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EFFECTIVENESS OF COSMIC FUNCTION POINTS FOR MOBILE APPLICATION DEVELOPMENT: A CRITICAL REVIEW

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Abstract

Context. With the increased complexity in mobile applications, many challenges and issues emerged for project management to develop mobile applications effectively and accurately. Among these challenges Effort Estimation, is one of the critical issues faced by software project management team in general and mobile application management team in particular. Effort estimation helps software development team to approximate the cost required for the successful software application development. In order to perform mobile effort estimation, COSMIC estimation approach is followed. COSMIC effort estimation is based on various data movements corresponding to numerous functionalities a software application or mobile application is expected to deliver. The overall density of these data movements quantifies the aggregate size of the development.

Objective. This study is an effort to review the effectiveness of COSMIC in performing software effort estimation and different invariants of COSMIC FP method of effort estimation are reviewed for software projects, web applications and mobile applications.. The research work also highlights the importance of continuously refining the COSMIC FP approach in order to reduce the gap between the estimated and actual efforts.

Keywords: Mobile Effort Estimation, COSMIC FP, Mobile App.

I.   INTRODUCTION

Usability of mobile phones based communication has increased rapid life. The increasing diversity and heterogeneity in mobile phone communication have redefined the basic and fundamental principles of mobile and its various deliverability. The range of applicability provided through mobile phones has increased the tradition of mobile-based software known as mobile applications. Most of the services and operations delivered through software applications or web-based applications are being presented by means of mobile-based applications.

Thus software companies try to maintain their reputation in the market through better planning and by accurate estimating the software's. Software Estimation is defined as how much cost, time, efforts are required to build a specific product by time and within budget. In accuracy in estimation may lead to over estimation or underestimation (over budgeting or under budgeting) which can be disastrous for any software company. As earlier it was reported that product may go 150% to 200% high if proper estimation process is not followed [17]. For software estimation one should know the size of that software which means size depends on the functionality of the system which is provided to the user. There are internationally accepted standards for measuring surface area of a wall, volume of a bottle, weight of a person likewise we need to express standards for measuring size of a software or application. There are two ways to measure the size of a software or an application i.e., Code Size: It measures Source Lines Of Code(SLOC) in a software and Functional Size: It is measured in functional points using technique called Functional Size measurement (FSM). FSM is used to measure size of software by quantifying the functionality delivered to the user. FSM is used to overcome the limitations imposed by Code Size technique having following advantages:

- Based on Functional User Requirements.
- Independent of technology, Language, tools and technique used.

This paper attempts to focus on COSMIC FP based Estimation models that are designed to be used for estimation of resources, efforts, time, cost of software projects. For any software estimation model, there must be a clarity in function user requirements. The function user requirements of a software project is directly proportional to its size. Which is defined by set of parameters that are being measured. Early estimation of efforts in software projects is better for elicitation of resources that can help in implementation of the software project in budget and within time. Early estimation of software projects can be made when there is some understanding about the problem domain, system size etc. UML Modeling emerges the structural layouts for requirement elicitations of a software projects. where the functionalities of software applications can be portrayed efficiently that is to be delivered to the end user. The most two UML diagrams that is used in software development projects for   requirement elicitation is Class diagram and Use cases diagram. The benefits of COSMIC FP over other Effort estimation models are demonstrated through comparative analysis.

II.   LITERATURE WORK

Universit, 2001[1] performed a study to develop a costing model to investigate the cost requirements for project development. In this study, SLIM and COSMIC-FFP metrics measurement approach were used to obtain functional size of project development. Data from 5 projects were used to validate the effectivenss of SLIM and COSMIC-FFP. The results obtined were evuualuated using MMRE,MdMRE and Pred(0.25) and it was reported that COSMIC-FFP method   produced   comparatively promising results   than SLIM metrics. . It also means that according to COSMIC FFP the measures could be valid for projects larger than 100 function points obtained from the SLIM Back-Firing method. The only limitation to this conclusion is the size of the sample, which is restricted to five data points for the time being. However, the study advocates to further analysie the effectivess and validity of results obtained on much larger data set.

Costagliola, Ferrucci, & Gravino, 2004[2] developed an approach to estimate efforts required for the development of dynamic web application. In this study COSMIC-FFP were used to identify various data movements to obtain functional size. To provide an early size estimation, the proposal by Mendes et al.,was extended by defining some rules that allows to measure functional size of client-server applications, using class diagrams. In order to calculate efforts from COSMIC size ordinary least-square regression analysis were used as prediction model. Data from 32 web applications using MMRE and Pred(0.25) were used to evaluate the effectivenss of the proposed approach using Ordinary Least-Squares regression analysis. and the results reported were promising and suggested several research directions for future work.

Santillo, 2007[3]performed an investigation on seizing and sizing SOA applications with COSMIC function points. The boundary problem from the software measurment perspective is described and the guidelines for application of COSMIC function point sizing method is provided. In this study IFPUG is denoted as “near black box” and COSMIC FSM as “ near white box” approach to software measurement. It is revealed that COSMIC FFP is more promising than any other first generation FSM methods. This study advocates field to welcome trials and practical experiences to test an approach that can lead to a wider set of guidelines for practical application of COSMIC measurment for SOA- like systems.

Marín,2008[4] conducted a survey on automating the measurement of functional size of conceptual models in a MDA environment. In this study COSMIC approach is used to overcome the limitation posed by FPA approach. This study introduced OOmCFP approach to measure the functional size of OO-methods based on COSMIC to automate the measurement of functional size of applications generated in MDA environments. The objective of this study was to reduce the measurment time. The findings of this study showed the OOmCFP tool is more efficient that manual measurements for OO models. A comparative analysis proved COSMIC based approach like OOmCFP provided better measurments. This study advocates more empirical studies in the future work.

Gencel, 2008[5]conducted a study to perform effort estimation using COSMIC as functional size measurement method. The new representation of COSMIC Functional size for effort estimation purposes involves a vector of measures for the following elements: Interface, Business-Application Data Services and Control Data Services. This

170

new representation does not interfere with any of the principles of COSMIC. Three projects studied in this research were measured using COSMIC-FFP v.3.0 utilizing the software requirements specification documents..CHAR method was used to determine functional domains of the case projects. This study observed the results building estimation models using the vector of measures for functional size rather than on a single value is more promising.

F. Ferrucci, Gravino, & Di Martino, 2008[6] Performed an empirical study to investigate the effectiveness of COSMIC and Web Objects for web effort estimation using OLS regression method. 15 web applications were used to validate the effectiveness of the proposed methods and the reported results were evaluated by using MMRE, MdMRE and Pred(0.25). The effort estimation results obtained reported that both COSMIC and Web Objects in combination with OLS regression were good indicators of effort estimation. Thus, as future work, it was suggested to collect and analyze further data also from other companies and investigate other estimation techniques (e.g., Case-Based Reasoning)that have provided interesting results for traditional software systems.

Buglione, Ferrucci, Gencel, Gravino, & Sarro, 2010[7] Performed web effort estimation using COSMIC as the functional size of web application development. Data from twenty-five web applications were used to validate the accuracy of the proposed method using CHAR method and MMRE, MdMRE & Pred(0.25) were used to evaluate the results. The results obtained reported that COSMIC measurement method is reliable for web effort estimation. This study suggests that for Web applications, using the size of only one of the COSMIC BFC Types to estimate the development effort might be a promising option when an early and quick estimate is required. This study further advocates investigating the effectiveness of the proposed method using different datasets, considering different cost drivers.

Hussain, Kosseim, & Ormandjieva, 2010[8]in their study developed a tool to automatically perform an approximation of cosmic size without requiring the requirements. The data from four projects were used to validate the efficiency of COSMIC using box-plot analysis and reported promising results. The CFP values and the textual re-quirements of the 61 functional processes built our historical dataset. This study further advocates exploring the impact of impact of non-functional requirements on functional size software effort estimation for more accurate results.

André Nitze, 2013[9]performed a study to measure Mobile Application size using Cosmic-FP. In this study, the data from different applications were used to empirically analyze the results. The results reported showed better mobile effort estimation was reported using Cosmic-FP. This study further explored few inadequacies like Non-functional requirements, Team size, project size and Project complexity that might influence on the accuracy of effort estimation. This study advocates proper elicitation and identification of non-functional parameters required for mobile application development.

Abdullah, Rusli, & Ibrahim, 2013[10] This study has demontrated COSMIC measurement procedure for sizing angry birds mobile application using uml representation.A case study was carried out where the data from Angry birds mobile application was used to empirically annalysis the results.This study observed the mapping the COSMIC concepts and uml representation of angry bird mobile game was used to identify elements in the data movements.This study determined that CFP value for mobile game is possible to be estimated using COSMIC-UML representation.

De Marco, Ferrucci, & Gravino, 2013[11] performed an empirical analysis to provide an adaptation of COSMIC Full Function Point method for web application estimation. In this study 25 web applications were used to validate the results in combination with linear regression analysis2. In this study, two approaches COSMIC functional processes(cFunp) and COSMIC average functional process(AFP) were proposed to perform web application estimation. The results obtained were empirically evaluated by using MMRE, MdMRE and Pred(0.25). It was observed the comparative analysis for the results achievevdwith CFunp provided better estimates than CFafp based model. Therefore it was concluded that COSMIC based approximate countings resulted to be suitable for early effort estimations. This study advocates for larger number of dataset from other companies.

171

Paz, Zapata, & Pow-Sang, 2014[12] performed an investigation for effort estimation in incremental software projects using COSMIC Function Points. In this study the data from two different projects were used to empirically analysis the results. In this study, Incremental CFP was considered as an acceptable technique. Further observations showed that the comparative analysis between global estimation model and Incremental CFP proved better for effort estimation. In this study the results obtained were empirically validated by using MRE which showed more accurate estimation effort values. The study advocates this technique to be used for other contexts such as real world projects.

Heeringen & Gorp, 2014[13] conducted a survey to measure the functional size of a mobile application. This study focused on the way functional size measurement can be carried out using COSMIC method and a proposed method of sizing mobile apps in a fast and accurate way. In this study he proposed an "approximate method" which is based on the comparative analysis of differences between traditional software apps and mobile apps to size an mobile app in a fast and accurate way. This study offers guidelines on how to apply standard COSMIC method quickly when measuring mobile apps. This study advocates how proposed assumptions can be applied in future to carry out COSMIC measurements of mobile applications in a better way.

Filomena Ferrucci, Gravino, Salza, & Sarro, 2015[14] conducted a study to measure COSMIC functional size for mobile applications. The dataset from 13 android applications were used to analyze the results. The results obtained were emperically evaluated by using MMRE, MdMRE and PRED(0.25). In this study,Functional size obtained in terms of COSMIC has been used to predict some code size measures, viz., Loc's, Bytes of source and compiled code. It was observed that CFP based model provide better predictions and the COSMIC functional size can be used to get early and accurate predictions of the size in terms of bytes.

Philbin, 2017[15] conducted an investigation on using COSMIC for functional size measurement of distributed applications in cloud environments. In this study he observed that effort for software project and its related cost depend on both functional and non functional aspects. The authors overviewd the application of COSMIC method to modern software such as mobile and cloud applications. Further in this study he observed sizing service oriented software with function point analysis failed when reconstructing or mapping the functional user requirments.He further observed that the COSMIC method defines the concept of layers that perfectly matches the SOA based software sizing. The study advocates empirical studies should be carried out to measure the the non-functional requirements of distributed applications in future and accessing the predictive accuracy of the built effort estimation models.

Abrahão, Silvia, 2018[16] performed an empirical validation of a COSMIC Measurement Procedure for Sizing Web Applications in a Model-Driven Development Environment. In this study he defined a new measurement approach named as Object-Oriented Hypermedia method (OO-H) specifically conceived for OO-H Web applications based on COSMIC method. In this work 30 web applications were used to validate the data. Mapping and measurement rules were devised to automatically derive the size measure from the OO-H conceptual models The results of our empirical study indicate that this measure can be considered as a suitable predictor of Web application development effort, since it provides more accurate estimations than a first generation FSM method and dimensional measures.

III.   FINDINGS AND RECOMMENDATIONS

The comparative list of Findings and Future Recommendations from different research publication selected in this literature work are given in table (1) below:

Table 1: Comparative Analysis list of research publications

Research work	Findings	future-research reccomendations
Universit, 2001[1]	COSMIC- FFP METHOD PRODUCED COMPARATIVELY PROMISING RESULTS THAN SLIM METRICS.	THE EFFECTIVESS AND VALIDITY OF RESULTS NEEDS TO BE TESTED ON LARGER DATA SET.
Costagliola, Ferrucci, & Gravino, 2004[2]	COSMIC FFP WITH ORDINARY LEAST-SQUARE REGRESSION ANALYSIS PROVIDED PROMISING RESULTS.	COSMIC FFP NEEDS TO BE REFINED FOR ACCPETANCE.
Santillo, 2007[3]	COSMIC FFP IS MORE PROMISING THAN ANY OTHER FIRST GENERATION FSM METHODS	MORE PRACTICAL EXPERIENCES TO BE DONE AND NEEDS MORE TRIALS TO BE TESTED FOR DIFFERENT PROJECTS.
Marín,2008[4]	PROPOSED COSMIC BASED NEW APPROACH .PROVIDED BETTER MEASUREMNETS THAN OBJET ORIENTED MODELS	MORE EVALUATIONS NEEDS TO BE DONE.
Gencel, 2008[5]	COSMIC FFP 3.0 PROVIDED BETTER RESULTS FOR VECTOR OF MEASURES.	REFINEMENT ID NEEDED.
F. Ferrucci, Gravino, & Di Martino, 2008[6]	EFFECTIVENESS OF COSMIC AND WEB OBJECTS WITH OLS REGRESSION MMRE, MDMRE AND PRED(0.25). PROVIDES BETTER RESULTS.	NEEDS TO BE TESTED FOR LARGER SIZE DATASETS.
Buglione, Ferrucci, Gencel, Gravino, & Sarro, 2010[7]	PROPOSED METHOD BASED ON COSMIC USING CHAR AND , MDMRE & PRED(0.25) PROVED RELIABLE FOR WEB APPLICATIONS.	TO INCREASE THE SIZE OF DATASETS AND REVISIT COST DRIVERS.
Hussain, Kosseim, & Ormandjieva, 2010[8]	THE EFFICIENCY OF COSMIC USING BOX-PLOT ANALYSIS REPORTED PROMISING RESULTS	REVISION OF NON-FUNCTIONAL PARAMETERS ON FUNCTIONAL SIZE OF SOFTWARE PROJECTS FOR ACCURATE RESULTS.
André Nitze, 2013[9]	COSMIC-FP SHOWED BETTER RESULTS FOR MOBILE EFOORT ESTIMATION.	ELICITATION OF NON FUNCTION PARAMETERS FOR BETTER ACURACY.
Abdullah, Rusli, & Ibrahim, 2013[10]	TRIED TO ESTIMATE DATA MOVEMENTS USING COSMIC-FP AND UML	MORE EVALUATIONS NEEDS TO BE DONE.

	REPRESNTATION FOR MOBILE APPLICATION. RESULTS WERE PROMISING.	
De Marco, Ferrucci, & Gravino, 2013[11]	COMPARATIVE ANALYSISFOR CFUNP USING MMRE, MDMRE, PRED(25) PROVIDED BETTER ESTIMATES THAN CFAFP BASED MODEL**.**	NEEDS TO BE TESTED FOR LARGER SIZED SOFTWARE PROJECTS.
Paz, Zapata, & Pow-Sang, 2014[12]	COMPARATIVE ANALYSIS OF ESTIMATION MODELS. WHERE INCREMENTAL CFP FOR EFFORT ESTIMATION	TO BE TESTED ON REAL WORLD PROJECTS.
Heeringen & Gorp, 2014[13]	PROPOSED GUIDELINES USING COSMIC FP FOR MEASURING FUNCTIONAL SIZE OF MOBILE APPS QUICKLY.	IMPLEMENTATION OF PROPOSED MODEL ON MOBILE APPLICATIONS .
Filomena Ferrucci, Gravino, Salza, & Sarro, 2015[14]	CFP BASED MODEL PROVIDE BETTER PREDICTIONS FOR MOBILE APP'S USING MMRE, MDMRE AND PRED(0.25).	NEEDS TO BE TESTED FOR LARGER MOBILE APPLICATIONS.
Philbin, 2017[15]	COST DEPEND ON BOTH FUNCTIONAL AND NON FUNCTIONAL ASPECTS. SOFTWARE WITH FUNCTION POINT ANALYSIS FAILED WHEN RECONSTRUCTING OR MAPPING THE FUNCTIONAL USER REQUIRMENTS. COSMIC FP PERFECTLY WORKS WITH SOA BASED SOFWTARE SIZING.	MEASRUEMENT OF NON-FUNCTIONAL PARAMETERS FOR DISTRIBUTED APPLICATIONS.
Abrahão, 2018[16]	New measurement approach based on COSMIC Measurement was proposed. Provides more accurate estimations than a first generation FSM method and dimensional measures.	CARRY OUT MORE EMPRICAL STUDIES ON LARGER DATASETS.

IV.   SUMMARY

The review of the research papers in this research study focuses on the importance of COSMIC FP in all the models discussed in previous research works. The Functional requirements are to be treated as building block for any

software effort estimation method based on COSMIC FP model. Therefore, the software project management team lies on how well an estimator has understood the system which will ensure correctness, completeness and accuracy of Functional requirements. Correct, complete and accurate functional requirements will help an estimator to count the number of data movements which will result in correctly categorizing software development project which will further strengthen the estimated efforts for the software development project at early stages of development.

Cosmic FP method is second generation measuring technique of FSM which came into existence in 1998 to overcome the limitation of Function points measuring technique where FP technique was used for specific applications while as COSMIC has the advantage to measure any kind of software i.e., conventional softwares , web-based softwares and mobile based applications. COSMIC FP is much more focused on data movements i.e., Entry, Exit, Read, Write which is suitable for client-server applications that is characterized by insignificant data movements. Each data movement represents one Cosmic Function Point (1 CFP) and thus the summation of all the data movements collectively specifies the total size of the system. Cosmic FP works on the Functional user requirements (FUR's).

A set of activities for successful implementation of any effort estimation method should start with building the foundations correctly followed by strategic planning and establishment of the processes. It was analyzed from previous research work that COSMIC FP proved better estimation approah for Software project development which can be ciently used for mobile application effort estimation.Since mobile applications are composed of components which in-turn work according to the functionality of a system. Therefore Cosmic FSM is considered to be the best example to measure the size of a mobile application where the size is counted on the basis of data movements.However, it is very important to continuously verify and validate estimates and compare the same with previously completed projects in order to evaluate performance of the effort estimation method which will result in improving the effort estimation model for software development projects

V.   CONCLUSION

In this study, many size measurement techniques were reviewed. On the basis of the literature reviewed it was analyzed the significance effort estimation process in early stages of software project development. The research papers reviewed in this study advocates the effectiveness of COSMIC FP for Mobile development process. The research papers from different authors reviewed emphasized on refining the COSMIC FP method of estimation for software development process, web based and mobile based applications. However in order to have effective COSMIC FP approach for estimation it needs to review and refine the way data movements are counted. Some of the researchers in the previous research work have also highlighted the need and importance of inclusion of function user requirements used in estimating size of mobile applications. Therefore the need of the hour is to further refine the parameters used in COSMIC FP with improving method of counting data movements which may lead to more effective COSMIC FP model of estimation of efforts for mobile application development projects. In order to obtain more precise and accurate results the COSMIC FP method of Mobile application effort estimation should me continuously refined for improvements.

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