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PREFACE

Assalaamu ‘alaykum warahmatullahi wabarakaatuh,

The CITSM 2018 is in the general area of communication and information technology. It provides a forum for presenting and discussing the latest innovations, results and developments in IT Management & organizations, IT Applications, Cyber & IT Security, and ICT. The main objective of this conference is to provide a forum for engineers, academia, scientist, industry, and researchers to present the result of their research activities in the field of Computer and Information Technology. The primary focus of the conference is to create an effective medium for institutions and industries to share ideas, innovations, and problem solving techniques.

There are 282 papers submission and only 150 papers are accepted and 147 papers have been registered and presented. Accepted papers will be presented in one of the regular sessions and will be published in the conference proceedings volume. All accepted papers are submitted to IEEEXplore. IEEE Conference Number: # 43622. Catalog Number: CFP1837Z-PRT, ISBN: 978-1-5386-5433-0, CFP1837Z-USB, ISBN: 978-1-5386-5434-7.

On behalf of the CITSM organizers, we wish to extend our warm welcome and would like to thank for the all Keynote Speakers, Reviewers, authors, and Committees, for their effort, guidance, contribution and valuable support. Last but not least, thanks to all lecturers and staffs of the Faculty of Science & Technology, Syarif Hidayatullah Jakarta State Islamic University and Universitas Potensi Utama-Medan and other parties that directly and indirectly make this event successful.

Wa billahi taufiq wal hidaayah.
Wallahul muwaffiq ila aqwamit-tharieq.
Wasalaamu ‘alaykumu warahmatullahi wabarakaatuh.

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Specify of Estimation Using C4.5 Algorithm of Software Project Estimation at the Point of Sales Application with Cocomo II

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Abstract—In software development, it is required an appropriate estimate. One of the most commonly used software project estimation models is Constructive Cost Model (COCOMO II). The model is often used to obtain accurate results in estimating important factors such as cost and human resources. However, to obtain more accurate estimation results, this study proposes a C4.5 algorithm based on COCOMO II estimation results. In this study, software project estimates are used in the Point of Sales (POS) applications. Based on these data with COCOMO II method, it is estimated that the schedule, staff, and cost are specifying estimation from the result of COCOMO II using a C4.5 algorithm. The accuracy of the estimation results is around 90% with Algorithm C4.5. The value can be used as a reference for the development of the next POS software project.

Keywords—cocomo II, algorithm C4.5, decision tree, point of sales, software project estimation

I. INTRODUCTION

Currently, the software has been used to support various business activities. The software is used in offices, small industries, manufacturing, entertainments, and others. In the development of software projects, it is required a good estimate of costs, human resources, and development schedule.

Estimated software development can use the COCOMO II Model approach [1] [2]. This approach is useful for making decisions in developing software projects [2]. However, the estimates using COCOMO II are less accurate [3].

Therefore, to improve the accuracy of software projects, Models such as COCOMO II must use The C4.5 Algorithm [4]. It has been used to overcome the problem of software project accuracy using COCOMO II model [5] [6]. Previous studies have shown that a C4.5 algorithms are more effective in predicting software projects [6] [7].

This study will estimate project development in Point of Sales application based on COCOMO II using C4.5 approach. The main purpose of this study is to analyse the effectiveness of using a C4.5 algorithm to determinate estimation from the result of COCOMO II.

II. RELATED WORK

Software is a physical abstraction that allows us to talk to hardware machines [12]. The software estimate is a prediction resources, such as development costs and timelines for specific software projects in certain environments, using defined methods [8]. One of the most common approaches to software estimation is the COCOMO II model.

The COCOMO II model has helped the company to estimate cost software development projects [3]. Software cost estimation is required to complete all of the resources work on the software project [1]. Resources estimates must be made at the beginning of the project for accuracy cost and requirements of other resources [9]. Therefore COCOMO II model needs to estimate the accuracy of costs and other resources before the development of software projects.

In addition, in their research on The Impact of CMMI Based Software Process Maturity on COCOMO II's Effort Estimation concludes an accurate cost estimation of software development is essential in budgeting, project planning, and effective project management control [14]. Different software cost estimation models have different inputs [13]. A study reviewed the cost estimation methodology concluded that the most important reason for the failure of software projects has been the subject of much research in the last decade. According to the results of some of the research presented in their paper, the root cause of software project failure is an improper estimate at the initial stage of the project [14]. Thus, introducing and focusing on estimation methods is very crucial to achieve accurate and reliable estimates.
In the current study, most of the current estimation techniques have been systematically illustrated. There is no estimation method that can present the best estimate in all situations and each technique can fit within a specific project. It is important to understand the principal of each estimation method to choose the best. The main reason is that the performance of each estimation method depends on several parameters such as project complexity, project duration, staff skills, development methods and so on. Some evaluation metrics and actual estimation examples have been done only to illustrate the performance of estimation methods (eg. Cocomo) [14]. Efforts to improve the performance of existing methods and introducing new estimation methods based on today's software project requirements can be a future work in this field.

An analysis of the estimated cost of software development using COCOMO II method in Inagata Technosmith concluded that cost estimation obtained from the results of this research can provide recommendations for further projects. Estimated time to complete the project using COCOMO II method was 12 months. Estimated employee to work on this project was 4 people, the estimated cost in 1 month amounted to Rp 8,396,000. So the estimated total cost of this project was Rp 100,752,000 [17].

In research estimation of software creation cost using COCOMO II method in information system [18] reporting development activities system of software project, concluded that:

- By using COCOMO II method can calculate or estimate business or cost and schedule or duration of time of a software project.
- In the first software project, the size used is derived from the conversion of Unadjusted Function Point (UFP) to the Source Line of Code (SLOC).
- On software projects that have been done and are intended for the development of the size used are derived from manual source code line calculation or using the help of freeware.
- On the other hand, it takes an accuracy of resource estimation from software project development. Limitations of the COCOMO II method in the estimation accuracy require another approach. One approach that can be used is the C4.5 algorithm.

A study reviewed the cost estimation methodology concluded that the most important reason for the failure of software projects has been the subject of much research in the last decade. Some evaluation metrics and actual estimation examples have been presented in this paper only to illustrate the performance of estimation methods (eg COCOMO). Attempting to improve the performance of existing methods and introducing new estimation methods based on today's software project requirements can be a future work in this field [13].

On the other hand, it takes an accuracy of resource estimation from software project development. Limitations of the COCOMO II method in the estimation accuracy require another approach. One approach that can be used is the C4.5 algorithm.

Responding to this, in the next research it is crucial a test with Algorithm C4.5 to get the results on the accuracy calculation of estimation of the COCOMO II method if it is used in project needs. The line of code (LOC) data originated from the repository of software projects on POS applications.

The C4.5 algorithm is one of the most popular Decision Tree methods, and more easily understood for classification or prediction. It is built in the form of a decision tree based on criteria as a learning model of the data sample [14].

Build decision trees from a project software prediction is based on the similarity data to describe precision, recall, and accuracy [9]. Such decision trees help managers decide whether projects are worth developing. The prediction accuracy of C4.5 in the software project can improve the accuracy percentage exceeds 40%. [10] and 89% [11]. Then, for recall and accuracy prediction of software project using decision tree are 84%, precision is 72% [9].

III. RESEARCH METHODOLOGY

The research method is done starting count the line of code (LOC) data of POS project, counting process the LOC data by using the SLOC Metric 3.0 application, estimation analysis using COCOMO II method, and result estimation with C4.5algorithm. Figure 1 shows the stages of the research conducted to estimate software projects.

A. LOC Data and Sloc Matric 3.0

The data required for the software cost estimation analysis materials is based on the LOC data that have been collected. The data is derived from the software project repository in the POS application. The analysis using the COCOMO II method must be based on calculations from the SLOC that are obtained from the LOC data of POS application, ie. in the form of a file uses PHP programming language.

It is processed by counting the number of lines of code on by using the SLOC Metric 3.0 application that serve as the determination of the estimated effort of the POS software project. Figure 2 shown the results of SLOC data retrieval using SLOC Metric 3.0 from POS application.
Fig. 2. SLOC Metric 3.0 Application

After all the files are inputted in SLOC Metric, then we obtained data from the SLOC or the modules of POS. There are several modules in the POS such as Sales, Order, Manual In Out Goods, Target, Returns, Stock, Mutation, Report, Customer, and Admin. Table I shows the number of files and SLOC data for the Customer module based on PHP files.

### TABLE I. SLOC DATA CUSTOMER MODULE

<table>
<thead>
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<th>SLOC</th>
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<tr>
<td>customer.php</td>
<td>298</td>
</tr>
<tr>
<td>_print_transaction_cust.php</td>
<td>277</td>
</tr>
<tr>
<td>edit_customer.php</td>
<td>231</td>
</tr>
<tr>
<td>daily_cust.php</td>
<td>207</td>
</tr>
<tr>
<td>customer_transaction.php</td>
<td>191</td>
</tr>
<tr>
<td>detail_transaction_cust.php</td>
<td>187</td>
</tr>
<tr>
<td>add_customer.php</td>
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<tr>
<td>detail_pelanggan.php</td>
<td>158</td>
</tr>
<tr>
<td>_print_daily_all.php</td>
<td>152</td>
</tr>
<tr>
<td>_print_customer.php</td>
<td>142</td>
</tr>
<tr>
<td>_print_daily_customer.php</td>
<td>112</td>
</tr>
<tr>
<td>_print_daily_cust_total.php</td>
<td>100</td>
</tr>
<tr>
<td>_print_customer_extend.php</td>
<td>100</td>
</tr>
<tr>
<td>update_customer.php</td>
<td>95</td>
</tr>
<tr>
<td>history_customer.php</td>
<td>91</td>
</tr>
</tbody>
</table>

Table II, shows the overall results of SLOC data from all modules POS application. Based on a total of 61275 SLOT data, the order module has the largest data, and the target module has the smallest data. This SLOT data will be used to estimation analysis using COCOMO II method.

### TABLE II. THE RESULTS OF SLOC OF MODULES POS APPLICATION

<table>
<thead>
<tr>
<th>Modules</th>
<th>SLOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>12092</td>
</tr>
<tr>
<td>Order</td>
<td>12431</td>
</tr>
<tr>
<td>Manual In Out Goods</td>
<td>7503</td>
</tr>
<tr>
<td>Target</td>
<td>1492</td>
</tr>
<tr>
<td>Retur</td>
<td>2801</td>
</tr>
<tr>
<td>Stock</td>
<td>3103</td>
</tr>
<tr>
<td>Mutation</td>
<td>2745</td>
</tr>
<tr>
<td>Report</td>
<td>8847</td>
</tr>
<tr>
<td>Customer</td>
<td>2761</td>
</tr>
<tr>
<td>Admin</td>
<td>7500</td>
</tr>
<tr>
<td>Total</td>
<td>61275</td>
</tr>
</tbody>
</table>

B. Estimation Analysis using COCOMO II Method

The estimation analysis using COCOMO II model required scale factor and cost driven for effort estimation [15]. The Scale Factor ($S_Fi$) used is PREC, FLEX, RESL, TEAM, and PMAT for each module. The data obtained from the interview with users.

### TABLE III. SCALE FACTOR

<table>
<thead>
<tr>
<th>Module</th>
<th>PREC</th>
<th>FLEX</th>
<th>RESL</th>
<th>TEAM</th>
<th>PMAT</th>
<th>$S_Fi$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>H</td>
<td>N</td>
<td>L</td>
<td>N</td>
<td>N</td>
<td>20.56</td>
</tr>
<tr>
<td>Order</td>
<td>H</td>
<td>N</td>
<td>L</td>
<td>N</td>
<td>N</td>
<td>20.56</td>
</tr>
<tr>
<td>Manual In Out Goods</td>
<td>H</td>
<td>N</td>
<td>L</td>
<td>N</td>
<td>N</td>
<td>20.56</td>
</tr>
<tr>
<td>Target</td>
<td>H</td>
<td>N</td>
<td>L</td>
<td>N</td>
<td>N</td>
<td>20.56</td>
</tr>
<tr>
<td>Retur</td>
<td>H</td>
<td>N</td>
<td>L</td>
<td>N</td>
<td>N</td>
<td>20.56</td>
</tr>
<tr>
<td>Stock</td>
<td>H</td>
<td>N</td>
<td>L</td>
<td>N</td>
<td>N</td>
<td>20.56</td>
</tr>
<tr>
<td>Mutation</td>
<td>H</td>
<td>N</td>
<td>L</td>
<td>N</td>
<td>N</td>
<td>20.56</td>
</tr>
<tr>
<td>Report</td>
<td>H</td>
<td>VH</td>
<td>L</td>
<td>N</td>
<td>N</td>
<td>20.86</td>
</tr>
<tr>
<td>Customer</td>
<td>H</td>
<td>N</td>
<td>L</td>
<td>N</td>
<td>N</td>
<td>20.56</td>
</tr>
<tr>
<td>Admin</td>
<td>N</td>
<td>H</td>
<td>L</td>
<td>N</td>
<td>N</td>
<td>20.79</td>
</tr>
</tbody>
</table>

Table III, represents the Scale Factor value used to process estimation with COCOMO II, while the value obtained for PREC with $H = 2.48$ and $N = 3.72$ for FLEX with $N = 3.04$, $VH = 1.01$, for RESL with $L = 5.62$, for TEAM with value $N = 3.29$ and $L = 4.38$, for PMAT with value $N = 4.68$. 

Then, the data cost driven in the estimation is required for each module as follows:

- \( \prod \) Emi Module of Sales = 16.74
- \( \prod \) Emi Module of Order = 16.74
- \( \prod \) Emi Module of Manual In Out Goods = 16.64
- \( \prod \) Emi Module of Target = 16.64
- \( \prod \) Emi Module of Return = 16.64
- \( \prod \) Emi Module of Stock = 16.64
- \( \prod \) Emi Module of Mutation = 16.64
- \( \prod \) Emi Module of Report = 17.14
- \( \prod \) Emi Module of Customer = 16.64

Thus, the results of effort estimation for each POS module as follows:

- \( E \) Module of Sales = 31,2452
- \( E \) Module of Order = 32,2254
- \( E \) Module of Manual In Out Goods = 16,8857
- \( E \) Module of Target = 2,78588
- \( E \) Module of Return = 2,78588
- \( E \) Module of Stock = 6,30124
- \( E \) Module of Mutation = 5,49977
- \( E \) Module of Report = 31,9163
- \( E \) Module of Customer = 5,53554
- \( E \) Module of Admin = 16,9566

The above data is the result of estimation of effort from the calculation by COCOMO II method, which then will be processed to get estimation result of schedule, cost estimation, and personnel estimation. Table IV shows the calculation of estimated schedule (TDEV), personnel (P), cost (Cost). Table V shows the criteria for determining validation. A condition for determining the value of the attribute whether it will be worth No or Yes, and Priority or Not.

### Table IV. Estimated of Schedule, Cost, and Personnel

<table>
<thead>
<tr>
<th>Module</th>
<th>TDEV (in month)</th>
<th>P = ( E / TDEV )</th>
<th>Cost = Personnel x Avg Labor Cost</th>
<th>Urgency Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>9,757796</td>
<td>3.202071</td>
<td>16.010.353</td>
<td>No</td>
</tr>
<tr>
<td>Order</td>
<td>9,843809</td>
<td>3.273668</td>
<td>16.368.340</td>
<td>No</td>
</tr>
<tr>
<td>Manual In Out Goods</td>
<td>8,192545</td>
<td>2.061103</td>
<td>10.305.517</td>
<td>No</td>
</tr>
<tr>
<td>Target</td>
<td>4,910044</td>
<td>0.567385</td>
<td>2.836.924</td>
<td>No</td>
</tr>
<tr>
<td>Return</td>
<td>5,994966</td>
<td>0.938301</td>
<td>4.691.506</td>
<td>No</td>
</tr>
<tr>
<td>Stock</td>
<td>6,191453</td>
<td>1.017732</td>
<td>5.088.659</td>
<td>No</td>
</tr>
<tr>
<td>Mutation</td>
<td>5,9547614</td>
<td>0.923289</td>
<td>4.616.444</td>
<td>No</td>
</tr>
<tr>
<td>Report</td>
<td>9,818934</td>
<td>3.250486</td>
<td>16.252.428</td>
<td>No</td>
</tr>
<tr>
<td>Customer</td>
<td>5,967697</td>
<td>0.927584</td>
<td>4.637.922</td>
<td>No</td>
</tr>
<tr>
<td>Admin</td>
<td>8,203367</td>
<td>2.067023</td>
<td>10.335.116</td>
<td>No</td>
</tr>
</tbody>
</table>

Conformity is the schedule for the target, return, transfer and customers module (project held > 6 month). Personnel suitability is the in or out goods manual, target, return, stock, mutation and customer module (personnel > 2 staff). While the cost estimation results, there are five modules that have a cost match, namely: target, return, stock, mutation and customer (cost > Rp. 10,000,000). Thus, urgency requirement is the sales, order, transfer and report module.
B. The result of C4.5 estimation

The results of estimation schedule, cost, and personnel will be used to data set (data training sample). It can be processed in the C4.5 algorithm in addition attributes of conformity and urgency (Table V represents). The following are the steps of the C4.5 classification algorithm model [16]:

- Calculating the number of cases for priority rather than priority and entropy from all cases. Entropy total rows are calculated based on training data using the equation:

\[ \text{Entropy}(i) = -\sum_{j=1}^{m} f(i,j) \cdot \log_2 f[(i,j)] \]  

(1)

\[ \text{Entropy}(\text{total}) = (-4/10 \times \log_2(4/10)) + (-6/10 \times \log_2(6/10)) = 0.97095059445 \]

- Then calculate the entropy and gain values of each attribute, for example below is calculation of the entropy and gain values for attributes Conformity Schedule:

\[ \text{Entropy}(i) = -\sum_{j=1}^{m} f(i,j) \cdot \log_2 f[(i,j)] \]  

(2)

\[ \text{Yes} = \left( -\frac{1}{4} \times \log_2 \left( \frac{3}{4} \right) \right) + \left( -\frac{3}{4} \times \log_2 \left( \frac{1}{4} \right) \right) \]

\[ \text{No} = \left( -\frac{3}{6} \times \log_2 \left( \frac{3}{6} \right) \right) + \left( -\frac{3}{6} \times \log_2 \left( \frac{3}{6} \right) \right) \]

\[ \text{Gain} = \text{Etotal} - \sum_{j=1}^{m} \text{total}/\text{total Kasus. E} \]  

(3)

\[ \text{Gain} = 0.971 - \left( \frac{4}{10} \times 0.811 \right) + \left( \frac{6}{10} \times 1 \right) \]

\[ = 0.9709 - 0.926 \]

\[ = 0.0469. \]

Entropy and gain calculations can be seen as follow:

1) Schedule Conformity for Gain 0.046, Entropy Yes 0.811 and Entropy No 1
2) Personnel Conformity for Gain 0.046, Entropy Yes 1 and Entropy No 0.811
3) Cost Conformity for Gain 0, Entropy Yes 0.971 and Entropy No 0.971
4) Urgency Conformity for Gain 0.042, Entropy Yes 0 and Entropy No 918.

The data from Table VI above is a value for making a decision tree. Figure 3 shows the decision tree to determine the module priority of the POS application project. The main purpose of analyzing data using the decision tree algorithm is to get the rule which will be used for decision making on the module priority. Then Table VII shows the result of project decision for priority.

![Decision Tree Specify of Estimation](image)

Fig. 3. Decision Tree Specify of Estimation

The rules derived from Figure 3 above are (1) If Urgency = "Yes", then "Priority"; (2) If Urgency = "No" and Schedule Conformity = "Yes", then "Priority"; and If Urgency = "No" and Schedule Conformity = "No", then "No". Table VII shows the result of project decision based on decision tree rules.

<table>
<thead>
<tr>
<th>Module</th>
<th>Schedule Conformity</th>
<th>Personnel Conformity</th>
<th>Cost Conformity</th>
<th>Urgency Requirement</th>
<th>Project Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Priority</td>
</tr>
<tr>
<td>Order</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Priority</td>
</tr>
<tr>
<td>Manual In Out Goods</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Target</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Return</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Priority</td>
</tr>
<tr>
<td>Stock</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Mutation</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Report</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Priority</td>
</tr>
<tr>
<td>Customer</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Priority</td>
</tr>
<tr>
<td>Admin</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Based on Table VII the project decision of priority is the sale, order, target, return, mutation, report, and customer module.
The result of the decision tree that has been done is required to measure the accuracy level using K-Fold Cross method (see Table VIII). Based on K-Fold Cross method using C4.5 Algorithm it produces accuracy equal to 90%.

**TABLE VIII. K-FOLD CROSS VALIDATION**

<table>
<thead>
<tr>
<th>Pred. Priority</th>
<th>True Prioritas</th>
<th>True No</th>
<th>Class Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pred. No</td>
<td>1</td>
<td>0</td>
<td>100.00%</td>
</tr>
<tr>
<td>Class recall</td>
<td>100.00%</td>
<td>75.00%</td>
<td></td>
</tr>
</tbody>
</table>

**accuracy: 90.00% +/- 30.00% (micro: 90.00%)**

**CONCLUSIONS**

Based on the results of POS modules estimation using COCOMO II the important conclusions of this study are:
(1) Conformity the schedule is the target, return, transfer and customers module. (2) Personnel suitability is the in out goods manual, target, return, stock, mutation and customer module. (3) There are five modules that have a cost match, namely: target, return, stock, mutation, and customer. (4) The urgency requirement is the sales, order, transfer and report module. While estimation result with the decision tree method of C4.5 Algorithm for the decision of priority is the sale, order, target, return, mutation, report, and customer module that produces accuracy equal to 90%. The results of the estimation can be used for subsequent project development.

The recomandations in the next research are: (1) For further research, in estimating software costs, it is desirable to use sub models other than Early Design in order to gain a better understanding of this COCOMO II method; (2) Further research can improve this research by adding other cost estimation methods as a comparison with the results of this study.

**REFERENCES**


