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Analysis of ISBSG Data for Understanding Software Testing Efforts

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Questions we will try to answer

- ✓ **Q1.** How does functional size relate to software testing efforts?
- ✓ **Q2.** What are the typical test productivity ranges?
- ✓ **Q3.** What are the influences of reviews on test efforts?
- ✓ **Q4.** What is the effect of % life cycle efforts spent on testing?
- ✓ **Q5.** Does automated testing affect test efforts?
- ✓ **Q6.** What is the influence of application domains & engineering approaches on testing efforts?

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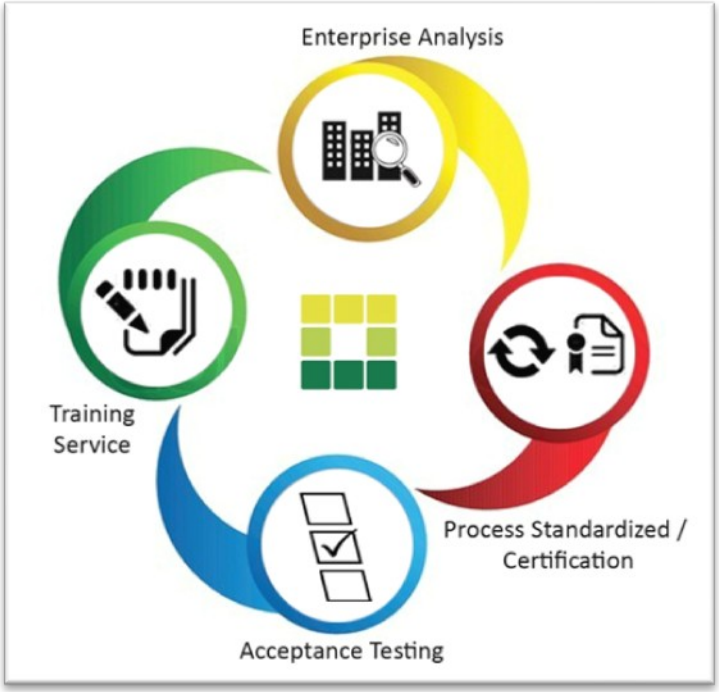
About Amitysoft

- Software Process Engineering Consulting, Measurements Programs, COSMIC Function Point consulting & implementation
- Software Testing – functional, load, acceptance testing
- Training – Corporate and Individual training
- Enterprise Business Process Analysis & Solutions



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Data Subset for Analysis

ISBSG R12 Data contains data of 6006 projects

Data subset selected for analysis: **Set A**

- Data Quality Rating = A or B
- UFP Rating = A or B
- Application Group = Business Application
- Development Type = New Development
- FSM = COSMIC or IFPUG4+
- Architecture = Web, Client/ Server, Blanks (in case of blanks architecture was determined by checking other related columns and included in the data set)
- Test Effort > 16 hours
- Functional Size <= 3500
- Normalized Work Effort >= 80 hrs

Total number of projects in this subset = 191

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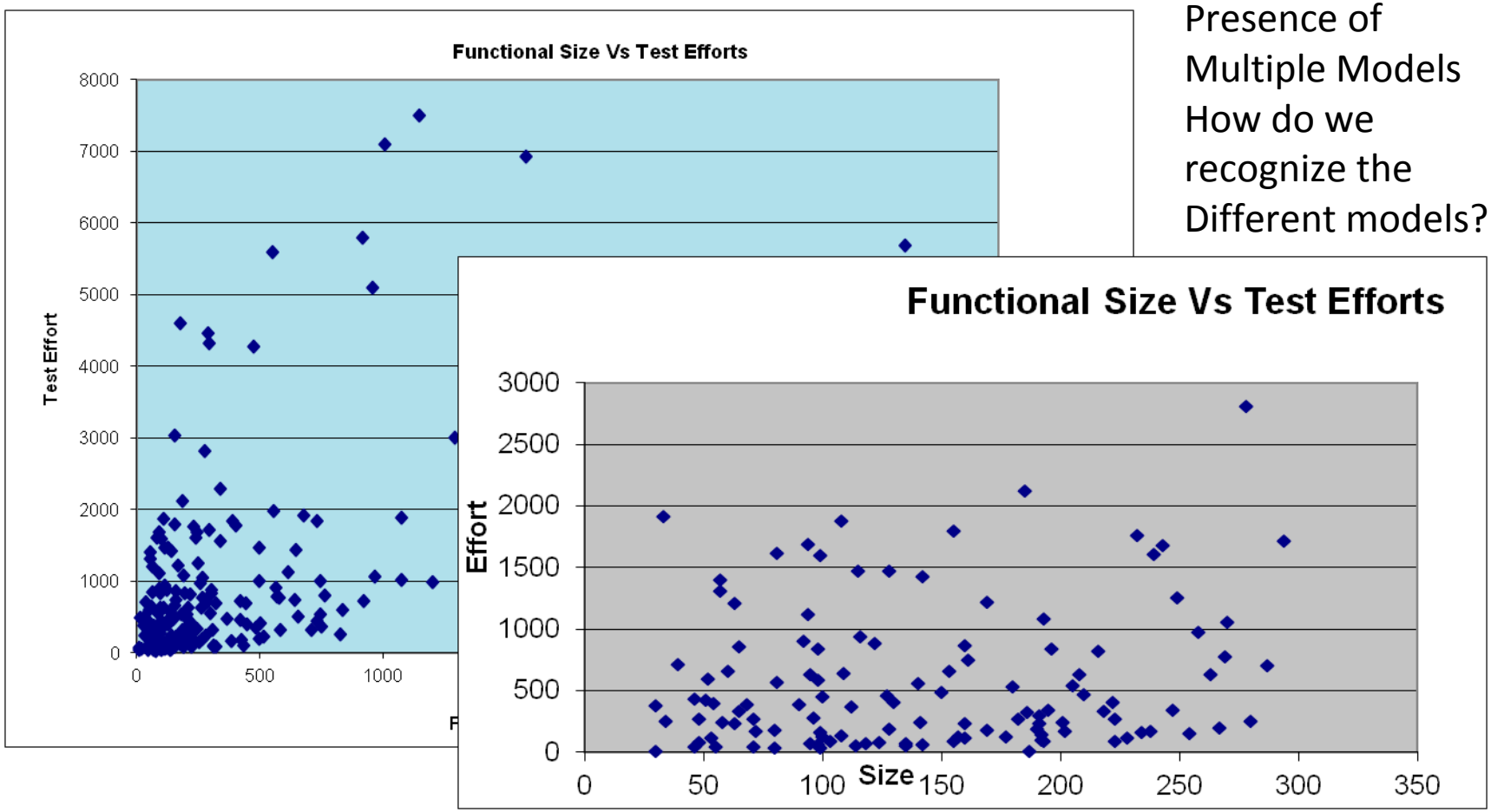
Size vs. Test Effort Scatter Diagram (Data Set A)



Presence of Multiple Models How do we recognize the Different models?

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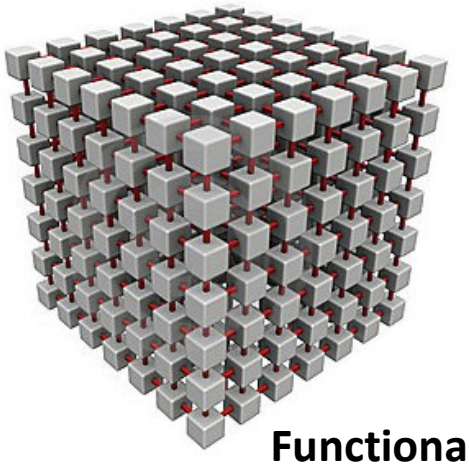
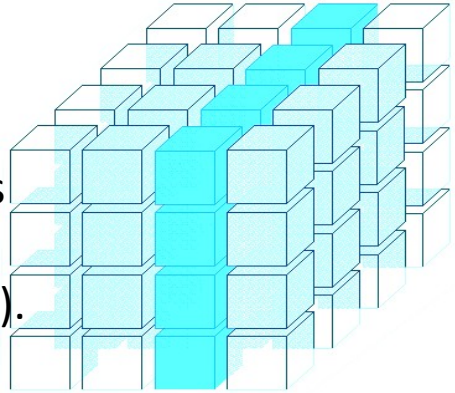
Slices & Dices – Sizes & Test Delivery Rates



Functional Size Range (IFPUG FP/ COSMIC FP)	Test Delivery Rate (Hrs/ Functional Size)
30 - 50	0.16 – 9.4
51 - 100	0.6 – 13.15
101 – 200	0.36 – 11.48
200 - 300	0.49 – 10.11

Functional Size:
Projects size measured using
either IFPUG FPA **or** COSMIC Function Point.
Test Delivery Rate (TDR):
Measures the rate at which software functionality is
Tested as a factor of the effort required to do so.
Expressed as Hours per Functional Size Unit (hr/ FSU).



Test Delivery Rate does not depend on the Functional size!

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Identification of 3 distinct Test Delivery Rate ranges (Data Set A)

TDR	N	MIN	P10	P25	P50/ Median	P75	Max	Mean	Stdev
ALL	191	0.0233	0.46	0.82	2.22	5.83	32.87	4.47	5.57
< 1 hr/ FSU	53	0.24	0.35	0.43	0.59	0.74	0.99	0.59	0.20
1 - 3 hr/ FSU	55	1.04	1.18	1.34	1.73	2.29	2.97	1.84	0.59
> 3 hr/ FSU	79	3.04	3.76	4.56	6.92	11.48	32.87	9.09	6.15

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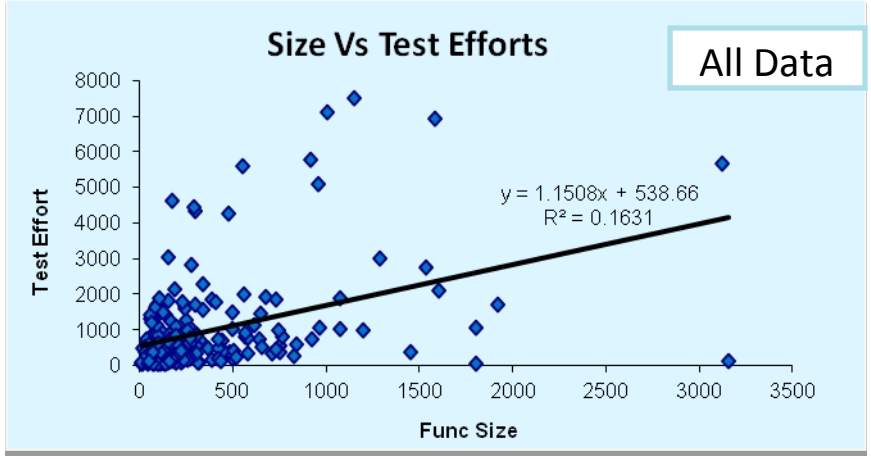
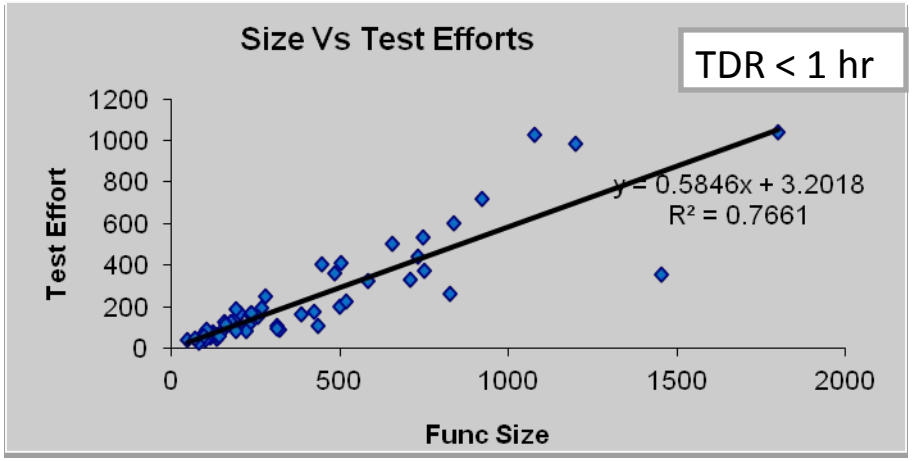
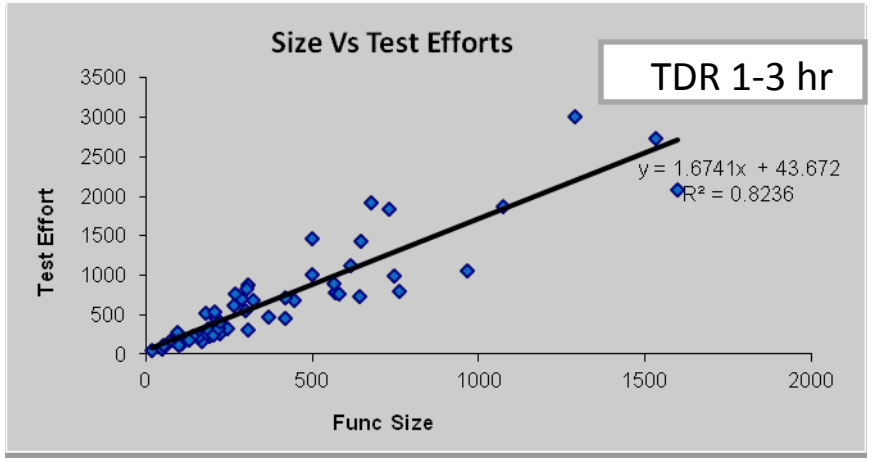
TDR based models: (Data Set A)







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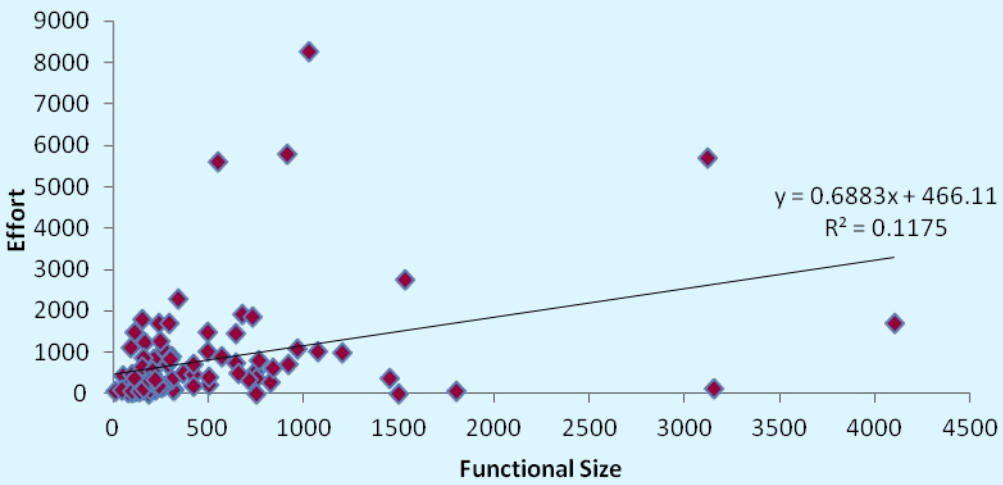
Data Set B – *more homogeneous*

Data selected for analysis: **Set B**

- Data Quality Rating = A or B
- Application Group = Business Application
- Development Type = New Development
- FSM = COSMIC or IFPUG4+
- **Architecture = Web, Client/ Server (Blanks excluded)**
- Test Effort > 16 hours
- Functional Size <= 3500
- Total number of projects in this subset of data = **95**



Homogeneous data set of Business applications, new development, client/server or web architecture

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Identification of 3 distinct Test Delivery Rate ranges (Data Set B)

	Test Delivery Rate - Key Statistics								
N	P10	P25	P50/ Median	P75	P90	Min	Max	Mean	SD
95	0.357	0.583	1.142	2.917	6.583	0.004	12.800	2.357	2.791
	Test Delivery Rate - Key Statistics for Low Test Effort Projects (Less than 1 hr per functional size)								
N	P10	P25	P50/ Median	P75	P90	MIN	MAX	Mean	SD
36	0.33	0.41	0.58	0.73	0.80	0.24	0.95	0.6	0.191
	Test Delivery Rate - Key Statistics for Average Test Effort Projects (1 hr to less than 3 hrs per functional size)								
N	P10	P25	P50/ Median	P75	P90	MAX	MIN	Mean	SD
23	1.07	1.28	1.59	2.12	2.58	2.89	1.04	1.72	0.566
	Test Delivery Rate - Key Statistics for High Test Effort projects (Above 3 hrs per functional size)								
N	P10	P25	P50/ Median	P75	P90	MAX	MIN	Mean	SD
11	3.29	3.69	4.30	4.95	6.90	8.3	3.08	4.7	1.611

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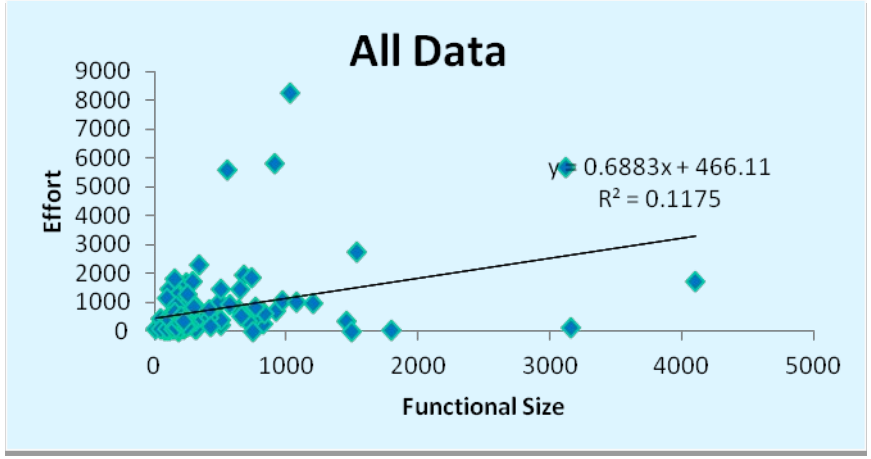
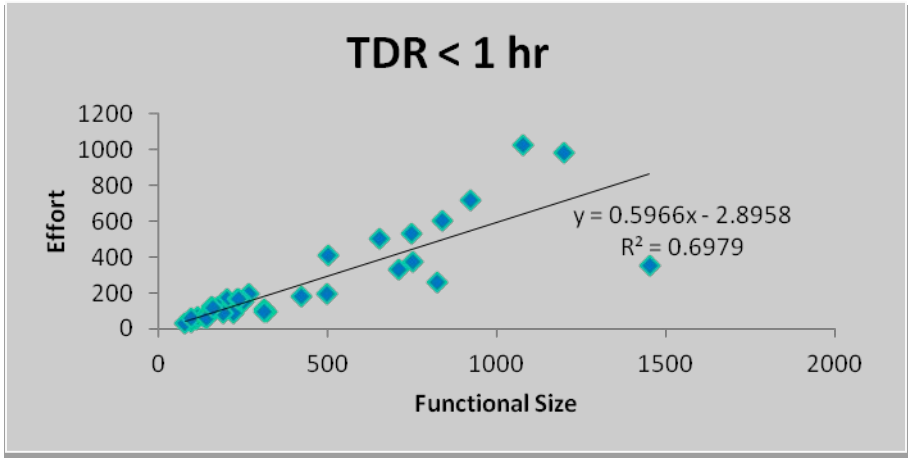
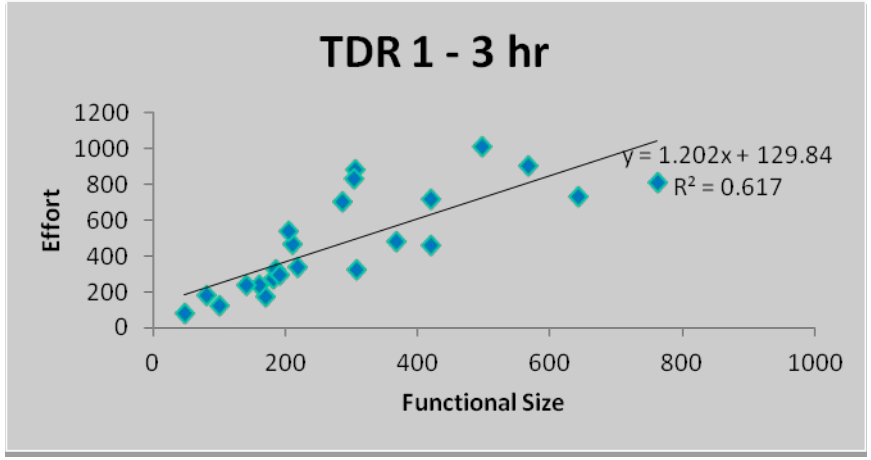
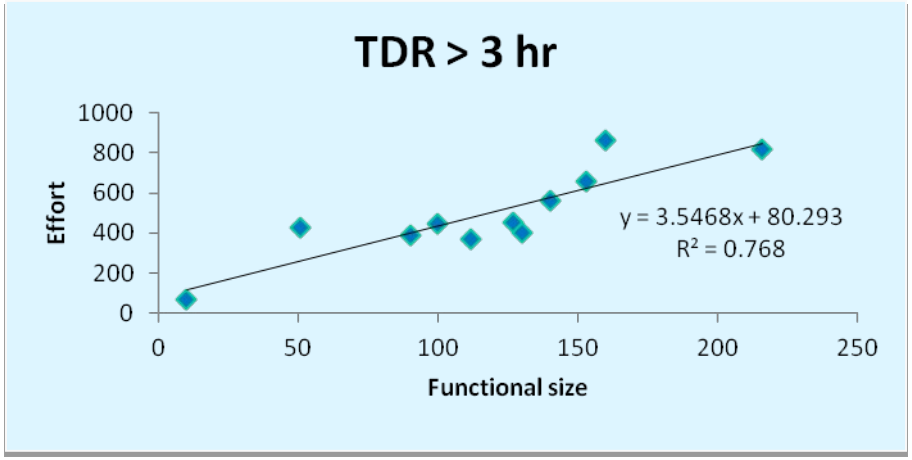
TDR based models: (Data Set B)









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Standard Test Delivery Rate based Models

TDR based individual model can be grouped into:

- Low Test Efforts consuming Less than 1 hr/ functional size – (**LTE**)
- Average Test Efforts consuming between 1 hr and < 3 hrs/ functional size –(**ATE**)
- High Test Efforts consuming > 3 hrs per functional size – (**HTE**)

These models are consistent between the larger data set (Data Set A) and its sub set (Data Set B)

Can we dwell deeper into analysis of other project characteristics to understand each of these 3 models better?

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Discussions on 'extreme values'

Base data for each data set contain data from all projects which include extreme values at low and higher end.

A few projects exist with extreme values that can affect the individual model.

Test delivery rate such as 24, 26, 34 hrs per functional size are present as a part of HTE (> 3 hrs per functional size) model.

- Most of these projects are of Banking Domain.
- One of the projects developed using 'Assembler'
- Two of the projects are related to 'Security'.
- There is no clear pattern emerges of such extreme behavior.

Test delivery rate such as 0.001, 0.01, 0.03 hrs per functional size are present as a part of LTE (< 1 hrs per functional size model).

- Such projects have taken test hours less than 16 hrs OR
- Test hrs spent per functional size does not justify considering those projects for analysis.

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Q3. What are the influences of reviews on test efforts (**Data Set B)**

Category	Specification Reviews		Design Reviews		Code Reviews	
	Data Set B	Data Set A	Data Set B	Data Set A	Data Set B	Data Set A
Low Test Efforts	16	17	17	17	14	14
Avg. Test Efforts	4	4	6	8	5	7
High Test Efforts	4	4	4	6	4	7
Total Projects	24	25	27	31	23	28
Low Test Efforts%	**67**	**68**	**63**	**55**	**61**	**50**
Avg. Test Efforts%	17	16	22	26	22	25
High Test Efforts%	17	16	15	19	17	25

1. Significantly higher no of projects with **Specs reviews =** lower test efforts.
2. Majority projects with **Design Reviews** = lower test efforts.
3. Large number of projects with **Code reviews =** lower test efforts.
4. Test Effort = average or high with **no review** (Spec, Design & Code).

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What if data is heterogeneous? Data Set C

Data subset selected for analysis: Set C

Data Quality Rating = A or B

Application Group = Business Application

Development Type = New Development & Enhancement & Re-development

FSM = COSMIC or IFPUG4+

Architecture = Web, Client/ Server, (Blanks excluded)

Total number of projects in this subset of data = **178**

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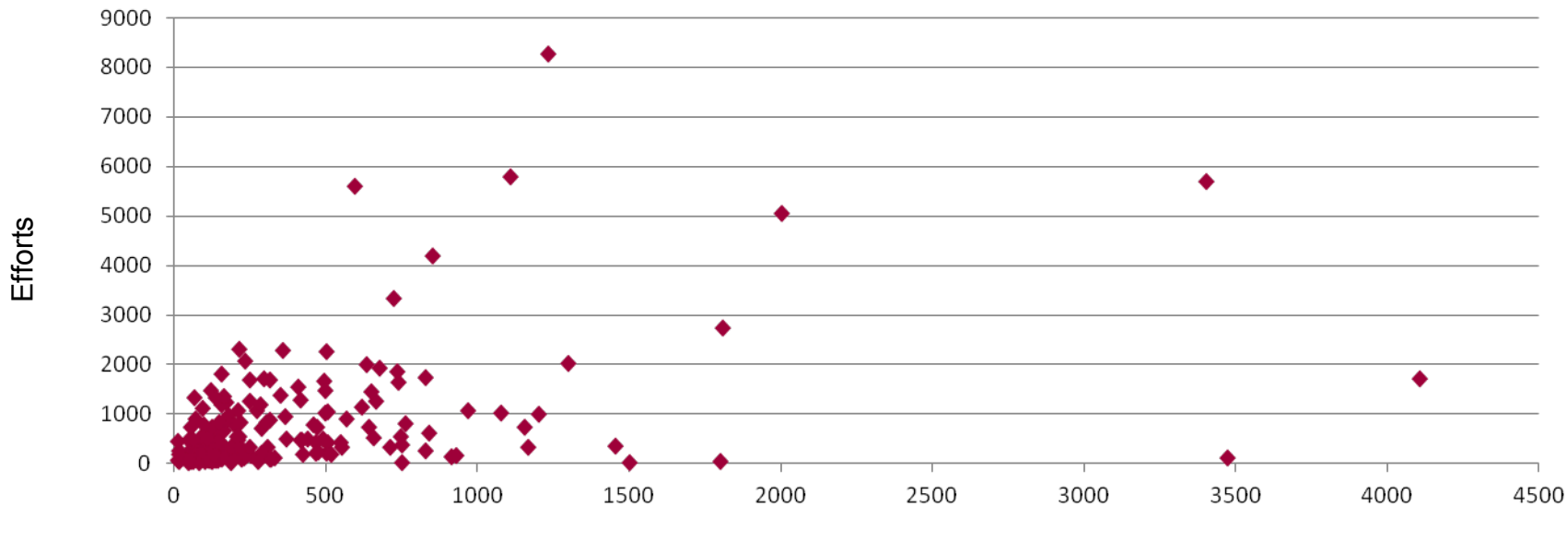
Scatter Diagram for Heterogeneous Data Set C



	Test Delivery Rate (Hrs/ Functional Size) - Key Statistics								
N	P10	P25	P50/ Median	P75	P90	MIN	MAX	Mean	SD
178	0.37	0.72	1.87	4.60	7.68	0.004	45.20	3.36	4.581

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Test Delivery Rate Ranges for Data Set C

Business Applications (Development, Enhancement & Redevelopment)

	Test Delivery Rate - Key Statistics for Low Test Effort Projects (Less than 1 hr per functional size)								
N	P10	P25	P50/ Median	P75	P90	MIN	MAX	Mean	SD
52	0.28	0.38	0.49	0.72	0.82	0.15	0.98	0.54	0.22

	Test Delivery Rate - Key Statistics for Average Test Effort Projects (1 hr to less than 3 hrs per functional size)								
N	P10	P25	P50/ Median	P75	P90	MIN	MAX	Mean	SD
51	1.11	1.34	1.73	2.36	2.74	1.01	2.99	1.86	0.59

	Test Delivery Rate - Key Statistics for High Test Effort projects (Above 3 hrs per functional size)								
N	P10	P25	P50/ Median	P75	P90	MIN	MAX	Mean	SD
64	3.47	3.99	5.22	7.67	11.41	3.08	20.02	6.37	3.36

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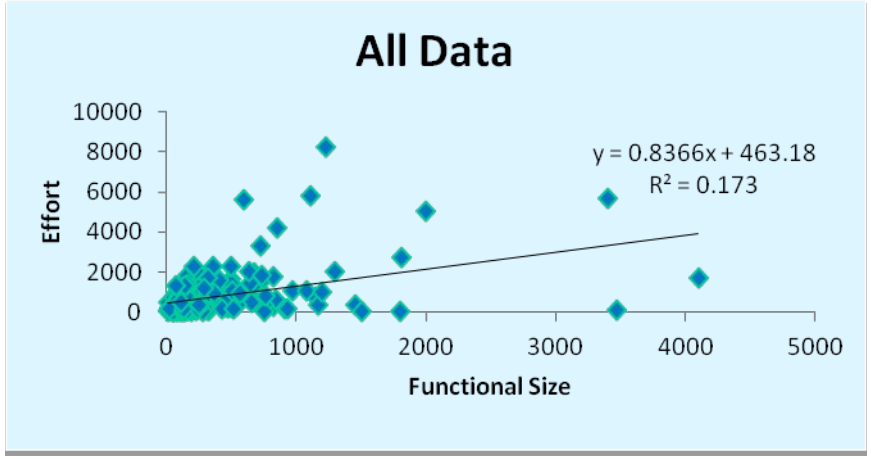
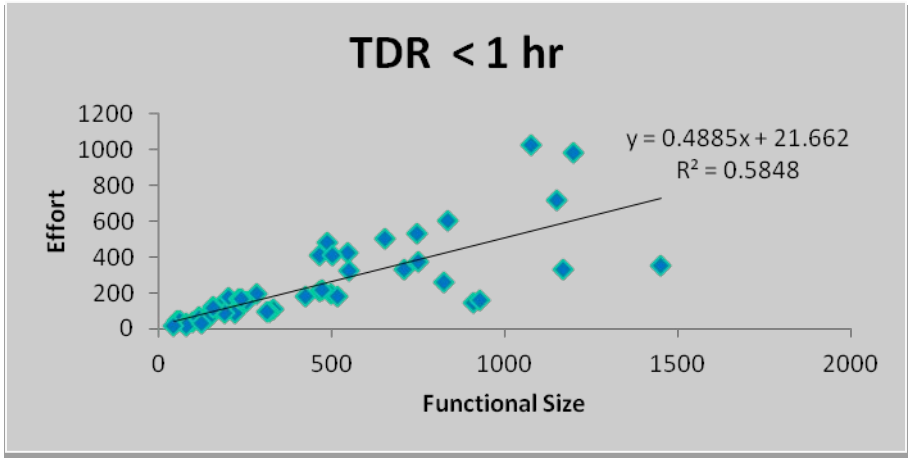
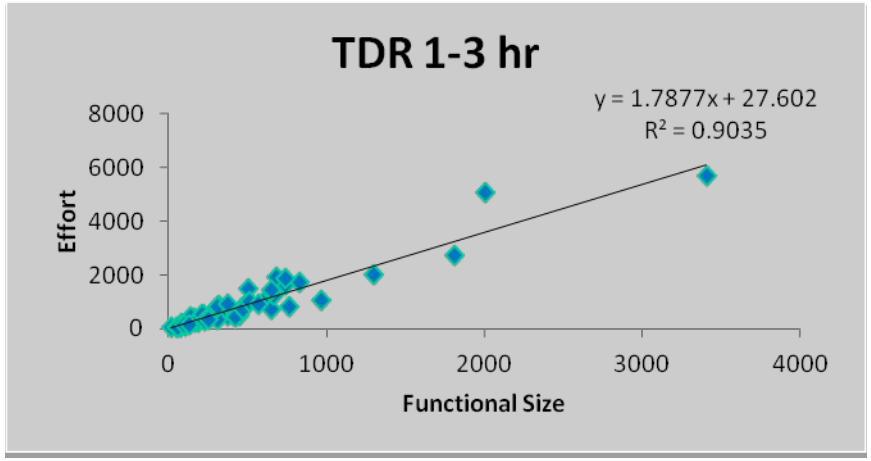
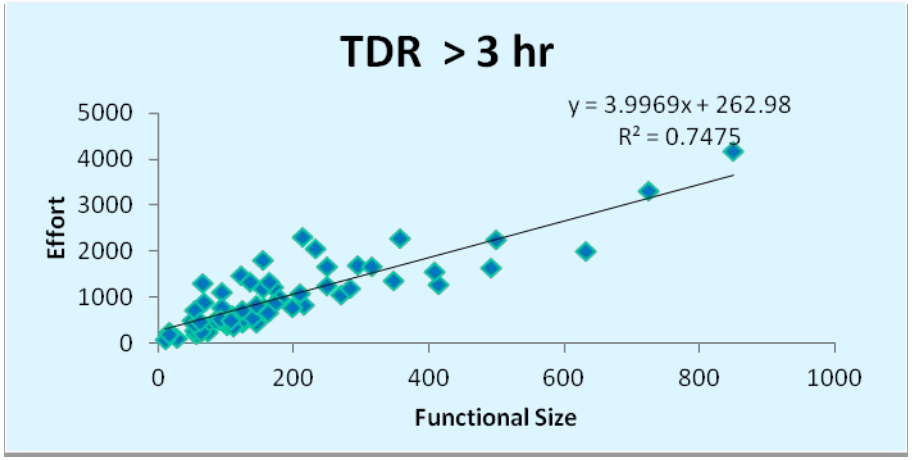
Test Delivery Rate based models: (Data Set C)









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Engineering characteristics for Data Set C

Category	Specification Reviews	Design Reviews	Code Reviews
Low Test Efforts	24	22	18
Avg. Test Efforts	12	12	14
High Test Efforts	9	12	13
Total Projects	45	46	45
Low Test Efforts%	**53**	**48**	**40**
Avg. Test Efforts%	27	26	31
High Test Efforts%	20	26	29

We have again similar observations!

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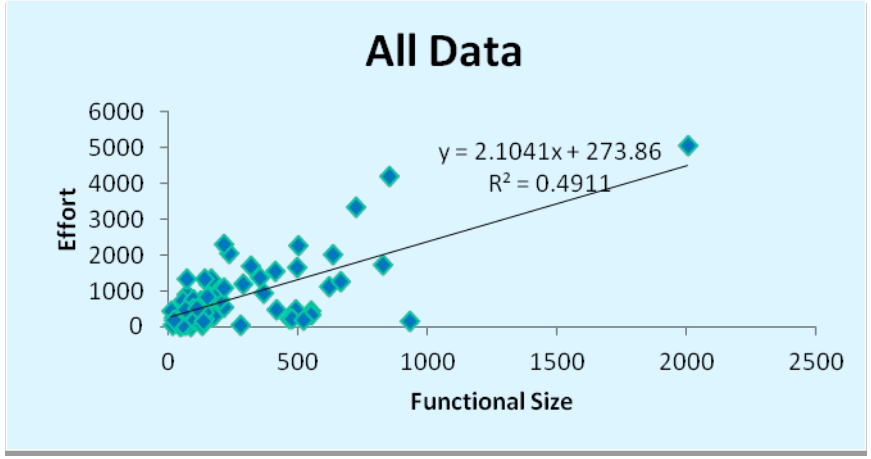
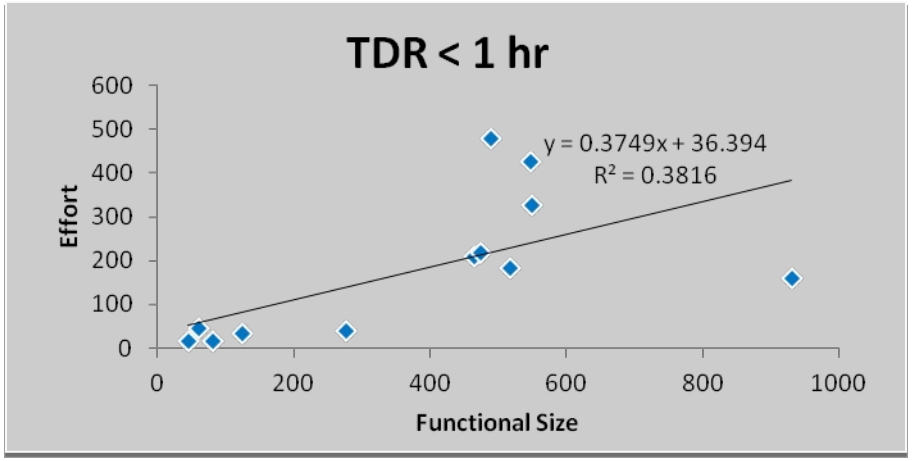
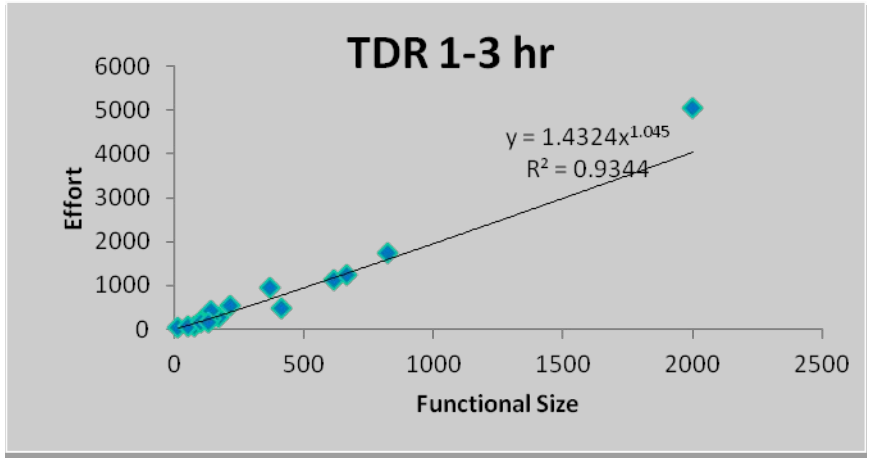
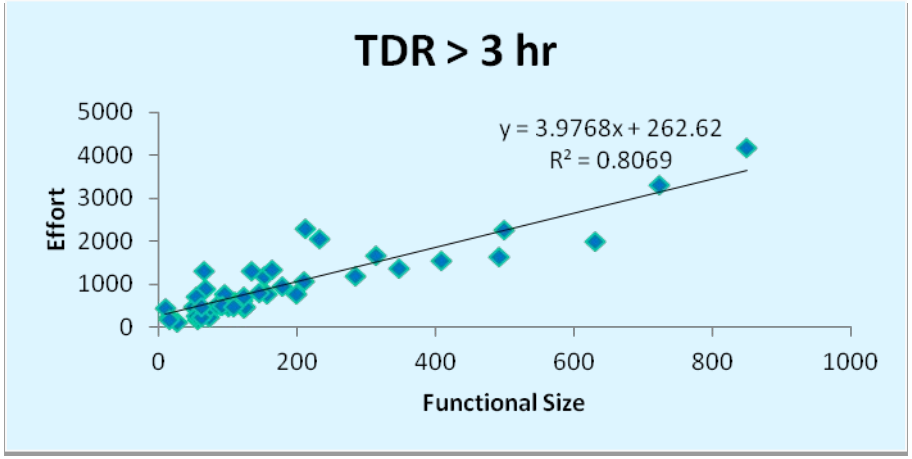
Test Delivery Rate Models for Business Applications - Enhancements









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What with COSMIC? Data Set D

Data subset selected for analysis: Set D

Data Quality Rating = A or B

Application Group = Business Application

Development Type = New Development

FSM = COSMIC

Architecture = Web, Client/ Server, (Blanks included)

Total number of projects in this subset of data = **113**

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Test Delivery Rate Ranges & RSQ for COSMIC

Sample Code	N	MIN	P10	P25	P50	P75	Max	Mean	Stdev	RSQ
Base Sample	113	0.2844	0.47	1.05	2.90	7.23	32.87	5.46	6.31	0.30
< 1 hr / FSU	53.00	0.24	0.35	0.43	0.59	0.74	0.99	0.59	0.20	0.77
Bet 1 & 3 hrs / FSU	56.00	1.04	1.18	1.34	1.73	2.29	2.97	1.84	0.59	0.91
> 3hrs / FSU	79	3.04	3.76	4.56	6.92	11.48	32.87	9.09	6.15	0.74

COSMIC Measured Project Data has better RSQ values for regression Between COSMIC Functional Size and Effort

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Q4. Effect of % life cycle efforts spent on testing

Statistic	Low TE Projects	Average TE Projects	High TE Projects
N	53	55	74
Min	0.01	0.03	0.07
P10	0.04	0.34	0.17
P25	0.06	0.09	0.19
Median/P50	0.11	0.12	0.27
P75	0.15	0.16	0.36
Max	0.38	0.41	0.58
Mean	0.12	0.14	0.28
Std Dev	0.08	0.08	0.11

% Life cycle efforts for testing:
11% - 15% for Low Test Effort Projects,
12 % - 16% for Average Test Effort Projects and reaches
27% - 36% for High Test Effort Projects in P50 – P75.

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Question 5: Effect of automated testing?

Category	Projects Reporting Automated Testing
Low Test Effort (< 1 hr/ functional size)	11
Average Test Effort (< 1 hr/ functional size)	0
High Test Effort (< 1 hr/ functional size)	1
Total	12
Low Test Effort Projects %	92
Average Test Effort Projects %	0
High Test Effort Projects %	8

- Over 90% of the projects reporting test automation fall in Low Test Effort Category.
- Does it mean automated testing reduces overall test efforts?
- What kind of test automation? What type of automated tools? No information available in the data base.

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Question 6: Effect of Processes Models & Domains

Low Test Effort Projects:

- Software Processes: CMMI & PSP
- Major Domains: Education, Banking & Government

Average Test Effort Projects:

- Software Processes: CMMI
- Major Domains: Government, Banking & Manufacturing

High Test Effort Projects:

- Software Processes: CMMI
- Major Domains: Banking (70%)
- Banking applications & CMMI models appear predominantly in High Test Effort projects.
- Education/ Government & PSP models appear predominantly in Low Test Effort Projects.
- CMMI usage appears in all categories without data specific to engineering artifacts & reviews.

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Conclusions

Estimation models for Testing grouped into 3 categories:

1. Low Test Effort projects of less than 1 hr per functional size
2. Average Test Effort projects consuming > 1 hr to < 3hr/ functional size
3. High Test Effort projects consuming > 3 hr/ functional size

- **Low Test Effort projects:** characterized by rigorous engineering with more number of specification reviews, design reviews and code reviews than other categories.
- **Low Test Effort projects:** typically in education, government and banking domains and **Most of the High TE projects:** in Banking domain.
- **CMMI is used across all categories, PSP is prevalent in Low Test Effort projects**.
- **15- 20% of life cycle efforts put in for testing**; Low Test Effort projects exhibits lower percentage and higher Test Effort projects exhibits higher percentage.
- **COSMIC** measured project data displays better RSQ Values for Functional size vs Test Effort correlation.
- **Automated testing consume less than 1hr/ functional size** while manual testing consumes more efforts? *(Need more data & further analysis)*

Feedback & Acknowledgements

Improving ISBSG Database:

1) Release a report based on Testing (core presented in this presentation)
2) Collect Test Effort data in detail:
   Effort – Test: Data for testing efforts can be refined to capture Effort – Manual Testing, Effort – Automated Testing (Functional), Efforts – Performance Testing, Efforts – Security Testing, Efforts – Other Testing.
3) Start collecting data from testing only projects and produce benchmarks which would be useful for vendors of testing services.

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Lakshna, daughter of Jayakumar, 4th year University Student of M.S. (Software Engineering), VIT University, India helped in statistical analysis.

THANK YOU FOR LISTENING

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