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Use Case Point Methods For Analysis of Software Development Cost In Information Communication Technology Units of Khairun University

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Abstract. The Information and Communication Technology Unit (ICTU) is a technical implementation unit in the field of information and communication technology development and management. Currently, Khairun University's ICTU is undertaking a software development project, one of which involves creating an application called "Permata". In the process of developing this application, one of the common challenges faced is estimating the project costs for software development, as the developers do not yet have a standard method to determine the costs of software development. The objective of this research is to produce a Use Case Point application for estimating the costs of software development at ICTU, Khairun University. The Use Case Point (UCP) method is derived from the Function Point Analysis (FPA) method and aims to provide a simple estimation method oriented toward software project objects. The software objects involved in this method are Actor Types (UAW), Use Case Weight (UUCW), Technical System Development Complexity (TF), and Development Environment Complexity (EF). The estimated time value for developing the Permata application is 1,389.844855 man-hours, equivalent to approximately 1.904 months. The estimated cost for the Permata application is Rp129,099,127.

Keywords: *Estimating Software Costs, Use Case Points, ICTU (Information and Communication Technology Unit) Support, Permata.*

1 Introduction

In the 4th Industrial Revolution era, technology plays a crucial role in all sectors, especially in government agencies. Government agencies are expected to be quick and adaptive in implementing technology in their business processes, including the development of software applications that are now being demanded to enhance service quality. Software is a physical abstraction that allows us to interact with hardware machines; without software, the created hardware would be useless or unable to function optimally [1].

The Information and Communication Technology Technical Implementation Unit (ICT TIU) is a technical implementation unit in the field of information and communication technology development and management. Currently, the ICT TIU of Khairun University is carrying out a software development project, one of which involves creating an application called "Permata." In the application development process, one of the common challenges faced is the estimation of project costs for software development, as the developers do not have a standard to determine the costs. Therefore, the current estimation is still under evaluation because it often results in tasks that do not align with the provided

estimates. For example, some projects may be completed later or earlier than the given estimates. The estimates are frequently based on past projects, which may not accurately match the actual implementation time. Besides time estimation, there are also issues with cost estimation in the project.

The Use Case Point (UCP) method is derived from the Function Point Analysis (FPA) method and is designed to provide an easily understandable estimation approach, especially for object-oriented software projects. Several software objects involved in this method include Actor Type (UAW), Use Case Weight (UUCW), Technical Complexity of the development system (TF), and Environmental Complexity of the development system (EF). A research study conducted by [2] states that the Use Case Point (UCP) method is highly effective in estimating the required effort. This approach enables companies to allocate actual resources without relying on a specific method.

1.1 Estimated Costs

The estimation of costs plays a crucial role in a project because, without cost estimation, a project will not succeed. The quality of a project's cost estimation

depends on the availability of data and information, the techniques or methods used, as well as the skill and experience of the estimator. The availability of data and information is crucial in producing high-quality project cost estimates [3]. For instance, during the initial formulation of the project scope, if some data or information is not yet available or determined, the resulting cost estimate will still be a rough estimate. A good project's value or price depends on how well a good cost estimation is made, where costs that may arise should be controlled as minimally as possible [4].

1.2 Software

Software or software is a set of program instructions that resides inside a computer. When executed by its user, it provides multiple functions while displaying the desired information. This explains that this software has the function of giving computer commands [5].

1.3 Use Case Point Method

Gustav Karner introduced the Use Case Point (UCP) method in 1993, drawing inspiration from the Function Point Analysis (FPA) method, with a particular focus on estimating object-oriented software projects [6].

The UCP approach involves analyzing use cases, use case actors, scenarios, environmental factors, and technical factors to formulate a comprehensive equation. UCP comprises three primary variables: the Unadjusted Use Case Point (UUCP), the Technical Complexity Factor (TCF), and the Environment Complexity Factor (ECF) [7]. Effort Rate

The effort rate represents the amount of effort per use case point in software development, maintenance, and other software engineering tasks [8]. It is calculated as the ratio of person-hours per use case point based on past projects [9]. For new projects without historical data, values between 15 and 30 are commonly used, with 20 being the most frequently applied value [10]. In the context of business applications in Indonesia, the Effort Rate (ER) is determined to be 8.2 man-hours based on research [11]. This value directly converts Unadjusted Use Case Points (UCP) into the effort required, measured in Hours of Effort, using a specific calculation formula.

$$\text{Hours of Effort} = \text{UCP} \times \text{ER} \quad (1)$$

Where:

Hours of Effort: Working Hours

UCP: Use Case Point

Effort Rate: Effort Level

1.4 Standard Developer Salary

The calculation of costs for each project implementation activity uses the salary standard issued by the Indonesian National Association of Consultants [12] (INKINDO) 2023.

Table 1. Salary Standard (INKINDO, 2023)

Position	Standard Salary (per month)	Salary Per Hour
Project Manager	Rp27.122.500	Rp169.516
System Analyst	Rp13.917.500	Rp86.984
Software Engineer	Rp13.917.500	Rp86.984
Test Analyst	Rp13.490.000	Rp84.313
Software QA	Rp13.490.000	Rp84.313

1.5 Database

A database differs from a mere collection of files as it serves as a centralized source that allows multiple users to access it through various applications [13]. At the heart of the database lies the Database Management System (DBMS), responsible for database creation, modification, updates, data retrieval, and generating reports and displays. Overseeing the achievement of the database's objectives falls under the responsibility of the Database Administrator [14].

2 Results and Discussion

2.1 Estimation of Cost Calculation

1. Calculate Unadjusted Use Case Points (UUCP)

In software development, calculating Unadjusted Actor Weight (UAW) involves classifying actors based on their interactions with the system. Actors are categorized as "Average" when they interact through protocols like TCP/IP, HTTP, or SOAP, or when human users use the command line. On the other hand, actors are classified as "Complex" if they involve humans interacting with the system through a Graphical User Interface (GUI) or web page. Refer to Table 2 for further details.

Table 2. Classification of Actors in Systems with Use Case Points (UCP)

Actor Name	Description	Type
Admin	Has full access to all functions in the system through the WEB page.	Complex
Head of Study Program	View and Approve Course Registration (KRS), expand KRS, and input student grades through the WEB page.	Complex
Student	Registers and after registration can log in. Students can then expend KRS, complete personal data, and view course grades through the WEB page.	Complex

The result of actor classification from the National Archipelago Student Exchange Program (PERMATA)

System is then used to calculate the total Unadjusted Actor Weight by multiplying the number of actors with the weight of each actor type, as shown in Table 3.

Table 3. Translation: Calculate the Unadjusted Actor Weight (UAW)

Type of Actor	Weight	Number of Actors	Weight x Number of Actors
Simple	1	0	0
Average	2	0	0
Complex	3	4	12
Total UAW			12

2. Calculating the Technical ComplexityFactor (TCF)

The next step is to calculate the Technical Complexity Factor (TCF), given the weighting values for the complexity factors of TCF with a range of 0, 1, 2, 3, 4, and 5, where the larger the influence of the respective factor in the software development project, the greater its estimated impact value.

Table 4. Technical Complexity Factor (TCF) results

Code	Indicator	Weight	Value (0-5)	Result
T1.	Distributed Systems	2	5	10
T2.	System Response Goal	1	4	4
T3.	End User Efficiency	1	5	5
T4.	Complex Internal Processing	1	4	5
T5.	Code Reusability	1	5	5
T6.	Ease of Installation	0,5	0	0
T7.	Ease of Use	0,5	5	2,5
T8.	Cross-Platform Support	1	3	3
T9.	Modifiability	1	5	5
T10.	Concurrency Level	1	5	5
T11.	Special Security Services	1	5	5
T12.	Dependence on Third-Party Code	1	0	0
T13.	Special User Training Facilities	1	0	0
Total TF				48,5

3. Calculating Effort Rate

Analyzing the value of hours of effort required by multiplying the Use Case Points by the Hours of Effort per Use Case Point. Based on the research (Subriadi, 2014), the Effort Rate (ER) is known to be 8.2 man-hours for business applications in Indonesia. This value will directly convert the UCP (Use Case Points) into the effort value, represented as Hours of Effort. The calculation formula is as follows:

$$\begin{aligned} \text{Hours of Effort} &= \text{UCP} \times \text{Effort Rate} \\ &= 142,1691 \times 8.2 \\ &= 1.389,844855 \text{ Hours} \end{aligned} \quad (2)$$

Based on the calculations above, a value of 1,389.844855 hours of effort is obtained, which means that the Nusantara Homeland Student Exchange System software development project requires a working time of approximately 1,389.844855 hours.

4. Calculating Estimated Costs

To determine the cost value of a project, an approach of estimating the cost of each activity is used,

which is obtained from the value of Hours of Effort. The Hours of Effort for each activity are multiplied by the standard salary of personnel involved in each activity. As for the standard salary, it refers to the Indonesian National Consultants Association (INKINDO). The average income per hour (pay rate per hour) for IT workers in Indonesia based on the data released is shown in Table 5.

Table 5. Estimation of Cost Results

Activity	Role Sentence	%Effort	Hours of Effort	Hourly Wage	Activity Cost
Needs analysis (Requirement)	System Analyst	7,5%	104,24	Rp86.984	Rp9.067.109
Specification	System Analyst	7,5%	104,24	Rp86.984	Rp9.067.109
Design	System Analyst	10%	138,98	Rp86.984	Rp12.089.479
Implementation	Software Engineer	10%	138,98	Rp86.984	Rp12.089.479
Acceptance & installation	Software Engineer	7,5%	104,24	Rp86.984	Rp9.067.109
Project management	Project manager	8,34%	115,91	Rp169.516	Rp19.649.075
Configuration management	Software Engineer	4,16%	57,82	Rp86.984	Rp5.029.223
Documentation	System Analyst	4,16%	57,82	Rp86.984	Rp5.029.223
Training & technical support	Software Engineer	4,16%	57,82	Rp86.984	Rp5.029.223
Integrated testing	Test Analyst	7,5%	104,24	Rp84.313	Rp8.788.597
Quality assurance	Software QA	8,34%	115,91	Rp84.313	Rp9.772.920
Evaluation & testing	Test Analyst	20,84%	289,64	Rp84.313	Rp24.420.582
Total					Rp129.099.127

From the calculation above, the estimated total cost required for the development of the Nusantara Homeland Student Exchange System software is Rp129,099,127.

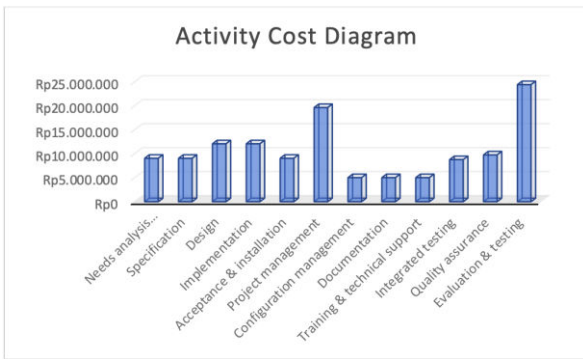


Fig. 1. Activity-Based Costing Diagram

The diagram above illustrates the cost figures per activity obtained. For the activities of need analysis, specification, and acceptance & installation, the cost is Rp 9,067,109 per month. The activities of design and implementation incur a cost of Rp 12,089,479 per month. The project management activity costs Rp 19,649,075 per month, while the activities of configuration management, documentation, and training & technical support have a cost of Rp 5,029,223. The integrated testing activity has a cost of Rp 8,788,597, and the quality assurance activity costs Rp 9,772,920. On the other hand, the activity of evaluation & testing incurs the highest cost among others, which is Rp 24,420,582.

2.2 Results of the System Implementation

3.2.1 Home Display

The homepage is the first page, and its purpose is to welcome the user when accessing the link. It can be seen in Figure 2.

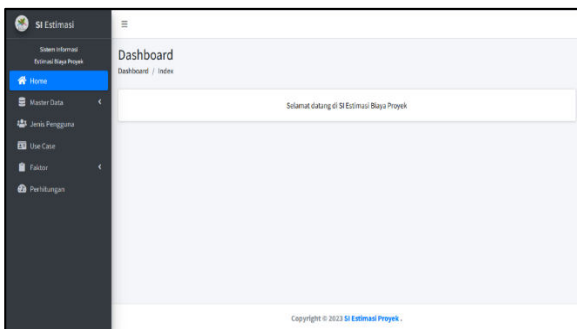


Fig. 2. Home Display

3.2.2 Use Case Display

This page displays the existing use case data in the system. For more clarity, please refer to Figure 3.

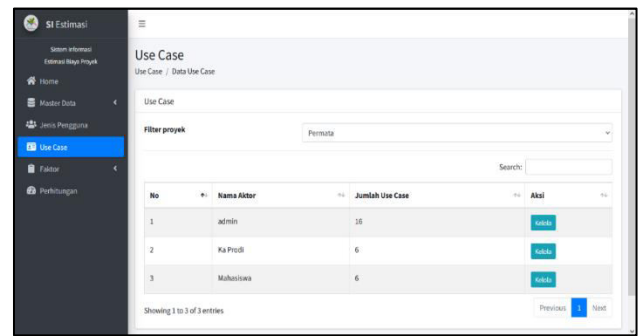


Fig. 2. Use Case Display

In Figure 4.12, data use cases are displayed, and in this view, the User can manage the existing use case data within the system.

3.2.3 Calculation Display

This page displays the data from the estimation cost calculation. For further details, please refer to Figure 3.

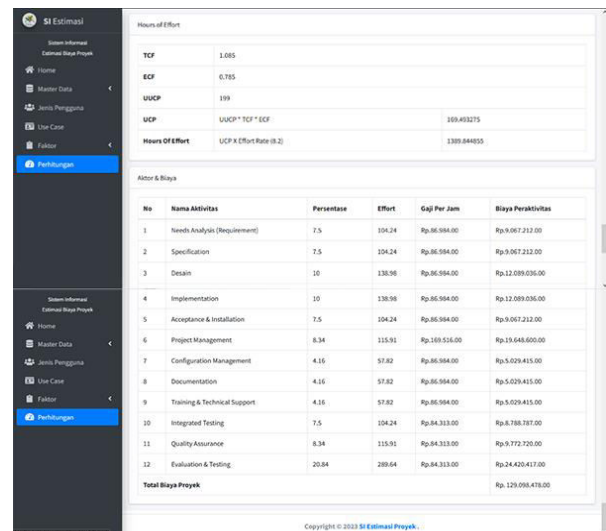


Fig. 3. Calculation Results Display

3 Conclusion

The researcher's conclusion from the conducted research is as follows: Cost estimation in software development involves predicting the effort and expenses required for the project. By utilizing case point methods, such as the use case point (UCP) method, we can determine the time and cost needed for software development. The research employed a web-based system using programming languages like PHP, CSS, HTML, and Javascript to calculate cost estimation. The system takes input data on actors, use cases, and Technical Complexity factor (TCF), and Environmental Complexity factor (ECF) to derive the cost estimation results for the software development project.

Using the use case point method, the system estimated 1,389.844855 man-hours for the "Permata" application, equivalent to approximately 1.904 months, with a cost value of Rp129,099,127.

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