Project Sizing and Estimating: A Case Study Using PSU, IFPUG and COSMIC

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Abstract. From the late '70s on, Albrecht's Function Point Analysis provided an insightful way to size a software system moving from the elicitation of Functional User Requirement (FUR), making an evaluation more objective than done before using Lines of Code (LOC). This technique has currently a plenty of variants, some of them become international de jure standards (e.g. COSMIC, NESMA, Mark-II and FISMA) - called FSM (Functional Size Measurement) methods - and they are widely adopted worldwide. A common problem when using a FSM for estimation purposes is that the software size (that is a product measure, referring only to its functional side) is used as the solely independent variable to estimate the overall project effort, that includes the effort of both the functional and non-functional activities within the project's boundary, as currently stressed more and more in the Scope Management field, also in the Software Engineering domain (see NorthernScope and SouthernScope approaches), not knowing neither the approximated distribution between the two parts. This missing information, usually not gathered in projects' repositories, can be one of the reasons leading to a lower capability in estimating project effort.

In 2003, a new technique called PSU (Project Size Unit) come out with the aim to size the 'project' entity from a Project Management viewpoint. It can be used alone or jointly with a FSM unit. In the second case, the joint usage of the two values can improve what a FSM cannot measure and therefore estimate, that is the non-functional side of a software project. This paper presents a case study with 33 projects measured both with IFPUG FPA and COSMIC methods as well as with PSU, showing the obtained results using the different sizes for estimating the overall effort, and providing a rationale for the better results with PSU.

Keywords: Estimation, Function Points, Project Size Unit (PSU), Case Study, Non-Functional Requirements, Scope Management.

1 Introduction

When dealing with every activity in the real world, a common strategy is firstly to apply a top-down view on the entity of interest and then to refine and integrate

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information with a bottom-up view. Shifting this concept to the estimation process, we need before to shape the logical boundary for the activity to perform, in order to properly understand – approximately - the amount of resources needed and consequently the time and costs such activity will require.

But when a software project must be analyzed in the feasibility phased and then planned, the above described approach often seems to be difficult to be applied. Observing the experiences in ICT companies as well as reading them in technical papers, it seems there is a large distance between the experiential estimations and a statistical usage of its own project data. And there is a tendency to use very few numbers – typically product measures - in order to estimate time and costs for the overall project.

During last years the "*scope management*" approach from the Project Management domain [1] come in also in the Software Engineering one: some examples are the SouthernScope [2] and the NorthernScope [3] approaches, integrating the usage of functional size measurement methods with other values and thoughts able to properly represent the whole project' scope. Again, another technique called Project Size Unit (PSU) was created in 2003 for trying to catch the overall project size and some experiences have been done with it [4].

The objective of this paper is to describe the PSU technique and discussing the way it can be used with or without a FSMM for refining project's estimations, taking always in mind that the final goal is to achieve improvements in estimating projects, and that size units – whatever they are – are the way to reach that goal, not the goal itself.

Section 2 discusses the estimation issue using a FSM method, delimiting the scope and boundary for such methods. Section 3 presents the basics for PSU and the way it can be also used jointly with a FSMM. Section 4 presents a case study with the analysis of 33 sample projects sized with IFPUG v4.2 [5], COSMIC v2.2 [6] and PSU v1.01 [7], proposing first results and thoughts for improving project estimations. Section 5 will conclude with a summary of what discussed and next work planned on this issue.

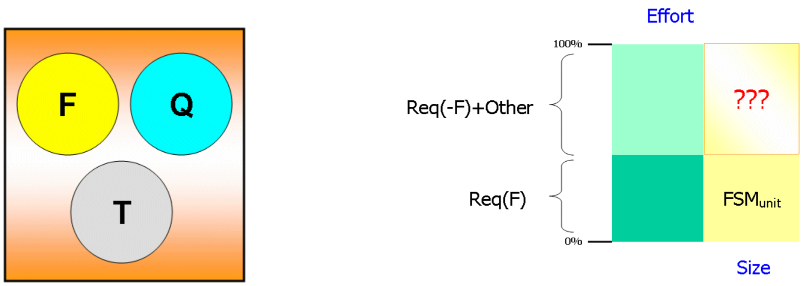
2 FSM and Estimation

2.1 What a FSM Method Size (And What Not)

According to the ISO/IEC 14143-1 standard [8][9], a functional size measurement method (FSMM) takes into account only the so-called FUR (Functional User Requirements), discarding the other ones – explicit and implicit ones – called in the latest version simply "non-functional requirements"[1]. Figure 1 shows the 1998 (software) product requirement classification into F/Q/T types and the relationships between Effort and Size against the project requirement types.

The direct consequences from this ISO clarification was the exclusion of the adjustment factors in the FSMM methods standardized from the final value (i.e. the ISO/IEC 20926:2003 for IFPUG CPM v4.1 considers only the first five steps in the calculation process, calculating the solely UFP value). The rationale is that the

[1] The 1998 version [8] split the non-functional part into Quality and Technical Requirements. This requirement classification for a software product (F/Q/T) was also received by IFPUG [5].



(a) (b)

Fig. 1. (a) Requirement types according to ISO 14143-1:1998; (b) Relationship between Effort and Size against project requirements (F vs NF)

non-functional side – as initially stated also in first's Albrecht's 1979 paper on FPA [10] – has to be treated separately but in a parallel manner with the functional one. From a mathematical viewpoint, using the non-functional factors as adjustments produces effort under-estimation for such kind of tasks. A simple example can be in IFPUG FPA a TDI value lower than 35 points (therefore a VAF lower than 1): the result would be a negative contribution on the unadjusted functional size, with a lower estimated number of man-days, even if a certain amount of man-days for non-functional activities would be anyway yet spent/planned. Again, from an economical viewpoint, it means that the cost/day of a role typically playing a non-functional job would be lower than those ones playing functional tasks. And it seems to do not properly shape what happens [11].

2.2 Estimation by a Functional Size Unit (fsu) with Some Open Questions

When dealing with whatever functional size unit (fsu), the typical way to estimate the project effort can be derived from:

- a regression equation (i.e. a linear one) based on its own data;
- productivity figures typical from a certain system (i.e. filtering by application type, development type, size range and technology used), according to its own data or from external sources (i.e. ISBSG repository);
- The crossing between the two above information.

Thus, there are some basic and open questions to be answered:

- Productivity, as currently defined and applied, is given by the ratio between the number of fsu and the overall project effort. It can be defined a 'nominal' productivity. Being the upper value referable to a product (and only for its functional portion), while the lower value refers to the overall project (including therefore the effort for all the types of requirements: F/Q/T/O), is it a valuable number to consider for deriving projects estimates?
- Since a fsu is a valid measure only for the functional part of a software product, what about its non-functional part?

3 PSU: Project Size Unit

3.1 Background

In 2003, during the path towards a Sw-CMM [12] ML3 certification process in an organizational unit (OU) of c.a. 80 people from a large ICT multinational company, one of the first questions to solve was to accomplish requirements from the Software Project Planning key process area, requesting to estimate efforts and costs (PP, Ac10), taking care of the overall project scope (PP, Ac2)[2].

Since the projects managed by such OU were typically TLC and Energy/Utility projects with an average 55-65% functional effort, with no enough time to properly train people with a FSMM, the point was to find out another solution for achieving the final goal taking into account also those constraints, but not too revolutionary to require too much extra time to be learned and used.

3.2 Rationale

The idea was to move from the boundary of the activities planned and run within a project, using the same approach Albrecht adopted for FPA, but extending the scope to all the user requirements (UR) a project has, not only FUR (Functional User Requirements), but also the Non-Functional (NFR) ones. From a Project Management viewpoint it means to consider the whole amount of activities included in a WBS, trying to estimate such amount of effort from requirements in an early stage, referring to the ISO 9000 quality definition [13], that includes both explicit and implicit requirements, where both ones generate activities and therefore effort to be estimated and planned within the project boundary.

Looking at Figure 2, our goal was to find out a new measure at the project level for approximating in early stages the overall "project size" and obtain acceptable estimates overcoming the inner scope of a FSMM, that's a functional product size measure. 'Project Size' is a term not yet defined in the ISO/IEEE/PMI glossaries. Our

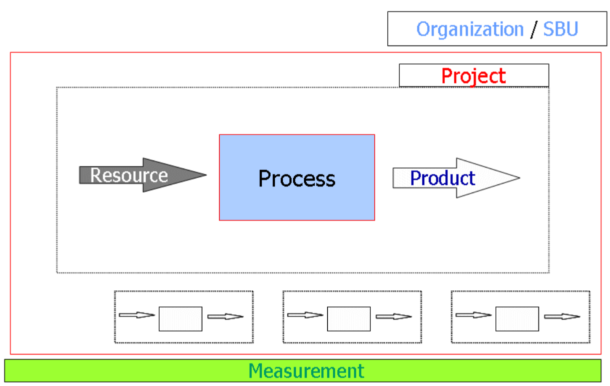


Fig. 2. STAR Taxonomy: measurable entities [14]

[2] The same happens also with the newer CMMI-DEV v1.2 [15] model, where the old SPP key process area was simply renamed Project Planning (PP).

proposal [11], according to the above premise, is to define it as "*the size of a software project, derived by quantifying the (implicit/explicit) user requirements referable to the scope of the project itself*". This term (and our own definition) was proposed to ISBSG for inclusion in a next revision of its Glossary of Terms [16].

Another objective to accomplish was to derive a mechanism valid for internal improvement first, and for external benchmarking in a second moment. The name for this new technique was **P**roject **S**ize **U**nit (**PSU**), definable as project management 'virtual' size technique.

3.3 Calculation Rules

Moving from the above premises, the FPA calculation rule was adapted to a project management logic. UFP are given by the sum of the 5 BFC (Base Functional Components) weighted by complexity.

In PSU the BFC corresponds to the WBS project tasks, firstly classified by nature: Management (M), Quality (Q) and Technical (T). The T-tasks refer to the primary processes, while the M/Q-tasks to the organizational and support processes. Other possible classifications of tasks are by requirement type (functional vs non-functional) and by SLC phase. All these classifications allow to easily gathering from early stages its own project historical data, which represent a foundation for PSU but for any process improvement initiative in general.

As in any good project management guideline, an activity should be always under control. The complexity of tasks is due by the effort of a task. The larger the effort for a task without any control/milestone in the middle, the more complex it is, therefore more risky and with higher probability to request a re-plan during the project lifetime. The PSU formula can be summarized as:

$$PSU = \sum_{i=M,Q,T} \sum_{j=H,M,L} task_i * weight_j \qquad (1)$$

where the weights ranges can vary according to the organizational style and definition for creating projects' WBS and can be easily derived applying on a regular basis Pareto Analysis on the project historical database (PHD). Please refer to the PSU Measurement Manual (MM) for detailed procedures and tips [4].

Another PSU characteristic is to be *general-purpose*: because the BFC are tasks from a project, it has no limitation about application domain, as FSMM. Therefore it can be used for a whatever kind of project (i.e. service, building, performing arts, ..).

3.4 Automating PSU

Since the calculation rule simply counts tasks weighted by effort ranges, differently from a FSMM, PSU can be easily automated from a project WBS within a spreadsheet or – with a macro – directly in any PM tool, needing the time for a 'click' just when creating/modifying your project plan. Requirements for automation are available and an implementation under open source software (GanttProject[3]) was yet done [17]. The added value of an integration of PSU calculation within a PM tool is the possibility to export project's data (i.e. in xml) for an easier creation/update of the

[3] URL: www.ganttproject.org

organizational PHD, allowing several views on project's data as a base for next estimations [18][19].

3.5 PSU: When Calculate Them?

As suggested for FSMM, there are three typical moments in time for calculating it and gather values in the PHD: Feasibility study, Design phase and at the Closure phase.

3.6 PSU and FSM Methods

PSU is definable as a 'virtual' size measure because, differently from a FSMM, it needs an experiential/analogous estimate to produce a more refined estimate, compared with the 'organizational memory' (the PHD). Since the reduced time to calculate PSU, it can be used easily by SMEs what could not have time or resources for learning and applying a FSMM.

But it is possible also to use jointly PSU and FSMM: the advantage could be in early estimating the whole project effort with PSU with a better approximation than an early FSM method and after to fully calculate (also for contractual quests) fsu at the end of the Design and Closure phases.

3.7 PSU: Internal vs. External Comparability

IFPUG FPA allows an external comparability among projects worldwide because the system of weights and BFC ranges is the same from 1984 and never more modified. PSU born firstly as a technique for internal improvement, therefore changing periodically weights and effort ranges according to the closed projects entering into the PHD and reshaping the regression equations based on the updated database. In order to use PSU for external comparability, it is sufficient to make stable weights and effort ranges during time and/or among interested stakeholders [20].

3.8 PSU: Available Assets

All the PSU assets are freely available on the SEMQ website[4] in several languages[5]. Nowadays the downloadable assets are:

- Measurement Manual [4];
- MS-Excel calculation sheet (traditional / agile projects);
- Requirements for automating PSU [19].

4 A Case Study

4.1 Background and Objectives

During a B.Sc. 2006-07 Software Engineering course at the University of Alcalà de Henares (UAH, Spain), some students worked on learning and applying FSM methods such as IFPUG and COSMIC methodologies. Moving from a previous B.Sc.

[4] PSU webpage: www.geocities.com/lbu_measure/psu/psu.htm
[5] English, Spanish, Italian.

study about the conversion between IFPUG v4.2 and COSMIC v2.2 fsu, where 33 medium-sized projects were measured using both FSM methods [21] with a verification of the FSM count by an experienced senior measurer, the same projects were also sized with PSU v1.01 counting rules [22] [23] and some of the research questions above posed was investigated, in particular:

a) the relationship between PSU and IFPUG/COSMIC (if any);
b) which size unit among the three seems to be the better one for such dataset;
c) and of course, why.

4.2 Presentation of Data Sample

The basic data from the 33 sample projects are listed with details in the Annexes at the end of the paper. Some highlights (see Annexes B and C with full details):

- **Application type:** Management (16 projects), Management & Communication (6 projects), Management & Control (7), Management, Communication & Control (2), Application (2);
- **Estimated effort ranges:** From 493 up to 2589 man/days, with an average and median distribution by requirement type closely to 44-56% (F vs. NF). The classification of effort by SLC phase was done using the Spanish Government standard METRICA3 [24].

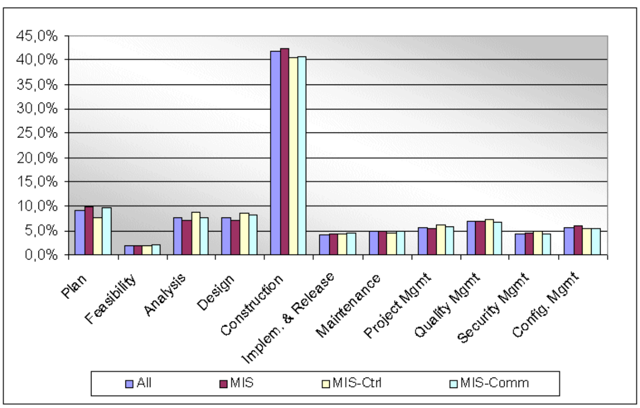


Fig. 3. Effort distribution by SLC phase according to METRICA3 [24]

Some highlights about the sizing measures (see Annexes B and C with full details):

- **Functional Size ranges:** From 109 up to 534 IFPUG UFP; from 41 up to 396 cfsu;
- **PSU weighting system:** The following values where assumed for the PSU calculation on the projects' sample:
  - o Effort: three levels of complexity → High (26+ m/d), Medium (11-25 m/d), Low (0-10m/d);
  - o Weights: H(1.8), M(1.4), L(1.0), that's an initial set of weights we experimented on such sample.

4.3 First Results

Linear regression analysis was performed using the three size units (taking care of their inner differences) in different combinations for building a size unit vs effort (using both the whole dataset and then by application type) estimation model. Since PSU values are the sum of two partial ones, derived from functional (PSU_f) and non-functional (PSU_{nf}) tasks elaboration, also PSU_f size was considered for being compared with IFPUG and COSMIC methods. About the first issue (effort estimation models), Table 1 summarizes the main results obtained (we discarded, obviously, those categories with too less projects):

Table 1. Some Estimation Models derived from the data sample

Id.	Relationship	Formula	R^2	Interpret.
Application Type: All; n=33				
1	PSU vs Effort	Y=4.4988x+183.23	0.5944	😐
2	PSU_f vs Effort	Y=5.1825x+669.97	0.2489	☹
3	UFP vs Effort	Y=-0.2767+1284.3	0.0019	☹
4	Cfsu vs Effort	Y=0.9057x+984	0.030	☹
Application Type: MIS; n=16				
5	PSU vs Effort	Y=5.2508x+145.3	0.7174	☺
6	PSU_f vs Effort	Y=5.5899x+781.62	0.2419	☹
7	UFP vs Effort	Y=-4.4025x+2738.1	0.1317	☹
8	Cfsu vs Effort	Y=0.6503x+1168+5	0.0072	☹
Application Type: MIS & Control; n=7				
9	PSU vs Effort	Y=3.6924x+208.04	0.6114	☺
10	PSU_f vs Effort	Y=5.3581x+500.7	0.4203	😐
11	UFP vs Effort	Y=7.2912x+1274.4	0.4068	😐
12	Cfsu vs Effort	Y=2.2822x+477.99	0.1912	☹
Application Type: MIS & Communication; n=6				
13	PSU vs Effort	Y=6.2849x+197.7	0.7552	☺
14	PSU_f vs Effort	Y=9.3033x+196.07	0.4332	😐
15	UFP vs Effort	Y=1.1943x+686.12	0.1351	☹
16	Cfsu vs Effort	Y=0.594x+917.38	0.0393	☹

From the observation of Table 1 results, it can be noted that in all cases PSU has a higher correlation with estimated effort than the other fsu, both IFPUG and COSMIC. This can be interpreted as a clear sign that there are some issues in projects that during the estimation phase having an influence on correlation; in particular:

- The non-functional effort (see the higher R^2 values for "PSU vs. effort" cases against the "PSU_f vs. effort" ones);
- A typical fsu is a *product*-level measure, therefore not covering such requirements, tasks and effort related to the *project*-level.

4.4 Applying PSU v1.21: A What-If Analysis

From the time of the comparative analysis, PSU calculation rules were modified. Instead taking into account M/Q tasks as an adjustment for T tasks (as well as VAF did referring to UFP), now all tasks – whatever their nature – are weighted by effort range. The difference comparing the same 33 sample projects sized with PSU v1.01

Table 2. Some Estimation Models derived from the data sample (PSU v1.21)

Id.	Relationship	Formula	R^2	Diff. %	Trend
Application Type: All; n=33					
1	PSU vs Effort	Y=4.2854x+32.067	0.6665	7.21	↑
2	PSU_f vs Effort	Y=5.2603x+222.13	0.6194	37.05	↑
3	UFP vs Effort	Y=-0.2767x+1284.3	0.0019	--	--
4	Cfsu vs Effort	Y=0.9057x+984	0.03	--	--
Application Type: MIS; n=16					
5	PSU vs Effort	Y=5.0612x-65.312	0.7844	0.70	↑
6	PSU_f vs Effort	Y=6.1357x+184.12	0.7129	47.10	↑
7	UFP vs Effort	Y=-4.4025x+2738.1	0.1317	--	--
8	Cfsu vs Effort	Y=0.6503x+1168.5	0.0072	--	--
Application Type: MIS & Control; n=7					
9	PSU vs Effort	Y=3.3145x+139.5	0.6800	6.86	↑
10	PSU_f vs Effort	Y=-1.0351x+1140.1	0.0802	-34.01	↓
11	UFP vs Effort	Y=7.2912x-1274.4	0.4068	--	--
12	Cfsu vs Effort	Y=2.2822x+477.99	0.1912	--	--
Application Type: MIS & Communication; n=6					
13	PSU vs Effort	Y=5.5681x-303.86	0.7094	-4.58	↓
14	PSU_f vs Effort	Y=7.3699x-157.85	0.7499	31.67	↑
15	UFP vs Effort	Y=1.1943x+686.12	0.1351	--	--
16	Cfsu vs Effort	Y=0.594x+917.38	0.0393	--	--

and v1.21 results is an increase close to 17% (see in detail Annex E). The consequence on the results previously presented is in Table 2, updates previous results (UFP and Cfsu results are repeated for making easier the reading of results).

As evincible from the last columns, the new definition introduced in new PSU version returned improved results. In particular, it was noted an improvement using the solely PSU_f part both on MIS projects (+47.10%) as well as for MIS & Communication ones (+31.67%). But also looking at the overall dataset the improvement was notable (+7.21%). On the opposite side, two lower results were noted for MIS & Control projects (-34.01%) and MIS & Communication projects (-4.58%). In order to confirm such first-level results, further validations on new datasets must be done in the near future.

5 Conclusions and Prospects

One of the first and more important activities in any project is the estimation phase. In the Software Engineering domain from the end of '70s on the usage of estimations based on a functional size unit is more and more applied. But the increasing amount of non-functional effort in software projects can reduce the probability to successfully use a fsu as the solely independent variable in a regression analysis. The evidence of such problems and limitation of FSMM is when dealing with new technologies (i.e. DWH, R/T, Web applications), where there is a proliferation of interpretation for the original counting rules.

Looking at Scope Management practices from other application fields, the usage of a 'project-level' size unit can be a possible solution to complement and/or overcome the value brought out from FSMM.

Project Size Unit (PSU) is a proposal emerged in 2003 and freely available, created firstly for internal improvements in estimation practices, intimately based on your own organization historical data, but also available for external usage with an agreement between customer and provider on the weighting system to be adopted.

The paper has presented main outlines for such technique and relationships with two of the most used FSM methods, namely IFPUG and COSMIC FSM. A case study with 33 sample projects was presented, sizing them against IFPUG v4.2, COSMIC-FFP v2.2 and PSU v1.01 methods. The comparison of regression analysis among the three techniques revealed that the proposed size unit (PSU) allows to obtain better effort estimates at the higher SLC phases more than FSM units as IFPUG and COSMIC. The update of PSU counting rules with the newer PSU version v1.21 shown that such changes (counting all tasks as peer types) was right both looking from a conceptual project management viewpoint and at the obtained numerical evidences. In any case, further attention will be paid in analyzing the reasons why for 'MIS & Control' or 'MIS & Communication' projects results are worst.

Next steps will be a further experiment with new projects, using an automated PM tool including PSU algorithm for verifying also the pros & cons in adopting PSU as a project size measure, observing also the effort needed for using it as well as the level of acceptance and feedbacks from estimators in project teams.

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Annex A: List of Acronyms

Acronym	Term / Definition
Ac	Activity
B.Sc.	Bachelor diploma
BFC	Base Functional Components
CMM	Capability Maturity Model
CMMI-DEV	CMM Integration for Development
COSMIC	Common Software Measurement International Consortium
CPM	Counting Practice Manual
DWH	Data WareHouse
F/Q/T	Functional / Quality / Technical
F/Q/T/O	Functional / Quality / Technical / Organizational
FISMA	Finnish Software Metrics Association
FP	Function Point
FPA	Function Point Analysis
FSM	Functional Size Measurement
FSMM	FSM Method
fsu	Functional Size Unit
FUR	Functional User Requirement
ICT	Information & Communication Technology
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IFPUG	International Function Point Users Group
ISBSG	International Software Benchmarking Standards Group
ISO	International Organization for Standardization
KPA	Key Process Area
LOC	Line Of Code
ML	Maturity Level
NESMA	Netherlands Software Metrics Users Association
NF	Non-Functional
NFR	Non-Functional Requirement
OU	Organizational Unit
PA	Process Area
PHD	Project Historical Database
PM	Project Management
PMI	Project Management Institute
PP	Project Planning
PSU	Project Size Unit
R/T	Real/Time
SME	Small-Medium Enterprise
SPP	Software Project Planning
STAR	Software Taxonomy Revised
Sw-CMM	Software Capability Maturity Model
TDI	Technical Degree of Influence
TLC	Telecommunication
UAH	Universidad de Alcalá de Henares
UFP	Unadjusted Function Point
UR	User Requirements
VAF	Value Adjustment Factor
WBS	Work Breakdown Structure

Annex B: Projects' Data – IFPUG FPA v4.2 & COSMIC-FFP v4.2

Id	IFPUG FPA v4.2											COSMIC-FFP v2.2				
Id	Appl.Type	#UR	#ILF/EIF	#EI	#EO	#EQ	UFP (data)	UFP (EI)	UFP (EO)	UFP (EQ)	UFP	E	X	W	R	Cfsu
01	Application	81	14	45	13	14	101	141	54	44	340	74	67	45	48	234
02	MIS	51	6	19	22	41	42	71	88	123	324	56	60	16	36	168
03	MIS & Ctrl.	18	12	36	12	17	92	162	66	66	386	49	112	36	72	269
04	MIS, Ctrl & Comm.	62	12	38	12	12	98	164	55	43	360	62	86	38	24	210
05	MIS, Ctrl & Comm.	54	14	12	93	8	98	40	372	24	534	46	81	10	54	191
06	MIS	38	14	44	6	15	107	132	24	45	308	136	63	87	50	336
07	MIS	63	7	17	15	21	49	72	82	84	287	21	105	16	86	228
08	Comm. & MIS	11	5	16	5	0	35	54	20	0	109	21	23	15	6	65
09	Comm. & MIS	42	19	48	15	16	131	189	64	54	438	97	79	123	97	396
10	MIS & Ctrl.	36	12	38	16	17	82	114	64	51	311	39	95	38	28	200
11	MIS	41	13	31	14	17	93	110	58	52	313	75	71	33	55	234
12	MIS	47	9	23	18	14	63	78	92	42	275	51	60	25	22	158
13	MIS	61	10	26	16	20	70	111	72	65	318	68	68	23	110	269
14	MIS	63	6	30	14	19	42	151	60	58	311	82	91	30	107	310
15	MIS	41	14	41	22	0	96	159	91	0	346	73	83	50	43	249
16	MIS	24	19	75	13	0	133	228	52	0	413	50	57	52	56	215
17	MIS	25	14	56	14	13	98	202	56	39	395	84	70	98	55	307
18	MIS	57	15	30	17	5	103	96	68	15	282	72	61	41	39	213
19	MIS	71	13	34	17	10	92	118	81	33	324	70	65	27	62	224
20	MIS & Comm.	56	19	33	10	21	123	169	49	27	368	114	70	35	29	248
21	MIS & Ctrl.	88	11	25	12	29	80	90	52	90	312	72	110	42	99	323
22	MIS	60	9	6	15	6	63	25	69	140	297	22	62	110	42	236
23	MIS & Ctrl.	45	14	23	20	2	101	110	90	6	307	43	42	42	137	264
24	Application	57	7	20	26	6	43	120	161	18	342	10	25	0	6	41
25	MIS	51	8	14	8	70	56	76	35	175	342	62	22	26	15	125
26	MIS	100	12	31	6	20	84	128	29	64	305	47	61	40	26	174
27	MIS	73	11	30	13	13	77	139	53	43	312	134	60	49	50	293
28	MISy control	38	11	18	9	28	77	86	45	97	305	37	57	33	68	195
29	MISy control	65	15	35	6	16	102	159	37	48	346	143	78	34	122	377
30	MIS & Comm.	46	11	22	19	13	77	101	82	39	299	72	93	20	82	267
31	MIS & Comm.	37	25	19	12	13	161	81	48	39	329	51	50	24	19	144
32	MIS & Ctrl.	23	19	17	9	13	133	59	37	41	270	29	29	21	65	144
33	MIS & Comm.	11	12	43	0	14	90	204	0	43	337	145	103	43	33	324
	Max										534					396
	Average										318,0					234,0
	Median										328,6					231,2
	Min										109					41

Annex C: Projects' Data – PSU v1.01 & Effort (Total and by SLC Phase, According to METRICA 3)

		Size		Effort	By SLC phase/process										
Id	#UR	PSU v1.01	PSU v1.01 (F)	Effort (m/D)	Plan	Feasibil.	Analysis	Design	Construct	Implement.	Maint.	Prj Mgm	Qual. Mg	Security	Config. Mgmt
01	81	282	136	1236	96	25	118	121	524	38	61	64	115	35	39
02	51	154	50	797	87	25	61	55	271	53	118	49	29	24	25
03	18	369	176	1752	121	25	154	151	742	26	61	91	150	94	137
04	62	309	160	1504	96	25	130	133	681	26	61	76	110	69	97
05	54	142	62	743	79	25	58	57	287	40	61	49	38	24	25
06	38	285	128	1388	109	25	118	122	527	74	61	76	110	69	97
07	63	171	75	1055	111	25	70	76	431	49	61	61	70	44	57
08	11	137	55	886	96	25	56	52	362	26	61	58	62	39	49
09	42	224	103	1308	126	25	92	98	543	59	61	70	94	59	81
10	36	132	56	810	96	25	54	53	335	26	61	52	46	29	33
11	41	213	94	1200	127	25	88	96	473	26	61	70	94	59	81
12	47	171	63	1260	115	25	70	68	481	64	61	79	118	74	105
13	61	309	177	1461	147	25	128	150	634	59	61	64	79	49	65
14	63	304	159	1565	149	25	126	132	667	59	61	70	110	69	97
15	41	222	97	1132	128	25	92	88	432	26	61	67	86	54	73
16	24	132	52	876	96	25	54	51	355	26	61	58	62	39	49
17	25	132	58	723	96	25	54	51	291	33	61	46	30	19	17
18	57	259	109	1835	210	25	106	104	767	114	61	88	142	89	129
19	71	358	97	2589	215	45	148	149	1492	115	61	76	110	81	97
20	56	276	132	1506	125	25	114	111	665	77	61	73	102	64	89
21	88	286	125	1451	126	25	118	122	557	90	61	76	110	69	97
22	60	204	101	1086	117	25	84	81	470	64	61	55	54	34	41
23	45	180	69	1036	96	25	74	71	399	54	61	64	78	49	65
24	57	288	151	1020	96	25	120	117	415	26	61	52	46	29	33
25	51	214	92	1353	125	25	88	90	534	69	61	85	110	69	97
26	100	137	44	1161	117	25	56	53	432	26	76	79	118	74	105
27	73	316	147	1647	133	25	132	137	685	26	61	88	142	89	129
28	38	183	87	493	17	8	54	44	229	10	12	50	28	27	14
29	65	301	161	950	17	8	126	127	434	75	12	62	36	35	18
30	46	213	87	1229	117	25	88	102	462	70	61	70	94	59	81
31	37	194	97	931	96	25	80	93	390	26	61	52	46	29	33
32	23	156	51	898	96	25	64	66	304	40	61	67	86	54	35
33	11	157	84	502	50	8	66	57	174	26	12	46	25	24	14
Max	100	369	176,60164	2589	215	45	154	151	1492	115	118	91	150	94	137
Avg	51,0	213,00	97,07	1161,00	111,00	25,00	88,00	93,00	462,00	40,00	61,00	67,00	86,00	54,00	65,00
Median	49,6	224,55	101,00	1193,42	109,94	24,06	92,15	93,27	498,33	49,03	58,73	66,15	82,73	52,24	66,79
Min	11	132	44	493	17	8	54	44	174	10	12	46	25	19	14

Annex D: Projects' Data – PSU v1.01 & Effort (Total, Abs by Nature/Task Type, by # Task: Type, Complexity, Nature)

	Size		Effort (m/d)								Tasks	By Type			By Compl			By Nature	
Id	PSU v1.01	PSU v1.01 (F)	Totl	F	NF	%F	%NF	M	Q	T	#task	M	Q	T	H	M	L	F	NF
01	282	136	1236	596	640	48,22%	51,78%	193	378	665	337	56	44	237	3	7	327	231	106
02	154	50	797	258	539	32,37%	67,63%	171	268	358	165	24	14	127	5	7	153	120	45
03	369	176	1752	835	917	47,66%	52,34%	334	524	894	434	68	56	310	4	8	422	304	130
04	309	160	1504	777	727	51,66%	48,34%	263	409	832	354	53	41	260	4	5	345	255	99
05	142	62	743	322	421	43,34%	56,66%	160	202	381	158	26	14	118	4	5	149	112	46
06	285	128	1388	624	764	44,96%	55,04%	274	409	705	332	53	41	238	6	6	320	232	100
07	171	75	1055	461	594	43,70%	56,30%	219	304	532	206	38	26	142	4	8	194	136	70
08	137	55	886	353	533	39,84%	60,16%	197	271	418	172	35	23	114	4	5	163	108	64
09	224	103	1308	600	708	45,87%	54,13%	258	378	672	268	47	35	186	6	7	255	180	88
10	132	56	810	345	465	42,59%	57,41%	175	225	410	156	29	17	110	4	5	147	104	52
11	213	94	1200	531	669	44,25%	55,75%	262	363	575	260	47	35	178	5	6	249	172	88
12	171	63	1260	462	798	36,67%	63,33%	285	432	543	242	56	44	142	5	7	230	136	106
13	309	177	1461	835	626	57,15%	42,85%	241	317	903	328	41	29	258	6	8	314	252	76
14	304	159	1565	817	748	52,20%	47,80%	288	409	868	348	53	41	254	6	7	335	248	100
15	222	97	1132	497	635	43,90%	56,10%	251	340	541	262	44	32	186	5	6	251	180	82
16	132	52	876	343	533	39,16%	60,84%	197	271	408	168	35	23	110	4	5	159	104	64
17	132	58	723	319	404	44,12%	55,88%	153	179	391	144	23	11	110	4	5	135	104	40
18	259	109	1835	770	1065	41,96%	58,04%	348	631	856	332	65	53	214	9	5	318	208	124
19	358	97	2589	702	1887	27,11%	72,89%	334	1454	801	392	53	41	298	10	6	376	292	100
20	276	132	1506	721	785	47,88%	52,12%	281	436	789	318	50	38	230	7	5	306	224	94
21	286	125	1451	634	817	43,69%	56,31%	286	439	726	332	53	41	238	8	4	320	232	100
22	204	101	1086	540	546	49,72%	50,28%	207	268	611	222	32	20	170	6	6	210	164	58
23	180	69	1036	398	638	38,42%	61,58%	219	337	480	220	41	29	150	4	7	209	144	76
24	288	151	1020	535	485	52,45%	47,55%	175	245	600	288	29	17	242	4	5	279	236	52
25	214	92	1353	582	771	43,02%	56,98%	303	409	641	272	53	41	178	6	6	260	172	100
26	137	44	1161	375	786	32,30%	67,70%	295	439	427	214	56	44	114	5	5	204	108	106
27	316	147	1647	764	883	46,39%	53,61%	338	521	788	384	65	53	266	5	5	374	261	123
28	183	87	493	234	259	47,46%	52,54%	87	152	254	191	47	35	109	1	2	188	103	88
29	301	161	950	508	442	53,47%	46,53%	103	309	538	359	59	47	253	4	2	353	254	105
30	213	87	1229	502	727	40,85%	59,15%	262	393	574	260	47	35	178	5	7	248	172	88
31	194	97	931	466	465	50,05%	49,95%	175	225	531	208	29	17	162	4	5	199	156	52
32	156	51	898	294	604	32,74%	67,26%	192	340	366	206	44	32	130	4	6	196	124	82
33	157	84	502	268	234	53,39%	46,61%	105	117	280	209	44	32	133	0	4	205	128	81
Max	369	176,60164	2589	835	1887	57,2%	72,9%	348	1454	903	434	68	56	310	10	8	422	304	130
Avg	213,00	97,07	1161,00	508,00	638,00	44,1%	55,9%	241,00	340,00	574,00	260	47,00	35,00	178,00	5,00	6,00	249,00	172,00	88,00
Median	224,55	101,00	1193,42	523,27	670,15	44,2%	55,8%	231,24	375,58	586,61	265	45,30	33,36	186,21	4,88	5,67	254,33	180,48	84,39
Min	132	44	493	234	234	27,1%	42,8%	87	117	254	144	23	11	109	0	2	135	103	40

Annex E: Projects' Data – PSU v1.21 & Effort (Total, Abs by Nature/Task Type, by # Task: Type, Complexity, Nature)

	Size			Effort (m/d)								Tasks	By Type			Compl. (T-tasks)			Compl. (QM-tasks)		
Id	PSU v1.21	PSU v1.21 (F)	Diff. % PSU	Totl	F	NF	%F	%NF	M	Q	T	#task	M	Q	T	H	M	L	H	M	L
01	342	234	17,5%	1236	596	640	48,22%	51,78%	193	378	665	337	56	44	237	1	4	232	2	3	95
02	172	125	10,5%	797	258	539	32,37%	67,63%	171	268	358	165	24	14	127	1	6	120	4	1	33
03	440	308	16,1%	1752	835	917	47,66%	52,34%	334	524	894	434	68	56	310	1	4	305	3	4	117
04	359	259	13,9%	1504	777	727	51,66%	48,34%	263	409	832	354	53	41	260	1	3	256	3	2	89
05	163	116	12,9%	743	322	421	43,34%	56,66%	160	202	381	158	26	14	118	1	3	114	3	2	35
06	339	237	15,9%	1388	624	764	44,96%	55,04%	274	409	705	332	53	41	238	3	3	232	3	3	88
07	212	140	19,3%	1055	461	594	43,70%	56,30%	219	304	532	206	38	26	142	1	5	136	3	3	58
08	177	111	22,6%	886	353	533	39,84%	60,16%	197	271	418	172	35	23	114	1	3	110	3	2	53
09	276	185	18,8%	1308	600	708	45,87%	54,13%	258	378	672	268	47	35	186	2	5	179	4	2	76
10	161	107	18,0%	810	345	465	42,59%	57,41%	175	225	410	156	29	17	110	1	3	106	3	2	41
11	266	176	19,9%	1200	531	669	44,25%	55,75%	262	363	575	260	47	35	178	1	4	173	4	2	76
12	249	140	31,3%	1260	462	798	36,67%	63,33%	285	432	543	242	56	44	142	2	4	136	3	3	94
13	336	258	8,0%	1461	835	626	57,15%	42,85%	241	317	903	328	41	29	258	2	6	250	4	2	64
14	356	254	14,6%	1565	817	748	52,20%	47,80%	288	409	868	348	53	41	254	2	5	247	4	2	88
15	268	184	17,2%	1132	497	635	43,90%	56,10%	251	340	541	262	44	32	186	1	4	181	4	2	70
16	173	107	23,7%	876	343	533	39,16%	60,84%	197	271	408	168	35	23	110	1	3	106	3	2	53
17	149	108	11,4%	723	319	404	44,12%	55,88%	153	179	391	144	23	11	110	1	3	106	3	2	29
18	341	214	24,0%	1835	770	1065	41,96%	58,04%	348	631	856	332	65	53	214	5	3	206	4	2	112
19	402	299	10,9%	2589	702	1887	27,11%	72,89%	334	1454	801	392	53	41	298	5	3	290	5	3	86
20	326	230	15,3%	1506	721	785	47,88%	52,12%	281	436	789	318	50	38	230	3	3	224	4	2	82
21	340	238	15,9%	1451	634	817	43,69%	56,31%	286	439	726	332	53	41	238	4	2	232	4	2	88
22	229	169	10,9%	1086	540	546	49,72%	50,28%	207	268	611	222	32	20	170	2	4	164	4	2	46
23	226	148	20,4%	1036	398	638	38,42%	61,58%	219	337	480	220	41	29	150	1	5	144	3	2	65
24	293	240	1,7%	1020	535	485	52,45%	47,55%	175	245	600	288	29	17	242	1	3	238	3	2	41
25	279	176	23,3%	1353	582	771	43,02%	56,98%	303	409	641	272	53	41	178	2	4	172	4	2	88
26	220	111	37,7%	1161	375	786	32,30%	67,70%	295	439	427	214	56	44	114	1	3	110	4	2	94
27	390	265	19,0%	1647	764	883	46,39%	53,61%	338	521	788	384	65	53	266	1	3	262	4	2	112
28	193	104	5,2%	493	234	259	47,46%	52,54%	87	152	254	191	47	35	109	0	0	109	1	2	79
29	363	257	17,1%	950	508	442	53,47%	46,53%	103	309	538	359	59	47	253	2	1	250	2	1	103
30	267	177	20,2%	1229	502	727	40,85%	59,15%	262	393	574	260	47	35	178	1	5	172	4	2	76
31	213	160	8,9%	931	466	465	50,05%	49,95%	175	225	531	208	29	17	162	1	3	158	3	2	41
32	212	128	26,4%	898	294	604	32,74%	67,26%	192	340	366	206	44	32	130	1	4	125	3	2	71
33	211	129	25,6%	502	268	234	53,39%	46,61%	105	117	280	209	44	32	133	0	0	133	0	4	72
Max	440	308	37,7%	2589	835	1887	57,2%	72,9%	348	1454	903	434	68	56	310	5	6	305	5	4	117
Avg	267,00	176,43	17,2%	1161,00	508,00	638,00	44,1%	55,9%	241,00	340,00	574,00	260	47,00	35,00	178,00	1,00	3,00	172,00	3,00	2,00	76,00
Median	271,00	184,65	17,4%	1193,42	523,27	670,15	44,2%	55,8%	231,24	375,58	586,61	265	45,30	33,36	186,21	1,61	3,45	181,15	3,27	2,21	73,18
Min	149	104	1,7%	493	234	234	27,1%	42,8%	87	117	254	144	23	11	109	0	0	106	0	1	29