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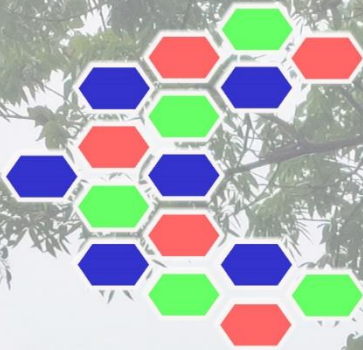
Penelitian Ilmu Komputer
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*The Massive Implementation of Artificial Intelligence and
Computational Methods Across Various Sectors*

Department of Computer Engineering

Universitas Islam "45" Bekasi



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Penelitian Ilmu Komputer Sistem *Embedded & Logic*

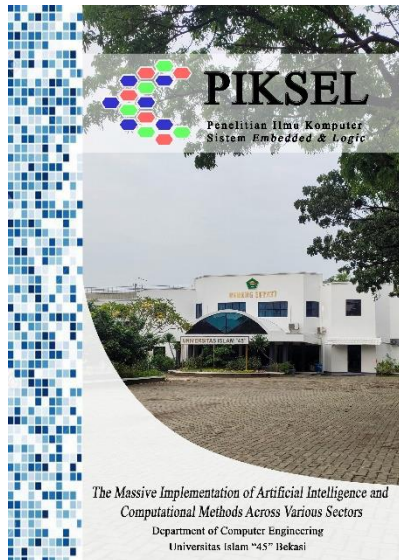
Storyboard Design of Android-Based Learning Multimedia Integration Application Using Standard Process Tutorial Model <i>Santi Purwanti</i>	1-10
Pi Hole on SOE Computer Network using Raspberry Pi 3 Model B+ to Optimize Bandwidth Management and Improve Employee Performance <i>Rahmat Novrianda Dasmien, Darwin, Irham, Bima Riansyah</i>	11-22
The Influence of Youtube Ads on Purchase Intention <i>Willy Kristian, RA Dyah Wahyu Sukmaningsih, Eric Gunawan, Rafy Pranadya Annaulfa, Rafi Giffari</i>	23-34
Optimization of Random Forest Prediction for Industrial Energy Consumption Using Genetic Algorithms <i>Sartini, Luthfia Rohimah, Yana Iqbal Maulana, Supriatin Supriatin, Dewi Yuliandari</i>	35-44
Cluster Analysis Using Principal Component Analysis Method and K-Means to Find Out the Compliance Group of Property Tax <i>Rully Pramudita, Nining Rahaningsih, Sekar Puspita Arum, Medina Aprilia Putri, Sok Piseth</i>	45-54
EfficientNetV2M for Image Classification of Tomato Leaf Diseases <i>Arazka Firdaus Anavyanto, Maimunah, Muhammad Resa Arif Yudianto, Pristi Sukmasetya</i>	55-76
Identification of Website-Based Product Sales Frequency Patterns using Apriori Algorithms and Eclat Algorithms at Rio Food in Bekasi <i>Salwa Nabiila Pramuhesti, Herlawati, Tyastuti Sri Lestari</i>	77-90
The Weighted Product Method and the Multi-Objective Optimization on the Basis of Ratio Analysis Method for Determining the Best Customer <i>Mugiarso, Rasim</i>	91-104
Factors Influencing Students' Intention to use Online Tutoring Applications in Jakarta <i>RA Dyah Wahyu Sukmaningsih, Adam Kurniawan, Ronald Ronald</i>	105-122
Decision Support System Design for Informatics Student Final Projects Using C4.5 Algorithm <i>Rafika Sari, Hasan Fatoni, Khairunnisa Fadhilla Ramdhaniania</i>	123-134
User Experience Evaluation on Production Performance Monitoring System Using Honeycomb Method <i>Moh. Sofyan Sauri, Arie Hidayat Putra, Emny Harna Yossy</i>	135-148
Usability Analysis on Health Tracking Application using User Experience Questionnaire in Jakarta Area <i>Richard, Aditya Kusumadwiputra, Adela Zahwa Firdaus Suherman</i>	149-158
Identifying Factors Affecting the Relationship between Department and Graduation Level of Informatics Engineering Students using Apriori Algorithm: A Case Study at Pamulang University <i>Thoyyibah T</i>	159-170
Sentiment Analysis of Sentence-Level using Dependency Embedding and Pre-trained BERT Model <i>Fariska Zakhralativa Ruskanda, Stefanus Stanley Yoga Setiawan, Nadya Aditama, Masayu Leylia Khodra</i>	171-180
Fuzzy Use Case Points as a Basis for Effort Estimation <i>Rakhmi Khalida, Tubagus Maulana Kusuma, Khairunnisa Fadhilla Ramdhaniania</i>	181-196
Learning Vector Quantization, Hebbian Learning, and Self-Organizing Map for Classification <i>Herlawati</i>	197-206

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From Editor-in-Chief

السَّلَامُ عَلَيْكُمْ وَرَحْمَةُ اللَّهِ وَبَرَكَاتُهُ

Best wishes to all the members of Editorial Board, Reviewers Panel, Authors and Readers of PIKSEL for a very happy, and stay healthy.



Rahmadya, Ph.D.
Editor-in-Chief

The World Health Organization declares an end to the Covid-19 global health emergency; hence, society has started to return to normal activities. This edition of articles extensively explores computational methods in fields such as education, finance, taxation, industry, and agriculture.

This edition introduces the use of IoT in bandwidth management, Random Forest and Genetic Algorithms in energy consumption prediction, clustering analysis in taxation, EfficientNetV2M for detecting tomato plant diseases, Apriori and Eclat algorithms in sales pattern detection, multi-objective optimization in selecting the best customers, decision support system for determining final project topics, sentiment analysis with pre-trained BERT models, Fuzzy Use Case Points for estimation and classification using learning vector quantization, and Hebbian learning and Self-Organizing Maps that have the potential to improve current models.

Several other research studies help monitor the effectiveness of a system, such as analyzing factors that influence the relationship between majors and graduation rates, evaluating user experience performance of products.

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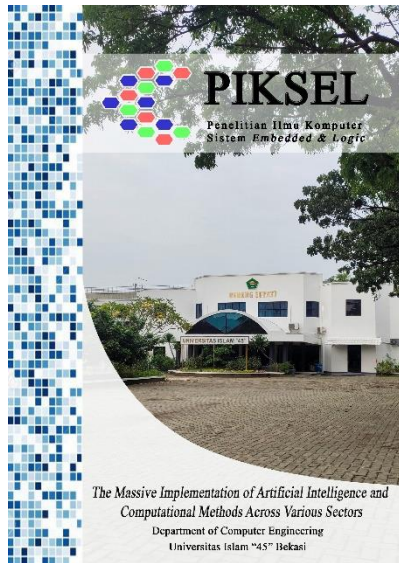
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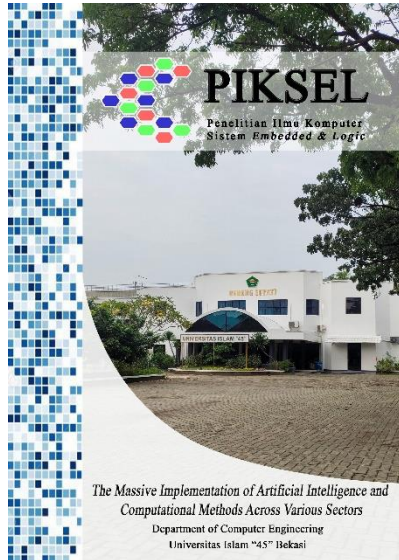
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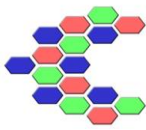
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Fuzzy Use Case Points as a Basis for Effort Estimation

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Abstract

Many software development projects encounter problems related to over- or under-estimation of effort. Accurate effort estimation is crucial for successful project management, but it can be challenging when resources are limited, and little is known about the project. The commonly used method for effort estimation is Use Case Points (UCP), which is mainly used for application-based objects and takes use cases as input. However, UCP has weaknesses, particularly in the high variation of weight factor values for Unadjusted Use Case Weight (UUCW). To address this problem, Fuzzy Use Case Points (FUCP), which is a combination of fuzzy logic and use case points, can be used. By applying fuzzy logic to the UUCW category, FUCP derives new weight factor values for UUCW. The implementation of FUCP to calculate effort estimation in ten government-based projects in this research has shown that FUCP yields the closest value to the actual effort required. It has also been demonstrated that FUCP outperforms UCP in terms of accuracy, with an improvement of 6.51%.

Keywords: effort, estimation, fuzzy, use case points

1. Introduction

One of the most important stages in building or developing software is the planning stage. During this stage, effort and resource estimation, human resources, materials, infrastructure, time, and budget must be taken into account (Kurniawan et al., 2013). The problem that is often encountered in software development projects is overestimation or underestimation. Overestimation can lead to unnecessary allocation of resources, while underestimation can indirectly reduce the quality of the product due to lower costs, resulting in software that does not meet standards. Both of these problems indicate that estimation is an important factor that must be carefully considered before starting a software development project (Ziauddin et al., 2013).

Although estimates may not always produce highly accurate results, these inaccuracies can be minimized by using evaluation methods that are tailored to the project being estimated. Effort estimation is an activity that is performed to predict or forecast the number of workers needed and the time it will take to complete the project (Vishal Sharma & Verma, 2010).

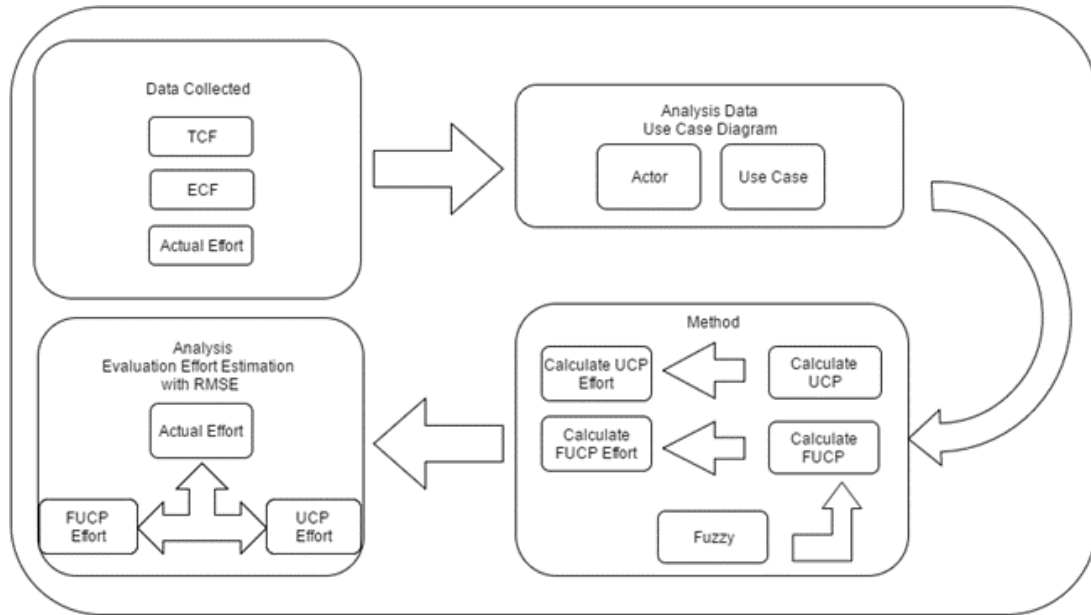
The methods used for effort estimation are Function Points and Use Case Points. The Function Points method has the advantage of not depending on the programming language and can be applied to different types of applications (Sholiq et al., 2019). This approach is also more predictable because its parameters are calculated based on the number of inputs and outputs. The Use Case Points (UCP) method is widely used in object-based applications. Estimating software projects using UCP is easy to use in complex software environments. The UCP method provides an estimate of the effort (person-hours) required to create a project. UCP method is valuable in the context of early size measurement and estimation of effort (Garg et al., 2014).

UCP estimation does not relate to the estimation of the cost factor, because the UCP has weaknesses, which is high difference among the value of weight factor of UUCW. In order to overcome the abovementioned problem, Fuzzy use case points (FUCP) which is the combination between fuzzy logic and use case points, can be used (Alostad et al., 2017).

This research has contributions to make effort estimation more accurate without increasing the time and money spent and simplifying effort estimation methods without compromising their accuracy.

2. Research Method

The concept of fuzzy use case points is created by expanding the UCP method with Mamdani-type fuzzy logic (Ashita Malik et al., 2013). It is also used for estimating project effort, offering more varied value estimates, and investigating the causal relationship between UCP and FUCP using an evaluation effort estimation model. The research methodology stages are illustrated in Figure 1.



Source: Research Result (2023)

Figure 1. Research Method

Starting from data obtained from data collection techniques, namely technical factors, environmental factors, use case diagrams, and actual effort. The second stage, to analyze the use case diagram, actor and use case become important things that are analyzed in this phase. When analyzing the use case diagram, actor and use case would be the reference for the calculation of effort estimation. Actor and use case analysis can then provides values to variables estimated calculation effort. The third stage calculating effort estimation using UCP and FUCP. When doing calculations using FUCP effort estimation, there is a fuzzy influence on the calculation effort estimation. The final stage is the evaluation of effort estimation methods. Activities such measurements are compared with FUCP and UCP method. Activities such evaluation will produce the best methods that appear to approach the value of actual effort.

2.1. Effort

As the name suggests, 'effort' is the number of work units that is vital to complete an activity. In simple terms, it is the number of hours we put in, focused on a particular task, to get a certain job done. Effort has to do with how hard you're trying. If something is easy, it doesn't take much effort. If it's hard, it takes a lot of effort. Effort estimation is predict the real work in completing the

project by reviewing the schedule, project size, even the project risk will be borne (Reddy et al., 2011). The common methods used for effort estimation is use case points and fuzzy use case points.

Actual effort is the amount of time needed by programmers in completing the project, starting from the stage of planning, analysis, design to implementation. Column person, working days, and working hours these, three things next will be the reference to get the actual effort of a software development project (Hariyanto & Wahono, 2015). The formula for calculating the actual effort is as follows:

$$Actual\ effort = \sum person - \sum working\ days * working\ hours \quad (1)$$

2.2. Use Case Points

Use Case Points is a method of effort estimation in software development. The concept of UCP is based on the requirements for the system being written using use cases diagram. The UCP concept is based on use case diagrams for the system requirements created. The value of the UCP system is obtained by a person assessing the complexity of the actor. The use case is adjusted to two types of technical factors, namely those that characterize the development environment and the technical complexity of the system being developed (Iraji et al., 2012). The UCP is detailed as follows (Nassif et al., 2011):

a. In UCP, actors are weighted with standard Unadjusted Actor Weights (UAW) values: actors are classified as simple, average, or complex. A weight is assigned to each category as follows:

- 1) Simple actors (SA) have a value weight of 1. Actors are usually described as other systems via an API.
- 2) The average actor (AA) has a value of 2. Actors are described as systems that interact through a text-based user interface or protocol.
- 3) Complex actors (CA) have a value of 3. Complex actors are described as systems that interact through a graphical user interface (GUI).

The UAW is calculated as:

$$UAW = (\sum SA * 1) + (\sum AA * 2) + (\sum CA * 3) \quad (2)$$

b. Unadjusted Use Case Weight (UUCW): Use cases have categories based on the number of transactions in the success and alternative scenarios. A weight is assigned to each category as follows :

- 1) Simple Use Case (SU) Its weight is 5. A use case is classified as Simple if
- 2) the number of transactions is ≤ 3 .
- 3) Average Use Case (AU) Its weight is 10. A use case is classified as Average if the number of the transactions is between 4 and 7.
- 4) Complex Use Case (CU) Its weight is 15. A use case is classified as Complex if the number of transactions is more than 7.

The UUCW is calculated as :

$$UUCW = (\sum SU * 1) + (\sum AU * 2) + (\sum CU * 3) \quad (3)$$

5) The sum of the UAW and UUCW values is the Unadjusted Use Case Points (UUCP) value. This is described as :

$$UUCP = UAW + UUCW \quad (4)$$

c. Technical Complexity Factor (TCF): Factors that influence success and contribute to project complexity. The technical complexity factor (TCF) is calculated as follows:

$$TCF = C_1 + C_2 \sum_{i=1}^{13} TF \quad (5)$$

The TCF weight factor are depicted in Table 1. Where C1 = 0.6, C2 = 0.01 and TF is a factor that takes values between “0” and “5”. The value “0” means the factor is irrelevant while the value “5” is essential. The value “3” means that the factor is not very essential, neither irrelevant (average). For instance, if all the factors have a value of “3”, the TCF will be 1.

Table 1. Technical Complexity Factor (TCF)

No	Factor contributing to complexity	Weight
T ₁	Distributed systems	2
T ₂	Response time or through put performance Objectives	1
T ₃	End user online efficiency	1
T ₄	Complex internal processing	1
T ₅	Reusability of code	1
T ₆	Easy installation	0.5
T ₇	Ease of use	0.5
T ₈	Portability	2
T ₉	Ease of change	1

No	Factor contributing to complexity	Weight
T ₁₀	Concurrency	1
T ₁₁	Special security objective includes	1
T ₁₂	Direct access for thrid parties	1
T ₁₃	Special user training required	1

Source: Research Result (2023)

- d. Environmental Complexity Factor (ECF): Factors that affect and contribute to team efficiency and productivity. The environmental factors are presented in Table 2. The environmental complexity factor (ECF) is calculated as follows:

$$ECF = C_1 + C_2 \sum_{i=1}^8 EF \tag{6}$$

Table 2. Environmental Complexity Factor (ECF)

No	Factor contributing to complexity	Weight
E ₁	Familiarity with system development process being used	1.5
E ₂	Application experience	0.5
E ₃	Object-oriented experience	1.0
E ₄	Lead analyst capability	0.5
E ₅	Motivation	1.0
E ₆	Requirements stability	2.0
E ₇	Part time staff	-1.0
E ₈	Difficulty of programming language	-1.0

Source: Research Result (2023)

Where C₁ = 1.4, C₂ = -0.03 and this factor EF environmental has a weight which is equivalent to the EF of the technical factor (i.e. between 0 and 5).

- e. Use Case Points (UCP), which is an estimation method for making software and measuring the size of the software using use cases. The value of technical factors such as TCP and technical quality and environmental complexity factor (ECF) of development resources and environmental factors have been obtained, then the UCP can be calculated. UCP is calculated as follows:

$$UCP = UUCP * TCF * ECF \tag{7}$$

if the value of all technical factors is 5, then the maximum value of TCF is 1.3. If a project has high complexity and low team efficiency, then the risk of project failure will be high. Typically, taking technical and environmental factors into account, an adjusted use case (UCP) point value will be 30% more or less than an unadjusted use case points (UUCP).

- f. Effort is a technique to change value of UCP into value in the form person man hours (PHM). UCP effort illustrates size of the workforce required in hours. UCP effort can be calculated after UCP results have been obtained. PHM value is influenced by the Environmental Complexity Factor in UCP. Environmental Complexity Factor (ECF) on UCP can be seen in Table 2. Value PHM obtained by the following rules:

$W1 = \text{Total weighted value } E1 \text{ to } E6 \text{ which has a value } < 3$

$W2 = \text{Total weighted value } E7 \text{ to } E8 \text{ which has a value } > 3$

If $W1 + W2 \leq 2$ then $PHM = 20$

If $W1 + W2 = 3 \text{ or } 4$ then $PHM = 28$

If $W1 + W2 > 4$ then the project should be canceled

UCP effort calculation with the following formula:

$$Effort = UCP * PHM \quad (8)$$

Description :

UCP = Use Case Point

PHM = Person Man Hours

2.3. Fuzzy Inference System

The concept of fuzzy logic was introduced by Lotfi Zadeh, Prof. of University of California at Berkeley in 1965. Fuzzy inference system is computing systems that work on the basis of the principle of fuzzy reasoning (Maleki et al., 2014). Fuzzy inference system can perform reasoning with similar principles such as human reasoning on instinct (Iraji et al., 2012). There are several types of Fuzzy Inference System (FIS) are recognized Mamdani, Sugeno and Tsukamoto. FIS is the easiest to understand. because it suits human instincts (Reddy et al., 2011).

2.4. Fuzzy Use Case Points

The FUCP method is an extension of the UCP method that incorporates Mamdani-type fuzzy logic to calculate project effort estimates. This method allows for a wider range of estimated effort values and can be used to investigate the relationship between UCP and FUCP using an evaluation effort estimation model (Nwaiwu & Oluwadare, 2016).

Essentially there is no difference in the step of the process calculating the estimate project effort using fuzzy use case points with using use case points, that the difference is the weight factor when looking for value classification UUCW transaction use case. Using the same data that is value UAW, TCF, and ECF use the value obtained by using use case points. Do the calculation of estimated effort using fuzzy use case points. Only one category given the influence of fuzzy logic, namely weighting factor UUCW while other categories of data processed using the appropriate method of use case points.

2.5. Evaluation Effort Estimation

Evaluation effort estimation is a comparison was conducted that predict software effort estimation from use cases which are the UCP and FUCP method (Nassif et al., 2011). Evaluation model effort estimation used to perform analysis of the correlation that is Root Mean Square Error (RMSE), R square, adjusted R square and Spearman's rank order correlation which is a very common criterion used to evaluate the software effort estimation model (Hariyanto & Wahono, 2015).

When using Root Mean Square Error (RMSE) to evaluation between actual with estimation, good results are shown with a low value. Specifically for R square and adjusted R square to be good models if the indicator measuring goodness of fit models' high value or closer to 1. If the value of one variable is high, then the value of the other variable will be low and vice versa. In the Spearman rank-order correlation it is called a monotone relationship. In Table 3 shows the evaluation formula was conducted on four different criteria, these include R square, adjusted R square, RMSE and Spearman's rank-order correlation (Hariyanto & Wahono, 2015).

Table 3. Model Evaluation for Effort Estimation

Model Evaluation	Formula
R Square	$R^2 = 1 - \frac{SSR}{SST} = 1 - \frac{\sum(\hat{y}_i - \bar{y})}{\sum(y_i - \bar{y})}$
Adjusted R Square	$Adjusted\ R\ square = 1 - \frac{(1 - R^2) - (N - 1)}{N - M - 1}$
RMSE	$RMSE = \sqrt{\frac{\sum(Actual\ effort - Effort\ estimation)^2}{n}}$

Model Evaluation	Formula
Spearman's Rank	$\rho = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)}$ or $\rho = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}}$

Source: Research Result (2023)

3. Results and Analysis

3.1. Use Case Diagram

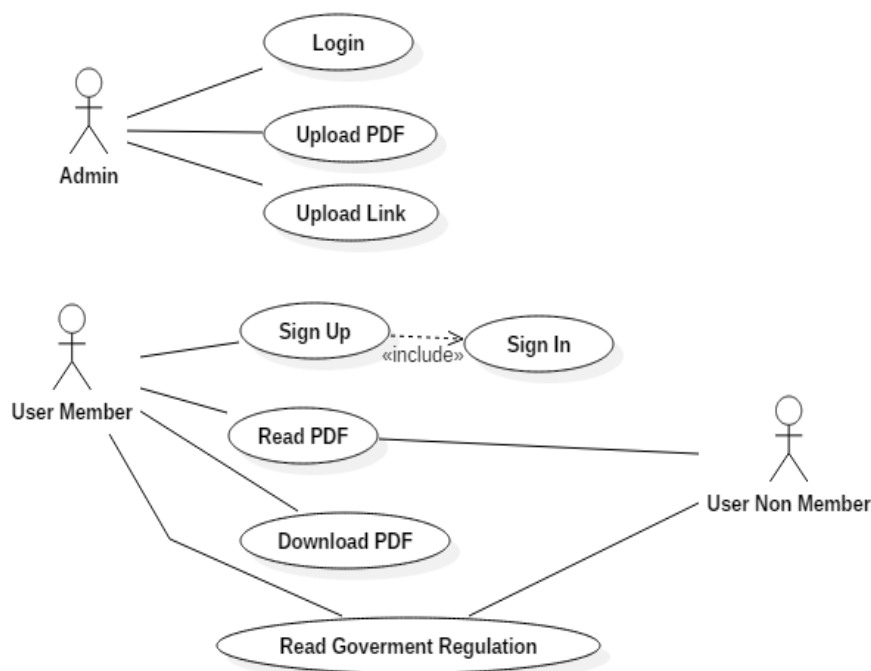
A use case diagram is composed of use cases and actors, which describe the system's capabilities. This diagram is used to identify the business processes of the system. Once the actors that play a role in the system are identified, the processes that can be performed using the system are determined and illustrated in a use case diagram.

The Assessment Library Website development project is used as an example in this study. Figure 2 shows the main page of the Assessment Library Website, while Figure 3 displays the use case diagrams of the website.



Source: Research Result (2023)

Figure 2. Main Page Assesment Library Website



Source: Research Result (2023)

Figure 3. Use Case Diagram Assesment Library Website

3.2. Use Case Points

Based on Figure 3, the use case diagram for the Assessment Library Website consists of three actors and eight use cases. The actors on the use case diagram will be used as the variable Unadjusted Actor Weight (UAW), and the UAW for the Assessment Library Website is shown in Table 4. Similarly, the use cases on the use case diagram will be used as the variable Unadjusted Use Case Weight (UUCW), and the UUCW for the Assessment Library Website is shown in Table 5.

Table 4. UAW Value Assesment Library Website

Actor Type	Description	Weighting Factor	Number	Result
Simple	External System with well-defined API	1	0	0
Average	External system using a protocol based interface	2	0	0
Complex	Human	3	3	9
Unadjusted Actor Weight (UAW)				9

Source: Research Result (2023)

Table 5 shows the UUCW values for the Assesment Library Website project, including the actor type, description, weighting factor, number, and resulting value.

Table 5. UUCW Value Assesment Library Website

Actor Type	Description	Weighting Factor	Number	Result
Simple	1-3 transaction	5	5	25
Average	4-7 transaction	10	2	20
Complex	> 7 transaction	15	1	15
Total				60

Source: Research Result (2023)

Unadjusted Use Case Points (UUCP) value is the result of the UAW value added by UUCW. Based on formula number 4, UUCP value of Assesment Library Website is 69. Calculating the value of technical factors to obtain the value of TCP. Based on formula number 5, TCF value of Assesment Library Website is 1.17. Calculating the value of environment factors to obtain the value of Environment Complexity Factor (ECF). Based on formula number 6, ECF value of Assesment Library Website is 0,67.

UUCP, TCF and ECF value used to calculate UCP. Based on formula number 7, UCP value of Assesment Library Website is $54.0891 \approx 54.09$. Based on ECF of Assesment Library Website, PHM value is 20. UCP effort can be calculated after UCP and PHM results have been obtained. Based on formula number 8, UCP effort value of Assesment Library Website is $1081.79 \approx 1082$ hour.

3.3. Fuzzy Use Case Points

Using the same data from the Assesment Library Website, UAW, TCF, and ECF value use the value obtained by using use case points. Only one category given the influence of fuzzy logic, namely weighting factor UUCW while other categories of data processed using the same method of use case points. UUCW value for the Assesment Library Website using fuzzy logic influence can be seen in Table 6. UUCW value combined with fuzzy called FUUCW.

Table 6. FUUCW Value Assesment Library Website

No	Use Case	Type of Transaction	Weighting Factor	Value
1	Login	3	5,70	5,70
2	Upload PDF	7	10,30	10,30
3	Upload Link	4	6,72	6,72
4	Sign up	10	13,70	13,70
5	Sign in	3	5,70	5,70
6	Read PDF	1	4,79	4,79
7	Upload PDF	1	4,79	4,79
8	Read Government Regulation	1	4,79	4,79
Total				56,49

Source: Research Result (2023)

Unadjusted Use Case Points (FUUCP) value is the result of the UAW value added by FUUCW. Based on formula number 4, FUUCP value of Assesment Library Website is 65,49. Using the same data from the value obtained by using use case points, UAW, TCF, and ECF and then value of FUUCP, TCF and ECF value used to calculate FUCP. Based on formula number 7, FUCP value of Assesment Library Website is $51.337611 \approx 51.34$. Based on ECF of Assesment Library Website, PHM value is 20. FUCP effort can be calculated after FUCP and PHM results have been obtained. Based on formula number 8, FUCP effort value of Assesment Library Website is $1026.76 \approx 1027$ hour.

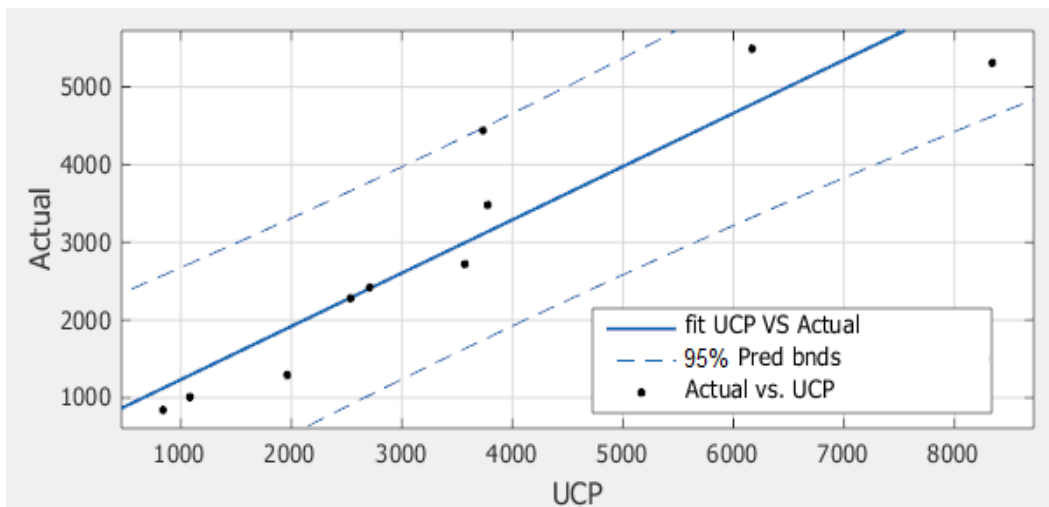
3.4. Actual Effort

Actual effort value is the amount of time required by the programmer in completing the project, starting from the stage of planning, analysis, design to implementation. On the Assesment Library Website has a person is two people, working days Assesment Library Website is 101 days and do the project for five hours each day. Based on formula number 1 actual effort value of Assesment Library Website is 1010 hours.

3.5. Evaluation Model for UCP Method

A comparison is performed between UCP method with actual effort. The implementation of UCP to calculate effort estimation in projects used in this research has shown that UCP has RMSE is 699,4. Display train data with a

fitted polynomial, degree is one, and 95% prediction bounds intervals. Figure 3 shows the evaluation result of UCP method and actual effort.

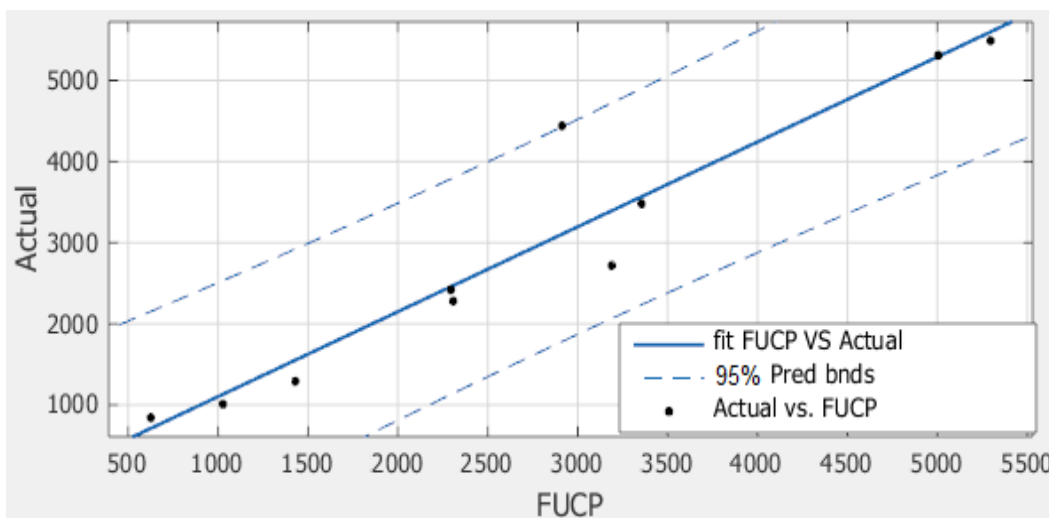


Source: Research Result (2023)

Figure 4. Polynomial Graph UCP Method Versus Actual Effort

3.5. Evaluation Model for FUCP Method

A comparison is performed between FUCP method with actual effort. The implementation of FUCP to calculate effort estimation in projects used in this research has shown that FUCP has RMSE is 547.1. Display train data with a fitted polynomial, degree is one, and 95% prediction bounds intervals. Figure 4 shows the evaluation result of FUCP method and actual effort.



Source: Research Result (2023)

Figure 5. Polynomial Graph FUCP Method Versus Actual Effort

4. Conclusion

In this study that applying fuzzy logic to this use case points in the UUCW category provides a significant improvement in the accuracy of effort estimation. The implementation of FUCP to calculate effort estimation in ten projects government used in this research and it has shown that FUCP has the closest value to the actual effort. It is also demonstrated that FUCP outperforms UCP in terms of accuracy by 6.51 % improvements based on adjusted R square and low value of RMSE the closer to the value actual effort. The correlation calculation effort estimation between UCP and FUCP method with actual effort is FUCP method gives good results for effort estimation in software development projects because FUCP has smaller RMSE is 547.1 than UCP has 699,4. A low value indicates that the effort estimation method approaches the accuracy of the actual value effort.

Rakhmi Khalida, Tubagus Maulana Kusuma, Khairunnisa Fadhillah Ramdhanian

Author Contributions

Rakhmi Khalida proposed the topic; Rakhmi Khalida, Tubagus Maulana Kusuma conceived models and designed the experiments; Rakhmi Khalida, Tubagus Maulana Kusuma, and Khairunnisa Fadhillah Ramdhanian conceived the optimisation algorithms; Rakhmi Khalida, Tubagus Maulana Kusuma, and Khairunnisa Fadhillah Ramdhanian analysed the result.

Conflicts of Interest

The author declare no conflict of interest.

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Hasil Penilaian Reviewer Eksternal Kotak Masuk x



Rahmadya <piksel.unisma@gmail.com>
kepada saya, khairunnisa.fadhilla, mkusuma

Sel, 2 Mei 2023, 16:14 ☆ ↶ ⋮

Translator English (UK) Indonesian Translate email

→ Forward translated email

Terjemahkan ke Indonesia

To:
Rakhmi Khalida, Tubagus Maulana Kusuma, Khairunnisa Fadhilla Ramdhania

We have reached a decision regarding your submission to PIKSEL : Penelitian Ilmu Komputer Sistem Embedded and Logic, "Fuzzy Use Case Points as a Basis for Effort Estimation".

Our decision is: Accepted Submission

Reviewer A: Need brief info about the title, only use abbreviation explanation once

Reviewer B: Year on research result should be added in fig/table

Recommendation: Revisions Required

2 Lampiran • Dipindai dengan Gmail



Balas Balas ke semua Teruskan

Cek_Fuzzy Use Case Points as a basic for Effort Estimation

by Rafika Sari

Submission date: 19-Apr-2023 05:44AM (UTC-0500)

Submission ID: 2069223516

File name: Cek_Fuzzy_Use_Case_Points_as_a_basic_for_Effort_Estimation.docx (692.56K)

Word count: 3555

Character count: 17873

Fuzzy Use Case Points as a basic for Effort Estimation

Abstract

Many problems taht found in software development projects are either over-estimated or under-estimated. Effort estimation is very important for successful project management. Estimation activities are a challenge for project management when the resources used are so small then not much is known about the project. The common methods used for effort estimation is Use Case Points. Use case points are mainly used for application based objects, because it makes use case as the input. The UCP has weaknesses, which is high difference among the value of weight factor of UUCW. In order to overcome the abovementioned problem, Fuzzy use case points (FUCP) which is the combination between fuzzy logic and use case points, can be used. Applying fuzzy logic to this use case points in the UUCW category, fuzzy use case point has a new weight factor value of UUCW. The implementation of FUCP to calculate effort estimation in ten government based project used in this research has shown that FUCP has the closest value to the actual effort. It is also demonstrated that FUCP outperforms UCP in terms of accuracy by 6,51 % improvements.

Keywords: Effort, Estimation, Fuzzy, Use Case Points

1. Introduction

One of the most important stages in building or developing a software is planning stages. In this stage, the effort and resource estimation, human resources, materials, infrastructure, time, and budget must be taken into account(Kurniawan et al., 2013). The problems that found in software development projects is over estimates or under-estimates. Over estimates will lead to an additional allocation of necessary resources. While under-estimates can indirectly reduce the quality of the product, due to lower costs, then the software can be made not in accordance with the standards. Both of these problems indicates that the estimate is one important factor that must be considered before running a software development project (Ziauddin, Shahid Kamal, 2013).

Although estimates may not be able to produce a highly accurate results, but these inaccuracies can be minimized by using some method of evaluation in accordance with the project will estimate. Effort estimation is an activity perform to predict or forecast of how many workers and how long it will take to complete the project(Vishal Sharma and Harsh Kumar Verma, 2010).

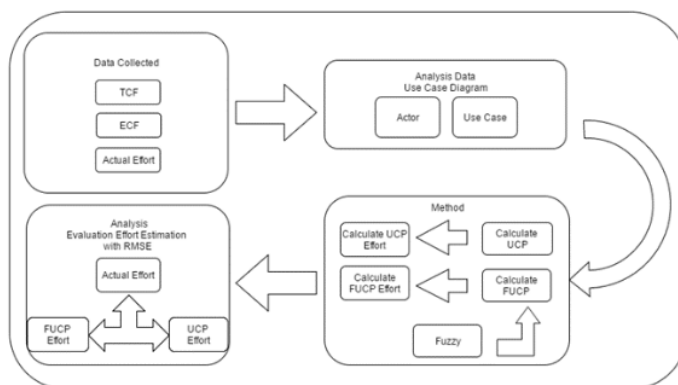
The methods used for effort estimation is Function Points and Use Case Points. Function Points method has advantages not depend on the programming language that can be applied to different types of applications(Sholiq, Apol Pribadi Subriadi & Muqtadiroh, 2019). This approach is also more predictable because its parameters are calculated based on the number of input and ouput. In the method Use Case Points (UCP) is widely used in object based applications. Estimation of software projects by using UCP easy to use on the software environment that have complex factors. UCP method is a method that is able to provide an estimate of effort (person per hour) required to create a project. Methods of Use Case Points (UCP) was invaluable in the context of early size measurement and estimation of effort (Komal Garg, Paramjeet Kaur, Shalini Kapoor, 2014)

UCP estimation does not relate to the estimation of the cost factor, because the UCP has weaknesses, which is high difference among the value of weight factor of UUCW. In order to overcome the abovementioned problem, Fuzzy use case points (FUCP) which is the combination between fuzzy logic and use case points, can be used (Alostad et al., 2017)

This research has contributions to making effort estimation more accurate without increasing the time and money spent and simplifying effort estimation methods without compromising their accuracy.

2. Research Method

The concept fuzzy use case points methods created from the expansion method use case points (UCP) with fuzzy logic Mamdani type (Ashita Malik, Varun Pandey, Anupama Kaushik, 2013). This method is also used to calculate estimates of the project effort. This method is used to obtain the estimated effort of more varied value and investigate the causal relationship between the UCP with FUCP using the evaluation effort estimation model. The stages of research method shown in figure 1



Source: Research Result

Figure 1. Research Method

Starting from data obtained from data collection techniques, namely technical factors, environmental factors, use case diagrams, and actual effort. The second stage, to analyze the use case diagram, actor and use case on a use case diagram becomes important things that are analyzed in this phase. When analyzing the use case diagram, actor and use case would be the reference for the calculation of estimated effort. Actor and use case analysis can then provides values to variables estimated calculation effort. The third stage calculating effort estimation using use case points (UCP) and fuzzy use case points (FUCP). When doing calculations using FUCP effort estimation, there is a fuzzy influence on the calculation effort etimation. The final stage is the evaluation of effort estimation methods. Activities such measurements are compared with FUCP and UCP method. Activities such evaluation will produce the best methods that appear to approach the value of actual effort.

2.1. Effort

As the name suggests, 'effort' is the number of work units that is vital to complete an activity. In simple terms, it is the number of hours we put in, focused on a particular task, to get a certain job done. Effort has to do with how hard you're trying. If something is easy, it doesn't take much effort. If it's hard, it takes a lot of effort. Effort estimation is predict the real work in completing the project by reviewing the schedule, project size, even the project risk will be borne (Prasad Reddy P.V.G.D., 2011). The common methods used for effort estimation is use case points and fuzzy use case points.

Actual effort is the amount of time needed by programmers in completing the project, starting from the stage of planning, analysis, design to implementation. Column person, working days, and working hours these, three things next will be the

reference to get the actual effort of a software development project (Hariyanto & Wahono, 2015). Formula calculates the actual effort as follows:

$$Actual\ effort = \sum person - \sum working\ days * working\ hours \quad (1)$$

2.2. Use Case Points

Use Case Points is a method of effort estimation in software development. The concept of UCP is based on the requirements for the system being written using use cases diagram. The UCP concept is based on use case diagrams for the system requirements created. The value of the UCP system is obtained by a person assessing the complexity of the actor. The use case is adjusted to two types of technical factors, namely those that characterize the development environment and the technical complexity of the system being developed (Mohammad Saber Iraj, Aboutalebi & H., 2012). The use case point model (UCP) is detailed as follows (Ali Bou Nassif, Luiz Fernando Capretz, 2011):

1. In UCP, actors are weighted with standard Unadjusted Actor Weights (UAW) values: actors are classified as simple, average, or complex. A weight is assigned to each category as follows:
 - a. Simple actors (SA) have a value weight of 1. Actors are usually described as other systems via an API.
 - b. The average actor (AA) has a value of 2. Actors are described as systems that interact through a text-based user interface or protocol.
 - c. Complex actors (CA) have a value of 3. Complex actors are described as systems that interact through a graphical user interface (GUI).

The UAW is calculated as:

$$UAW = (\sum SA * 1) + (\sum AA * 2) + (\sum CA * 3) \quad (2)$$

2. Unadjusted Use Case Weight (UUCW): Use cases have categories based on the number of transactions in the success and alternative scenarios. A weight is assigned to each category as follows :
 - a. Simple Use Case (SU) Its weight is 5. A use case is classified as Simple if the number of transactions is ≤ 3 .
 - b. Average Use Case (AU) Its weight is 10. A use case is classified as Average if the number of the transactions is between 4 and 7.

- c. Complex Use Case (CU) Its weight is 15. A use case is classified as Complex if the number of transactions is more than 7.

The UUCW is calculated as :

$$UUCW = (\sum SU * 1) + (\sum AU * 2) + (\sum CU * 3) \quad (3)$$

3. The sum of the UAW and UUCW values is the Unadjusted Use Case Points (UUCP) value. This is described as :

$$UUCP = UAW + UUCW \quad (4)$$

4. Technical Complexity Factor (TCF) : Factors that influence success and contribute to project complexity. The technical complexity factor (TCF) is calculated as follows:

$$TCF = C_1 + C_2 \sum_{i=1}^{13} TF \quad (5)$$

The TCF weight factor are depicted in Table 1. Where C1 = 0.6, C2 = 0.01 and TF is a factor that takes values between "0" and "5". The value "0" means the factor is irrelevant while the value "5" is essential. The value "3" means that the factor is not very essential, neither irrelevant (average). For instance, if all the factors have a value of "3", the TCF will be 1.

Table 1. Technical Complexity Factor (TCF)

No	Factor contributing to complexity	Weight
T ₁	Distributed systems	2
T ₂	Response time or throughput performance objectives	1
T ₃	End user online efficiency	1
T ₄	Complex internal processing	1
T ₅	Reusability of code	1
T ₆	Easy installation	0,5
T ₇	Ease of use	0,5
T ₈	Portability	2
T ₉	Ease of change	1

T ₁₀	Concurrency	1
T ₁₁	Special security objective include	1
T ₁₂	Direct access for third parties	1
T ₁₃	Special user training required	1

Source: Research Result

5. Environmental Complexity Factor (ECF): Factors that affect and contribute to team efficiency and productivity. The environmental factors are presented in Table 2. The environmental complexity factor (ECF) is calculated as follows:

$$ECF = C_1 + C_2 \sum_{i=1}^8 EF \quad (6)$$

Table 2. Environmental Complexity Factor (ECF)

No	Factor contributing to complexity	Weight
E ₁	Familiarity with system development process being used	1,5
E ₂	Application experience	0,5
E ₃	Object-oriented experience	1,0
E ₄	Lead analyst capability	0,5
E ₅	Motivation	1,0
E ₆	Requirements stability	2,0
E ₇	Part time staff	-1,0
E ₈	Difficulty of programming language	-1,0

Source: Research Result

Where C₁ = 1.4, C₂ = -0.03 and this factor EF environmental has a weight which is equivalent to the EF of the technical factor (i.e. between 0 and 5).

6. Use Case Points (UCP), which is an estimation method for making software and measuring the size of the software using use cases. The value of technical factors such as technical complexity factor (TCF) and technical quality and environmental complexity factor (ECF) of development resources and environmental factors have been obtained, then the UCP can be calculated. UCP is calculated as follows:

$$UCP = UUCP * TCF * ECF \quad (7)$$

if the value of all technical factors is 5, then the maximum value of TCF is 1.3. If a project has high complexity and low team efficiency, then the risk of project failure will be high. Typically, taking technical and environmental factors into account, an adjusted use case (UCP) point value will be 30% more or less than an unadjusted use case points (UUCP).

7. Effort is a technique to change value of UCP into value in the form person man hours (PHM). UCP effort illustrates size of the workforce required in hours. UCP effort can be calculated after UCP results have been obtained. PHM value is influenced by the Environmental Complexity Factor in UCP. Environmental Complexity Factor (ECF) on UCP can be seen in Table 2. Value PHM obtained by the following rules:

- i. W1 = Total weighted value E1 to E6 which has a value <3
- ii. W2 = Total weighted value E7 to E8 which has a value > 3
- iii. If W1 + W2 <= 2 then PHM = 20
- iv. If W1 + W2 = 3 or 4 then PHM = 28
- v. If W1 + W2 > 4 then the project should be canceled

UCP effort calculation with the following formula:

$$Effort = UCP * PHM \quad (8)$$

Description :

1. UCP = Use Case Point
2. PHM = Person Man Hours

2.3. Fuzzy Inference System

The concept of fuzzy logic was introduced by Lotfi Zadeh, Prof. of University of California at Berkeley in 1965. Fuzzy inference system is computing systems that work on the basis of the principle of fuzzy reasoning (Maleki I., Ebrahimi L., Jordati S., Ramesh, 2014). Fuzzy inference system can perform reasoning with similar principles such as human reasoning on instinct (Mohammad Saber Iraj, Aboutalebi & H., 2012). There are several types of Fuzzy Inference System (FIS) are recognized Mamdani, Sugeno and Tsukamoto. FIS is the easiest to understand because it suits human instincts (Prasad Reddy P.V.G.D., 2011).

2.4. Fuzzy Use Case Points

The concept fuzzy use case points methods created from the expansion method use case points (UCP) with fuzzy logic Mamdani type. This method is also used to calculate estimates of the project effort. This method is used to obtain the estimated effort of more varied value and investigate the causal relationship between the UCP with FUCP using the evaluation effort estimation model (Nwaiwu & Oluwadare, 2016).

Essentially there is no difference in the step of the process calculating the estimate project effort using fuzzy use case points with using use case points, that the difference is the weight factor when looking for value classification UUCW transaction use case. Using the same data that is value UAW, TCF, and ECF use the value obtained by using use case points. Do the calculation of estimated effort using fuzzy use case points. Only one category given the influence of fuzzy logic, namely weighting factor UUCW while other categories of data processed using the appropriate method of use case points.

2.5. Evaluation Effort Estimation

Evaluation effort estimation is a comparison was conducted that predict software effort estimation from use cases which are the UCP and FUCP method (Ali Bou Nassif, Luiz Fernando Capretz, 2011). Evaluation model effort estimation used to perform analysis of the correlation that is Root Mean Square Error (RMSE), R square, adjusted R square and Spearman's rank order correlation which is a very common criterion used to evaluate the software effort estimation model (Hariyanto & Wahono, 2015).

When using Root Mean Square Error (RMSE) to evaluation between actual with estimation, good results are shown with a low value. Specifically for R square and adjusted R square to be good models if the indicator measuring goodness of fit models high value or closer to 1. If the value of one variable is high, then the value of the other variable will be low and vice versa. In the Spearman rank-order correlation it is called a monotone relationship. In table 3 shows the evaluation formula was conducted on four different criteria, these include R square, adjusted R square, RMSE and Spearman's rank-order correlation (Hariyanto & Wahono, 2015).

Table 3. Model Evaluation for Effort Estimation

Model Evaluation	Formula
R Square	$R^2 = 1 - \frac{SSR}{SST} = 1 - \frac{\sum(y_i - \bar{y})^2}{\sum(y_i - \bar{y})^2}$
Adjusted R Square	$Adjusted\ R\ square = 1 - \frac{(1 - R^2) - (N - 1)}{N - M - 1}$
RMSE	$RMSE = \sqrt{\frac{\sum(Actual\ effort - Effort\ estimation)^2}{n}}$
Spearman's Rank	$\rho = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)} \text{ or } \rho = \frac{\sum_i(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i(x_i - \bar{x})^2 \sum_i(y_i - \bar{y})^2}}$

Source: Research Result

3. Results and Analysis

3.1. Use Case Diagram

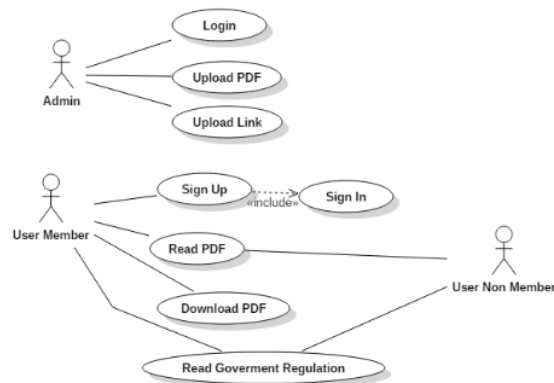
Use case diagram composed of use cases and actors describe what can be done by the system. At this stage of use case diagram illustrates the identification of the business process system. After knowing the actors that play a role in the system, then that is getting any process that can be performed using the system, and is further illustrated in a use case.

In this study as a discussion, the Assesment Library Website development project is taken as a data example for this research. The main page Assesment Library Website can be seen in figure 1 and use case diagrams Assesment Library Website can be seen in figure 2.



Source: Research Result

Figure 2. Main Page Assesment Library Website



7

Source: Research Result

Figure 3. Use Case Diagram Assesment Library Website

3.2. Use Case Points

From Figure 3, it is known that there are three actors and eight use cases. Actor on the use case diagram will be used as a variable Unadjusted Actor Weight (UAW). The UAW Assesment Library Website shown in table 4. Use case on a use case diagram will be used as a variable unadjusted Use Case Weight (UUCW). The UUCW Assesment Library Website shown in table 5.

Table 4. UAW Value Assesment Library Website

31

Actor Type	Description	Weighting Factor	Number	Result
Simple	External System with well-defined API	1	0	0
Average	External system using a protocol based interface	2	0	0
Complex	Human	3	3	9
Unadjusted Actor Weight (UAW)				9

Source: Research Result

35

Table 5. UUCW Value Assesment Library Website

Actor Type	Description	Weighting Factor	Number	Result
Simple	1-3 transaction	5	5	25
Average	4-7 transaction	10	2	20
Complex	> 7 transaction	15	1	15
Total				60

Source: Research Result

1

Unadjusted Use Case Points (UUCP) value is the result of the UAW value added by UUCW. Based on formula number 4, UUCP value of Assesment Library Website is 69. Calculating the value of technical factors to obtain the value of Technical Complexity Factor (TCF). Based on formula number 5, TCF value of Assesment Library Website is 1,17. Calculating the value of environment factors to obtain the value of Environment Complexity Factor (ECF). Based on formula number 6, ECF value of Assesment Library Website is 0,67.

UUCP, TCF and ECF value used to calculate Use Case Points (UCP). Based on formula number 7, UCP value of Assesment Library Website is 54,0891 ≈ 54,09. Based on ECF of Assesment Library Website, PHM value is 20. UCP effort can be calculated after UCP and PHM results have been obtained. Based on formula number 8, UCP effort value of Assesment Library Website is 1081, 79 ≈ 1082 hour.

3.3. Fuzzy Use Case Points

Using the same data from the Assesment Library Website, UAW, TCF, and ECF value use the value obtained by using use case points. Only one category given the influence of fuzzy logic, namely weighting factor UUCW while other categories of data processed using the same method of use case points. UUCW value for the Assesment Library Website using fuzzy logic influence can be seen in table 6. UUCW value combined with fuzzy called FUUCW.

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No	Use Case	Type of Transaction	Weighting Factor	Value
1	Login	3	5,70	5,70
2	Upload PDF	7	10,30	10,30
3	Upload Link	4	6,72	6,72
4	Sign up	10	13,70	13,70
5	Sign in	3	5,70	5,70
6	Read PDF	1	4,79	4,79
7	Upload PDF	1	4,79	4,79
8	Read Government Regulation	1	4,79	4,79
Total				56,49

Source: Research Result

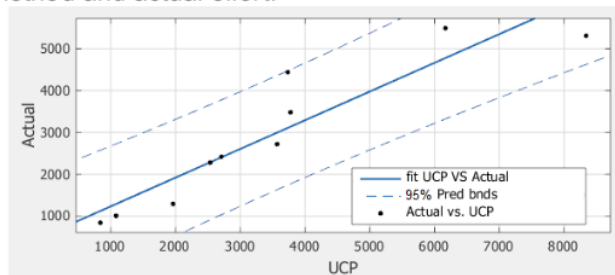
2
Unadjusted Use Case Points (FUUCP) value is the result of the UAW value added by FUUCW. Based on formula number 4, FUUCP value of Assesment Library Website is 65,49. Using the same data from the value obtained by using use case points, UAW, TCF, and ECF and then value of FUUCP, TCF and ECF value used to calculate Fuzzy Use Case Points (FUCP). Based on formula number 7, FUCP value of Assesment Library Website is $51,337611 \approx 51,34$. Based on ECF of Assesment Library Website, PHM value is 20. FUCP effort can be calculated after FUCP and PHM results have been obtained. Based on formula number 8, FUCP effort value of Assesment Library Website is $1026,76 \approx 1027$ hour.

3.4. Actual Effort

Actual effort value is the amount of time required by the programmer in completing the project, starting from the stage of planning, analysis, design to implementation. On the Assesment Library Website has a person is two people, working days Assesment Library Website is 101 days and do the project for five hours each day. Based on formula number 1 actual effort value of Assesment Library Website is 1010 hours.

3.5. Evaluation Model for UCP Method

A comparison is performed between UCP method with actual effort. The implementation of UCP to calculate effort estimation in projects used in this research has shown that UCP has RMSE is 699,4. Display train data with a fitted polynomial, degree is one, and 95% prediction bounds intervals. Figure 3 shows the evaluation result of UCP method and actual effort.

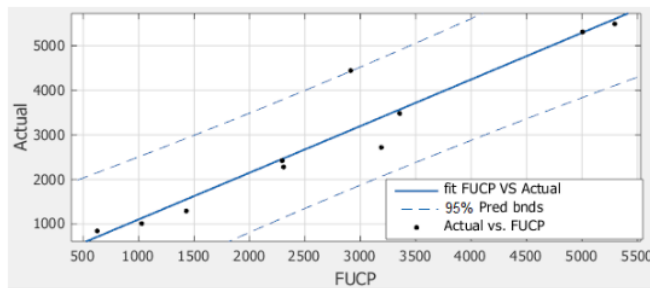


Source: Research Result

Figure 4. Polynomial Graph UCP Method Versus Actual Effort

3.5. Evaluation Model for FUCP Method

A comparison is performed between FUCP method with actual effort. The implementation of FUCP to calculate effort estimation in projects used in this research has shown that FUCP has RMSE is 547,1. Display train data with a fitted polynomial, degree is one, and 95% prediction bounds intervals. Figure 4 shows the evaluation result of FUCP method and actual effort.



Source: Research Result

Figure 5. Polynomial Graph FUCP Method Versus Actual Effort

4. Conclusion

In this study that applying fuzzy logic to this use case points in the UUCW category provide a significant improvement in the accuracy of effort estimation. The implementation of FUCP to calculate effort estimation in ten projects government used in this research has shown that FUCP has the closest value to the actual effort. It is also demonstrated that FUCP outperforms UCP in terms of accuracy by 6,51 % improvements based on adjusted R square and low value of RMSE the closer to the value actual effort.

The correlation calculation effort estimation between UCP and FUCP method with actual effort is FUCP method gives good results for effort estimation in software development projects because FUCP has smaller RMSE is 547,1 than UCP has 699,4. A low value indicates that the effort estimation method approaches the accuracy of the actual value effort.

Author Contributions (12 pt)

Rakhmi Khalida proposed the topic; Rakhmi khalida, T.M.Kusuma conceived models and designed the experiments; Rakhmi khalida, T.M.Kusuma and Khairunnisa F.R conceived the optimisation algorithms; Rakhmi khalida, T.M.Kusuma and Khairunnisa F.R analysed the result

Conflicts of Interest (12 pt)

The author declare no conflict of interest.

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PAGE 3

PAGE 4

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PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11
