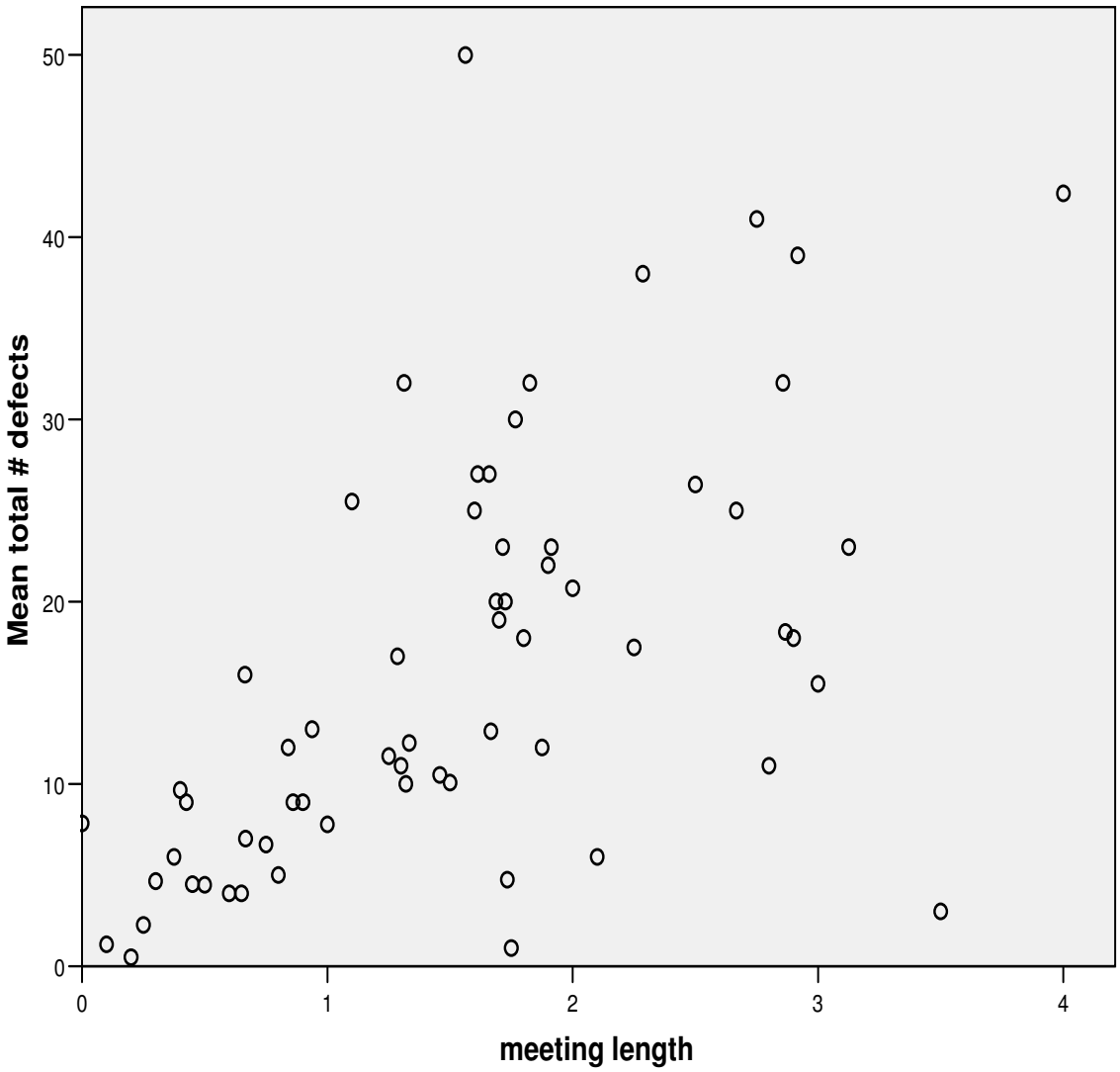
AllParams in range		total time spent	total # defects	norm defects	defect rate
0	Mean	5.983	7.2343	.57	1.714
	N	876	559	559	467
	Std. Deviation	12.4375	10.24365	2.368	1.8429
1	Mean	26.162	15.8462	1.20	.738
	N	60	65	65	54
	Std. Deviation	15.3120	10.67010	1.483	.5041
Total	Mean	7.277	8.1314	.64	1.613
	N	936	624	624	521
	Std. Deviation	13.5651	10.61188	2.298	1.7771

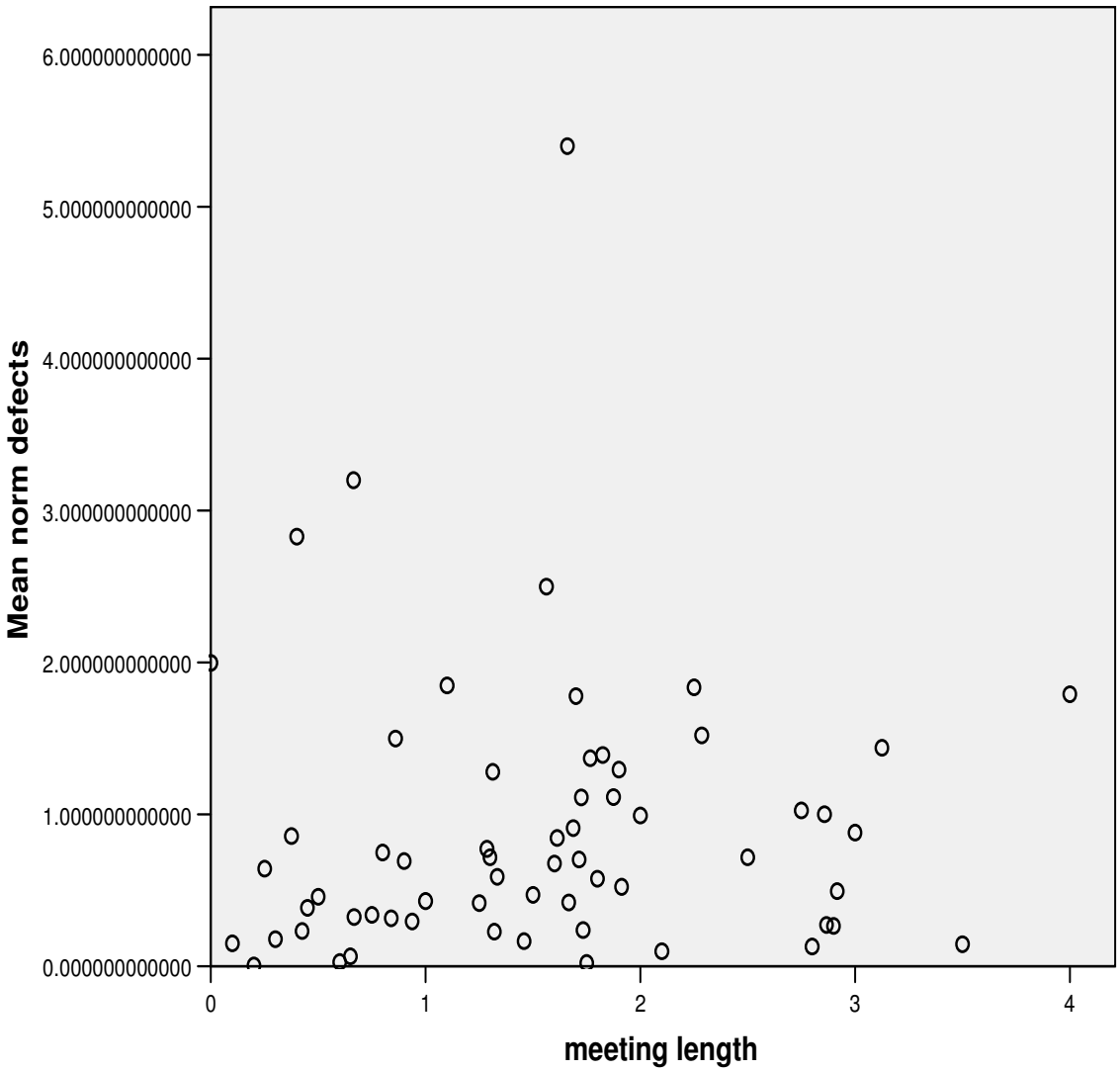
3. Scatter plots of independent and dependent variable pairs




Mean total time spent
60
40
20
0
0
1
2
3
4
5
6
7
8
9
15
17
participants


Mean total time spent
60
40
20
0
0
1
2
3
4
meeting length


Mean total # defects
50
40
30
20
10
0
0
1
2
3
4
meeting length


Mean norm defects
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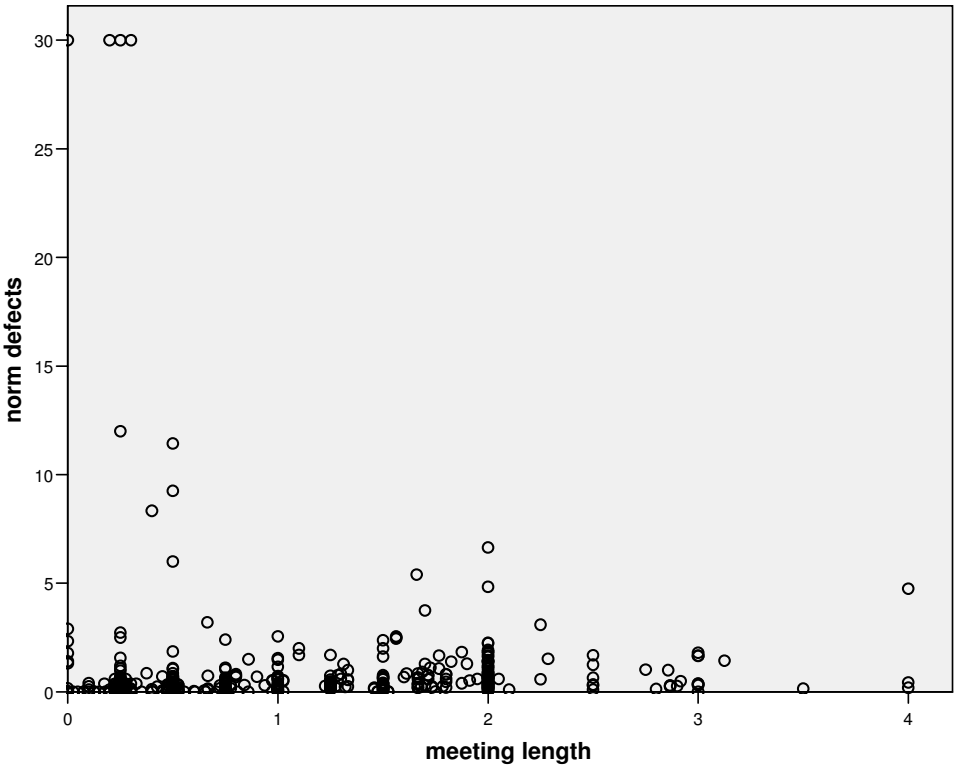
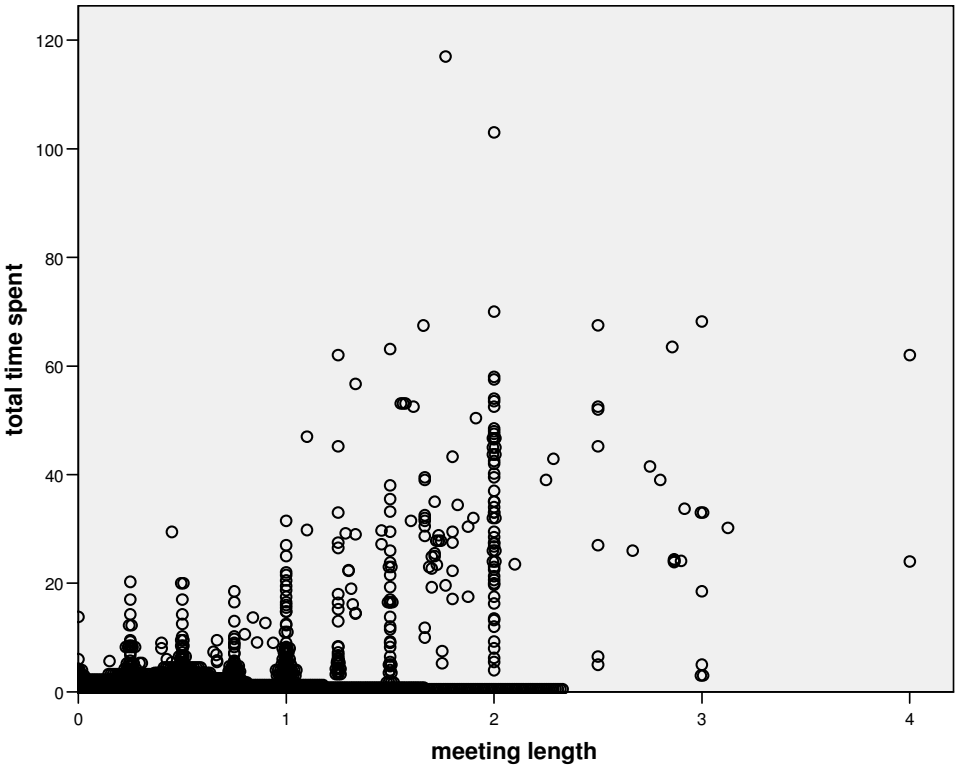
5.000000000000
4.000000000000
3.000000000000
2.000000000000
1.000000000000
0.000000000000
0
1
2
3
4
meeting length


norm defects
30
25
20
15
10
5
0
0
1
2
3
4
meeting length


total time spent
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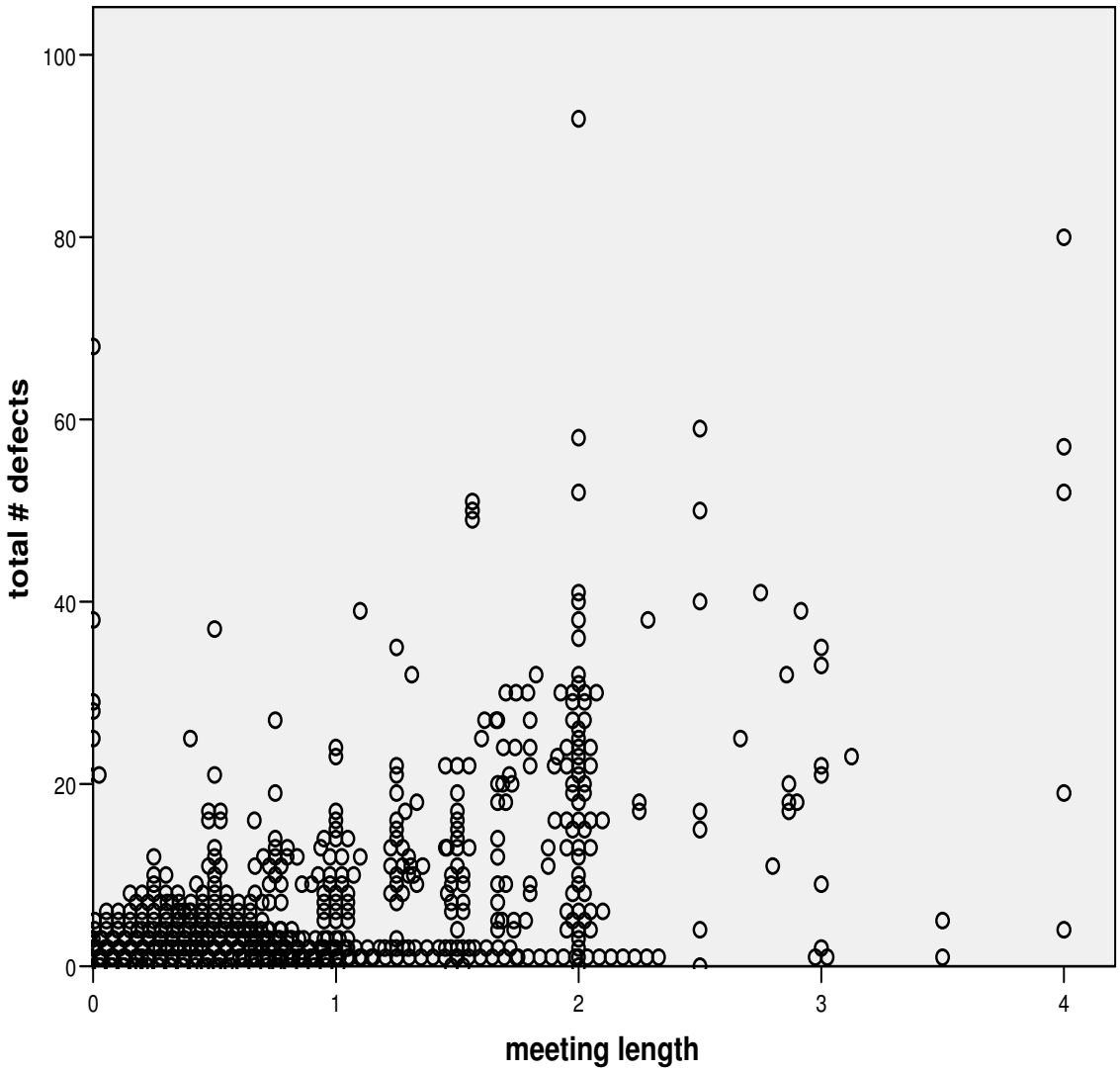
100
80
60
40
20
0
0
1
2
3
4
meeting length


total # defects
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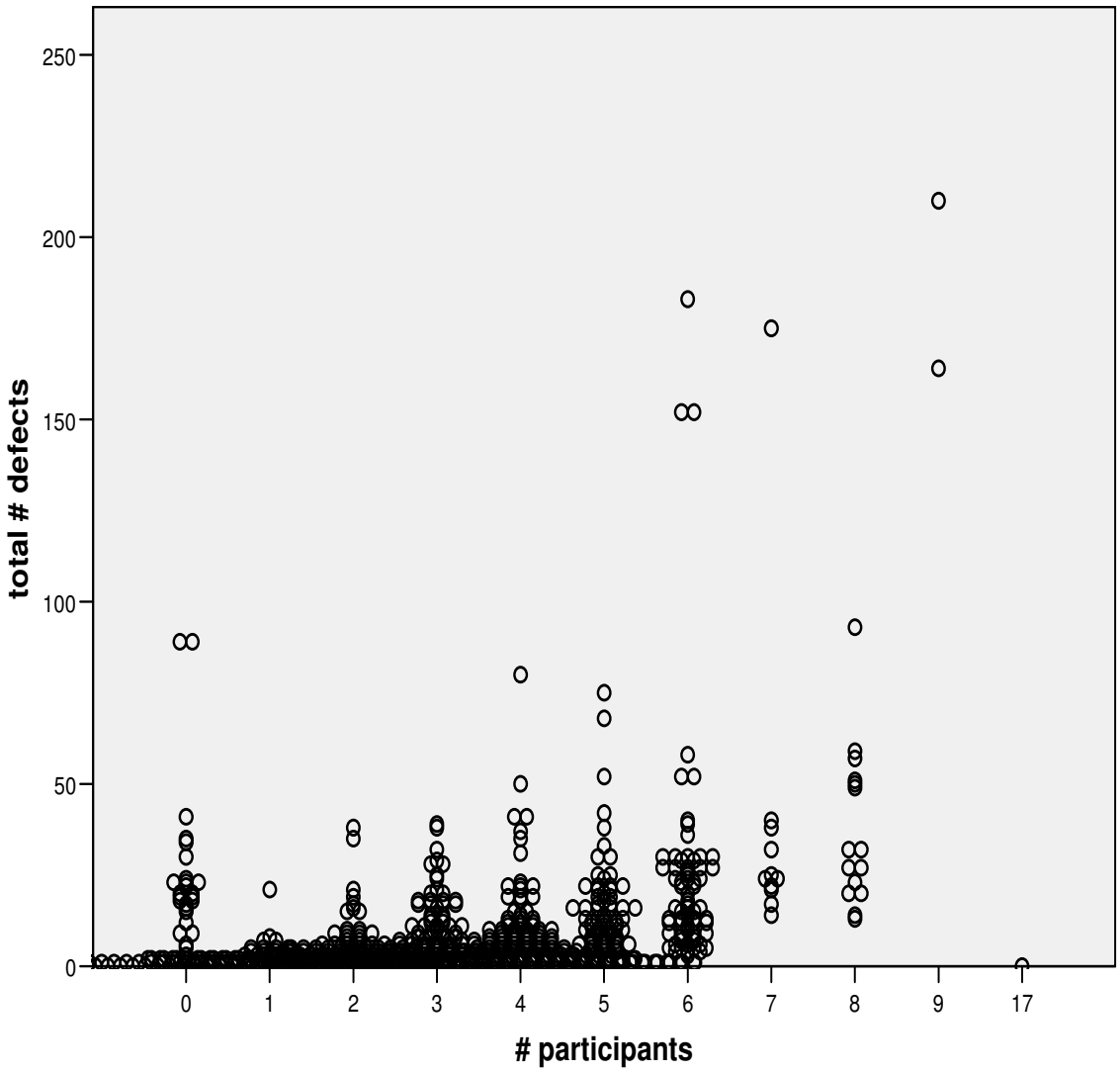
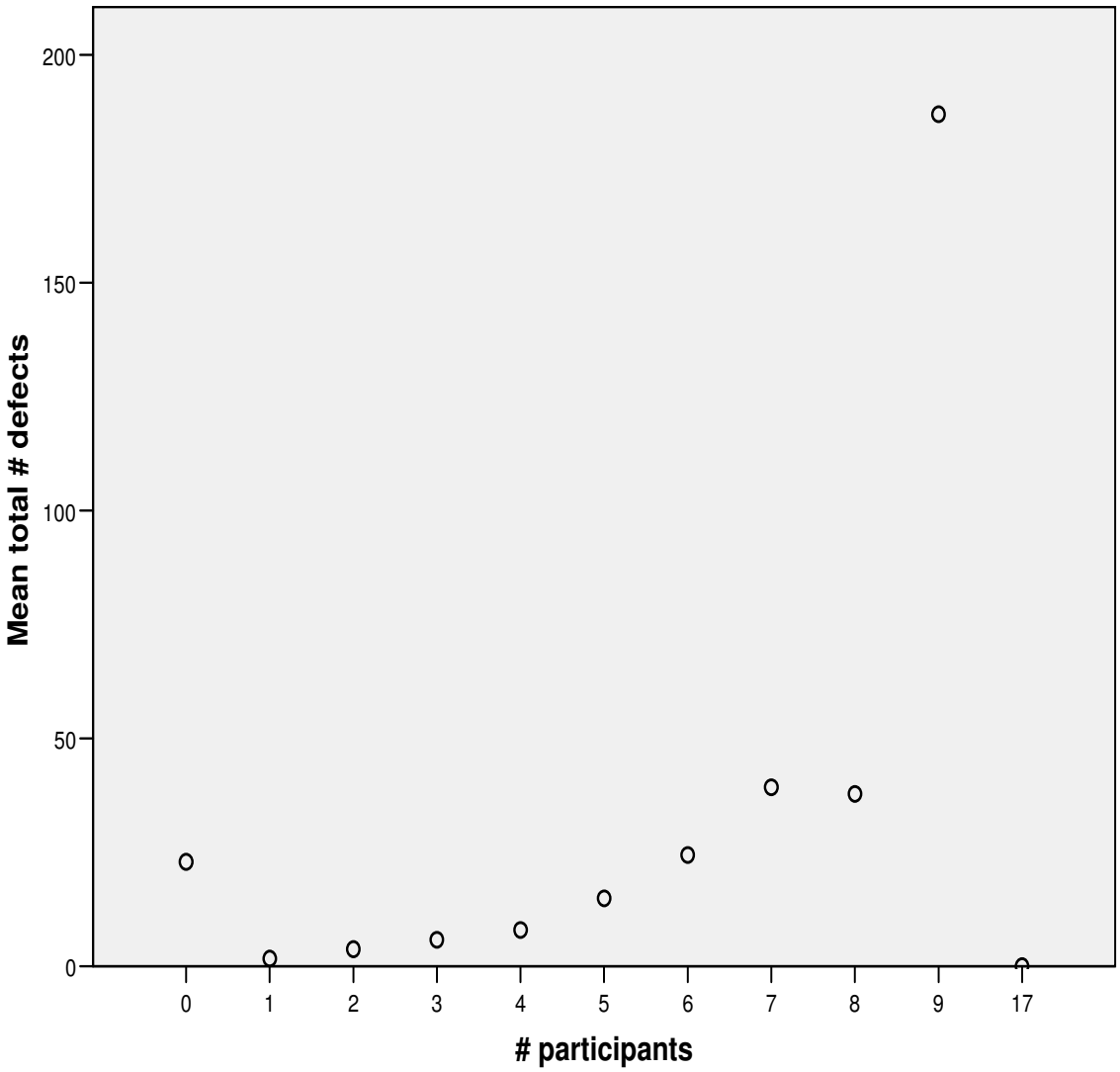
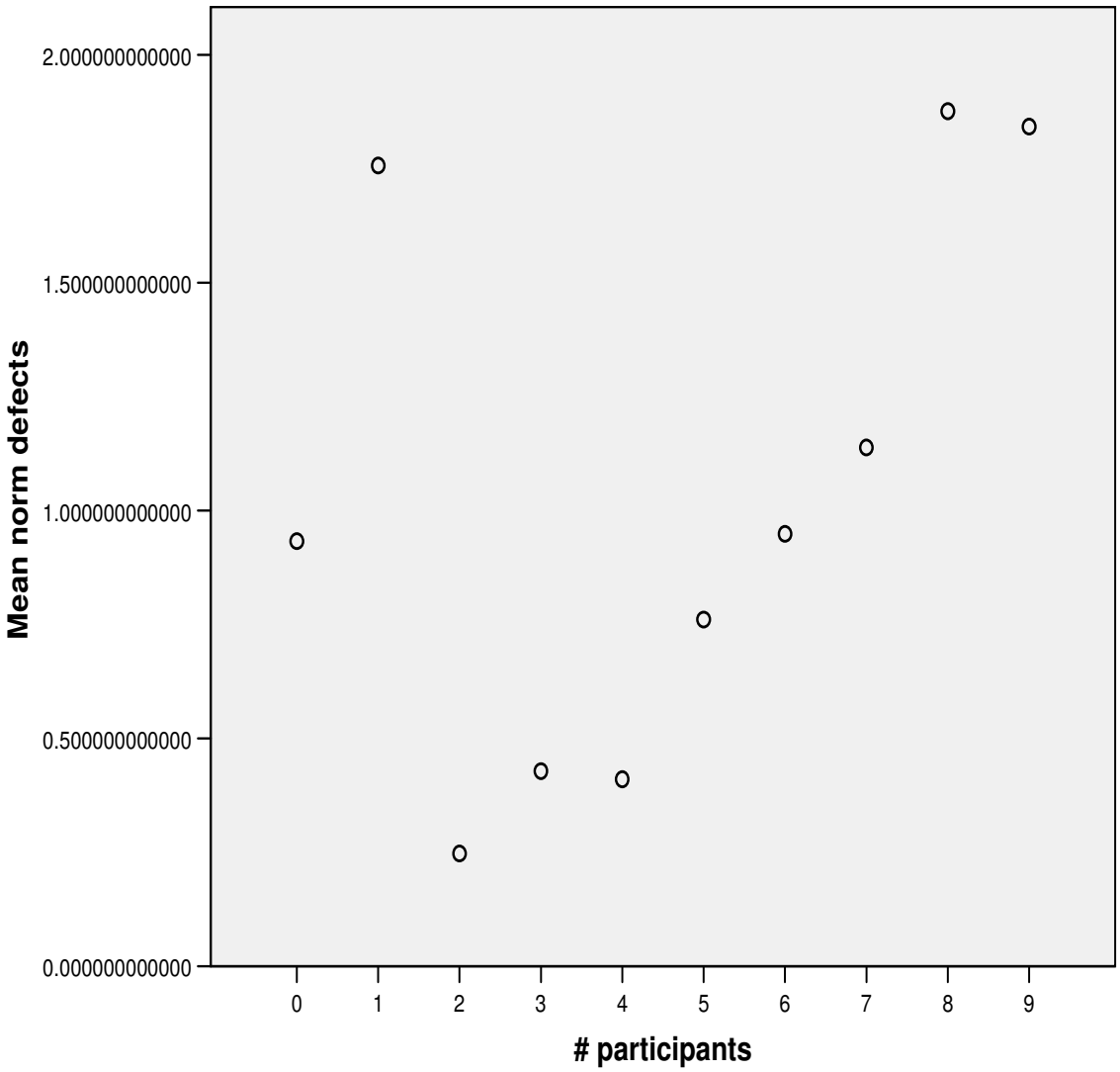
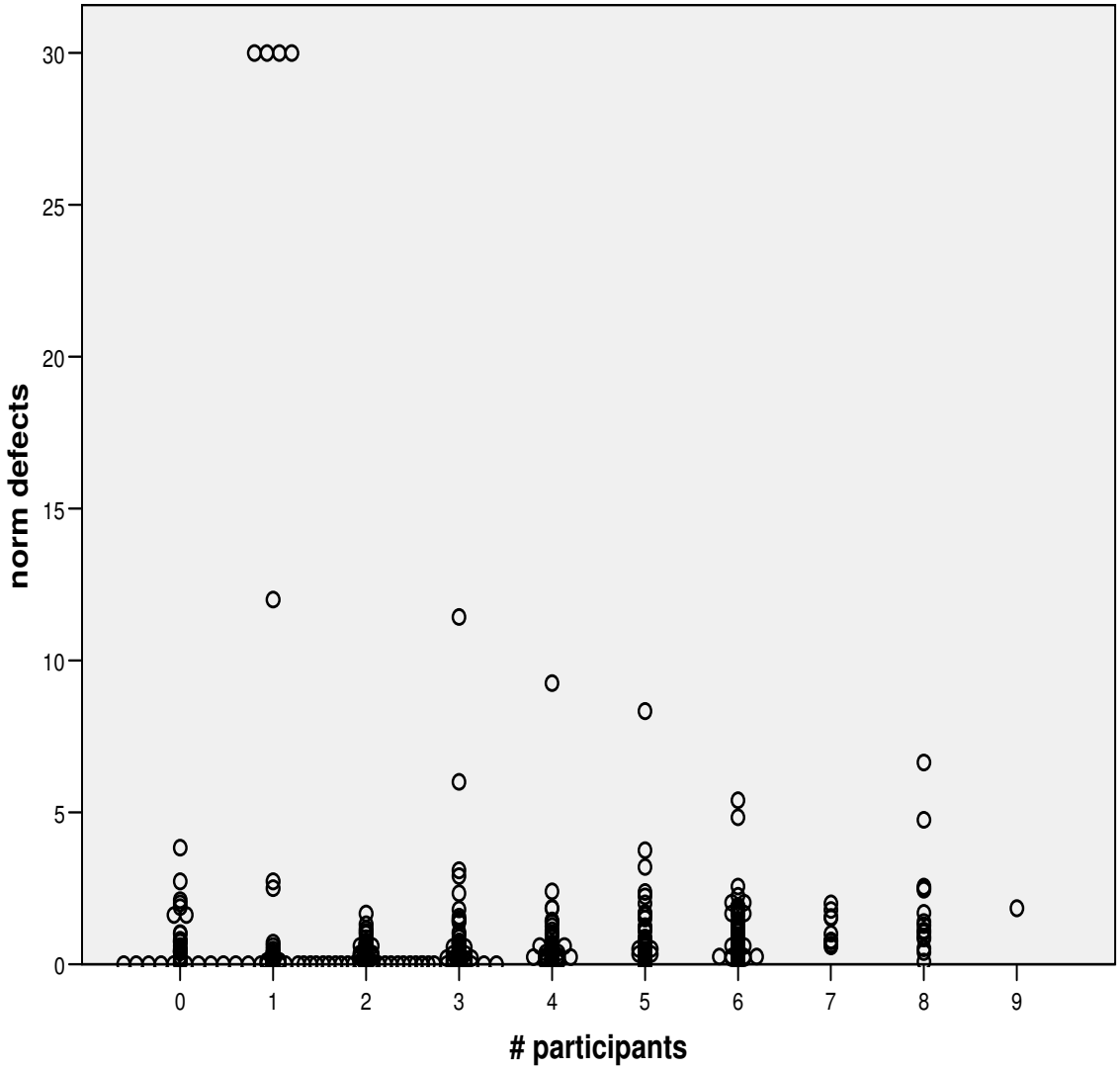
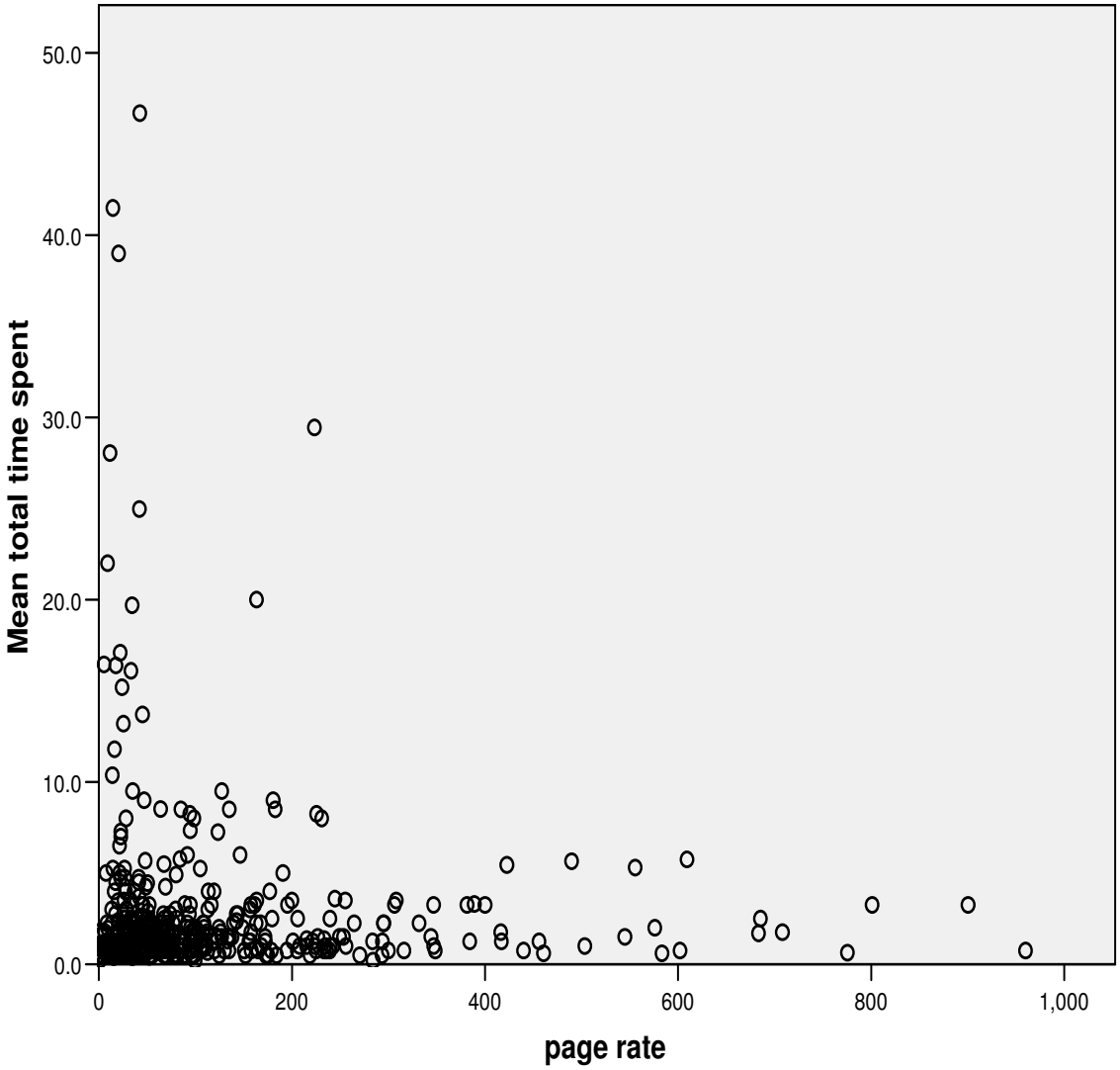
80
60
40
20
0
0
1
2
3
4
meeting length


250
200
150
100
50
0
total # defects
0
1
2
3
4
5
6
7
8
9
17
participants


Mean total # defects
200
150
100
50
0
0
1
2
3
4
5
6
7
8
9
17
participants


2.000000000000
1.500000000000
1.000000000000
0.500000000000
0.000000000000
Mean norm defects
0
1
2
3
4
5
6
7
8
9
participants


norm defects
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
participants


Mean total time spent
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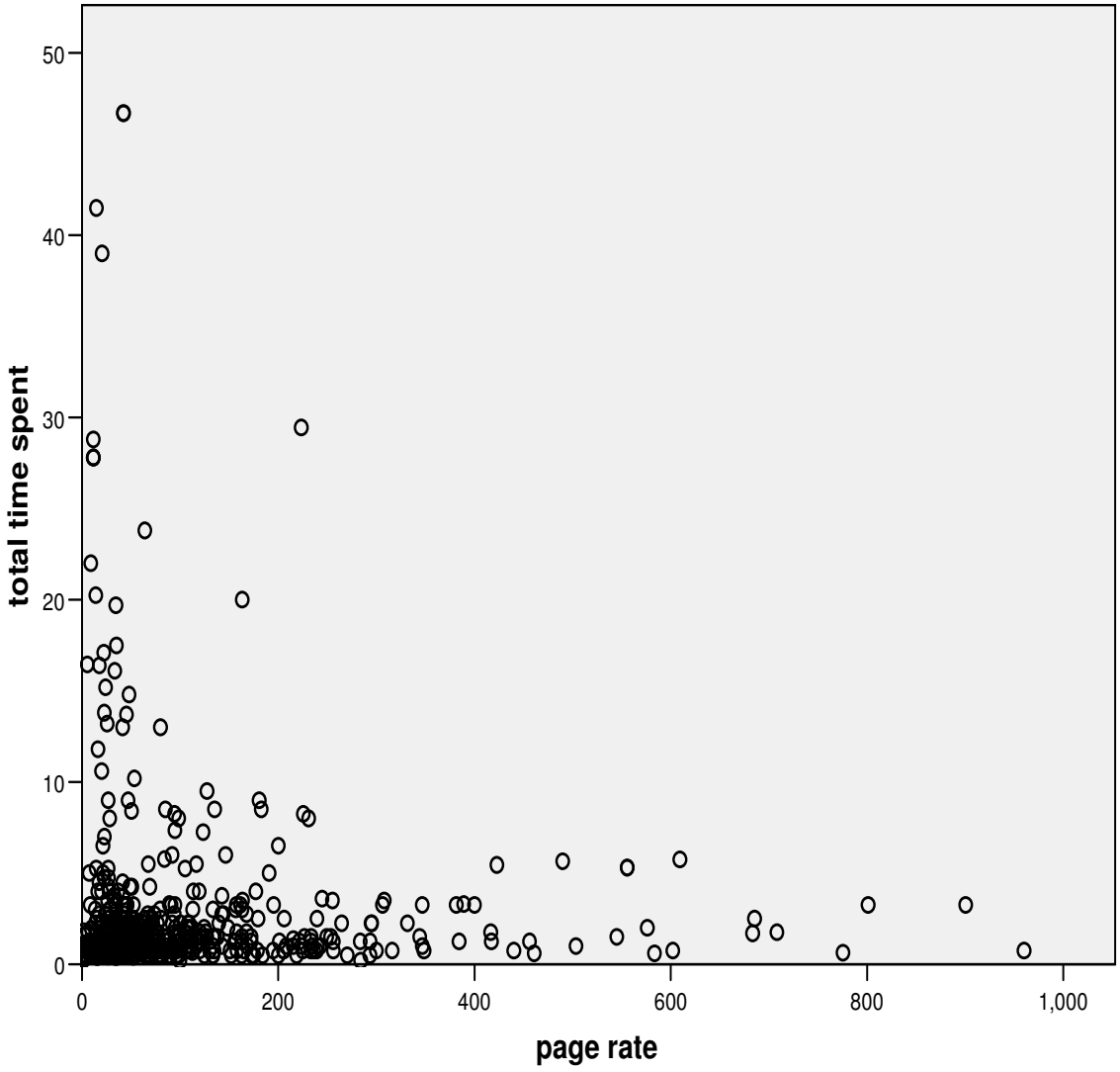
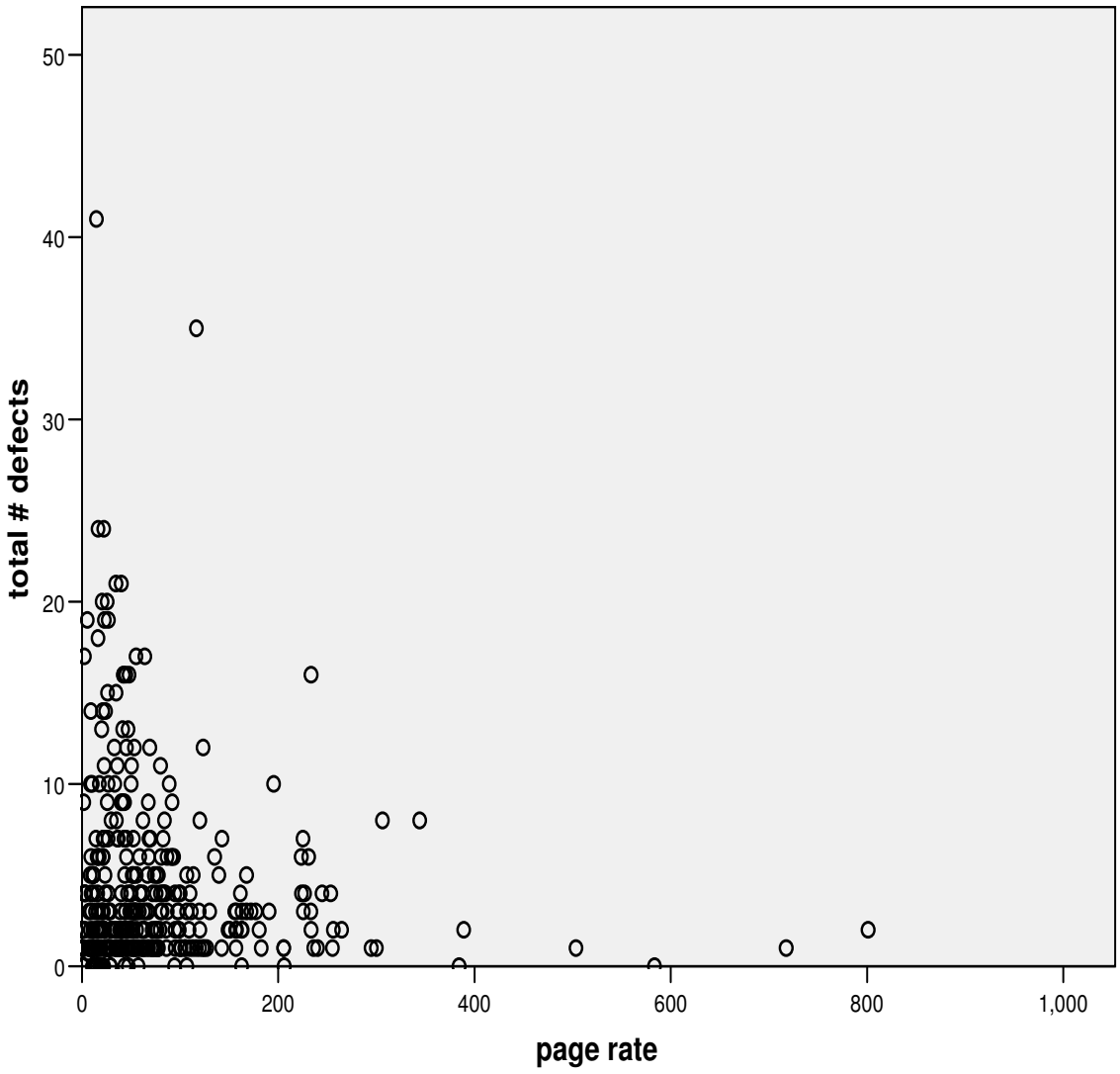
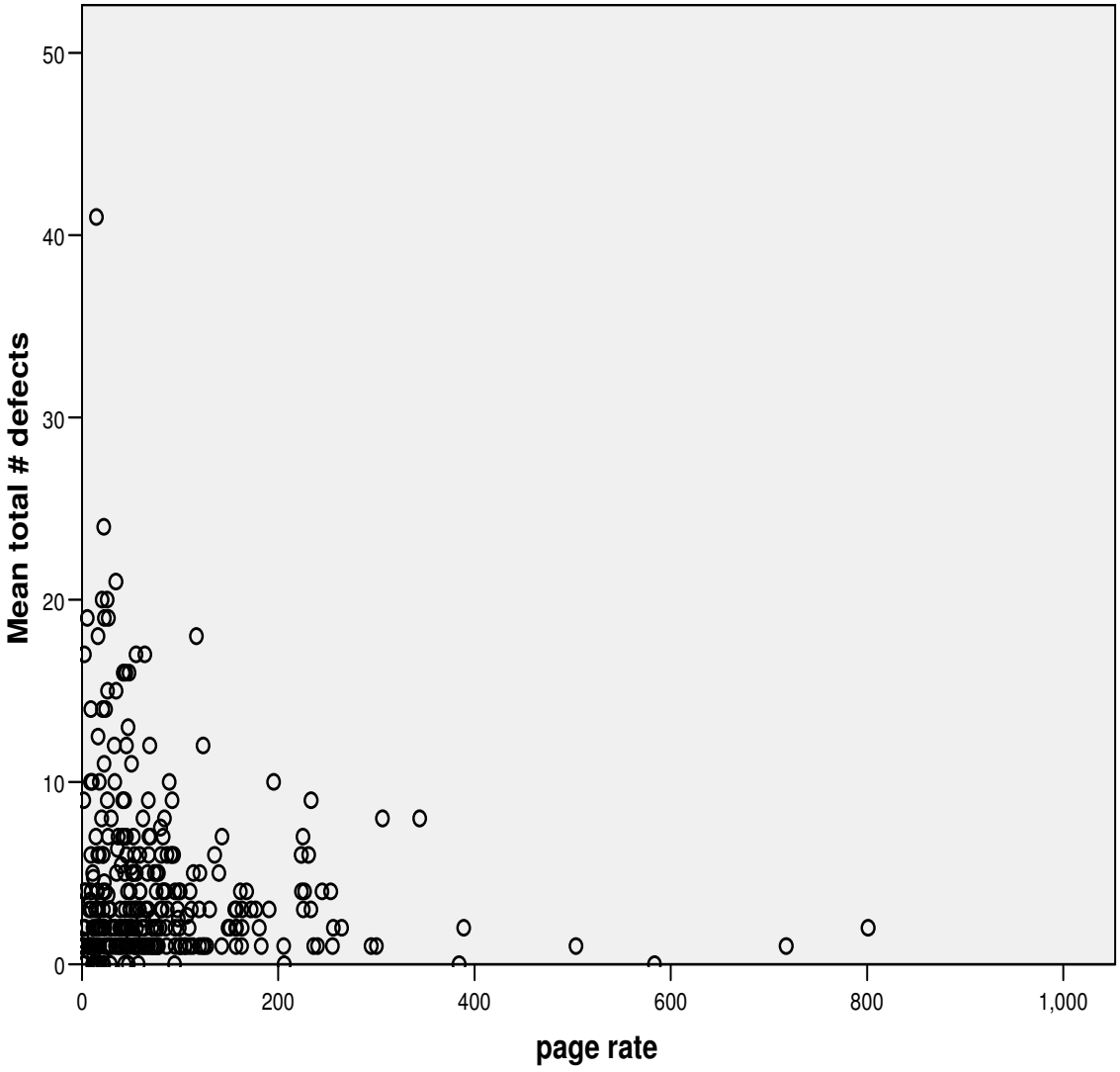
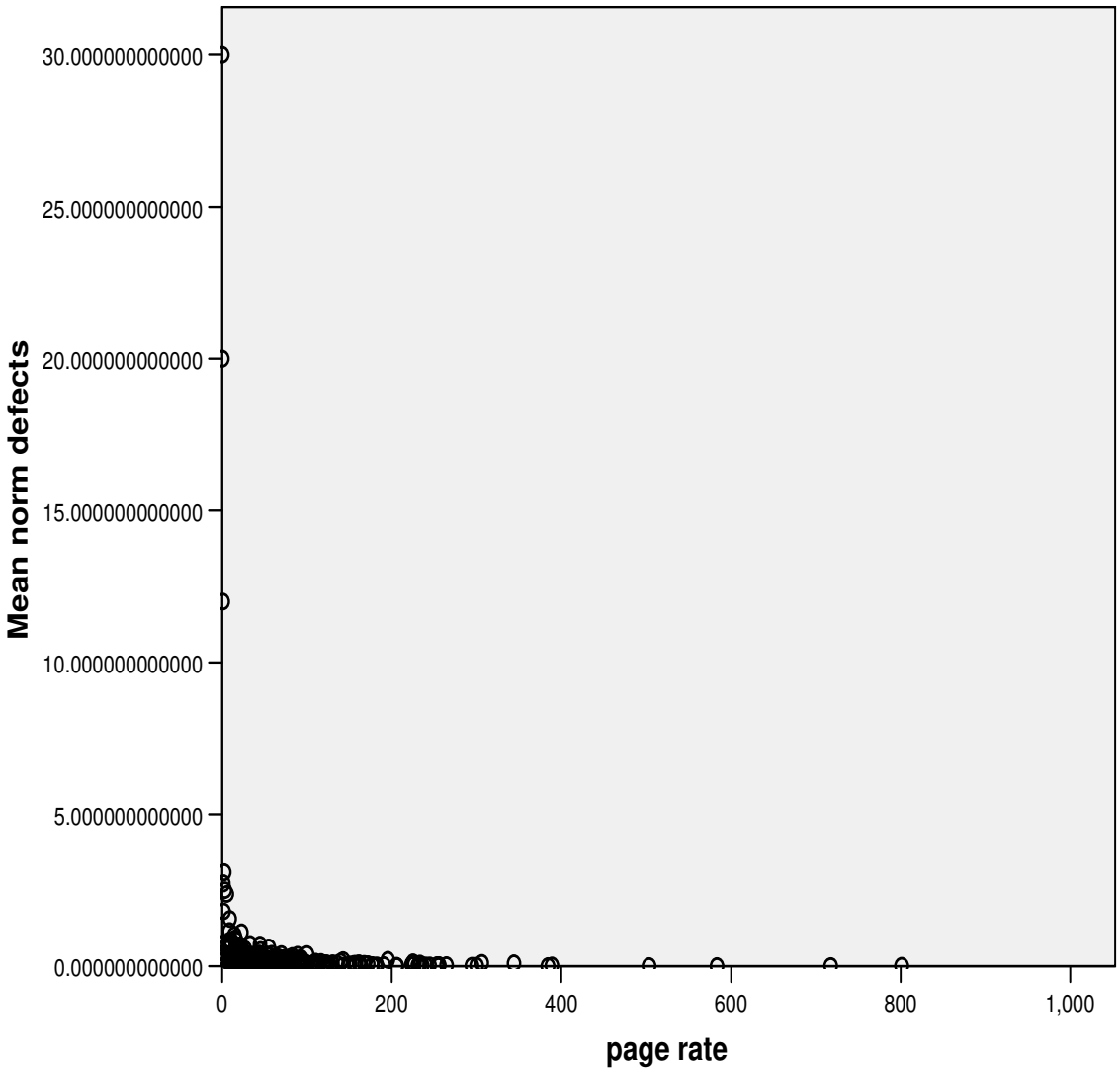
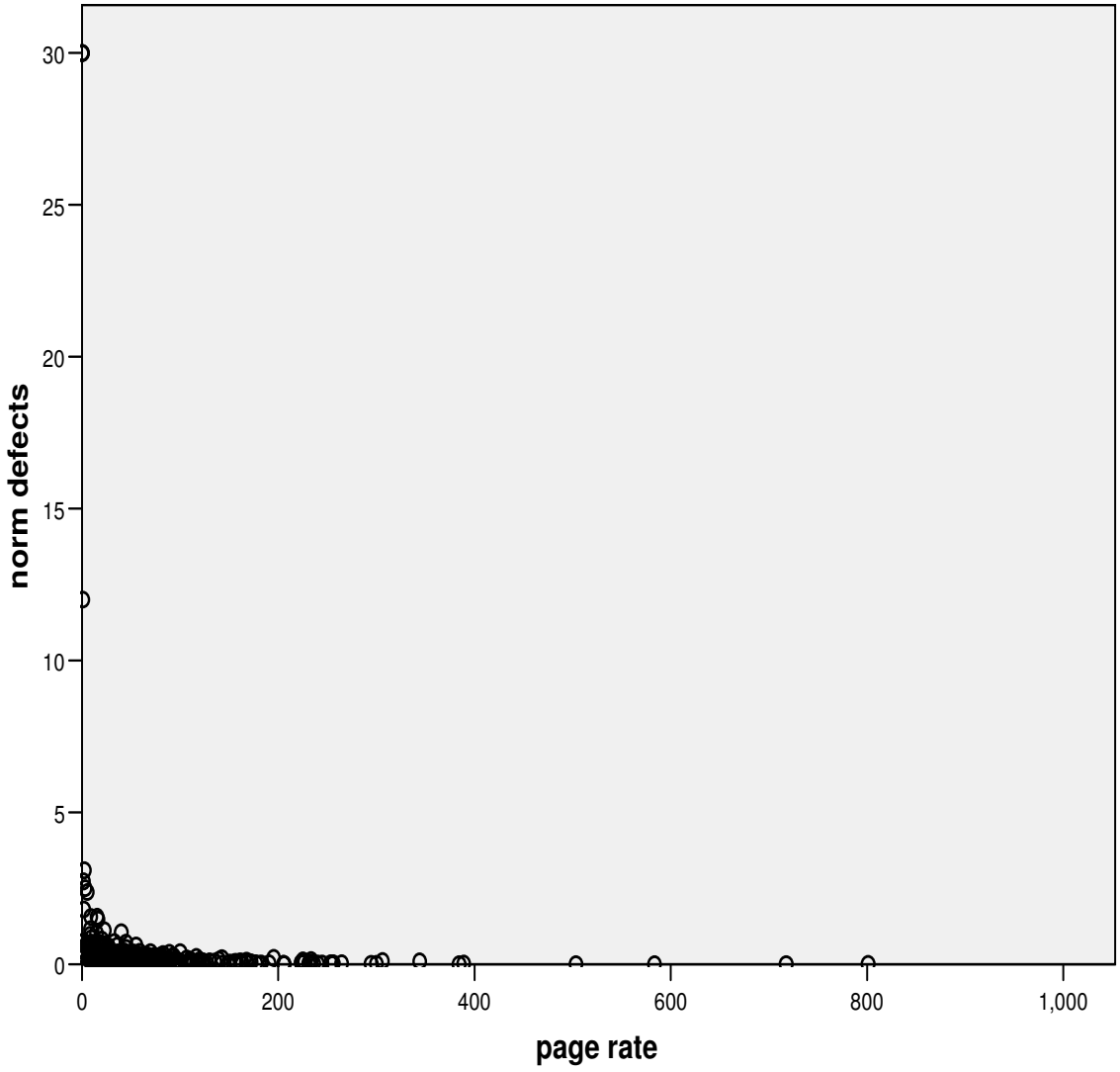
40.0
30.0
20.0
10.0
0.0
0
200
400
600
800
1,000
page rate


total time spent
50
40
30
20
10
0
0
200
400
600
800
1,000
page rate


total # defects
50
40
30
20
10
0
0
200
400
600
800
1,000
page rate


Mean total # defects
50
40
30
20
10
0
0
200
400
600
800
1,000
page rate


30.000000000000
25.000000000000
20.000000000000
15.000000000000
10.000000000000
5.000000000000
0.000000000000
Mean norm defects
0
200
400
600
800
1,000
page rate



4. Analysis of project characteristics

```
Software type includes "Attitude"
```

Ranks

	Ptps in range	N	Mean Rank	Sum of Ranks
total time spent	0	162	87.26	14136.00
	1	18	119.67	2154.00
	Total	180		
total # defects	0	162	89.87	14558.50
	1	18	96.19	1731.50
	Total	180		
norm defects	0	147	82.50	12127.00
	1	18	87.11	1568.00
	Total	165		
defect rate	0	162	91.76	14865.50
	1	18	79.14	1424.50
	Total	180		

Test Statistics(a)

	total time spent	total # defects	norm defects	defect rate
Mann-Whitney U	933.000	1355.500	1249.000	1253.500
Wilcoxon W	14136.000	14558.500	12127.000	1424.500
Z	-2.511	-.497	-.387	-.976
Asymp. Sig. (2-tailed)	.012	.619	.699	.329

a Grouping Variable: Ptps in range

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * Ptps in range	2141	84.7%	387	15.3%	2528	100.0%
total # defects * Ptps in range	721	28.5%	1807	71.5%	2528	100.0%
norm defects * Ptps in range	655	25.9%	1873	74.1%	2528	100.0%
defect rate * Ptps in range	577	22.8%	1951	77.2%	2528	100.0%

Report

Ptps in range		total time spent	total # defects	norm defects	defect rate
0	Mean	2.600	6.9303	.72	2.195
	N	1739	445	393	342
	Std. Deviation	6.5018	17.61812	3.156	2.3434
1	Mean	13.560	13.9638	.64	1.155
	N	402	276	262	235
	Std. Deviation	18.3134	20.25399	1.017	1.1403
Total	Mean	4.657	9.6227	.69	1.772
	N	2141	721	655	577
	Std. Deviation	10.7474	18.96837	2.527	2.0102

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
total time spent	182	2.67	3.829	1	33
total # defects	182	3.88	4.001	1	35
norm defects	167	.2292111 5193698	.20015332 5835864	.0019418 73260	1.071428 571429
defect rate	182	2.310950 60666186	2.1556189 40798249	.0307692 30769	14.00000 0000000
Mtg in range	178	1.00	.000	1	1

Ranks

	Mtg in range	N	Mean Rank	Sum of Ranks
total time spent	0	0(a)	.00	.00
	1	178	89.50	15931.00
	Total	178		
total # defects	0	0(a)	.00	.00
	1	178	89.50	15931.00
	Total	178		
norm defects	0	0(a)	.00	.00
	1	164	82.50	13530.00
	Total	164		
defect rate	0	0(a)	.00	.00
	1	178	89.50	15931.00
	Total	178		

a Mann-Whitney Test cannot be performed on empty groups.

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
total time spent	182	2.67	3.829	1	33
total # defects	182	3.88	4.001	1	35
norm defects	167	.2292111 5193698	.20015332 5835864	.0019418 73260	1.071428 571429
defect rate	182	2.310950 60666186	2.1556189 40798249	.0307692 30769	14.00000 0000000
PgRate in range	164	.11	.314	0	1

Ranks

	PgRate in range	N	Mean Rank	Sum of Ranks
total time spent	0	146	82.98	12114.50
	1	18	78.64	1415.50
	Total	164		
total # defects	0	146	85.05	12417.50
	1	18	61.81	1112.50
	Total	164		
norm defects	0	146	75.77	11062.50
	1	18	137.08	2467.50
	Total	164		
defect rate	0	146	84.63	12356.50
	1	18	65.19	1173.50
	Total	164		

Test Statistics(a)

	total time spent	total # defects	norm defects	defect rate
Mann-Whitney U	1244.500	941.500	331.500	1002.500
Wilcoxon W	1415.500	1112.500	11062.500	1173.500
Z	-.367	-1.990	-5.169	-1.641
Asymp. Sig. (2-tailed)	.714	.047	.000	.101

a Grouping Variable: PgRate in range

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * PgRate in range	164	90.1%	18	9.9%	182	100.0%
total # defects * PgRate in range	164	90.1%	18	9.9%	182	100.0%
norm defects * PgRate in range	164	90.1%	18	9.9%	182	100.0%
defect rate * PgRate in range	164	90.1%	18	9.9%	182	100.0%

Report

PgRate in range		total time spent	total # defects	norm defects	defect rate
0	Mean	2.68	4.10	.19708727208787	2.42652631296089
	N	146	146	146	146
	Std. Deviation	3.416	4.176	.16476574495090 3	2.307926497659025
1	Mean	1.89	2.61	.51919620944337	1.42754159420827
	N	18	18	18	18
	Std. Deviation	1.192	2.330	.23637693693288 4	.790353217613085
Total	Mean	2.60	3.93	.23244069204152	2.31688164870755
	N	164	164	164	164
	Std. Deviation	3.254	4.037	.20044245659286 8	2.213950667506034

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * AllParams in range	162	89.0%	20	11.0%	182	100.0%
total # defects * AllParams in range	162	89.0%	20	11.0%	182	100.0%
norm defects * AllParams in range	162	89.0%	20	11.0%	182	100.0%
defect rate * AllParams in range	162	89.0%	20	11.0%	182	100.0%

Report

AllParams in range		total time spent	total # defects	norm defects	defect rate
0	Mean	2.62	3.94	.23247363925179	2.31256331515250
	N	162	162	162	162
	Std. Deviation	3.269	4.054	.20049237076364 6	2.22235098268475 6
Total	Mean	2.62	3.94	.23247363925179	2.31256331515250
	N	162	162	162	162
	Std. Deviation	3.269	4.054	.20049237076364 6	2.22235098268475 6

```
software type includes "Orbit"
```

Ranks

	Ptps in range	N	Mean Rank	Sum of Ranks
total time spent	0	42	33.08	1389.50
	1	45	54.19	2438.50
	Total	87		
total # defects	0	42	37.98	1595.00
	1	45	49.62	2233.00
	Total	87		
norm defects	0	42	41.98	1763.00
	1	45	45.89	2065.00
	Total	87		
defect rate	0	42	43.83	1841.00
	1	45	44.16	1987.00
	Total	87		

Test Statistics(a)

	total time spent	total # defects	norm defects	defect rate
Mann-Whitney U	486.500	692.000	860.000	938.000
Wilcoxon W	1389.500	1595.000	1763.000	1841.000
Z	-3.922	-2.241	-.722	-.060
Asymp. Sig. (2-tailed)	.000	.025	.470	.952

a Grouping Variable: Ptps in range

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * Ptps in range	87	98.9%	1	1.1%	88	100.0%
total # defects * Ptps in range	87	98.9%	1	1.1%	88	100.0%
norm defects * Ptps in range	87	98.9%	1	1.1%	88	100.0%
defect rate * Ptps in range	87	98.9%	1	1.1%	88	100.0%

Report

Ptps in range		total time spent	total # defects	norm defects	defect rate
0	Mean	1.61	2.12	.19556 81983 1115	1.50372841444271
	N	42	42	42	42
	Std. Deviation	.944	1.596	.24804 45336 10144	1.112932948558521
1	Mean	2.26	3.73	.23394 06870 0604	1.55774591230732
	N	45	45	45	45
	Std. Deviation	1.071	3.732	.23490 61412 94519	1.115938711747703
Total	Mean	1.95	2.95	.21541 60372 9126	1.53166849954509
	N	87	87	87	87
	Std. Deviation	1.056	3.000	.24069 94837 58652	1.108323915179908

Ranks

	PgRate in range	N	Mean Rank	Sum of Ranks
total time spent	0	86	44.27	3807.00
	1	2	54.50	109.00
	Total	88		
total # defects	0	86	44.77	3850.50
	1	2	32.75	65.50
	Total	88		
norm defects	0	86	44.06	3789.00
	1	2	63.50	127.00
	Total	88		
defect rate	0	86	44.82	3854.50
	1	2	30.75	61.50
	Total	88		

Test Statistics(b)

	total time spent	total # defects	norm defects	defect rate
Mann-Whitney U	66.000	62.500	48.000	58.500
Wilcoxon W	3807.000	65.500	3789.000	61.500
Z	-.564	-.687	-1.064	-.772
Asymp. Sig. (2-tailed)	.573	.492	.287	.440
Exact Sig. [2*(1-tailed Sig.)]	.604(a)	.535(a)	.327(a)	.470(a)

a Not corrected for ties.
b Grouping Variable: PgRate in range

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * PgRate in range	88	100.0%	0	.0%	88	100.0%
total # defects * PgRate in range	88	100.0%	0	.0%	88	100.0%
norm defects * PgRate in range	88	100.0%	0	.0%	88	100.0%
defect rate * PgRate in range	88	100.0%	0	.0%	88	100.0%

Report

PgRate in range		total time spent	total # defects	norm defects	defect rate
0	Mean	1.92	2.97	.2057012935036386	1.53371632447520
	N	86	86	86	86
	Std. Deviation	1.007	3.015	.2282585787802896	1.111673506837714
1	Mean	3.13	1.50	.5514385353095122	.90000000000000
	N	2	2	2	2
	Std. Deviation	2.652	.707	.5887419145886225	.989949493661167
Total	Mean	1.95	2.93	.2135589580901388	1.51931368073713
	N	88	88	88	88
	Std. Deviation	1.051	2.990	.2399454043518367	1.108014000348916

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * AllParams in range	87	98.9%	1	1.1%	88	100.0%
total # defects * AllParams in range	87	98.9%	1	1.1%	88	100.0%
norm defects * AllParams in range	87	98.9%	1	1.1%	88	100.0%
defect rate * AllParams in range	87	98.9%	1	1.1%	88	100.0%

Report

AllParams in range		total time spent	total # defects	norm defects	defect rate
0	Mean	1.95	2.97	.20666806173073089	1.53087394721422
	N	86	86	86	86
	Std. Deviation	1.060	3.015	.22777546172072033	1.114799480759438
1	Mean	1.25	2.00	.96774193548387088	1.60000000000000
	N	1	1	1	1
	Std. Deviation	.	.	.	.
Total	Mean	1.95	2.95	.21541603703729126	1.53166849954509
	N	87	87	87	87
	Std. Deviation	1.056	3.000	.24069948375875865	1.108323915179908

flight sw

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * Ptps in range	15	100.0%	0	.0%	15	100.0%
total # defects * Ptps in range	15	100.0%	0	.0%	15	100.0%
norm defects * Ptps in range	11	73.3%	4	26.7%	15	100.0%
defect rate * Ptps in range	15	100.0%	0	.0%	15	100.0%
total time spent * Mtg in range	8	53.3%	7	46.7%	15	100.0%
total # defects * Mtg in range	8	53.3%	7	46.7%	15	100.0%
norm defects * Mtg in range	6	40.0%	9	60.0%	15	100.0%
defect rate * Mtg in range	8	53.3%	7	46.7%	15	100.0%
total time spent * PgRate in range	6	40.0%	9	60.0%	15	100.0%
total # defects * PgRate in range	6	40.0%	9	60.0%	15	100.0%
norm defects * PgRate in range	6	40.0%	9	60.0%	15	100.0%
defect rate * PgRate in range	6	40.0%	9	60.0%	15	100.0%
total time spent * AllParams in range	6	40.0%	9	60.0%	15	100.0%
total # defects * AllParams in range	6	40.0%	9	60.0%	15	100.0%
norm defects * AllParams in range	6	40.0%	9	60.0%	15	100.0%
defect rate * AllParams in range	6	40.0%	9	60.0%	15	100.0%

total time spent total # defects norm defects defect rate * Ptps in range

Ptps in range		total time spent	total # defects	norm defects	defect rate
0	Mean	29.13	51.75	.98736100772212	1.29110149110150
	N	4	4	3	4
	Std. Deviation	28.967	75.526	.88199682190607 4	.858719822263170
1	Mean	14.43	42.27	3.17873715538848	2.39533677536151
	N	11	11	8	11
	Std. Deviation	11.530	56.393	3.54621344647 7719	1.517998116867361
Total	Mean	18.35	44.80	2.58108911511583	2.10087403289217
	N	15	15	11	15
	Std. Deviation	17.888	59.268	3.16326759419 4088	1.435073409746303

total time spent total # defects norm defects defect rate * Mtg in range

Mtg in range		total time spent	total # defects	norm defects	defect rate
1	Mean	14.22	18.25	3.52108820851596	1.43374751581021
	N	8	8	6	8
	Std. Deviation	7.171	10.674	4.134576479244082	.812391649260129
Total	Mean	14.22	18.25	3.52108820851596	1.43374751581021
	N	8	8	6	8
	Std. Deviation	7.171	10.674	4.134576479244082	.812391649260129

total time spent total # defects norm defects defect rate * PgRate in range

PgRate in range		total time spent	total # defects	norm defects	defect rate
0	Mean	17.67	19.33	.562017686873	1.31478527969757
	N	3	3	3	3
	Std. Deviation	8.808	6.807	.478785269790	.693823636024920
1	Mean	15.33	25.00	6.48015873015	1.86808278867103
	N	3	3	3	3
	Std. Deviation	5.686	12.000	4.02979853914	1.096898739214931
Total	Mean	16.50	22.17	3.52108820851	1.59143403418430
	N	6	6	6	6
	Std. Deviation	6.753	9.261	4.13457647924	.875027241193170

total time spent total # defects norm defects defect rate * AllParams in range

AllParams in range		total time spent	total # defects	norm defects	defect rate
0	Mean	17.67	19.33	.56201768687318	1.31478527969757
	N	3	3	3	3
	Std. Deviation	8.808	6.807	.47878526979037	.693823636024920
1	Mean	15.33	25.00	1 6.4801587301587 3	1.86808278867103
	N	3	3	3	3
	Std. Deviation	5.686	12.000	4.0297985391408 82	1.096898739214931
Total	Mean	16.50	22.17	3.5210882085159 6	1.59143403418430
	N	6	6	6	6
	Std. Deviation	6.753	9.261	4.1345764792440 82	.875027241193170

Ranks

	Ptps in range	N	Mean Rank	Sum of Ranks
total time spent	0	4	9.50	38.00
	1	11	7.45	82.00
	Total	15		
total # defects	0	4	8.50	34.00
	1	11	7.82	86.00
	Total	15		
norm defects	0	3	4.00	12.00
	1	8	6.75	54.00
	Total	11		
defect rate	0	4	5.50	22.00
	1	11	8.91	98.00
	Total	15		

Test Statistics(b)

	total time spent	total # defects	norm defects	defect rate
Mann-Whitney U	16.000	20.000	6.000	12.000
Wilcoxon W	82.000	86.000	12.000	22.000
Z	-.783	-.261	-1.228	-1.307
Asymp. Sig. (2-tailed)	.433	.794	.220	.191
Exact Sig. [2*(1-tailed Sig.)]	.489(a)	.851(a)	.279(a)	.226(a)

a Not corrected for ties.
b Grouping Variable: Ptps in range

Flight Dynamics SW tool

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * Ptps in range	41	100.0%	0	.0%	41	100.0%
total # defects * Ptps in range	41	100.0%	0	.0%	41	100.0%
norm defects * Ptps in range	37	90.2%	4	9.8%	41	100.0%
defect rate * Ptps in range	41	100.0%	0	.0%	41	100.0%
total time spent * Mtg in range	41	100.0%	0	.0%	41	100.0%
total # defects * Mtg in range	41	100.0%	0	.0%	41	100.0%
norm defects * Mtg in range	37	90.2%	4	9.8%	41	100.0%
defect rate * Mtg in range	41	100.0%	0	.0%	41	100.0%
total time spent * PgRate in range	37	90.2%	4	9.8%	41	100.0%
total # defects * PgRate in range	37	90.2%	4	9.8%	41	100.0%
norm defects * PgRate in range	37	90.2%	4	9.8%	41	100.0%
defect rate * PgRate in range	37	90.2%	4	9.8%	41	100.0%
total time spent * AllParams in range	37	90.2%	4	9.8%	41	100.0%
total # defects * AllParams in range	37	90.2%	4	9.8%	41	100.0%
norm defects * AllParams in range	37	90.2%	4	9.8%	41	100.0%
defect rate * AllParams in range	37	90.2%	4	9.8%	41	100.0%

total time spent total # defects norm defects defect rate * Ptps in range

Ptps in range		total time spent	total # defects	norm defects	defect rate
0	Mean	1.04	1.88	.1301597606494923	1.88846153846154
	N	26	26	23	26
	Std. Deviation	.297	.993	.1082745029281435	1.058172105627533
1	Mean	2.02	4.80	.1596157171000514	2.49210586798823
	N	15	15	14	15
	Std. Deviation	1.054	3.098	.0885984346520362	1.316663550032445
Total	Mean	1.40	2.95	.1413052576848437	2.10930702487374
	N	41	41	37	41
	Std. Deviation	.820	2.449	.1010377953249321	1.180357584049355

total time spent total # defects norm defects defect rate * Mtg in range

Mtg in range		total time spent	total # defects	norm defects	defect rate
1	Mean	1.40	2.95	.14130525768484	2.10930702487374
	N	41	41	37	41
	Std. Deviation	.820	2.449	.101037795332493	1.180357584049355
Total	Mean	1.40	2.95	.14130525768484	2.10930702487374
	N	41	41	37	41
	Std. Deviation	.820	2.449	.101037795332493	1.180357584049355

total time spent total # defects norm defects defect rate * PgRate in range

PgRate in range		total time spent	total # defects	norm defects	defect rate
0	Mean	1.40	2.73	.14130525768484	1.96436724377901
	N	37	37	37	37
	Std. Deviation	.855	2.281	.10103779532493	1.09103227685961 9
Total	Mean	1.40	2.73	.14130525768484	1.96436724377901
	N	37	37	37	37
	Std. Deviation	.855	2.281	.10103779532493	1.09103227685961 9

total time spent total # defects norm defects defect rate * AllParams in range

AllParams in range		total time spent	total # defects	norm defects	defect rate
0	Mean	1.40	2.73	.14130525768484	1.96436724377901
	N	37	37	37	37
	Std. Deviation	.855	2.281	.10103779532493	1.09103227685961 9
Total	Mean	1.40	2.73	.14130525768484	1.96436724377901
	N	37	37	37	37
	Std. Deviation	.855	2.281	.10103779532493	1.09103227685961 9

Ranks

	Ptps in range	N	Mean Rank	Sum of Ranks
total time spent	0	26	15.63	406.50
	1	15	30.30	454.50
	Total	41		
total # defects	0	26	16.04	417.00
	1	15	29.60	444.00
	Total	41		
norm defects	0	23	17.30	398.00
	1	14	21.79	305.00
	Total	37		
defect rate	0	26	18.98	493.50
	1	15	24.50	367.50
	Total	41		

Test Statistics(b)

	total time spent	total # defects	norm defects	defect rate
Mann-Whitney U	55.500	66.000	122.000	142.500
Wilcoxon W	406.500	417.000	398.000	493.500
Z	-3.856	-3.592	-1.222	-1.428
Asymp. Sig. (2-tailed)	.000	.000	.222	.153
Exact Sig. [2*(1-tailed Sig.)]	.000(a)	.000(a)	.231(a)	.157(a)

a Not corrected for ties.
b Grouping Variable: Ptps in range

Class of SW = C

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * Ptps in range	66	100.0%	0	.0%	66	100.0%
total # defects * Ptps in range	66	100.0%	0	.0%	66	100.0%
norm defects * Ptps in range	58	87.9%	8	12.1%	66	100.0%
defect rate * Ptps in range	66	100.0%	0	.0%	66	100.0%
total time spent * Mtg in range	59	89.4%	7	10.6%	66	100.0%
total # defects * Mtg in range	59	89.4%	7	10.6%	66	100.0%
norm defects * Mtg in range	53	80.3%	13	19.7%	66	100.0%
defect rate * Mtg in range	59	89.4%	7	10.6%	66	100.0%
total time spent * PgRate in range	53	80.3%	13	19.7%	66	100.0%
total # defects * PgRate in range	53	80.3%	13	19.7%	66	100.0%
norm defects * PgRate in range	53	80.3%	13	19.7%	66	100.0%
defect rate * PgRate in range	53	80.3%	13	19.7%	66	100.0%
total time spent * AllParams in range	53	80.3%	13	19.7%	66	100.0%
total # defects * AllParams in range	53	80.3%	13	19.7%	66	100.0%
norm defects * AllParams in range	53	80.3%	13	19.7%	66	100.0%
defect rate * AllParams in range	53	80.3%	13	19.7%	66	100.0%

total time spent total # defects norm defects defect rate * Ptps in range

Ptps in range		total time spent	total # defects	norm defects	defect rate
0	Mean	3.96	6.90	.186637104249	1.71107901357902
	N	40	40	40	40
	Std. Deviation	11.707	25.873	.946307425013772	
1	Mean	7.27	20.65	1.25747805829	2.45116509803077
	N	26	26	26	26
	Std. Deviation	9.640	40.422	2.53109773623	1.376561665909791
Total	Mean	5.27	12.32	.592818155784	2.00262807715092
	N	66	66	66	66
	Std. Deviation	10.983	32.802	1.64449559379	1.182749851044657

total time spent total # defects norm defects defect rate * Mtg in range

Mtg in range		total time spent	total # defects	norm defects	defect rate
1	Mean	3.15	4.86	.51166041547775	1.90051394449254
	N	59	59	53	59
	Std. Deviation	5.136	6.864	1.682339897767411	1.087111695091021
Total	Mean	3.15	4.86	.51166041547775	1.90051394449254
	N	59	59	53	59
	Std. Deviation	5.136	6.864	1.682339897767411	1.087111695091021

total time spent total # defects norm defects defect rate * PgRate in range

PgRate in range		total time spent	total # defects	norm defects	defect rate
0	Mean	2.40	3.58	.1535505 1659689	1.81609396875342
	N	50	50	50	50
	Std. Deviation	4.370	4.751	.1698923 8678254 5	1.003100397532918
1	Mean	15.33	25.00	6.480158 7301587 3	1.86808278867103
	N	3	3	3	3
	Std. Deviation	5.686	12.000	4.029798 5391408 82	1.096898739214931
Total	Mean	3.13	4.79	.5116604 1547775	1.81903673214498
	N	53	53	53	53
	Std. Deviation	5.324	7.196	1.682339 8977674 11	.997287987850705

total time spent total # defects norm defects defect rate * AllParams in range

AllParams in range		total time spent	total # defects	norm defects	defect rate
0	Mean	2.40	3.58	.1535505 1659689	1.81609396875342
	N	50	50	50	50
	Std. Deviation	4.370	4.751	.1698923 86782545	1.003100397532918
1	Mean	15.33	25.00	6.480158 73015873	1.86808278867103
	N	3	3	3	3
	Std. Deviation	5.686	12.000	4.029798 53914088 2	1.096898739214931
Total	Mean	3.13	4.79	.5116604 1547775	1.81903673214498
	N	53	53	53	53
	Std. Deviation	5.324	7.196	1.682339 89776741 1	.997287987850705

Ranks

	Ptps in range	N	Mean Rank	Sum of Ranks
total time spent	0	40	26.10	1044.00
	1	26	44.88	1167.00
	Total	66		
total # defects	0	40	25.49	1019.50
	1	26	45.83	1191.50
	Total	66		
norm defects	0	36	24.69	889.00
	1	22	37.36	822.00
	Total	58		
defect rate	0	40	29.70	1188.00
	1	26	39.35	1023.00
	Total	66		

Test Statistics(a)

	total time spent	total # defects	norm defects	defect rate
Mann-Whitney U	224.000	199.500	223.000	368.000
Wilcoxon W	1044.000	1019.500	889.000	1188.000
Z	-3.913	-4.289	-2.773	-2.000
Asymp. Sig. (2-tailed)	.000	.000	.006	.045

a Grouping Variable: Ptps in range

Small projects

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * Ptps in range	51	100.0%	0	.0%	51	100.0%
total # defects * Ptps in range	51	100.0%	0	.0%	51	100.0%
norm defects * Ptps in range	46	90.2%	5	9.8%	51	100.0%
defect rate * Ptps in range	51	100.0%	0	.0%	51	100.0%
total time spent * Mtg in range	50	98.0%	1	2.0%	51	100.0%
total # defects * Mtg in range	50	98.0%	1	2.0%	51	100.0%
norm defects * Mtg in range	45	88.2%	6	11.8%	51	100.0%
defect rate * Mtg in range	50	98.0%	1	2.0%	51	100.0%
total time spent * PgRate in range	45	88.2%	6	11.8%	51	100.0%
total # defects * PgRate in range	45	88.2%	6	11.8%	51	100.0%
norm defects * PgRate in range	45	88.2%	6	11.8%	51	100.0%
defect rate * PgRate in range	45	88.2%	6	11.8%	51	100.0%
total time spent * AllParams in range	45	88.2%	6	11.8%	51	100.0%
total # defects * AllParams in range	45	88.2%	6	11.8%	51	100.0%
norm defects * AllParams in range	45	88.2%	6	11.8%	51	100.0%
defect rate * AllParams in range	45	88.2%	6	11.8%	51	100.0%

total time spent total # defects norm defects defect rate * Ptps in range

Ptps in range		total time spent	total # defects	norm defects	defect rate
0	Mean	1.11	2.06	.1181985096523632	2.15883838383839
	N	36	36	36	36
	Std. Deviation	.737	1.638	.0946976827655 22	1.819692211750938
1	Mean	2.02	4.80	.1596157171000514	2.49210586798823
	N	15	15	15	15
	Std. Deviation	1.054	3.098	.0885984346520 36	1.316663550032445
Total	Mean	1.38	2.86	.1308037467016646	2.25685823211775
	N	51	51	51	51
	Std. Deviation	.930	2.482	.0938970379158 61	1.681316374540518

total time spent total # defects norm defects defect rate * Mtg in range

Mtg in range		total time spent	total # defects	norm defects	defect rate
1	Mean	1.39	2.90	.13289649581436	2.28199539676011
	N	50	50	45	50
	Std. Deviation	.937	2.493	.093866884494253	1.688677486981977
Total	Mean	1.39	2.90	.13289649581436	2.28199539676011
	N	50	50	45	50
	Std. Deviation	.937	2.493	.093866884494253	1.688677486981977

total time spent total # defects norm defects defect rate * PgRate in range

PgRate in range		total time spent	total # defects	norm defects	defect rate
0	Mean	1.33	2.75	.13284561764798	2.13863113268194
	N	44	44	44	44
	Std. Deviation	.814	2.403	.09495145917717	1.601600967091491
1	Mean	5.00	1.00	.13513513513514	.20000000000000
	N	1	1	1	1
	Std. Deviation	.	.	.	.
Total	Mean	1.41	2.71	.13289649581436	2.09555044084456
	N	45	45	45	45
	Std. Deviation	.973	2.390	.09386688449425	1.609454851121190

total time spent total # defects norm defects defect rate * AllParams in range

AllParams in range		total time spent	total # defects	norm defects	defect rate
0	Mean	1.41	2.71	.13289649581436	2.09555044084456
	N	45	45	45	45
	Std. Deviation	.973	2.390	.09386688449425	1.609454851121190
Total	Mean	1.41	2.71	.13289649581436	2.09555044084456
	N	45	45	45	45
	Std. Deviation	.973	2.390	.09386688449425	1.609454851121190

Ranks

	Ptps in range	N	Mean Rank	Sum of Ranks
total time spent	0	36	20.89	752.00
	1	15	38.27	574.00
	Total	51		
total # defects	0	36	21.36	769.00
	1	15	37.13	557.00
	Total	51		
norm defects	0	32	21.41	685.00
	1	14	28.29	396.00
	Total	46		
defect rate	0	36	24.28	874.00
	1	15	30.13	452.00
	Total	51		

Test Statistics(a)

	total time spent	total # defects	norm defects	defect rate
Mann-Whitney U	86.000	103.000	157.000	208.000
Wilcoxon W	752.000	769.000	685.000	874.000
Z	-3.870	-3.598	-1.600	-1.287
Asymp. Sig. (2-tailed)	.000	.000	.110	.198

a Grouping Variable: Ptps in range

Medium projects

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * Ptps in range	78	100.0%	0	.0%	78	100.0%
total # defects * Ptps in range	78	100.0%	0	.0%	78	100.0%
norm defects * Ptps in range	68	87.2%	10	12.8%	78	100.0%
defect rate * Ptps in range	78	100.0%	0	.0%	78	100.0%
total time spent * Mtg in range	70	89.7%	8	10.3%	78	100.0%
total # defects * Mtg in range	70	89.7%	8	10.3%	78	100.0%
norm defects * Mtg in range	63	80.8%	15	19.2%	78	100.0%
defect rate * Mtg in range	70	89.7%	8	10.3%	78	100.0%
total time spent * PgRate in range	63	80.8%	15	19.2%	78	100.0%
total # defects * PgRate in range	63	80.8%	15	19.2%	78	100.0%
norm defects * PgRate in range	63	80.8%	15	19.2%	78	100.0%
defect rate * PgRate in range	63	80.8%	15	19.2%	78	100.0%
total time spent * AllParams in range	63	80.8%	15	19.2%	78	100.0%
total # defects * AllParams in range	63	80.8%	15	19.2%	78	100.0%
norm defects * AllParams in range	63	80.8%	15	19.2%	78	100.0%
defect rate * AllParams in range	63	80.8%	15	19.2%	78	100.0%

total time spent total # defects norm defects defect rate * Ptps in range

Ptps in range		total time spent	total # defects	norm defects	defect rate
0	Mean	5.07	5.97	.2483937169 8525	1.26558443901863
	N	64	64	57	64
	Std. Deviation	9.825	20.432	.3221617554 25949	.804988374111890
1	Mean	13.13	33.79	2.361308821 72208	2.14758343903145
	N	14	14	11	14
	Std. Deviation	11.177	52.258	3.281856109 783941	1.553092168258100
Total	Mean	6.51	10.96	.5901888074 5738	1.42389195184144
	N	78	78	68	78
	Std. Deviation	10.476	30.300	1.519438342 818596	1.026390515965459

total time spent total # defects norm defects defect rate * Mtg in range

Mtg in range		total time spent	total # defects	norm defects	defect rate
1	Mean	4.94	4.67	.52170456971307	1.24314916966759
	N	70	70	63	70
	Std. Deviation	6.015	6.266	1.543657392821577	.771866222072772
Total	Mean	4.94	4.67	.52170456971307	1.24314916966759
	N	70	70	63	70
	Std. Deviation	6.015	6.266	1.543657392821577	.771866222072772

total time spent total # defects norm defects defect rate * PgRate in range

PgRate in range		total time spent	total # defects	norm defects	defect rate
0	Mean	5.04	4.04	.1725930910794 7	1.22386248721873
	N	52	52	52	52
	Std. Deviation	6.186	4.524	.1902009319880 19	.792571949987778
1	Mean	5.19	8.00	2.172049741435 54	1.35132416603005
	N	11	11	11	11
	Std. Deviation	7.005	12.223	3.310524415221 620	.855047642294734
Total	Mean	5.07	4.73	.5217045697130 7	1.24611770097944
	N	63	63	63	63
	Std. Deviation	6.276	6.575	1.543657392821 577	.798135503860912

total time spent total # defects norm defects defect rate * AllParams in range

AllParams in range		total time spent	total # defects	norm defects	defect rate
0	Mean	4.56	3.72	.22378186169079	1.21501944659 486
	N	60	60	60	60
	Std. Deviation	5.888	4.314	.2409335023860 12	.779725462678 415
1	Mean	15.33	25.00	6.4801587301587 3	1.86808278867 103
	N	3	3	3	3
	Std. Deviation	5.686	12.000	4.0297985391408 82	1.09689873921 4931
Total	Mean	5.07	4.73	.52170456971307	1.24611770097 944
	N	63	63	63	63
	Std. Deviation	6.276	6.575	1.5436573928215 77	.798135503860 912

Ranks

	Ptps in range	N	Mean Rank	Sum of Ranks
total time spent	0	64	35.47	2270.00
	1	14	57.93	811.00
	Total	78		
total # defects	0	64	35.60	2278.50
	1	14	57.32	802.50
	Total	78		
norm defects	0	57	31.75	1809.50
	1	11	48.77	536.50
	Total	68		
defect rate	0	64	37.39	2393.00
	1	14	49.14	688.00
	Total	78		

Test Statistics(a)

	total time spent	total # defects	norm defects	defect rate
Mann-Whitney U	190.000	198.500	156.500	313.000
Wilcoxon W	2270.000	2278.500	1809.500	2393.000
Z	-3.366	-3.310	-2.615	-1.759
Asymp. Sig. (2-tailed)	.001	.001	.009	.079

a Grouping Variable: Ptps in range

Ranks

	PgRate in range	N	Mean Rank	Sum of Ranks
total time spent	0	52	33.05	1718.50
	1	11	27.05	297.50
	Total	63		
total # defects	0	52	32.83	1707.00
	1	11	28.09	309.00
	Total	63		
norm defects	0	52	27.22	1415.50
	1	11	54.59	600.50
	Total	63		
defect rate	0	52	31.56	1641.00
	1	11	34.09	375.00
	Total	63		

Test Statistics(a)

	total time spent	total # defects	norm defects	defect rate
Mann-Whitney U	231.500	243.000	37.500	263.000
Wilcoxon W	297.500	309.000	1415.500	1641.000
Z	-.990	-.795	-4.499	-.417
Asymp. Sig. (2-tailed)	.322	.427	.000	.677

a Grouping Variable: PgRate in range

Maintenance

Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
total time spent * Ptps in range	96	99.0%	1	1.0%	97	100.0%
total # defects * Ptps in range	96	99.0%	1	1.0%	97	100.0%
norm defects * Ptps in range	95	97.9%	2	2.1%	97	100.0%
defect rate * Ptps in range	96	99.0%	1	1.0%	97	100.0%
total time spent * Mtg in range	96	99.0%	1	1.0%	97	100.0%
total # defects * Mtg in range	96	99.0%	1	1.0%	97	100.0%
norm defects * Mtg in range	95	97.9%	2	2.1%	97	100.0%
defect rate * Mtg in range	96	99.0%	1	1.0%	97	100.0%
total time spent * PgRate in range	95	97.9%	2	2.1%	97	100.0%
total # defects * PgRate in range	95	97.9%	2	2.1%	97	100.0%
norm defects * PgRate in range	95	97.9%	2	2.1%	97	100.0%
defect rate * PgRate in range	95	97.9%	2	2.1%	97	100.0%
total time spent * AllParams in range	94	96.9%	3	3.1%	97	100.0%
total # defects * AllParams in range	94	96.9%	3	3.1%	97	100.0%
norm defects * AllParams in range	94	96.9%	3	3.1%	97	100.0%
defect rate * AllParams in range	94	96.9%	3	3.1%	97	100.0%

total time spent total # defects norm defects defect rate * Ptps in range

Ptps in range		total time spent	total # defects	norm defects	defect rate
0	Mean	1.49	2.22	.17734814015740	1.79558382793677
	N	51	51	50	51
	Std. Deviation	.911	1.847	.231038306677615	1.698485835967565
1	Mean	2.26	3.73	.23394068700604	1.55774591230732
	N	45	45	45	45
	Std. Deviation	1.071	3.732	.234906141294519	1.115938711747703
Total	Mean	1.85	2.93	.20415513603307	1.68409730498547
	N	96	96	95	96
	Std. Deviation	1.057	2.971	.233369614983183	1.452363060858626

total time spent total # defects norm defects defect rate * Mtg in range

Mtg in range		total time spent	total # defects	norm defects	defect rate
1	Mean	1.86	2.93	.20431685214845	1.6783102 6794843
	N	96	96	95	96
	Std. Deviation	1.054	2.971	.23325758769 0965	1.4562192 89527774
Total	Mean	1.86	2.93	.20431685214845	1.6783102 6794843
	N	96	96	95	96
	Std. Deviation	1.054	2.971	.23325758769 0965	1.4562192 89527774

total time spent total # defects norm defects defect rate * PgRate in range

PgRate in range		total time spent	total # defects	norm defects	defect rate
0	Mean	1.85	2.96	.19685186971488	1.6485783411080 6
	N	93	93	93	93
	Std. Deviation	1.007	3.011	.221694784456497	1.4007134909447 94
1	Mean	3.13	1.50	.55143853530951	.90000000000000
	N	2	2	2	2
	Std. Deviation	2.652	.707	.588741914588625	.98994949366116 7
Total	Mean	1.87	2.93	.20431685214845	1.6328187970847 3
	N	95	95	95	95
	Std. Deviation	1.050	2.987	.233257587690965	1.3936825039878 99

total time spent total # defects norm defects defect rate * AllParams in range

AllParams in range		total time spent	total # defects	norm defects	defect rate
0	Mean	1.88	2.96	.19774587044116	1.645949062215 6
	N	93	93	93	93
	Std. Deviation	1.058	3.011	.22127151527874 6	1.403224703738 269
1	Mean	1.25	2.00	.96774193548388	1.600000000000 00
	N	1	1	1	1
	Std. Deviation	.	.	.	.
Total	Mean	1.87	2.95	.20593731794162	1.645461077431 97
	N	94	94	94	94
	Std. Deviation	1.055	2.996	.23397008901342 0	1.395668141906 439

Ranks

	Ptps in range	N	Mean Rank	Sum of Ranks
total time spent	0	51	35.87	1829.50
	1	45	62.81	2826.50
	Total	96		
total # defects	0	51	42.49	2167.00
	1	45	55.31	2489.00
	Total	96		
norm defects	0	50	44.74	2237.00
	1	45	51.62	2323.00
	Total	95		
defect rate	0	51	49.66	2532.50
	1	45	47.19	2123.50
	Total	96		

Test Statistics(a)

	total time spent	total # defects	norm defects	defect rate
Mann-Whitney U	503.500	841.000	962.000	1088.500
Wilcoxon W	1829.500	2167.000	2237.000	2123.500
Z	-4.760	-2.359	-1.215	-.434
Asymp. Sig. (2-tailed)	.000	.018	.224	.664

a Grouping Variable: Ptps in range