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Statistical Analysis of various models of Software Cost Estimation

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Abstract - Cost estimation is one of the most challenging tasks in project management. It is to accurately estimate needed resources and required schedules for software development projects. The software estimation process includes estimating the size of the software product to be produced, estimating the effort required, developing preliminary project schedules, and finally, estimating overall cost of the project.

The accurate prediction of software development costs may have a large economic impact. As a consequence, considerable research attention is now directed to understand better the software development process. The objective of this paper is to provide an example base study of four software cost estimating models which were applied on four different projects. Chi Square test is being applied for statisitical analysis of these methods.

Index Terms – Cost Estimation, COCOMO II, Effort estimation, Putnam Model, Chi Square Test, cost parameters

1 Introduction

It is very difficult to estimate the cost of software development. Many of the problems that plague the development effort itself are responsible for the difficulty encountered in estimating that effort. One of the first steps in any estimate is to understand and define the system to be estimated. Software, however, is intangible, invisible, and intractable. It is inherently more difficult to understand and estimate a product or process that cannot be seen and touched. Software grows and changes as it is written. When hardware design has been inadequate, or when hardware fails to perform as expected, the "solution" is often attempted through changes to the software. This change may occur late in the development process, and sometimes results in unanticipated software growth.

After 20 years research, there are many software cost estimation methods available including algorithmic methods, estimating by analogy, expert judgment method etc. No one method is necessarily better or worse than the other, in fact, their strengths and weaknesses are often complimentary to each other. To understand their strengths and weaknesses is very important when you want to estimate your projects. This paper introduces some of the important and popular methods of software cost estimation. Also strengths and weaknesses are of each method is discussed here. All these methods are applied on the four examples. Chi-Square test is being used for statistical analysis of these methods.
Popular methods for estimation in software engineering include:

- Expert Judgement Method/Delphi Method
- Analogy
- Putnam Method
- COCOMO II

2. STATISTICAL ANALYSIS OF COCOMO-II

Various methods were applied on various applications which produces following results:

Table 1: Various Values of Different Projects

S.N.	Name of Project	Techn-ology	Estimated PM using Analogies Method	Estimated PM using Delphi Method	Estimated PM using Putnam Method	Estimated PM using COCOMO II	Actual PM
1	Advocate's Desktop	C#.Net	4	3	56.62	4.6	4
2	Online TrueLogic	DotNet	9	10	13.66	11.83	9.5
3	Online Project Management	Java	5	6	75.07	5.76	4
4	Unit Converter	Android	.66 20 days	.20	165.88	.76 (22 Days)	.53 (16 Days)

To see significance of difference between estimated and actual values, chi-square test can be applied with the following formula.

$$\chi^2 = \sum_{i=1}^{k} \frac{(O-E)^2}{E}$$

H0 (Null Hypothesis): There is no significance difference between actual value and estimated value

Calculation for COCOMO-II

$\chi 2$ = (4-4.6)2 / 4.6 + (9.5-11.83)2 /11.83 + (4-5.76)2 /5.76 + (.53-.76)2/.76

=1.1434

Table Value for 3 degree of freedom and 5% level of significance is 7.815
By above values it is clear that

Calculated Value< Tabled Value

So there is no significant difference between actual value and estimated value thus H0 is accepted for COCOMO-II.

Calculation for Delphi Method

$\chi 2$ =(4-3)2 /3 + (9.5-10)2 /10 + (4-6)2 /6 + (.53-.20)2/.20
=1.4817
Table Value for 3 degree of freedom and 5% level of significance is 7.815
By above values it is clear that

Calculated Value< Tabled Value

So there is no significant difference between actual value and estimated value thus H0 is accepted for Delphi Method.

Calculation for Analogy Method

$\chi 2$ = (4-4)2 /4 + (9.5-9)2 /9 + (4-5)2 /5 + (.53-.66)2/.66
=.2533
Table Value for 3 degree of freedom and 5% level of significance is 7.815
By above values it is clear that

Calculated Value< Tabled Value

So there is no significant difference between actual value and estimated value thus H0 is accepted for analogy method.

Calculation for Putnam method

$\chi 2$ = (4-56.62)2 /56.62 + (9.5-13.66)2 /13.66 + (4-75.07)2 /75.07 + (.53-165.88)2/165.88
= 282.27

Table Value for 3 degree of freedom and 5% level of significance is 7.815

By above values it is clear that

Calculated Value> Tabled Value

So there is a significant difference between actual value and estimated value thus H0 is rejected for Putnam method.

3 Comparison of various methods

Parameters → Methods ↓	Type of method	Advantages	Need to calibrate	Disadvantages
COCOMO II	Algorithmic	• Clear Results • Very Common	Yes	Much Data is required, not suitable for any project.
Delphi	Non-algorithmic	Fast Prediction	No	Success depends on experts
Analogy	Non-algorithmic	Work based on actual experience	No	A lots of data of past projects is required
Putnam	Algorithmic	Very sensitive to time constraint	No	Not good for small projects.

4. CONCLUSION

From the above analysis, it is clear that H0 is accepted in COCOMO II, Delphi and analogy methods whereas it is rejected in Putnam model. Putnam model is highly sensitive with the value of time. In last chapter, it is described that Putnam model give a big variance on small changes in time factor.

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