Agricultural Information Application Design using User Centered Requirements Engineering

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Abstract. In Indonesia there are 43.55 percent of low-education people where majority depend on life as farmer and the needs of farmers for information in agriculture are very diverse. So far, farmers have only used agricultural information for generations. Although technology has entered the agricultural sector, such as the use of smartphone devices. However, its use is still not productive because there are no mobile applications that can provide integrated agricultural information suitable to farmer needs. So that the User Centered Requirements Engineering (UCRE) method is needed as a process of classifying farmers information needs that are very diverse and packaged into an integrated agricultural information application design model. The results of the application design obtained usability size by 80.32% and correctness by 79% so that, it illustrates a good quality value of the application based on the need for usefulness and accuracy of information on the McCall method testing.

1. Introduction
In Indonesia there are 43.55 percent of low-education people where majority depend on life as farmer (Badan Pusat Statistik, 2018:83) and information on agriculture is very diverse and farmers have different needs of agricultural information. At the moment, many farmers have smartphone as long distance communication, for example, Wanajaya farmer group - located in Pinggirsari village, Bandung Regency, West Java - have not used it to get more information on agriculture because there is no application for providing their mutually integrated needs about agriculture information [1].

Therefore, need a single method which can manage different needs from each farmer. One of method which can be used is User Centered Requirements Engineering (UCRE) to determine agriculture information mapping for farmers by ordinal needs ranking accord by farmers importance as the common users. This method is very suitable for managing and defining every user need [2], in fact requirements engineering has developed to tackle the vexed problem of obtaining the user needs for a new system as accurately and completely as possible. Failure to carry out effective requirements analysis has led to many system disasters, and requirements errors become progressively more expensive to cure as system development progresses [2]. From the information on agriculture rank which obtained in the form of specification requirements packed in system design of agriculture information guide mobile app (infotani) [2]. The purpose of the research is implementing UCRE method for agriculture information mobile app development and creating infotani app needs specification to obtain accurate wants and needs of the farmers as the user.
2. Related Works

2.1. User Centered Requirements Engineering (UCRE)
Requirements Engineering is a first phase of software engineering process, where requirements from user and customer are collected and realized. According from the meaning of requirement engineering itself, User Centered Requirement Engineering method is used in the process of software engineering to collect requirements data that only focused on the user. The first stage from UCRE is collect the requirement specification data from the prospective user. Data collection is conducted through questionnaires or direct interview to every respondent [2] [3]. Requirement data are needed for analysis process in the next stage. Requirement data analysis aims to give a description of the user requirements specification. This is really useful for deciding analysis model and module in the designed system. In other side, the need of validation for prospective user to ensure the requirements which obtained from the gathering process are ready to be designed into the system.

Software requirements can be classified into three categories: Normal, Exciting and Expected [4]. The gathering of questionnaire data will be managed by the use of Likert scale formula, where the number of respondents involved (N people), and the number of ideal score (criterium) for all of the items with formula of $5 \times N = \text{IdealNumber}$. According to that data, then the approval level (AL) against questionnaire research variable with the formula of $\text{Score total}/\text{IdealNumber} \times 100\% = \text{AL}$. With ScoreTotal was obtained from the number of assessments every score item from N respondents [5] [6].

2.2. Agro App: An Application for Healthy Living
Agro App is another app to supports the farmers in agriculture information where researched for Sri Lanka society (specially for farmer) [7], the app built keeping the farmers in mind also a common man who wants to grow vegetables for his daily need. The Agro App helps a farmer keeps to up to date many information related about agriculture such as crop, pesticides, insecticides, financial sector etc [7]. One of reason this app had been develop because the background of problem Information Communication Technology (ICT) services are not economical to use by everyone specially for farmer as a common user. Collection of randomly assumption based on what the problem issued, then it obtained some features about information items who farmer really needs. Then the information’s need use as basing of feature of Agro App until development phase. The application would definitely help in bridging the gap between the farmers and technology and would prove beneficial to all sectors interested in farming [7].

2.3. E-Krishak Mitra
Majority in Indian society focused on agriculture as a backbone of Indian economy. Since a long time, they had problem issued like climate change, and made the farmers economy loss [8]. Information technology always growing up to raise a problem solve to use for developing an application such a mobile application called e-Krishak Mitra. The aim of research is developing information agriculture based on mobile application consist of three layers, User Interface (UI) layer, Application layer, and Database layer. E-Krishak Mitra is mobile application which multilingual development and currently support two languages (Hindi and English). Research process define six modules as features inside of application such as crop, nutrient, irrigation, seeds, pest and disease, and yield [8].

2.4. MobiCrop: Supporting Crop Farmers with a Cloud-Enabled Mobile App
MobiCrop is an application for supporting crop farmers [9], where the research implemented cloud-enabled technology for aiming the app can be accessed by mobile device. In other side, it adapted caching methodology on mobile propose to support offline accessibility. Mobicrop’s research aim to farmers to make quick on pesticide decisions [9], however the problem things are the farmers use this app when on offline mode, then the caching method unable to work according to design system. MobiCrop needs to redesign by layers model such a proxy layer until mobile layer, so that obtained the result of testing by synchronization time caching to get some data when offline mode has activated as quickly [9].
3. Research Flow

3.1. Flow Model
This research held according to research flow model in Figure 1.

![Figure 1. Research flow model.](image)

3.2. Data Processing from Requirements Elicitation Results
This observation aims to identify and collect requirements from prospective user as much as 20 respondents, the observation process is using a questionnaire with reference to Likert scale.

![Figure 2. Ordinal data result (part 1).](image)
Research variable determination is taken from the existing application benchmark result. From this data observation through a questionnaire, prospective user’s qualitative requirement data is obtained. Requirements data are processed to obtain data in qualitative form by using Likert scale. The use of Likert scale on questionnaire model is made in interval form, so the output from this process is in the form of approval level from every research variable on the questionnaire. Meanwhile, the requirements observation model also done on the questionnaire model in ordinal form. The result of data collecting and processing from observation questionnaire are shown in Figure 2 and Figure 3.

In Figure 2 and 3, priority number (x axis) is a number of priority sorting that was obtained from ordinal questionnaire, while respondent score numbers (y axis) are the respondent total that decides sorting from every requirement on ordinal questionnaire.
3.3. Requirements Classification

This stage is a process to classify every data which have been collected by Elicitation Results, and on Table 1, it categorizes based on importance level. According to Table 1, the requirements data are selected based on normal category. Normal category which has selected because the requirements is basic importance requirements should be fulfilled. Then the result of Table 1 made into requirement functionality as in Table 2.

Table 2. Functional Requirements.

| No | Code | Requirement          | Sub-Requirements                                                                 |
|----|------|----------------------|----------------------------------------------------------------------------------|
| 1  | F-01 | Seed Information     | a. Give information about description, price and location where the seed is sold  |
|    |      |                      | b. Display a map of the location where the seed is sold                           |
| 2  | F-02 | Fertilizer Information | a. Give information about description, price and location where the fertilizer is sold |
|    |      |                      | b. Display a map of the location where fertilizer is sold                         |
|    |      |                      | c. Give a usage dose of fertilizer based of crop’s type, age and land area        |
| 3  | F-03 | Pest Information     | a. Give information about description regarding pest and disease on crop that has been categorized based on crop’s type. |
|    |      |                      | b. Give information about pesticide involving content’s description, price and how to use the pesticide. |
|    |      |                      | c. Give a usage dose of pesticide based on crop’s type, age and land area.       |
| 4  | F-04 | Cultivation Information | a. Give information about cultivation procedures based on crop’s type, start from seeding until planting process. |
| 5  | F-05 | Weather Information  | a. Give information about weather in user’s location today and seven days later that covers temperature, rainfall and air pressure. |
|    |      |                      | b. Give information about weather in another area for today and seven days later that covers temperature, rainfall and air pressure. |
| 6  | F-06 | Calendar             | a. Covers calendar note start from planting period that entered by user before.   |
|    |      |                      | b. Give reminder schedule like spraying pesticide schedule and fertilizer application on crops. |
| 7  | F-07 | Farm Records         | a. Covers farm records throughout planting period, consists of crop’s type that planted this time, start date of planting, area of planting and another notes on every planting period. |
|    |      |                      | b. Store notes about plant’s age from the start date of the planting process until the end of planting. |

Sub-requirements data are obtained through the questionnaire along with collecting requirements questionnaire.

3.4. Validation

This Validation process is done to ensure that the data result that have been analyzed on the previous stage already appropriate to what the prospective user’s need (farmer).
3.5. Development
At this stage is the development of information guide application (infotani) on the smartphone platform include interface design process with the output that development process is a prototype model application which can be used like released application. We can see the interface model in Figure 4.

![Infotani User Interface](image)

**Figure 4.** Infotani user interface.

4. Result and Discussion
The testing process is measured by a quality factor of functional correctness and usability because UCRE is a method that focused on user. Moreover, the two quality factors take effect on user satisfaction. From 20 respondents that fill up the usability and correctness testing questionnaire separately.

![System's Aspect Chart](image)

**Figure 5.** System’s aspect chart results.

![User's Aspect Chart](image)

**Figure 6.** User’s aspect chart results.
Meanwhile, Figure 9 shows correctness testing result according to 20 respondents.

In Figure 5 until Figure 8, the testing questionnaire results on the usability and correctness factor by x shows that the number of question item or measurement variable. Meanwhile y is a respondent values on every answer option on the questionnaire. The calculation of the number of test results of functional correctness and usability using McCall formula (Equation 1) is as follows.

\[ \sum_{i=1}^{n} w_i c_i = F_a \]

\[ F_a = \text{Fitness testing value} \]
\[ w = \text{Weight value} \]
\[ c = \text{Testing criteria average value} \]

\[ F_{\text{usability}} = (0.04 \times 4.3) + (0.06 \times 4.1) + (0.1 \times 4) + (0.1 \times 4.3) + (0.06 \times 3.7) + (0.04 \times 4.3) + (0.04 \times 4) + (0.06 \times 4.1) + (0.06 \times 4.2) + (0.06 \times 3.7) + (0.04 \times 4.2) + (0.06 \times 4.3) + (0.1 \times 3.9) + (0.1x 4.1) + (0.08 \times 3.8) \]

\[ F_{\text{usability}} = 0.172 + 0.243 + 0.395 + 0.425 + 0.219 + 0.172 + 0.158 + 0.246 + 0.249 + 0.222 + 0.166 + 0.255 + 0.385 + 0.405 + 0.304 \]

\[ F_{\text{usability}} = 4.016 \]

\[ F_{\text{correctness}} = (0.2 \times 4) + (0.3 \times 3.75) + (0.2 \times 3.95) + (0.1 \times 3.8) + (0.1 \times 4.25) + (0.1 \times 4.3) \]

\[ F_{\text{correctness}} = 0.8 + 1.125 + 0.79 + 0.38 + 0.425 + 0.43 \]

\[ F_{\text{correctness}} = 3.95 \]
The calculation results from $F_{\text{usability}}$ and $F_{\text{correctness}}$ is normalized so it can be measured based on index scale 0-100% using formula (Equation 2). The normalization result from those two factors are as follows:

$$\frac{F_a}{i_{\text{max}}} \times 100\% = F_n$$

$F_a = \text{Fitness testing value}$

$i_{\text{max}} = \text{Maximum Respondent's Score}$

$F_n = \text{Fitness testing normalization value}$

$F_{\text{usability}} = \frac{4.016}{5} \times 100\% = 80.32\%$

$F_{\text{correctness}} = \frac{3.95}{5} \times 100\% = 79\%$

From the normalization calculation result of $F_{\text{usability}}$ is obtained 80.32% by 20 respondents as farmers, that affected by the usability factor testing based on Figure 5, Figure 6, and Figure 7. $F_{\text{correctness}}$ is obtained 79% by 20 respondents as farmer too, that affected by correctness factor testing based on Figure 8.

5. Conclusion

This research produces an agricultural information application (Infotani) based on android mobile that was designed by user’s (farmer) requirement specification that has been classified. From the result of quality testing to agricultural information application with McCall method, we have the number of total quality measurement was obtained for usability factor in the amount of 80.32% and for correctness factor in the amount of 79%. The usability testing result means the user already satisfied with the application that match their needs, meanwhile the correctness testing is more to examine whether the application running correctly according to the design.

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