

Is Estimating the Cost of a Mobile Application Development really so Easy?^{1, 2}

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ABSTRACT

The traditional information systems are undergoing a rapid transformation as per the environmental needs, and undergoing an adaptation process. But many mobile application development projects are failing because of inaccurate cost estimation. The paper addresses the problems of the different methods of cost estimation that can be used for mobile application development as well as which method gives the most efficient and accurate cost estimate. Different methods give different results basis the attributes and the method which abides by the maximum attributes gives the most accurate cost estimation. The following methods were used in the research namely Expert Judgement (Delphi technique), COCOMO II, Estimation by Analogy, Top-Down Approach and Bottom-Up Approach. However, a single method isn't sufficient to solve the purpose, hence, the best method to follow is by combining two or more alternatives which would give us a HYBRID method, which has also been proven with the help of the Additive Weightage MADM Technique.

Cost estimation is a tedious task and each method has its own pros and cons, and satisfies a different criterion depending on the requirement of the mobile application which is being worked on. Therefore, we finally can conclude that no one single method can satisfy all the project's requirements and give an accurate cost estimation.

Keywords: Cost Estimation, Mobile application development, Software cost Estimation, time estimation, Delphi technique, IT project, Project success, COCOMO II model, MADM methodology

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INTRODUCTION

Ever wondered the overshooting costs of projects in the world of today, especially in the field of IT. As per an article in Harvard Business Review, “it was revealed that, one in six IT projects has a cost overrun of 200%,” which is a quite high rate of failure for estimation.

Cost estimate is quantitative assessment of forecasting cost and analysis of the work required by the design documents. Cost estimation is used for evaluating individual component values and thereby estimates the total value of the project. It is a continuous process which is carried out throughout the project’s life starting from planning stage.

The cost estimation of a mobile application development starts with the reviewing of concepts with designers and developers, and identifying the size of the app. Then the time schedule is forecasted which is needed for design, development and QA. These steps are bifurcated as Design Estimate, Development Estimate and QA, Testing and Debugging Estimate. On the basis of these steps, Project Cost is estimated.

The cost of developing a mobile application is based on many factors like complexity, features and the platform. Of this, the most important factor which contributes to accurate cost estimation is the complexity of the app. As a general thumb rule, the cost of building a mobile app usually moves up the scale the more robust and complex it is. Another factor which contributes to the cost estimation is the platform, for which the mobile application is being developed for. The Android version of the app usually costs more than the iOS version. Also, the features added to the app, adds more cost.

1. Problem Definition

Cost estimation is considered to be one of the most challenging tasks in project management. It depends on accurate effort estimation and time estimation for development of mobile application development projects. The development of a mobile application process includes size of the mobile app, effort estimation, project schedule, and overall cost estimation of the project.

There are many methods for estimating the cost of a mobile app project, but only few gives the accurate results. Inaccurate cost estimation is one of the major reasons of a project’s failure.

There are adverse consequences of inaccurate Cost Estimation techniques:

1. Profitability- Inaccurate cost estimation will impact the profitability of the project. If cost is overestimated or underestimated, profit will be understated or overstated respectively.

2. Inefficient Distribution of Resources- An inaccurate allocation of resources also results in inaccurate estimation of cost which results in over or under utilization of resources affecting the productivity of the project.
3. Poor Decision Making- Inaccuracy in cost estimation causes inaccurate financial information which also effects in making poor decision-making processes which affects the projects. These incorrect figures may result in unnecessary or detrimental effects on the project and the organization, ultimately affecting the profitability.

In this context, it can be summarized that the research is addressing the problem of:

1. What different methods can be used to do mobile app development cost estimation?
2. Which method gives the most efficient and accurate cost estimate?

METHODOLOGY

A project may be simple or complex and the overall cost of developing a mobile application is calculated by considering key factors like complexity as well the effort involved. Tools like app estimator solves the purpose by easily calculating the cost of developing an application. This allows even the non-experts to conduct cost estimation for mobile apps. Furthermore, no detail level knowledge on the features of the application is required, and the calculation is mostly based on vague information at an early stage of the development process. Hence, this data is not that much reliable as it is not based on any logical foundation and not does not reveal an appropriate methodology. Hence, we have shortlisted few cost estimation techniques out of so many methods which give accurate cost estimates and helps in delivering successful projects.

2. Feasible alternatives

Different types of Cost estimation methods were analyzed on the basis of different attributes to define which method abides by the maximum attributes to give the most accurate cost estimate. Here are few techniques that will be discussed in this paper:

1. Expert Judgment (Delphi technique)
2. COCOMO II
3. Estimation by Analogy
4. Top-Down Approach
5. Bottom-Up Approach

3. Development of the Outcomes for alternatives

Before comparing these alternatives on the basis of Multiple Attribute Decision Making (MADM) to prove which is more efficient and accurate, let's have an overview of each method.

Expert Judgment (Delphi Technique)

This technique captures the estimates on the basis of the past experience of the estimation experts. Delphi technique is an example of this which is a multi-stage survey used for cost estimation of mobile app development projects. The experts identify recurring app features and their associated effort estimates based on different roles, perspectives and complexity levels. This method provides estimates which are rather subjective and it solely depends on the judgment and intuition of the experts. For increasing the accuracy, the estimates can be reviewed by using 3-point estimation methodology on Work Breakdown Structure. This method lacks the documentation of factors used by the experts, which means that the decision making may be biased and hence the method is not full proof.

COCOMO II

The cost estimation for an algorithmic model involves making use of mathematics and equations. Constructive Cost Model II (COCOMO II) is one of the most used algorithmic models used which was developed as an enhancement of COCOMO model. The cost estimation in COCOMO II model involves taking source of line codes, function point analysis and object as inputs. The set used is a broader one and thereby the result estimates come in the form of effort and size which eventually help in calculating the schedule for the project. This method is not able to deal with exceptional conditions. The model has 3 sub-models - Applications Composition (suitable for projects built with modern GUI builder tools), Early Design (uses small set of new cost drivers to get rough estimates of a project's cost before its entire architecture is determined) and Post-Architecture (most detailed COCOMO II model, used after project's overall architecture is developed).

Estimation by Analogy

Historical projects of similar nature are used as base to calculate the cost of the current project. The project whose cost needs to be calculated has certain attributes which are determined and compared to those of the previous projects. The cost estimate for every project cannot be calculated by this method.

Top-Down Approach

This model is favorable when cost needs to be calculated at a very early stage at an overview level by making use of global properties. Complex and difficult problems are not given adequate importance which makes this method faster to implement. Management, Integration etc. are key components of this method which no other method considers.

Bottom-Up Approach

Each individual component gives a cost and total cost of the project is the summation of the individual component cost. This technique is very stable, but it takes more time.

On the basis of thorough research from different cost estimation papers and case studies, different attributes were identified which will help in providing more accurate cost estimates. The methods mentioned above use some or all of these attributes while considering the cost of mobile application development, which eventually gives a correct measure of the cost of the project and thereby helps deliver a successful project.

4. Selection of the Criteria

1. Size of the application
2. Detailed Requirements
3. Timely Output
4. Past Experience/ Historical Data

Considering size of the mobile application while calculating the cost estimate is an essential factor as it tells the amount of effort required and also defines the complexity of the project. If the detailed requirements are considered while giving the cost estimates, more accurate results can be obtained. If the methods used are more time consuming, then this might delay the planning of the project and hence, delay the project as to initiate any project we need a method which gives the cost estimate in time. Hence, the third factor considered is timely output. If a similar project has been used in past, or the people who have already worked on such projects, and are experts in calculating the cost, then this will also help in giving more successful cost estimates which won't impact the success of the project.

The analysis of the alternatives by following MADM approach gave us the following result which will help us to prove which method is more reliable and efficient, and gives more accurate cost estimation results.

Selection Attributes	Expert Judgment	COCOMO II	Estimation by Analogy	Top-Down Approach	Bottom-Up Approach
Size of the Application	Low	Positive	Negative	Middle	Middle
Detailed Requirements	Middle	Middle	Negative	Negative	Positive
Timely output	Low	Negative	Middle	Positive	Negative
Past Experience/ Past data	Positive	Middle	Positive	Low	Low

Negative = Highly unlikely to satisfy the objective of the Alternative

Low = Unlikely to satisfy the objective of the Alternative

Middle = Likely to satisfy the objective of the Alternative

Positive = Highly likely to satisfy the objective of the Alternative

According to MADM analysis, Estimation by Analogy approach has more “Negative”, hence it is less efficient and gives less accurate cost estimates. This method is being eliminated.

FINDINGS

5. Analysis and Comparison of the Alternatives

To choose our better and best alternative, we will focus on comparing the Expert Judgment, COCOMO II model, Top-Down Approach and Bottom-Up Approach by using another MADM method, that is based on compensatory techniques. The analysis is Additive Weighting Technique and the results are shown in the table:

Quality	
Positive	1
Middle	0.67
Low	0.33
Negative	0.00

	Step 1	Step 2	Expert Judgment		COCOMO II		Top-Down Approach		Bottom Up Approach	
	Relative Ranking	Normalized weight (A)	B	A*B	C	A*C	D	A*D	E	A*E
Size of the Application	4	0.4	0.33	0.13	1	0.4	0.67	0.27	0.67	0.27
Detailed Requirements	1	0.1	0.67	0.07	0.67	0.07	0	0	1	0.1
Timely output	2	0.2	0.67	0.13	0	0	1	0.2	0	0
Past Experience/ Past data	3	0.3	1	0.3	0.67	0.2	0.33	0.1	0.33	0.1
SUM	10	1	SUM	0.63	SUM	0.67	SUM	0.57	SUM	0.47

Based on the above table, it appears that, COCOMO II model has the highest score, and hence gives the most accurate cost estimation. However, we can see that it is valid for those mobile applications which are complex.

It can also be seen that Expert Judgment method is very near to the score of COCOMO II model. But if we see the Past Experience criteria, Expert Judgment method is scoring the highest, and hence, if a similar project is being implemented, then Expert Judgment can be used to estimate the cost for development of the mobile application.

Also, if the cost estimates are required as soon as possible, depending on the criticality of the application development, it can be seen that Top-Down approach is scoring the highest and hence, can be chosen to give the cost estimate of the mobile application being developed.

If the detailed requirements are given then it can be seen that Bottom-Up approach is given the highest and hence, is considered to be the best approach.

6. Selection of the Preferred Alternative

In an ideal situation, COCOMO II model is considered to be the best as it takes into consideration almost all the criteria to give the most accurate cost estimation for mobile applications. But considering the importance of different criteria, we can consider different alternatives, depending on the situation. Out of these four alternatives, a single alternative isn't sufficient to solve the purpose. Hence, the best method to follow is by combining two or more alternatives which would give us a HYBRID method, which will be more efficient and accurate.

7. Performance Monitoring and Post Evaluation Results

Hybrid Method is developed by integrating two or more cost estimating methods which helps in improving the accuracy of cost estimation and removing the weaknesses of any particular method. The Hybrid method helps get rid of the negative impacts of any technique and overpowers it with the individual strengths of the others. Unlike COCOMO II model and Expert Judgment, we can use Hybrid method for any kind of mobile app development project which will favour all the criteria and will be more accurate as compared to following only one method and doing the estimation on the basis of that single method. Hybrid technique should be proposed based on the different requirements and design phases and should make use of the information of both the techniques to compute the cost estimation of the mobile application.

CONCLUSION

Cost estimation is a tedious task and is one of the main criteria to deliver a successful project especially for mobile application related projects. This paper answers the below questions:

- What different methods can be used to do mobile app development cost estimation?
There are many methods for estimating cost and some of them were discussed above like Expert Judgment, COCOMO II, Estimation by Analogy, Top-Down approach and Bottom-Up approach. Each method has its own pros and cons, and each method satisfies a different criterion depending on the requirement of the mobile application which is being worked on.
- Which method gives the most efficient and accurate cost estimate?
After the research and analysis, and with the help from Additive Weightage Technique of Multi Attribute Decision Making, we finally can conclude that in ideal situation COCOMO II method is the best one, but depending on the different requirements and

features of the mobile application, there is no one single method which can satisfy all the project's requirements and give an accurate cost estimation. This answers the question on which this paper was based on.

Hence, to produce more reliable and accurate estimates, it is imperative to have a good knowledge of all the techniques and establish relationships between the attributes.

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