Re-Assessing the Intention to Use a Measurement Procedure based on COSMIC-FFP*

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Abstract. This paper describes the replication of an empirical study that was designed to evaluate the adoption of RmFFP in practice. RmFFP is a measurement procedure designed to measure the functional size of object-oriented systems from requirements specifications obtained in the context of the OO-Method approach. This procedure has been designed in accordance with the COSMIC-FFP standard method. The evaluation is based on the Method Adoption Model (MAM), where the intention to use a method is determined by the users' perceptions. The results show that an intention to use RmFFP exists, and that it is more influenced by usefulness than ease of use.

1 Introduction

Functional size measurement (FSM) methods currently play a crucial role in software project management, IFPUG Function Point Analysis (FPA) being the most popular. However, a rapid evolution of development paradigms has given rise to a new FSM method, COSMIC-Full Function Point (FFP) [1], which is more compatible with modern software engineering concepts and is applicable to various software domains. COSMIC-FFP has been awarded the ISO/IEC19761 standard [2] and is seen as the first second-generation FSM method.

In recent years we have been working on a method based on model transformation called the OO-Method [3], supported by an automatic code generation tool, Oliva Nova [4]. This tool includes a module that allows the estimating of the functional size of applications from conceptual models (object model, dynamic model, and functional model) in function points [5]. However, this estimation process is at present carried out during the analysis phase of the OO-Method development process, and our intention is to enrich the Oliva Nova tool by allowing estimation of functional size at an earlier stage using high-level specifications.

To implement this we have designed an FSM procedure called RmFFP, based on the COSMIC-FFP standard method for estimating the functional size of object-oriented systems generated by the OO-Method from requirements specifications [6]. We have applied this procedure to various case studies (Rent a Car Management, Golf Management, and Maintenance Service Management) with groups of undergraduate

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students to evaluate its reproducibility and productivity [7]. However, there is a need also to assess users' response to the new procedure and their intention to use it in the future, for which reason we have designed an empirical study, which has been carried out twice. For the first evaluation, we used computer science major students as experimental subjects. However, for the second evaluation, we used PhD students in Computer Science; this last evaluation is the subject-matter of this paper.

The empirical study designed is based on a pre-existing theoretical model called the Method Adoption Model (MAM) [8]. This model includes the same primary constructs as the Technology Acceptance Model [9], which has been adapted to explain and predict the adoption of methods. These constructs are:

- *Perceived Ease of Use:* the extent to which a person believes that using a particular method would be effort-free.
- *Perceived Usefulness:* the extent to which a person believes that a particular method will be effective in achieving the intended objectives.
- *Intention to Use:* the extent to which a person intends to use a particular method.

This empirical study has been carried out to evaluate the intention to use RmFFP on the basis of the MAM constructs, which was also applied by Poels [10] y Abrahao [11].

This paper is organized as follows: Section 2 presents an overview of the evaluation process carried out. Section 3 describes the assessment of the intention to use RmFFP in the future. Section 4 discusses the analysis and interpretation of these results. Finally, Section 5 sets out our conclusions and indicates further work to be carried out.

2 General Description

The process of evaluation carried out was initiated with the selection of participants, who formed part of a training process. The aim of the training was to develop a level of expertise required for the subjects to be able to measure requirements specifications using the RmFFP measurement procedure. As shown in Figure 1, a package of training materials was utilized, which was designed and prepared in advance, comprising specific case studies with the OO-Method Requirements Model [12], examples of the use of RmFFP and a measurement guide.

At the end of the training process, the participants demonstrate what they have learned by means of the measurement of a case study selected in advance. If this demonstration is not satisfactory, a training session will be given again for reinforcement. If satisfactory, the next step will be the recording of perceptions and intentions of the participants on the use of RmFFP by means of a questionnaire, which is described in more detail in Section 3. Each of the answers of the participants is then recorded, validated and analyzed, to be finally interpreted and presented in a report.

This evaluation process was carried out twice. The results obtained in the first evaluation were reported in [13]. However, we replicated the empirical study with the purpose of improving the reliability of the results.

The experimental planning carried out is described below.

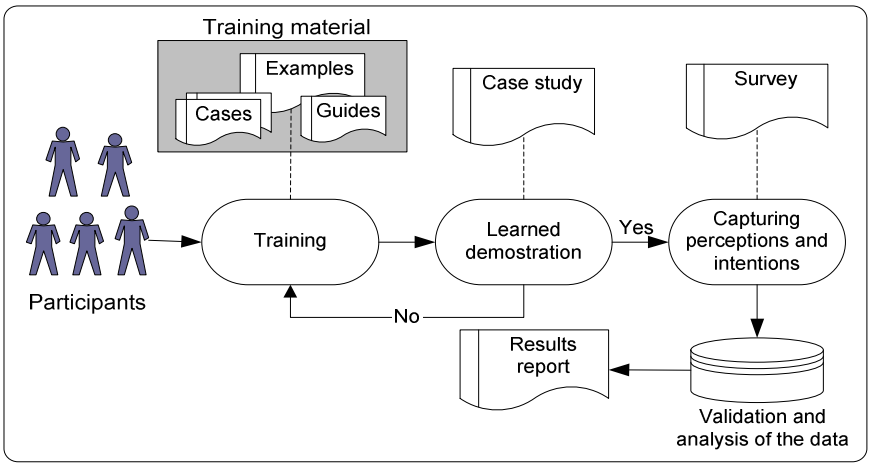

Fig. 1. General process carried out to evaluate the intention to use RmFFP in the future

3 Re-assessing the intention to use RmFFP

According to the Goal/Question/Metric template [14], the goal of the empirical study was to analyze user's responses for the purpose of assessing RmFFP with respect to its intention to use from the viewpoint of researchers in the context of students measuring OO-Method requirements specifications.

3.1 Experiment Planning

The **subjects** were eleven Computer Science PhD students at the Valencia University of Technology, enrolled in the "*Software Technologies*" course during the period from February to June of 2006. All subjects were familiar with modelling and measuring techniques.

The **independent variable** is the variable for which the effects should be evaluated. In our study, this variable corresponded to the functional size measurement procedure RmFFP. The **dependent variables** were the three perception-based variables of the MAM: *perceived ease of use (PEOU), perceived usefulness (PU), and intention to use (ITU).*

We wanted to test the following **hypotheses**:

- H_1: There is an intention to use RmFFP.
- H_2: Intention to use is determined by perceived ease of use and perceived usefulness.

From Hypothesis H2 we can derive two simple hypotheses, which are the following:

- H_3: Intention to use is determined by perceived ease of use.
- H_4: Intention to use is determined by perceived usefulness.

The **instruments** used in this experiment included the experimental object, training materials and a survey. The *experimental object* was the OO-Method requirements specification of three case studies: a Car Rental application, the Management of a Maintenance Service in a Hospital, and Golf Management. The *training materials* were the following: a set of instructional slides on the OO-Method Requirements Model and the RmFFP procedure; a case-study that describes an example of the application of RmFFP, a measurement guide, and another case study to verify the training.

The original *survey* was adjusted for the replication of this empirical study. Table 1 summarizes the main changes carried out.

Table 1. Differences between the original survey and the adjusted survey

Original survey, adapted from [5]	Adjusted survey
- **PEOU construct included 5 items: I1, I3, I4, I6 and I9.** - **PU construct included 5 items: I2, I5, I8, I10, and I11.** - **IU construct included 3 items: I7, I12, and I13.** - **Items I2 and I11 were moved to evaluate the PEOU construct as items I2 and I12 respectively.** - **Items I12 were moved to evaluate the PEOU construct as items I14.**	- PEOU construct included 8 items: I1, I2, I3, I4, I6, I9, I12 and I14. - PU construct included 3 items: I5, I8, and I11. - IU construct included 4 items: I7, I10', I13', and I15. - Items I10' and I13' were increased to evaluate the IU construct. - Items I11 and I15 are items I10 and I13 (in the original survey) respectively.

This adjusted survey[12] included fifteen closed questions, based on the items used to measure PEOU, PU, and ITU, as shown in Figure 2. The items were formulated using a 5-point Likert scale, using the opposing statement question format.

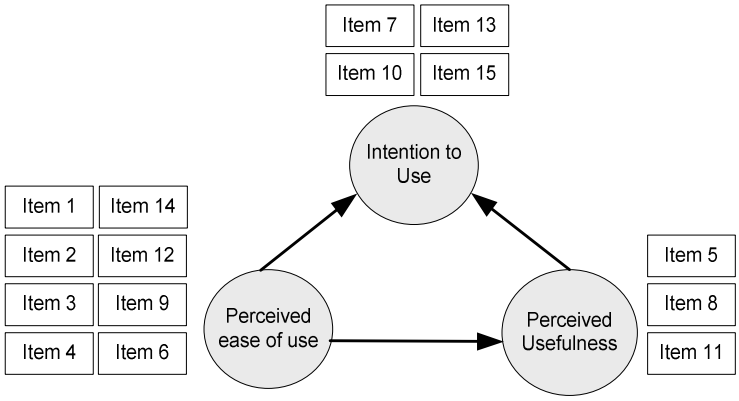

Fig. 2. Operationalized Method Adoption Model

[12] http://www.dsic.upv.es/~nelly/survey2.pdf

3.2 Experiment Operation

When the participants demonstrated what they had learned by means of the measurement of an OO-Method requirements specification, no time-limit was set and the interaction among subjects was controlled to avoid plagiarism.

Once the training phase had ended, we carried out a ***post-task survey***, in which the subjects were asked to complete a survey to evaluate their perceptions of RmFFP use and intentions of use.

3.3 Validity evaluation

In order to ensure that the experimental results are valid, we considered the following threat to **construct validity**:

Inadequate pre-operational explanation of constructs: This threat means that the constructs are not sufficiently defined, and hence the experiment cannot be sufficiently clear. We used an **inter-item correlation analysis** to evaluate the construct validity of the variables PEOU, PU, and ITU. We employed two criteria, Convergent Validity (CV) and Discriminant Validity (DV), for each item; if convergent validity was higher than discriminant validity, the item would be validated. However, we found that the CV value was lower than the DV value for items I2 and I12 (see Table 6 of the appendix). For this reason these two items were removed from the analysis.

In addition, we also conducted a **reliability analysis** on the validated items to calculate the degree to which the values of the constructs are free of measurement error. The reliability analysis was conducted using the Chronbach alpha technique, where the corresponding alpha value for each MAM construct is shown in Table 2.

Table 2. Reliability analysis for the MAM constructs

Construct	Cronbach(α)	α without I2 and I12
PEOU	0.71	0.802
PU	0.818	0.818
ITU	0.846	0.846

These values indicate that the items included in the survey are reliable, alphas of 0.7 or above being acceptable according to Nunally [15]. In addition, the alphas of PU and ITU were better than the alphas obtained in the first evaluation (PU = 0.5 and ITU = 0.5), more details in [13].

4 Analysis and Interpretation

Once the data were collected and validated (see Table 5 of the appendix), the scores of each subject were averaged over the different items that are relevant for a construct, and we obtained three mean values for each subject. Table 3 shows

descriptive statistics for each construct of the MAM; we note that the mean ITU score obtained with eleven subjects is greater than 3.

Table 3. Descriptive statistics for PEOU, PU and ITU

Statistic	PEOU	PU	ITU
Mean	3.98	3.67	3.61
Standard dev.	0.59	0.87	0.89
Minimum	2.83	2.33	1.75
Maximum	5.00	5.00	5.00

To evaluate the intention to use RmFFP, hypothesis H1 was formally tested by verifying whether the scores that the students assigned to this construct were significantly better than the middle score on the 5-point Likert scale. We verified the normality of these data using the Shapiro-Wilk test. As the data distribution was normal, we used the one-tailed sample t-test to evaluate the statistical significance of the observed differences in mean ITU. The objective was to verify whether the scores that students assign to the construct of the MAM were significantly higher than the score of 3. The statistical test was applied with a significance level of 5%, i.e. alpha = 0.05. The results of the t-tests (Table 4) allow rejection of the null hypotheses with medium significance level, meaning that we empirically corroborated the intention to use RmFFP in the future.

Table 4. One Sample t-test for Intention to Use variable

Statistic	ITU
Mean Difference	.614
95% Conf. Interval for the diff.	.016 (lower) 1.212 (upper)
t	2.29
1-tailed p-value	.022

In order to test hypothesis H2, regression analysis technique was applied. The regression equation resulting was: **ITU=-0.18+0.76*PU+ 0.25*PEOU**.

The regression model had a medium significant level (p = 0.0133), which means that H2 was confirmed. The determination coefficient (R^2 = 0.66) indicated that 66% of total variation in intention to use can be explained by variation in the perceived usefulness and perceived ease of use.

With respect to Hypothesis H_3: Perceived ease of use → Intention to use. The regression equation resulting from the analysis is: **ITU = 1.151 + 0.618* PEOU**. The regression had a low significance level (p = 0.212), which means that H3 was not confirmed.

Finally, with respect to Hypothesis H_4: Perceived usefulness → Intention to use. The regression equation resulting from the analysis is: **ITU = 0.621 + 0.816* PU**. The regression had a high significance level (p = 0.003), which means that H4 was confirmed. The determination coefficient (r2 = 0.635) showed that 63.5% of the total variation in intention to use can be explained by variation in perceived usefulness. Figure 3 represents the lineal regression obtained.

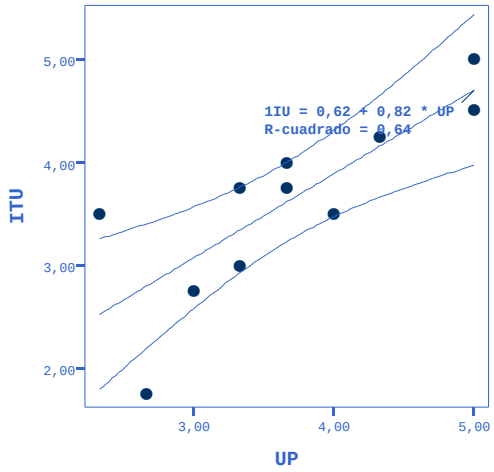

Fig. 3. Regression model: Intention to Use vs. Usefulness Perceived

5 Conclusions

This paper describes the replication of an empirical study that evaluates the intention to use the RmFFP procedure, which was designed for measuring the size of object oriented systems, in accordance with the COSMIC-FFP method. The results indicate that there is an intention to use RmFFP when sizing OO-Method requirement specifications. Although RmFFP is perceived as easy to use, the results of our tests show that perceived usefulness can have a stronger influence on intention to use RmFFP than perceived ease of use. This means that the user intends to use RmFFP more because of its usefulness, in terms of its accuracy in estimating other indicators, than because of its ease of use.

Therefore, the MAM relation between the Perceived Ease of Use and the Intention to Use could not be verified empirically in the software measurement domain.

In a future study, we plan to identify and evaluate other variables that may affect the intention to use a measurement procedure.

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References

1. Abran A., J. M. Desharnais, S. Oligny, D. St-Pierre, and C. Symons, "COSMIC-FFP Measurement Manual Version 2.2, The COSMIC Implementation Guide for ISO/IEC 19761:2003", École of technologie supérieure- ETS, Montreal (Canada) 2003. Available free at: www.gelog.etsmtl.ca/cosmic-ffp
2. ISO, ISO/IEC 19761 Software Engineering-COSMIC-FFP-A Functional Size Measurement Method, International Organization for Standardization_ISO, Geneva, 2003.

3. Pastor O., Gomez J., Insfran E., Pelechano V., 2001. “The OO-Method approach for information systems modelling: from object-oriented conceptual modelling to automated programming”, Information Systems 26, pp. 507-534.
4. CARE S.A: http://www.care-t.com/ , last visited 15 September 2006
5. Abrahão S., "On the Functional Size Measurement of Object-Oriented Conceptual Schemas: Design and Evaluation Issues", PhD Thesis, Department of Information Systems and Computation, Valencia University of Technology, October 2004.
6. N. Condori-Fernández, S. Abrahão, O. Pastor, Towards a Functional Size Measure for Object-Oriented Systems from Requirements Specifications. IEEE Quality Software Int. Conf. 2004, Germany, pp. 94-101.
7. N. Condori-Fernández, O. Pastor, Evaluating the Productivity and Reproducibility of a Measurement Procedure, ER Workshop on Quality of Information Systems, Minnesota, USA, November 2006.
8. Moody D. L., "Dealing with Complexity: A Practical Method for Representing Large Entity Relationship Models", PhD. Thesis, Department of Information Systems, University of Melbourne, Australia, 2001.
9. F. D. Davis, “Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information Technology”, *MIS Quarterly*, 1989, pp. 319-340.
10. Poels G., Maes A., Gailly F., Paemeleire R., “Measuring User Beliefs and Attitudes towards Conceptual Schemas: Tentative Factor and Structural Equation Model”, Fourth Annual Workshop on HCI Research in MIS, December 2005.
11. Abrahao S., Poels G., Pastor O. “A Functional Size Measurement Method for Object-Oriented Conceptual Schemas: Design and Evaluation Issues”. Software & System Modelling, Springer Verlag, 5(1): 48-71, 2005.
12. Insfran E., Pastor O. and Wieringa R., “Requirements Engineering-Based Conceptual Modelling”. Journal Requirements Engineering, Springer-Verlag, 7(2): 61-72, 2002.
13. N. Condori-Fernández, O. Pastor, “An Empirical Study on the Likelihood of Adoption in Practice of a Size Measurement Procedure for Requirements Specification” IEEE Quality Software International Conference, China, October 2006.
14. Wohlin C., Runeson P., Höst M., M. C. Ohlsson, B. Regnell, and A. Wesslén, Experimentation in Software Engineering: An Introduction, 2000.
15. Nunally J., Psychometric Theory, McGraw-Hill, 2nd ed., New York, NY1978.

Appendix

Table 5. Data set used in the analysis

Students	I1	I2	I3	I4	I6	I9	I12	I14	I5	I8	I11	I7	I10	I13	I15
1	3	3	5	5	3	4	2	5	4	2	2	1	1	3	2
2	5	4	5	3	2	5	4	5	4	3	4	5	2	5	4
3	4	4	4	3	4	4	3	5	4	3	2	3	3	4	1
4	4	4	5	4	3	4	4	5	5	4	4	4	4	5	4
5	4	4	5	5	5	4	3	5	4	3	3	4	4	3	4
6	4	3	4	3	4	4	4	4	3	4	4	4	4	4	3
7	3	4	4	3	3	3	4	4	4	4	4	3	4	4	3
8	5	3	5	5	5	5	5	5	5	5	5	5	5	5	5
9	4	5	4	3	4	4	5	5	5	5	5	5	4	5	4
10	2	4	3	2	3	3	3	4	4	3	3	3	3	3	3
11	4	4	4	4	4	2	4	4	4	2	1	3	4	4	3

Table 6. Correlation between Survey Items (Construct Validity)

		PEOU								PU			ITU				Mean		Valid
		I1	I2	I3	I4	I6	I9	I12	I14	I5	I8	I11	I7	I10	I13	I15	CV	DV	
PEOU	I1	1,00	-0,07	0,63	0,36	0,28	0,61	0,56	0,52	0,26	0,32	0,33	0,69	0,30	0,71	0,47	0,49	0,44	YES
	I02	-0,07	1,00	-0,31	-0,44	-0,13	-0,26	0,27	0,09	0,38	0,15	0,09	0,31	0,13	0,24	0,08	0,02	0,20	NO
	I03	0,63	-0,31	1,00	0,79	0,07	0,63	0,01	0,72	0,31	0,03	0,18	0,18	-0,11	0,29	0,39	0,44	0,18	YES
	I04	0,36	-0,44	0,79	1,00	0,48	0,25	-0,12	0,49	0,28	-0,11	-0,12	-0,12	0,07	-0,07	0,27	0,35	0,03	YES
	I06	0,28	-0,13	0,07	0,48	1,00	0,03	0,23	0,12	0,13	0,29	0,04	0,23	0,65	-0,08	0,20	0,26	0,21	YES
	I09	0,61	-0,26	0,63	0,25	0,03	1,00	0,18	0,74	0,26	0,43	0,60	0,50	-0,11	0,44	0,37	0,40	0,35	YES
	I12	0,56	0,27	0,01	-0,12	0,23	0,18	1,00	-0,02	0,47	0,79	0,70	0,82	0,72	0,83	0,68	0,27	0,71	NO
	I14	0,52	0,09	0,72	0,49	0,12	0,74	-0,02	1,00	0,57	0,16	0,22	0,25	-0,21	0,33	0,20	0,46	0,22	YES
PU	I05	0,26	0,38	0,31	0,28	0,13	0,26	0,47	0,57	1,00	0,49	0,42	0,38	0,31	0,56	0,52	0,64	0,37	YES
	I08	0,32	0,15	0,03	-0,11	0,29	0,43	0,79	0,16	0,49	1,00	0,91	0,71	0,66	0,64	0,58	0,80	0,39	YES
	I11	0,33	0,09	0,18	-0,12	0,04	0,60	0,70	0,22	0,42	0,91	1,00	0,74	0,43	0,62	0,70	0,78	0,38	YES
ITU	I07	0,69	0,31	0,18	-0,12	0,23	0,50	0,82	0,25	0,38	0,71	0,74	1,00	0,57	0,73	0,76	0,77	0,43	YES
	I10	0,30	0,13	-0,11	0,07	0,65	-0,11	0,72	-0,21	0,31	0,66	0,43	0,57	1,00	0,38	0,53	0,62	0,26	YES
	I13	0,71	0,24	0,29	-0,07	-0,08	0,44	0,83	0,33	0,56	0,64	0,62	0,73	0,38	1,00	0,52	0,66	0,41	YES
	I15	0,47	0,08	0,39	0,27	0,20	0,37	0,68	0,20	0,52	0,58	0,70	0,76	0,53	0,52	1,00	0,70	0,41	YES