Implementation of the Use Case Point Method in a Web-Based Online Software Project Effort Estimation System

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Abstrak: *Software effort estimation is a critical factor in the success of software development projects. Estimation inaccuracies can result in cost overruns and project delays. This research aims to build and evaluate a web-based software effort estimation system that can produce more accurate and efficient estimates using the UCP, E-UCP and Re-UCP methods. This system is developed using PHP programming language and Laravel framework. The test results show that the developed system is able to produce business estimates according to the calculation standards of the UCP, E-UCP and Re-UCP methods with manual methods. This research successfully developed a software effort estimation system that can help software developers make better decisions regarding resource allocation and project planning.*

Keywords: UCP, E-UCP, Re-UCP, Laravel, Website.

1. Introduction

Effort estimation is a crucial component in software project planning, as it directly affects the optimal allocation of resources, time, and cost [1]. One widely used approach in this context is Software Effort Estimation (SEE), which supports estimation through a use case–based perspective [2].

Several methods have been developed to support use case–based effort estimation, including Use Case Points (UCP), Extended Use Case Points (E-UCP), and Revised Use Case Points (Re-UCP) [3]. UCP provides a relatively simple approach for estimating object-oriented projects, whereas E-UCP places greater emphasis on the internal aspects of use cases. Re-UCP further refines both approaches by integrating additional parameters to improve estimation flexibility across different project types [4]. Nevertheless, a major challenge in software project estimation is calculation inaccuracy, which is often caused by limited information during the early stages of a project. This issue may lead to cost overruns or insufficient resources, ultimately disrupting project execution [5].

To address this problem, this study develops a web-based system that implements the three estimation methods (UCP, E-UCP, and Re-UCP) to assist analysts in performing effort estimation more accurately and efficiently [6]. The system is developed using PHP with the Laravel framework [7]. Through this approach, the study is expected to provide practical contributions by reducing estimation error risks, supporting better decision-making, and improving efficiency in software project management [8].

Specifically, this research discusses how the three estimation methods are implemented in a web-based system and evaluates how the system supports the software effort estimation process. The

scope of this study is limited to developing a system that provides calculation features and comparison of estimation results across the three methods. The objective of this study is to implement UCP, E-UCP, and Re-UCP within a web-based software project estimation system [9]. The expected benefits include easier effort estimation, the availability of a comprehensive calculation framework, and improved support for project planning decision-making [10].

2. Research Methods

The research workflow in this study consists of five stages, beginning with problem identification, followed by literature review, software project effort estimation, system implementation, and system testing illustrated in Figure 1.
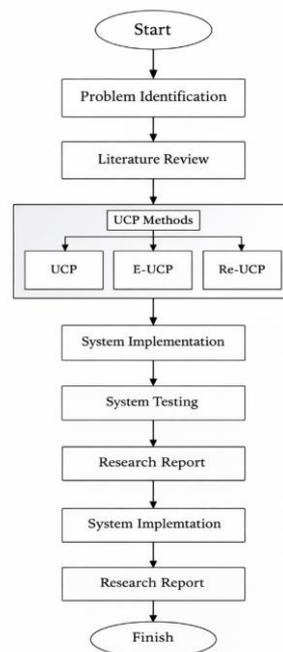
Figure 1. Research Flow

2.1 Use Case Points (UCP)

The Use Case Points (UCP) method is used to estimate software development effort, time, and cost based on the complexity of use cases. Introduced by Gustav Karner (1993), UCP produces estimates through the following stages:

1. Calculate UUCP (Unadjusted Use Case Points):

    o UAW (Unadjusted Actor Weight): Determined by the number and type of actors (Simple, Average, Complex).

    o UUCW (Unadjusted Use Case Weight): Determined by the number of transactions in each use case.

2. Calculate TCF (Technical Complexity Factor)**:** Consists of 13 technical factors, rated on a 0-5 scale, used to adjust the project's technical complexity.

3. Calculate ECF (Environmental Complexity Factor): Consists of 8 environmental (non-technical) factors, also rated on a 0-5 scale, to capture the influence of project environment conditions.

4. Compute Total UCP:

$$UCP = UUCP \times TCF \times ECF$$

5. Estimate Effort:

$$Effort = UCP \times 8.2 \text{ staff-hours}$$

6. Estimate Cost: Effort is divided into two main activities**:** Software Development and Ongoing Activity, each associated with specific roles and hourly wages (based on Kelly Services Indonesia Salary Guide 2018). The cost is calculated as:

$$Cost = Effort \times Hourly\ Rate$$

2.2 Extended Use Case Point (E-UCP) Method

Extended Use Case Point (E-UCP) is an extension of the UCP method introduced by Kasi Perivasamy & Aditi Ghade (2009), aiming to estimate software project costs in a more accurate and detailed manner. This method considers actor–use case relationships more explicitly by adding narrative elements[11]**.**

Advantages of E-UCP:

- More detailed and accurate than the classical UCP approach.

- The weights of TCF and EF may exceed the standard 0–5 range, enabling better adaptation to project complexity.

- More flexible, comparable to other estimation models (e.g., COCOMO II)**.**

Calculation Steps:

1. UAW (Unadjusted Actor Weights): Calculated based on actor types and the number of transactions.

2. UUCW (Unadjusted Use Case Weights): Based on the number of transactions in each use case.

3. UNW (Unadjusted Narrative Weights): Based on narrative elements such as inputs/outputs, conditions, and success scenarios.

4. UUCP (Unadjusted Extended UCP):

$$UUCP = UAW + UUCW + UNW$$

5. TCF & EF: Compute technical and environmental factors; weights are flexible (>5 if needed).

6. E-UCP:

$$E\text{-}UCP = UUCP \times TCF \times EF$$

7. Hours of Effort:

$$Hours = E\text{-}UCP \times 20$$

8. Cost Estimation: Effort is divided into two activity categories:

- Software Development: requirements, design, implementation, and testing.

- Ongoing Activity: project management, QA, documentation, training, etc. Total cost is computed as:
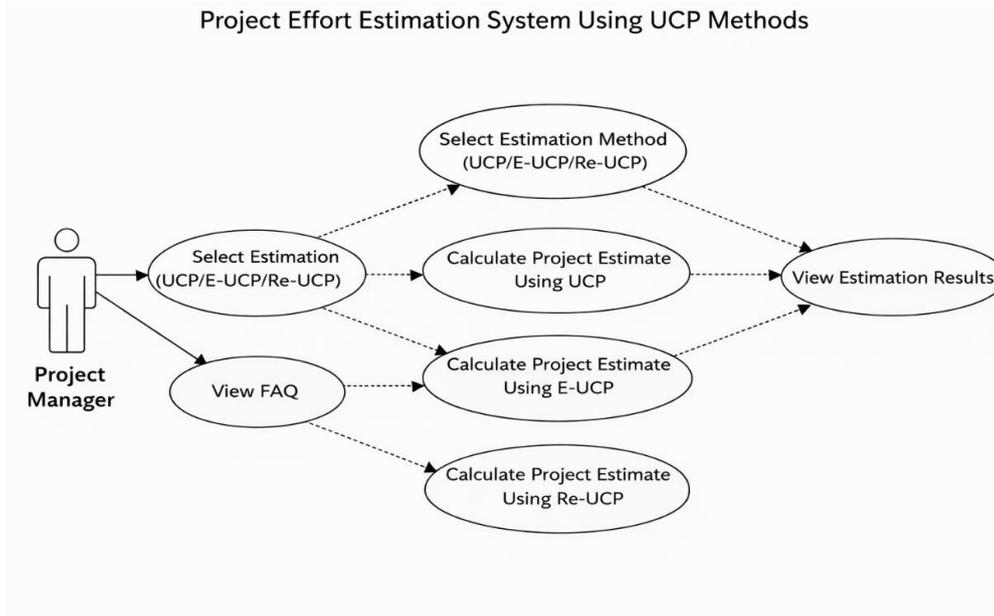
$$Total\ Cost = Hours \times Hourly\ Rate$$

Figure 2. Use Case Diagram

3. Results and Discussion

This section presents the results of the developed system, which provides UCP, E-UCP, and Re-UCP menus. The system outputs are described as follows.

3.1 Main Dashboard

This page displays three selectable menu options for users, consisting of UCP, E-UCP, and Re-UCP can be seen in the figure 3.
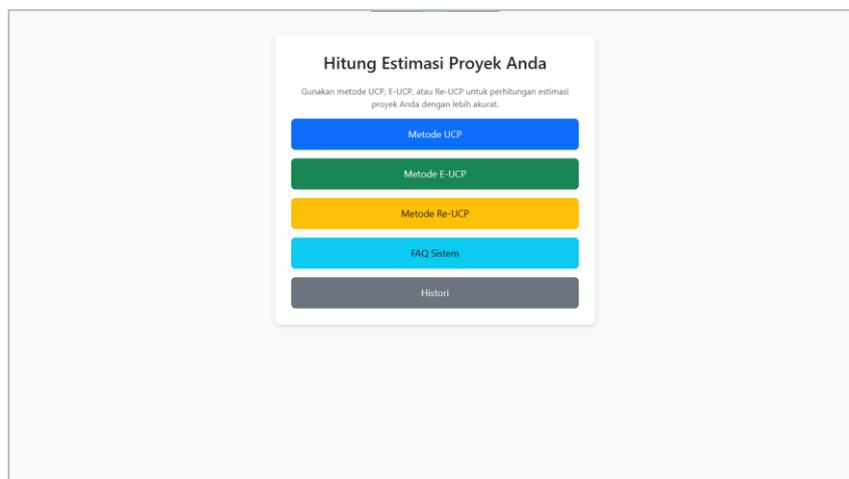

Figure 3. Main Dashboard

3.2 Total Effort Calculation

After completing all required input fields and clicking the Submit button, the system processes the UCP calculation and displays the total effort in hours. A button is also provided to proceed with determining personnel resources can be seen in the figure 4.

Figure 4. Total Effort Calculation

3.3 Determining Personnel Resources

After obtaining the total effort calculation, users can input and specify the required personnel resources. The input includes personnel name, working hours, hourly wage, and number of personnel can be seen in the figure 5.

Figure 5. Personnel Resource Determination

3.4 Cost Calculation Results

After personnel data have been defined and the Calculate Cost button is selected, the system displays the cost estimation results can be seen in the figure 6.

Figure 6. Cost Calculation Results

4. Conclusions

Based on the research results, a web-based online software project effort estimation system was successfully developed by implementing the UCP, E-UCP, and Re-UCP methods, enabling effective estimation of project time and cost. Black-box testing indicates that all system functions operate in accordance with user requirements. For future development, it is recommended to enhance the UI/UX design to improve usability for non-technical users and to extend the system into a mobile application using an appropriate framework to increase usage effectiveness.

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