



## Business Process Analysis: A Precursor to Software Cost Estimation in Software Development Projects

\*Oga, R.O., \*Egbokhare, F.A. & \*Obahiagbon, K.O.

\*Department Of Physical Science, Benson Idahosa University, Benin City

\*Department of Computer Science, University of Benin. Benin City. Edo State

### ABSTRACT

The software development process has transcended through several stages of development and improvement over the past few years. Most software engineering research reports that problems in cost estimation in both traditional and agile software systems are still a major cause of software project failures. A study of cost estimation techniques adopted in Nigerian software development organizations using a survey research showed that expert judgement is the most frequently used but the resultant effect is that these organizations still experienced schedule and cost overruns. This is attributed to the fact that every project is unique and the approach adopted in one project may not be suitable for another. This study proposed a Business Process Modelling and Analysis as a precursor to software cost estimation. This approach models the Software requirements as set of activities and tasks which are reduced to component parts for which cost estimates are drawn. This approach guides a cost estimator, irrespective of the technique adopted to determine the relevant parameters to consider while drawing cost estimates to achieve more realistic outcomes.

**Keywords:** Cost Estimation, Business Process Modelling, Cost estimation Technique, Information System Development

### iSTEAMS Cross-Border Conference Proceedings Paper Citation Format

Oga, R.O., Egbokhare, F.A. & Obahiagbon, K.O. (2018) Business Process Analysis: A Precursor to Software Cost Estimation in Software Development Projects. Proceedings of the 13th iSTEAMS Multidisciplinary Conference, University of Ghana, Legon, Accra, Ghana. Vol. 2, Pp 217 -224.

### 1. INTRODUCTION/BACKGROUND OF THE STUDY

Planning a budget is one of the most important aspects of a software project. Most software projects fail due to planning issues related to cost, time and schedule (Munialo and Muketha, 2016). Software Cost Estimation (SCE) is the process of predicting the actual or total cost required to develop a software system (Shekhar and Kumar, 2016; Munialo and Muketha, 2016). SCE is particularly more complex in Agile software projects which is receptive to requirement changes throughout the development process unlike most traditional methods of software development where clearly defined requirement is prerequisite to cost estimation and project execution (Miller, 2013). The Information System Development (ISD) process, regardless of the methodology adopted, requires effective planning which involves making estimates at the beginning of a project so that resources can be appropriately allocated. Cost estimation often helps to determine the resources and tools that should be assigned to a project to achieve success (Gupta *et al.*, 2016). Khatibi and Jawawi (2010) observed that effort and cost estimations are generally difficult because each project is often unique and there is no background or previous experience about them.

The main idea behind the process therefore is to make a fair estimate of the size, effort required, time required and the corresponding cost of the project (Gupta *et al.*, 2016). But most of the industries are unable to make these estimates properly, thus, creating a need for efficient models which can help to estimate the overall project cost. Estimation techniques and models are available to simplify this activity but the prevalence of cost and schedule overruns on ISD projects indicates that accurate estimation remains somewhat elusive and unsatisfactory (Osman and Musa, 2016). This study proposes a Business Process Modelling and Analysis (BPMA) approach that models the Software requirements as set of business processes consisting of various activities and tasks to determine the relevant parameters for cost estimation. This will guide a cost estimator, irrespective of the estimation technique adopted to obtain more realistic outcomes.



## 2. RESEARCH METHODOLOGY

### 2.1. DATA COLLECTION METHODS

In order to understand the current cost estimation models adopted by software development organizations in Nigeria, formal interviews were used to elicit information from selected software development organizations. The purpose of the interview was to elicit information on the software development models adopted, the cost estimation techniques used and the effect on the overall project outcomes. Ten (10) Software project managers selected from three cities in Nigeria (Lagos, Abuja and Akure) where there is intensive software development activity were interviewed. The interview questions were prepared in the form of a questionnaire to ensure consistency. Each interview session was scheduled and it lasted for about 40 minutes. The responses were recorded in the questionnaire. Analysis of the interview protocol (Table 1) showed that Four (4) of the software organisations studied adopt agile software development methodology, three (3) used traditional methods while the methodology by the other three (3) were unspecified. The software methodology adopted and cost estimation techniques adopted are presented in Table 1 and Table 2.

**Table 1: Software Methodology Adopted**

Methodology	No. of responses	Percentage %
Traditional	3	30
Agile	4	40
Unspecified	3	30
Total	10	100

**Table 2: Cost Estimation Techniques Adopted**

Cost Estimation Method	No of responses	Percentage
Expert Judgment (E)	10	100
Analogy (A)	0	0
Price-to-win (P)	3	30
Bottom-up (B)	1	10
Top-down (T)	2	20
Constructive Cost Model (COCOMO)	0	0
Function point analysis (F)	4	40
Story point (SP)	3	30
Ideal day (I)	0	0
Feature driven development (FD)	0	0

The Cost estimation techniques adopted and the overall project outcomes for the studied organizations is presented in Table 3. The interviewees were promised privacy and confidentiality therefore the company names in this project are denoted as Ci, (i = 1... 10).



**Table 3: Cost Estimation Techniques and Overall Project Outcome**

Project Status	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
<b>Cost Estimation Method</b>										
Expert Judgment (E)	E	E	E	E	E	E	E	E	E	E
Analogy (A)									P	
Price-to-win (P)				P		P				
Bottom-up (B)	B									
Top-down (T)	T						T			
Constructive Cost Model (COCOMO)										SP
Function point analysis (FP)										
Story point (SP)		FP	FP	FP	FP					
Ideal day (I)	SP	SP								
Feature Driven (FD)										
Major client (Government (G), (P Private))	G P		G P	G P			G P		P	P
Abandoned Projects? (Y/N)	N	Y	Y	Y	Y	Y	Y	Y	N	Y
Schedule overruns? (Y/N)	Y	N	Y	Y	Y	Y	Y	Y	Y	N
Need for re-estimation based on new functionality? (Y/N)	Y	Y	N	Y	N	Y	Y	N	Y	Y
Number of Successful software developed	5	42	10	3	8	4	15	6	7	12
Total number of employees	5	70	5	10	6	3	8	5	4	6

### 3. DISCUSSION

Traditional and Agile software development methodologies are adopted by the organizations studied. Findings in Table 3 show that all the software development organizations studied used experience gained from past projects as a basis for cost estimation (expert judgement) despite the methodology adopted. This is consistent with reports in literature that Expert estimation methods are the most commonly used estimation methods in the software industry (Moløkken and Jørgensen, 2003; Trendowicz 2013) because as human beings they have more information available and can use it more flexibly than algorithms. Every project is unique as observed in Khatibi and Jawawi (2010) and since a major characteristic of expert judgement is to predict an estimate for the current project based on past experience, this may not always be effective. This is reflected in Table 3 were almost all the organizations studied had abandoned projects, schedule overruns and the need for re-estimation. Issues in cost estimation are a major cause of software project failures both in agile and traditional software development processes. Irrespective of the model adopted, a starting point of any software development project is requirements engineering where user's needs are elicited, modelled and validated to ensure the development of satisfactory software systems. This requirements can be modelled as a business process and analysed to determine the necessary parameters for cost estimation.



#### 4. BUSINESS PROCESS MODELLING

Business Process Management (BPM) is the art and science of overseeing how work is performed in an organization to ensure consistent outcomes and to take advantage of improvement opportunities (Marlon *et al.*2013). BPM is about managing the entire chain of events, activities, and decisions that ultimately add value to the organization and its customers. These chain of events, activities and decision are called Processes. A typical process involves decision points (stages when a decision is made that affect the way the process is executed); a number of actors, (human actors, organizations or software systems acting on behalf of human actors or organizations) and the execution of a process leads to one or more several outcomes. (Marlon *et al.*2013).

Using a case study method, a set of user requirements are modelled in this research using algorithm1:

- Step 1. Get users story
  - Step 2. Identify the tasks and activities
  - Step 3. Represent the tasks using a business process model (BPM)
  - Step 4. Repeat step 5 to 9
  - Step 5. Refine user tasks
  - Step 6. Identify the roles for each tasks.
  - Step 7. If any complex processes, break into constituent tasks
  - Step 8. If decision points then analyse.
  - Step 9. Identify infrastructures required for implementation
- Until refinement is no longer needed

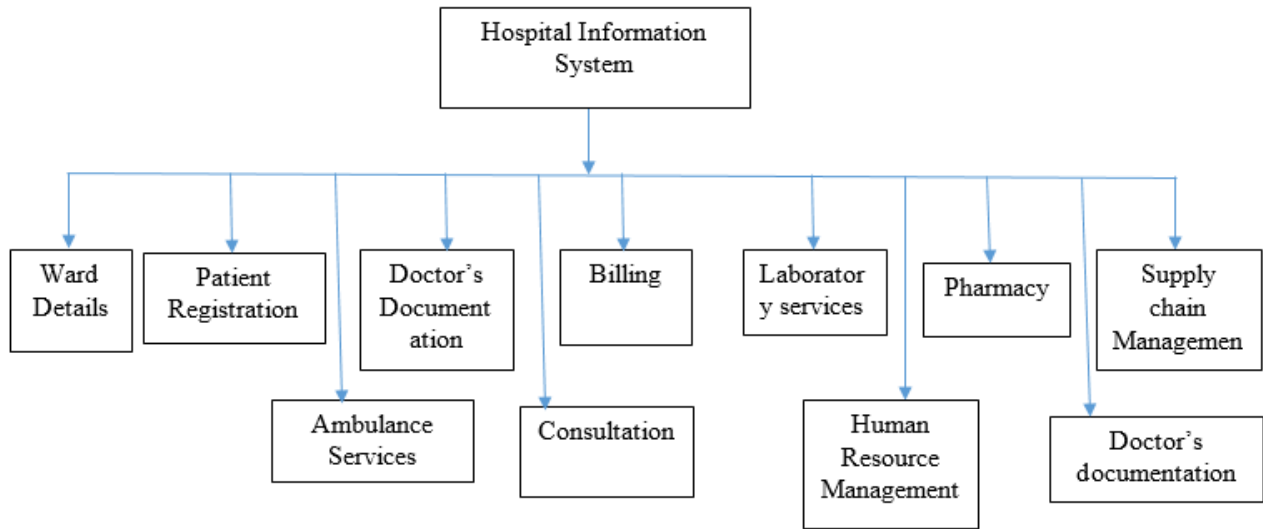
#### Algorithm 1: Proposed BPA Algorithm for Analysing User Tasks

#### 5. CASE STUDY: HOSPITAL INFORMATION SYSTEM

To test the algorithm 1, the case study approach was used to obtain user requirements for an Information Systems Development Project using a Hospital as a Business Process. A Case study method enables a researcher to closely examine the data within a specific context. In most cases, a case study method selects a small geographical area or a very limited number of individuals as the subjects of study. Case studies, explore and investigate contemporary real-life phenomenon through detailed contextual analysis of a limited number of events or conditions, and their relationships (Yin, 1984). A formal interview protocol was used to study the business processes in Health Creed Hospital, a Private Clinic in Lagos State, Nigeria. The aim of the interview was to identify the business processes required in a hospital Information System. The Managing Director of the Hospital and heads of some selected departments were interviewed to determine the activities and task performed. The following tasks for a hospital information system were identified from the study:

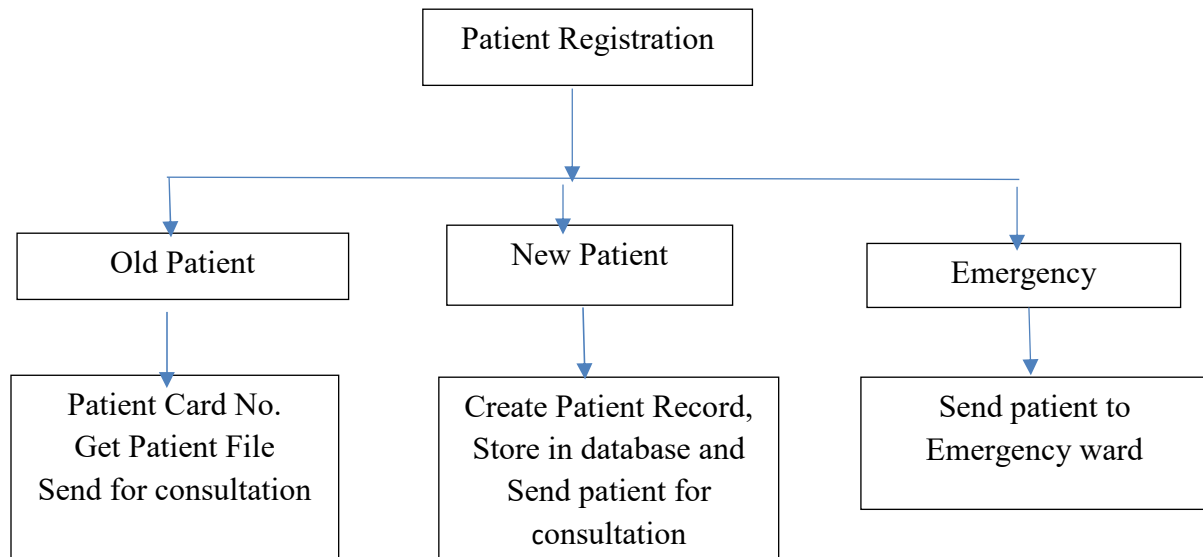
1. Patient Registration
2. Doctor's Documentation
3. Billing
4. Laboratory Services
5. Pharmacy
6. Supply Chain Management
7. Consultant Details
8. Ward Details
9. Ambulance Services
10. Human Resource Management

The next stage is to create a Business Process Model. This is modelled in Figure 1.



**Figure 1: Tasks in a Hospital Information System**

To identify appropriate parameters for cost estimation, each task is refined into component parts. At each stage of the refinement, the sub-processes required to accomplish the task, resources required, dependencies, decision points and the task complexity are identified. Figure 2 shows the activities and tasks for patient registration. Three sub-processes: Old, new and emergency patients are identified. Each of these sub-processes are further decomposed into other sub-activities and tasks until each user task corresponds to a line of code.



**Figure 2: Patient Registration task Analysis**



The activity **Create Patient Record** for new patients in Figure 2 includes the following tasks:

- Input. Patient Name ();
- Identify Patient type (\* Decision Point \*)
- Identify patient Status (\* Decision point)
- Input. First-name();
- Input. Middle-Name();
- Input. Last-Name();
- Input. Age ();
- Input. Address();
- Input. Date of Birth();
- Input. Next-of-kin ( );
- Input. Gender ();
- Input. State ();
- Input. Country();
- Check if Referred (\* Decision point \*);
- Input. Date-of-admission();
- Validate Input ()
- Append to Database() (\* Store the input into a database \*)

During the Analysis of the 'Patient Registration' activity the following parameters that will guide a cost estimator were identified:

- A. Human Resource Needs**
  - i. Software Developers
  - ii Database Administrator
  - iii Computer Operator
- B. Computer Software**
  - i. Database Management System
- C. Decision Points**

A decision point is a stage in a process where judgement has to be made that affects the execution of the process. Decision points add complexity to a software system because each decision point requires further refinement that could create new processes (sub-processes) hence a cost estimator needs to identify decision points in the users requirements to guide the estimation process.

The following decision points were identified for 'Patient Registration':

- i Patient Type ()
- ii Patient Status ()
- iii Referred ()

Each process in the BPM is analysed and the parameters, P(n = total number of each parameter type) is identified. To obtain the total parameters for cost estimation, we propose the following:

For each User Task, T and Parameter type Pi (i : 1 .. n), Parameter list, PL is given as:

$$PLT = \sum_{i=1}^n Pi \tag{1}$$

Total Parameter list for the entire project, TPL is given as:

$$TPL = \cup \sum_{i=1}^n PLT \tag{2}$$

Sharma *et al.*, (2012) reviewed cost estimation techniques for both traditional and agile software development to guide a cost estimator in predicting accurate cost estimates for a project. Obtaining a list of parameters for which estimates should be drawn for a software work project will guide the cost estimator in selecting the most appropriate technique to adopt and also to produce more accurate results.



## 6. CONCLUSION

Software cost estimation is a major problem in software development, and it has been identified as one of the root causes of software project failures. A business process modelling approach was adopted as a precursor to cost estimation in a software development project in this paper. This approach was tested using a hospital information system as a single case study. Using the BPA algorithm, complex tasks and decision points that can create estimation bottlenecks are identified to enable a cost estimator make more informed decisions. In situations where expert opinion is the only available option, having a purview of the various tasks and organizations workflow will add more value to the estimators judgement. Because the user is actively involved and directs most of the business process activities, it is easy for the user to understand the approximate cost of each feature, which improves decision making and requests for new features will no longer sound out of context since the developers can predict users requests and create allowance to accommodate such requests into the current cost. Even late changes in requirements can be welcomed.



## REFERENCES

1. Coelho, E. and Basu, A. (2012). Effort Estimation in Agile Using Story Points. *International Journal of Applied Systems (IJAS)*. 3(7), 7 – 10.
2. Dheeraj, R. and Gupta, K. (2016). Software Cost Estimation Techniques: A Review Of Literature *International Journal of Research and Development in Applied Science and Engineering (IJRDASE)*.
3. Highsmith, J., and Cockburn, A. (2001). *Agile Software Development: The business of Innovation Computer*, v34, p120-122.
4. Khatibi, V. and Jawawi, D.N.A. (2010) Software Cost Estimation Methods: A Review *Journal of Emerging Trends in Computing and Information Sciences*, v2, p21-29
5. Munialo, S.W. and Muketha, M. G. (2016). A Review of Agile Software Effort Estimation Methods. *International Journal of Computer Applications Technology and Research* 5(9), 612-618.
6. Molokken, K. and Jorgensen, M. (2003) A Review of Software Surveys on Software Effort Estimation. *International Symposium on Empirical Software Engineering*, p223-230.
7. Marlon, D., Marcello, L., Jan M. and Hajo, A. R. (2013). *Fundamentals of Business Process Management* p1-33.
8. Miller, G.J. (2013). Agile Problems, Challenges and Failures. *PM Global Congress 2013*. 8p
9. Osman, H. H. and Musa, M. E. (2016). A survey of agile software estimation methods. *International journal of computer science and Telecommunications*. Volume 7, p55
10. Shekar, S. and Kumar, U. (2016). Review of Various Software Cost Estimation Techniques *International Journal of Computer Applications* (0975 – 8887 Volume 141 – No.11.
11. Somerville, I. (2011). *Software Engineering*. 9<sup>th</sup> Edition. Pearson Education. 790P
12. Sharma, N., Bajpai, A., and Litoriya, M. R. (2012). A Comparison of Software Cost Estimation Methods: A survey. *The international Journal of Computer Science and Applications (TIJCS)*, v1(13)
13. Trendowicz, A. (2013) *Software Cost Estimation, Benchmarking, and Risk Assessment, The Software Decision-Maker's Guide to Predictable Software Development, The Fraunhofer IESE Series on Software and Systems Engineering*, Springer-Verlag Berlin Heidelberg
14. Yin, R.K., (1984). *Case Study Research: Design and Methods*. Beverly Hills, Calif: Sage Publications.