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Effective Software Project Estimation: An Excel Based Approach

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Abstract

The most essential factor for completion of project is the accurate Software Project Estimation in term of Cost, Effort, Schedule and Resources. As the size and complexity of project increases, it becomes a challenge for project manager to accurately predict the cost and effort with achievable scheduling. Each and every stakeholder of concern program wants to find out accurate estimation. Software industry is changing in lightning speed, so it is extremely difficult to develop parametric models that yield high accuracy for software development in all domains. This paper provides an overall overview on available cost estimation technique along with excel based cost estimation method which is more inclined towards expert judgment. Authors have analyzed different cost estimation techniques and came to a conclusion that no available techniques singly provide correct measurement for cost & schedule and is best for all situations. Authors have done a comparative study of the results of several approaches which in terms provide an overall accurate estimate. This paper reviews the different estimation techniques and illustrates an Excel based cost estimation model.

Key words

PV – project value, TC – total cost, RC – resource cost, person man-day(PD), FP – fixed price.

1. Introduction

Software is defined as an intangible, invisible and intractable product or services so it is hard to understand what customer expects to build and what to receive from vendor at initial phase or even as final delivery. That is why it is the most difficult task to calculate accurate cost of

software. Cost & Effort Estimation is always a challenging task since its inception whether it is a construction of a Bridge or DAM or highway or tunnel or airport or railways station. Similarly, in case of Software projects to build a system or product or upgrade from existing legacy to Oracle or SAP, or whatever the reason for taking the program on execution mode, in one line the new initiative has taken to provide services to customer based on its requirement for its business benefit.

These challenges can be guessed by the quote of Alfred M. Pietasanta in 1968, "Anyone who expects a quick and easy solution to the multifaceted problem of resource estimation is going to be disappointed". Thirty years later in 2006, Laird and his colleagues observed that "Despite the large number of cost factors collected and the rigorous data collection, a lot of uncertainty in the estimated (entity) can be observed" [1-3].

The time require to complete an overall task by single resource or group of resources is called effort which expressed in units such as person man-day(PD), person man-month(PM), and person man-year(PY). The numeric value of effort is essential to calculate the overall project cost along with non-manpower cost (like license, infrastructure, training, travel etc).

In this paper authors have done a comparative study of the results of several available approaches and proposed an Excel based cost estimation model. The paper is organized as follows: Section 2 states the Reason for Requirement of Proper Estimation, Section 3 considers the Factors for Cost Consideration, Section 4 discusses Comparative study of Cost Estimation Models, Section 5 introduces the proposed model: Cost Estimation Through Excel based Model following result and discussion in Session 6 and Conclusion in Section 7.

2. Reason for Requirement of Proper Estimation

Without measuring actual size in terms of scope of work, accurate cost & effort can't be calculated; hence incorrect productivity value may be arrived. Accurate Project Planning, Control & Executing can't be done without proper estimation. In terms of present & future business customer satisfaction through transparency of software project cost estimation is essential & totally critical.

There are numerous problems if cost of a project is not estimated properly. It can be overestimated causing cost overshooting, dissatisfaction to the customer, and poor utilization of resources. If project cost is underestimated, it may lead to understaffing, insufficient time for quality assurance (a Challenge to First Time Right-FTR) etc. Whereas Benefits of Appropriate Estimation of project cost to the Organization are proper Software Cost, Delivery Schedule, Managing / Tracking Project as It Progresses and maintain organization Brand Value.

Before in-depth discussion on the cost estimation topic, here is the definition of project as per software industry.

As per PMBOK: A project is a temporary endeavor with a definite beginning and a definite end and it creates a unique product, service or result. [4].

More precisely Project is not a routine operation, but a specific set of operations designed to accomplish a singular goal. A veteran project manager first wants to finalize scope of project in details so that time & cost can be estimated correctly within concerned boundary.

3. Factors for Cost Consideration

Tab.1. Different Types of Cost

SL. NO.	Cost Type	Description	Example
1	Direct Cost	Directly attributable to the work on the project	Team Travel, Team Wages, Awards for team motivation & recognition,
2	Indirect Cost	Overhead items or costs incurred for the benefit of more than one project	Taxes, fringe benefits, janitorial services
3	Variable Cost	Change with amount of production or amount of work involved	Cost of material / laptops being used for Production Support Project, wages
4	Fixed Cost	Does not change with respect to time.	Expenses for physical space, Link cost, telephone, front desk etc

In general, there are few things need to be considered while calculating the cost out of which few are precisely mentioned in standard literature. The authors also have added few other parameters (based on their work experience) which are in general require for calculating cost & effort more accurately.

- Cost of Quality efforts
- Cost of Risk efforts
- Cost of Project Manager‘s time
- Cost of Project Management Activities
- Infrastructure cost including office expenses for physical spaces, machine, license, telephone, link etc

- Cost for Training & certifications
- Travel cost like domestic, International
- Profit Require for executing the Program
- Overhead cost (like Management salaries, general office expenses)

Additionally following 3 cost management concepts need to be taken into account [5]

- Life cycle Costing
- Value Analysis
- Cost Risk

Few Guidelines to be considered while finalizing cost of a project,Cost need to be calculated in single currency like USD-$, GBP-£, EURO-€, Japanese YEN-¥, INR-₹, if multiple currency is used, proper conversion rate must be taken care. Following table describes different types of cost with example.

Tab.2. Comparative Study of Cost Estimation Models

Sl. No	Name	Method	Advantage	Disadvantage
1	Estimation By Expert Judgement	One or more experts in both software development and the application domain use their previous experience to predict software costs. The process iterates until some consensus is finalized.	Relatively cheap estimation method. can be accurate if experts have direct experience of similar systems & domains	Very inaccurate if experts are not available.
2	Estimation By Analogy	The Cost of a Project Is Computed By Comparing the Project to a Similar Project in the Same Application Domain	May be accurate if project data available and people/tools the same	Impossible if no comparable project has been tackled. Needs systematically maintained cost database
3	Estimation By Parkinson's Law	The project costs whatever resources are available	No Overspend	System is usually unfinished
4	Estimation By Cost	The project costs whatever the customer has to spend	Vendor company will awarded with Contract	The probability that the customer gets the

	Pricing To Win	on it		system whatever client wants is small. Costs do not accurately reflect the work required.

4. Comparative study of cost estimation models

Comparative study of Cost Estimation Models [6-8] is shown in Table 2. In the comparative study part COCOMO model is not considered as it works on idealistic situations and in actual scenario unable to provide required output [9].

5. Cost Estimation through Excel Based Model: A Different Approach

In this paper, Excel based cost estimation model has been discussed. Following assumptions are being considered before implementation of the model:

1. Need to finalize role based rate card
2. No of resource count required for entire project duration
3. Calculate resource cost based on role based rate and no of working days.
4. Non manpower cost like travel, software license, link& network, training, hardware etc
5. Additional cost based on situation on total cost likely 5% to 10%.

All the developed cost estimation models are taken into consideration. In this work the Excel based model has been developed using the following calculations:

$$\text{RC (FC)}=\sum_{i=1}^{n}(R_i * D) \quad (1)$$

$$\text{RC (Cr)} = \text{RC} * \text{CR} \quad (2)$$

$$\text{NMC} =\sum_{i=1}^{i}[(Trn_d * C_d) + (Trn_I * C_{dI})] + \text{Li} + \text{AMC} + \text{HW} + \text{La} + \text{NW} + \text{Trn} + \delta \quad (3)$$

$$\text{TC (Cr)} == \text{RC} + \text{NMC} \quad (4)$$

$$\text{PV} == \text{TC (Cr)} * \text{GM} \quad (5)$$

After replacing TC by (RC & NMC)

$$\text{PV} == (\text{RC} + \text{NMC}) * \text{GM} \quad (6)$$

where

RC: Resource Cost (in Functional Currency)

R: Rate Card daily for each Resource

D: No of Person Days worked for project

CR: Conversion Rate to INR

NMC: NON Manpower Cost

TRA (d): Domestic Travel cost

TRA (I): International Travel cost

C (d): Average cost for domestic travel

C (I): Average cost for International travel

Li: Software Licenses cost

AMC: Annual Maintenance cost

HW: Hardware

La: Laptop ,NW: Network / Link cost

Trn: Training & Certification cost

δ: Others Cost

TC: Total Cost , PV: Project Value

GM: Gross Margin

6. Output of the Proposed Software

The following figures show the output of the model when run on exact project data available from a reputed organization. The output shows that cost of the project can be calculated in terms of Rs (Cr.) when the required data is available.

Here the authors have showcased one e2e procedure how the cost has calculated for a hypothetical project.

Assumptions that Authors has taken care:

Time Line: 02 Years

Agreed Rate card hourly basis between client & vendor for both onsite & offshore

Training cost,Travel cost (domestic & international)

Laptop configuration with cost,Network cost

Link cost,Certification cost,Monthly Working Days: 22

Author has assumed that the hypothetical project will continue for 02 years i.e. almost 24 months. This is basically e2e development Fixed Price Project where as in Figure-01 authors have showed different rate card. Also phase wise scheduling also shown in Figure-02.Based on that authors have calculated onsite Figure-03 cost & offshore cost Figure-04.

Apart from manpower cost, non-manpower cost also calculated as per Figure-05.At end total

cost has calculated with summation of both manpower cost & non manpower cost. At end, cost iscalculated with GM which has different value based on vendor to vendor & specific to SWOT analysis.

			Solution Delivery Process Phase																					
			Initiate Project		Define Detailed Requirements		Design Solution		Develop Solution		Qualify & Test Solution		Deploy Solution		Close Project		Total		Cost Category					
Solution Component	Rate	Type	Effort	Cost	Effort	Cost	Effort	Cost	Effort	Cost	Effort	Cost	Effort	Cost	Effort	Cost	Effort	Cost	Category			Expense		
Project misc. tasks -- Consulting/Status Meetings (exp)	$ 48	Blended	0	$ -	1	$ 48	2	$ 96	1	$ 48	0	$ -	0	$ -	0	$ -	4	$ 192	Expense			$ 192		
Requirements																								
High Level Requirements Consulting	$ 48	Blended		$ -	2	$ 96		$ -		$ -		$ -		$ -		$ -	2	$ 96	Expense			$ 96		
Detail Level Requirements Consulting	$ 48	Blended		$ -	4	$ 192		$ -		$ -		$ -		$ -		$ -	4	$ 192	Expense			$ 192		
Design																								
High Level Design	$ 48	Blended		$ -		$ -	0	$ -		$ -		$ -		$ -		$ -	0	$ -	Expense			$ -		
Detail Design	$ 48	Blended		$ -		$ -	8	$ 384		$ -		$ -		$ -		$ -	8	$ 384	Capital			$ -		
Content Manager																								
Create New Data Model	$ 48	Blended		$ -		$ -		$ -		$ -	0	$ -	0	$ -		$ -	0	$ -	Capital			$ -		
Create New User Group and Security x 2 minimum	$ 48	Blended		$ -		$ -		$ -		$ -	0	$ -	0	$ -		$ -	0	$ -	Capital			$ -		
Development - Custom Services																								
Modify existing FN Key	$ 48	Blended		$ -		$ -		$ -	10	$ 480	0	$ -	0	$ -	0	$ -	10	$ 480	Capital			$ -		
Modify Datacap Application	$ 48	Blended		$ -		$ -		$ -	24	$ 1,152	0	$ -	1	$ 48	0	$ -	25	$ 1,200	Capital			$ -		
Reporting - documents loaded - weekly	$ 48	Blended		$ -		$ -		$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	Capital			$ -		
Misc.																								
Project misc. tasks -- Consulting/Status Meetings (cap)	$ 48	Blended	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	Capital			$ -		
Testing and Testing Support	$ 48	Blended		$ -		$ -		$ -	0	$ -	20	$ 960		$ -		$ -	20	$ 960	Capital			$ -		
Change Management Support	$ 48	Blended		$ -		$ -		$ -	0	$ -	4	$ 192	0	$ -		$ -	4	$ 192	Capital			$ -		
Configure Monitoring	$ 48	Blended		$ -		$ -		$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	Capital			$ -		
SME Misc.	$ 48	Blended	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	Capital			$ -		
Add Solution Component		Total	0	$-	7	$ 336.00	10	$ 480.00	35	$ 1,680.00	24	$ 1,152.00	1	$ 48.00	0	$-	77	$ 3,696.00		Expense Cost		$ 480	Capita	

Fig.1. Rate Chart (Onsite & Offshore)

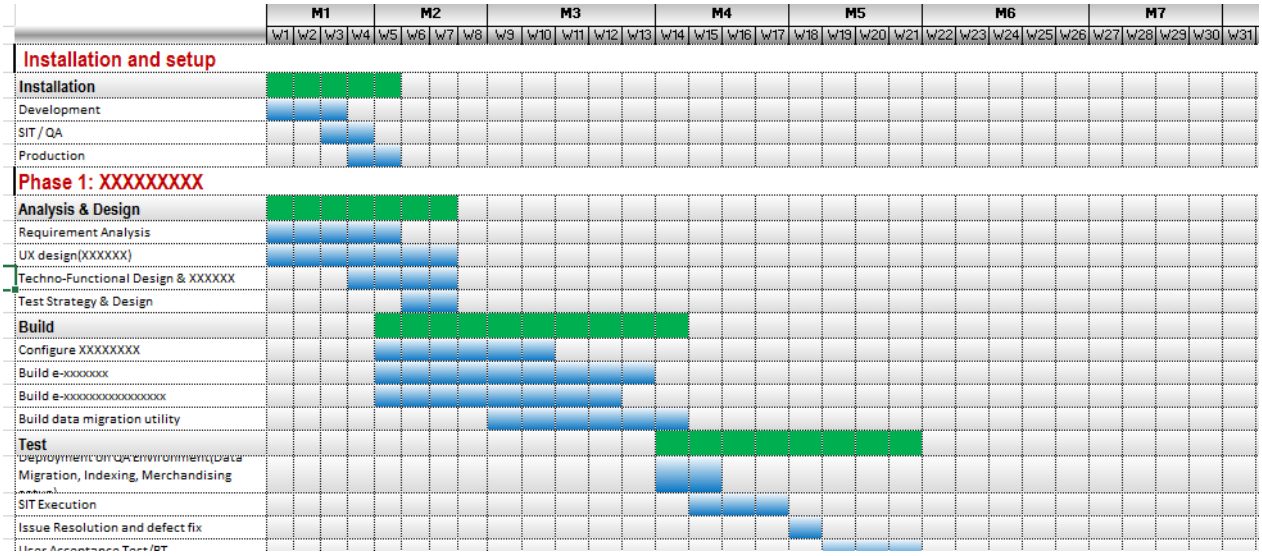

Fig.2. Project Scheduling

									M1				M2				M3					M4				M5					
	Staffing Plan								2	2	5	5	10	12	13	14	14	15	15	15	15	16	16	17	18	19	19	19	19	19	19
GBP Rate	Onsite Role /Designation	Resource count	Rate Chart (GBP/ Daily)	Effort (PW)	Effort (PD)	Effort (PH)	Cost (GBP)	Cost (Cr)	2	2	4	4	7	7	8	9	9	9	9	9	9	9	9	10	10	11	11	11	11	11	11
97.33	Project Manager (On)	1	480	52	260	2080	1,24,800	1.21	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	PMO (On)	1	310	52	260	2080	80,600	0.78	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Business Analyst - Type-01	2	410	100	500	4000	2,05,000	2.00	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Business Analyst - Type-02	3	370	132	660	5280	2,44,200	2.38	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Architecture (On)	1	570	50	250	2000	1,42,500	1.39	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Technical lead (On)	1	530	48	240	1920	1,27,200	1.24	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Sr. Middleware Developer	4	460	112	560	4480	2,57,600	2.51	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Infrastructure and DBA Lead (On)	1	460	48	240	1920	1,10,400	1.07	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Test Manager (On)	1	380	46	230	1840	87,400	0.85	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Tester - Type -01	2	330	74	370	2960	1,22,100	1.19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Tester - Type -02	2	310	70	350	2800	1,08,500	1.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
		19		784	3920	31360	16,10,300	15.67	2	2	4	4	7	7	8	9	9	9	9	9	9	9	9	10	10	11	11	11	11	11	11

Fig.3. Onsite Manpower Cost

Offshore Role /Designation	Resource count	Rate Chart (GBP/ Daily)	Effort (PW)	Effort (PD)	Effort (PH)	Cost (GBP)	Cost (Cr)	0	0	1	1	3	5	5	5	5	6	6	6	6	7	7	7	8	8	8	8	8
Project Manager (Off)	1	190	52	260	2080	49,400	0.48	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PMO (Off)	2	110	52	260	2080	28,600	0.28	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Business Analyst - Senior SME	3	230	52	260	2080	59,800	0.58	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Technical lead	1	210	54	270	2160	56,700	0.55	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Business Analyst - Type-01	2	140	48	240	1920	33,600	0.33	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Business Analyst - Type-02	2	110	87	435	3480	47,850	0.47	0	0	0	0	0	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
Sr. Middleware Developer	2	185	47	235	1880	43,475	0.42	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Jr. Middleware Developer	4	110	58	290	2320	31,900	0.31	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	2	2	2
Tester - Type -01 (Jr Functional)	2	110	13	65	520	7,150	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tester - Type -02 (Sr. Non-Functional)	4	110	18	90	720	9,900	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Infrastructure and DBA	2	140	48	240	1920	33,600	0.33	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	25		529	2645	21160	4,01,975	3.91	3	3	4	4	6	8	8	8	9	9	9	9	10	10	10	11	11	11	11	11	11

Fig.4. Offshore Manpower Cost

Expense Type	No	Avg (INR)	Total(INR)
Travel	20	1,50,000	30,00,000
Software	20	50,000	10,00,000
Laptop	18	63,000	11,34,000
Link	1	30,00,000	30,00,000
Training / Certification	1	5,00,000	5,00,000
Client Entertainment	1	8,00,000	5,00,000
Employee	1	5,00,000	-
			91,34,000

Fig.5. Non Manpower Cost

Location	Effort(PH)	Cost (million GBP)	Cost (Cr)
Onsite	31,360	1.61	15.67
Offshore	21,160	0.40	3.91
Total	52,520	2.01	19.59

Fig.6. Total Cost

Conclusions

The proposed model shows that Excel Based Software Cost Estimation models helps to guide the organization in a better way than other standard models available. It requires very less parameters for cost estimation and calculates the estimated cost of software more precisely. The authors have utilized numeric formulas which are generated based on work experience &therefore has taken care almost all parameters that should be considered while measuring project cost more accurately. As manpower cost is totally based on Project Manager's(PM) experience that means there is no answer here why PM has taken on no of travel say for example 5 in a month or 15 quarterly. How much cost needs to be estimated for training or what & how many certifications is required for first time right deliverable. Always ask to PM / estimator why this is considered & whether there is any requirement to decrease or increase the amount i.e. Estimator has to provide justification on estimation with significant reason. If possible, use previous project data with similar domain & technology, it provides better understanding & more accurate result. PM is accessed based on accurate cost estimation when it comes for decision to take among 3 or more options. PMs are advised to use top down & bottom up approach for accurate estimation to minimize the uncertainty factor. One major parameter, scope of work has to be well define in the contract, then this methodology is an excellent tool for cost calculation with very minimal inaccuracy.

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