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COST MODEL FOR E-LEARNING SYSTEM

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Abstract: E–Learning applies information technology concepts in teaching and learning process. Numerous sophisticated project cost estimation models are available that estimates the cost of a project based on size, schedule and components used. But developing e-learning system is still in crisis. Capability to exactly predict the cost of e-learning system is dubious because traditional cost estimation methods fail to address the e-learning requirements and features. This leads to either under-estimate or over-estimate the cost for developing an e-learning system. The need to develop a separate cost model for e-learning system is rising. Hence, in this paper, cost estimation model for e-learning system is proposed. The proposed method first differentiates ordinary project with e-learning systems and trace for independent variables. These variables are building blocks of e-learning system. Regression analysis, a mathematical tool is used to calculate the cost of each independent variable with already incurred dependent variables. A linear regression formula is derived which estimates the cost of e-learning system. The proposed method is compared with COCOMO, COCOMO-I and SLIM models. The experimental results show that the Proposed method estimates the e-learning system in an accurate way when compared to traditional methods.

Keywords: E-learning, Cost Estimation, COCOMO, SLIM, LOC, FPA, Regression,

1. INTRODUCTION

E-learning is the process of permitting people to learn at anytime, anywhere using computer technology. E-learning which is an abbreviation of electronic learning refers to delivery of learning contents using computers and interactive networks [1]. Categories of E-learning are computer based learning, web-based learning, digital collaborative learning and virtual classrooms. In e-learning, it is not necessary that a computer need to be the central element of activity. But computer must hold a significant involvement in learning process. In e-learning, the contents are delivered through audio/video tape, satellite TV, internet, intranet / extranet, etc[2]. Content is in the form of texts, animations, stimulations, streaming audio / video, etc. There are several advantages of e-learning

- It is less expensive – Since room or big infrastructure is not used, e-learning is a much cheaper option. For companies and big educational institutions, e-learning can reduce cost per head substantially [3].
- More flexible – E-learning can be performed in short durations that can fit around the clock. This facility avoids public scheduled and in-house training, where entire day is utilized for training. Set of learning contents is divided into small modules and user can learn modules when and where needed or during free time[4].
- Mobile – Since e-learning can be done using laptops, tablets, phones, etc learning can be done while moving in train, bus, etc. the whole world can now become classroom.
- No travel – It reduces travel time and travel cost for off campus students. Since e-learning can be done anytime / anywhere, no need to travel from home to training centre.
- Faster – E-learning courses progress up to 50% faster than traditional courses as stated by Jennifer

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Salopek in article "Training and Development Magazine". This is because the learners can skip the contents which they know learning only unknown contents[5].

- Consistent – In traditional training, different instructors teach with different methods on the same subject. E-learning eliminates this problem with same way of teaching for the whole subject.
- Easy updation – It is very easy to update the latest information as the materials are available in the server. CD ROM based approach are slightly expensive to update and distribute.
- Increased retention – Since learning contents are available in audio, video, messages, quizzes, etc there is a great chance to grasp the subject. Another biggest advantage of e-learning systems is the ability of the learner to revisit or replay the sections of the training that are not clearly understood during first time[6].

2. LITERATURE SURVEY

Gunjan Kumar Bhati and Pooja [7] presented an approach for software size estimation. The work presents guidelines for defining, recording and reporting frequently used measures of software size. The metrics considered are lines of code (LOC), function count and token count.

Yunsik Ahn et al [8] presented a paper on software project effort estimation. To estimate the volume of maintenance, function point analysis technique is used. It considers three adjustment factors viz. engineer's skills, technical characteristics and maintenance environment to estimate a project. It suggests an exponential function model for relationships among maintenance efforts, maintenance environment factor and function points of software project maintenance.

Chander Diwaker and Astha Dhiman [9] presented a paper on estimating size and effort for software development. A comparison has been made with existing methods such as COCOMO, COCOMO-II, etc. The paper suggests that parametric project estimation is good and the parameters discussed in the paper are LOC, function points, feature points, use case points and object points. The efforts are estimated by using techniques such as expert based, bottom-up, top-down, analogy based, SLIM, COCOMO-I & COCOMO-II.

Vahid Khatibi and Dayang N.A. Jawawi [10] presented a review on software cost estimation methods. Several algorithmic and non-algorithmic approaches are discussed in this paper. Narayanan Ramasubbu and Rajesh Krishna Belan [11] presented in their research paper on issues related to cost estimation for distributed software projects. The disadvantages of metric-based estimation tools such as inefficient in considering distributed project configurations and characteristics, non-availability of full data and required domain experience, are addressed in this paper. The method collects all the past incidents and put it in one repository. The project managers refer this during project cost estimation and it is proved that nearly 60% of the estimation errors were reduced.

It is quite clear from the above literature that cost estimation for projects has gained much attention by researchers. But cost estimation for e-learning system remains an untouched area. The difference between traditional projects and e-learning systems is usage of independent variables in e-learning systems. Very easily we can calculate the cost of software used in e-learning system by using any one of algorithmic or non-algorithmic strategy. Hence if we calculate the cost of independent variables, we can calculate the whole cost of e-learning system.

The paper is organized as follows: Definition for e-learning, properties and advantages of e-learning is presented in section 1. Section 2 provides details related work, independent variables which categorize e-learning system with other project system are discussed in section 3. Regression analysis for calculating

the cost of each independent variable from dependent variables is discussed in section 4. Section 5 provides experimental results and paper concludes by defining the conclusion.

3. INDEPENDENT VARIABLES

Apart from standard variables used for system construction, there are certain special variables sued for constructing e-learning systems [12]. These independent, special variables are as follows:

Screens: Screen is said to be each step of procedure, which is like number of pages in a e-learning system.

Interactions: The interface points between the user and e-learning system are interactions. It can be drag and drop exercises, multi-core questions, etc. It can be simple or complex interactions.

Graphics: Drawings, images, diagrams that are included in the e-learning systems.

Photographs: Photographs can be input, supplied by the client or output, to be displayed by the e-learning system to the user.

Animations: Animated gifs, flash animations used to explain the procedure / concept to the user. Few animations are simple where as complex animations are always used by e-learning systems.

Audio and Video: Teachers voice, background music, other sounds used by e-learning system plays a vital role. Small video clips which are used to demonstrate the concept effectively to the user also plays an important role in e-learning system.

It is not always the case that all the above independent variables are used in e-learning system. Depending upon the type of e-learning system, independent variables are used[13]. The cost of these variables is added with other cost to estimate the exact cost of the project.

4. REGRESSION ANALYSIS

It is a set of techniques used to express the relationship between more than one variable. One variable may be independent and another variable may be dependent. Most of the regression analysis implement linear regression model. This helps us to define the dependent variables in terms of linear combination of independent variables[14]. Let Y be the dependent variable representing value that varies in the population. Let x_1 and x_2 be the two independent variables whose value also varies in the population. The general form of relationship between dependent variables and independent variables is given by

$$Y = \alpha + \beta_1 x_1 + \beta_2 \boldsymbol{x}_2 + \varepsilon$$

Where 'ε' is the residual error and β1, β2 are regression coefficients.

For our problem, a simple regression model to express relationship between dependent and independent variables is defined. It will also reveal the outliers that exist in the project. Based on the above formula, regression equation for each independent variable is expressed as given below

Number of screens	$Y1 = \beta_1 x + \varepsilon$
Interactions	$Y_2 = \beta_2 x + \varepsilon$
Graphics	$Y_3 = \beta_3 x + \varepsilon$
Photographs	$Y_4 = \beta_4 x + \varepsilon$
Animations	$Y_5 = \beta_5 x + \varepsilon$
Audio clips	$Y_6 = \beta_6 x + \varepsilon$
Video clips	$Y_7 = \beta_7 x + \varepsilon$

If the independent variables fail to produce strong relationship among, then weak independent variables are identified and they are clubbed during cost estimation process. After merging the weak independent variables, regression analysis for each independent is performed with highest F value of other independent variables. This can be done by using analysis of variance method.

After this step, independent variables are added till they improve the accuracy of the model. Merging weak independent variables will improve the accuracy of the model so that no independent variable can be removed from the cost estimation equation.

Next, the manpower needed to design the e-learning system for each of the independent variable is calculated. This is done by either calculating man power for each independent variable per day or total cost of all the independent variables per day i.e. average daily wage the mathematical model to calculate number of many days for a project is as follows:

$$\text{Total cost} = \text{Number of Screens} * Y1 + \text{Interactions} * Y_2 + \text{Graphics} * Y_{3+} \text{Photographs} * Y_4 + \text{Animations} * Y_5 + \text{Audio clips} * Y_6 \text{ Video clips} * Y_7$$

5. EXPERIMENTAL RESULTS

For experimental purpose, 6 projects were selected and the details of each project are as follows. Since graphics and photographs have been identified as weak independent variables, both are merged to form the new independent variable under the name ‘images’.

Project Details	I	II	III	IV	V	VI
Man Days	204	181	57	176	109	60
Screens	400	300	120	360	250	110
Interactions	390	120	110	105	62	32
Images	400	240	120	324	262	124
Animations	23	67	–	36	12	7
Audio	780	420	–	450	250	24
Video	–	–	–	–	–	04

The results of COCOMO-I, COCOMO-II, SLIM and our method are as follows:

Project	*COCOMO-I*		*COCOMO-II*		*SLIM*	
	Predicted Cost (in US$)	*Incurred Cost (in US$)*	*Predicted Cost (in US$)*	*Incurred Cost (in US$)*	*Predicted Cost (in US$)*	*Incurred Cost (in US$)*
I	74,400	68,560	77,500	68,750	77,900	69,760
II	64,850	63,300	63,800	63,900	64,450	63,560
III	21,500	24,340	20,900	22,850	22,300	22,690
IV	63,500	71,600	66,500	69,975	65,600	70,050
V	40,200	42,235	41,600	43,030	40,900	43,300
VI	19,500	19,950	18,700	20,170	18,900	20,280

Project	*Our Method*	
	Predicted Cost (*in US$*)	*Incurred Cost* (*in US$*)
I	68,750	68,654
II	63,900	63,986
III	22,850	22,740
IV	69,975	69,868
V	43,030	42,946
VI	20,070	19,956

Project	*Difference in percentage*			
	COCOMO-I	*COCOMO-II*	*SLIM*	*Our Method*
I	7.8	11.29	10.44	0.13
II	2.3	1.56	1.38	0.13
III	13.2	9.33	8.74	0.48
IV	12.7	5.22	6.78	0.15
V	5.06	3.43	5.86	0.19
VI	2.3	7.86	7.33	0.56

From the above table, it is clear that the difference in predicted cost and incurred cost is much lower in the proposed method when compared to traditional methods. Project II exhibits low percentage of difference. But on the whole the traditional methods exhibit high percentage of difference. Hence it is concluded that our proposed method is well suited for estimation the cost of e-learning systems.

6. CONCLUSION

The market fruition forces e-learning system developers to adopt good cost estimation models for healthy business environment. It is often results in a under estimation or over estimation of e-learning systems. In this paper, we have addressed this problem, by defining a novel cost model for e-learning systems. Independent variables, which acts as a building blocks for e-learning systems are identified first from previous experience or from analyzing the past history This is done by using regression analysis which finds correlation for new values from old values. Weak independent variables are merged so that the resulting equation can contain the non removable variables. Again, man power for each independent variable is calculated and finally the total cost of the e-learning project is estimated. The results are compared with traditional COCOMO-I, COCOMO-II and SLIM methods. It is quite clear that the proposed method estimates the e-learning project in an accurate way.

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