Development of Fertilizer Selection using Knowledge Management System

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Abstract

Fertilizer is a chemical substance or organism that has the role in supplying the nutrient substance to the plants directly or indirectly added to the soil in order for the plant to ordinary grow. Much information on fertilizer is available on the internet, however the existence is still widely spread. Therefore, a forum to especially accommodate fertilizer selection using knowledge management system (KMS) is needed. In this research on fertilizer selection using knowledge management system is developed using the KMS Life Cycle (KMSLC) method, and implemented using Web based application. The knowledge in this system is obtained from expert explicit data entry and uploaded file from the users that has to be validated by an expert. The expert validation process is carried out with approval system, communication through messages and conversation. The outcome of the research is a web based application that was tried out by the users with good average tested value.

Keywords: fertilizer, fertilizer selection knowledge management system (KMS), knowledge management system life cycle (KMSLC).

1. Introduction

Indonesia is rich of wildlife as well as cultured biodiversity that is strongly affected by the relatively high soil fertility level spread all over the country. However, the soil fertility level will eventually decrease by the time the vegetation grow and multiply, in this regard an additional nutrient substance is needed to improve the soil fertility by adding fertilizer especially to cultured plants.

Fertilizer is a chemical substance or organism that functioned as nutrient substance supplement for plant directly or directly [11]. According to [4] fertilizer is an organic or inorganic, natural or processed that is added to the soil to provide certain necessity to the ordinary growth of plant. Fertilizer added as soil nutrient could be provided through roots as well as leaves with precise criteria and selection. A precise fertilizer selection strongly affected the yield of certain agriculture commodity; therefore the knowledge on fertilizer selection need to be further searched into and should come from a reliable expert. Various conducted researches on fertilizer selection resulting in much new knowledge. Reference [12] stated that 300 kg/ha of urea given to low N nutrient status soil, distinctly affected the increase growth component of ginger plant (temulawak), biomass, fresh tuber and dry medicinal plants. Varied NPK combination also distinctly affected the weight of husk cob, husk less cob per plant and husk less per hectare [6]. Besides inorganic fertilizer, organic fertilizer if use with an accurate measurement could affect the increase of commodity yield, e.g. manure fertilizer obtained from chicken coop with different dosage distinctly affected the growth and yield of green onion [8]. A good fertilizing technique using certain nutrient measurement and method is a valuable knowledge resource to be pursued and studied by the community and not only by farmers. The knowledge source could be in the form of data that consists of facts, observation, perception and information that is part of data compilation including data that have context, relevancy and objective [5].

Much information on fertilizer and fertilizing is available offline as well as online, but its existence is still widely spread, therefore a media to accommodate the Fertilizer Selection Knowledge Management System is needed. This research is trying to develop fertilizer selection

knowledge management using Knowledge Management System Life Cycle (KMSLC) presented by Awad and Ghazin (2010), the KMSLC method could bring in knowledge development and repository management, knowledge access increasing, knowledge scope enhancing, knowledge appraising [1] and knowledge sharing. The KMS application has already KMS standard classification feature i.e. knowledge capture and knowledge sharing except for knowledge application system and knowledge discovery that have not been included because of the explicit data needed is still limited and difficult to obtain. The develop KMS will have notification feature to all members should there be any new knowledge and it will remind us on something that should be carried out in the coming period according to the schedule [2]. The objective of this research is to develop a system based on Fertilizer selection knowledge which is KMS.

2. Research Method
2.1. KMSLC
The research is using Awad and Ghaziri (2010) KMSLC method that consists system, of Evaluate Existing Infrastructure, form the KM team, knowledge capture, design KM blueprint, verify and validate the KM system, implement the KM system. KMSLC from Awad and Ghaziri (2010), is shown in Figure 1.

2.2. Evaluate Existing Infrastructure
This is a process to evaluate the existing and needed infrastructure for system development; this covers financial, human resource, operational standard [3] and the use of technology [7]. In general the infrastructure evaluation covers hardware, software, net ware, brain ware, data ware, and process.

The existing infrastructure is closely related to the use of technology of to be developed KM, therefore diagnose on the use of technology for knowledge search, new knowledge formation, knowledge compilation and assembling, knowledge renew or revalidation should be carried out [17].
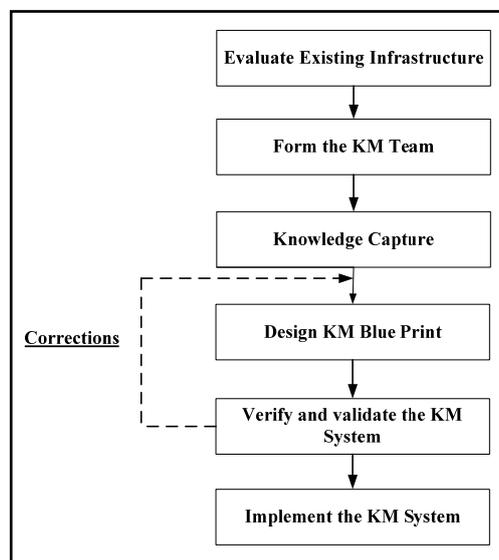

Figure 1. KMSLC

2.3. Form the KM Team
Resources identification on KMS fertilizer selection development is carried out through stakeholders identifying where they are further involved in the preparation of knowledge management system.

2.4. Knowledge Capture

The knowledge capture is carried out through interviewing and on-site observation identification and apprehended of tacit as well as explicit knowledge resource possessed by a fertilizer expert. The tacit knowledge is obtained from the expert idea and experience which is later documented while explicit knowledge is obtained from books, proceedings, research results and journals.

2.5 Design KM Blue Print
2.5.1. Knowledge Codification Design

In this research Knowledge Map and Production Rules is use to set up the Knowledge codification [3].

1. Knowledge map is a visual representation of related knowledge in a series of knowledge representations and not knowledge repository.

2. Production Rules is a representation of a tacit and popular knowledge. The rule being implemented is a statement that defined an action that will be carried out in a certain case. The syntax is: IF (premise) THEN (action).

2.5.2. Knowledge Management System Architectural Design

The designed architectural management system knowledge referred to architectural management system knowledge Awad and Ghazin (2010) that consisted of seven layers i.e. User Interface Layer, Authorized Access Control, Collaborative Intelligence and Filtering, Knowledge Enabling Applications, Transport Layer, Middleware, and the Physical Layer.

2.5.3. Model System Design

The represented design was as followed [13] :

1. Use Case Diagram is a model to describe the system behavior that will be prepared. The use case diagram described the interaction between one or more actor with the planned system.

2. Domain Model Class Diagram is an inter-related between the Class data   has an attribute as substitute of entity connection like ERD in the traditional approach.

3. Class Diagram describe the system structure of the classes definition that will be designed to create the system.

4. Sequence Diagram is used to describe the events sequence and the time of inter object message.

5. User Interface Design is the interface design of an application system that connect the user with the system.

2.6. Verify and validate the KM System

The verification and validation was carried out through knowledge testing. There were two types of Knowledge testing i.e. logical testing and user acceptance testing [3].

Logical testing covers KMS program syntaxes testing and tacit and explicit knowledge codification analysis. The application test was carried out by doing logical application attribute verification.

User acceptance testing is the KMS application test by the way of black box that is carried out by the admin, KMS developer, fertilizer expert, and users. Black box testing is used to test special functions of the designed software. The test technique carried out based only on the output data or the input condition of the existing function regardless of the process to obtain the output.

2.6. Implement the KM System

The developed KMS is a web based computer application with client-server system. This application was design to enable various users with access in line with each group.

3. Results and Analysis
3.1. Evaluate Existing Infrastructure
Clarify the existing infrastructure evaluation process and the system development requirement. The following is the output of the infrastructure evaluation at PT Pupuk Kujang as the research site for the KMS development reference (Table 1).

Table 1. Infrastructure existence Evaluation Result

No	Infrastructure	Infrastructure existence Evaluation Result
1	Hardware	Computer system complemented by sufficient input and output wares and chemical fertilizer laboratory.
2	Software	The computers are installed with legal operational system and some used Open Source application such as Web Server Apache, PHP and MySql to perform the Fertilizer KMS.of
3	Netware	Comprise of intranet network with RG-45 cable communication and wireless access point. While the internet capacity is exceeding 100Mbps.
4	Brainware	Having computer experts who comprehend the computer network and database e, and expert who understand about fertilizer and fertilizing.
5	Dataware	Data originally obtained from experts and scientific literature (books)
6	Process	Database documentation on fertilizer and fertilizing of the experts and researchers carried out by the computer experts.

The presence of the infrastructure is closely related to the use of technology available in KM that is to be developed, therefore technology usage diagnosis need to be carried out. The Technology Usage diagnosis outcome is as the following (Table 2).

Table 2. Technology Usage diagnosis outcome

No	Knowledge Object	Technology Usage	In System Existence
1	Knowledge search	Search tools and Retrieval tools	Using Structured Query Language (SQL) and Asycronous Javascript and XML (AJAX)
2	New Knowledge forming	Decision taking technique and Database repositories	Expert System, Knowledge map Implementation and Relational DBMS
3	Knowledge collection and assembling	Discussion group coordination and information updating	Chatting between users, Message sending and knowledge validation by an expert
4	Knowledge reformation	Database consultation and related research notation	Data chatting recording, fertilizing and fertilizer journal data.

3.2. Form the KM Team
Resources identification result for KMS fertilizer selection is carried out through KM team formation consisting of Fertilizer expert, KMS Developer, Administration, Member and Visitor.

Table 3. Resource Identification Result

No	KM Team	Resource	Notes
1	Fertilizer Expert	PT Pupuk Kujang Fertilizer Expert	One who has knowledge on fertilizer
2	KMS Developer	Analyst and Programmer	One who developed KMS Fertilizer Selection
3	Administration	IT Staff/IT Personnel	One who has full access to the KMS Fertilizer Selection system.
4	Member	Farmer, Fertilizer Distributor, Fertilizer Agency. etc	One who seeks and shares various knowledge on fertilizer registered as member.
5	Guests	Farmer, Fertilizer Distributor, Fertilizer Agency etc.	One who seeks and shares various knowledge on fertilizer but not registered as member.

3.3. Knowledge Capture
The result Identification on resource from books, scientific work, tacit as well as explicit fertilizer expert [10] was obtained through interview and on-site observation.

Table 4. KMS Fertilizer Selection Knowledge Transformation Result

To From	Result	
	Tacit	**Explicit**
Tacit	1. Carry out discussion and interview with fertilizer expert 2. Have a presentation and discussion with fertilizer expert 3. Carry out knowledge data entry and new document uploading	1. Print the document 2. Knowledge data stored in Fertilizer KMS database using DBMS MYSQL
Explicit	1. Document Checking by the expert 2. The result discussion is stored in repository or message history and chatting 3. New knowledge discovered in the field is stored in database.	1. Paper document become digital document. 2. Report or digital data into paper

3.4. Design KM Blue Print
3.4.1. Knowledge Codification Design
The result of knowledge codification designed in this research is obtained using Knowledge Map and Production Rules [3].

1. The knowledge map visual representation is based on knowledge mapping in fertilizer classification, fertilizer compound, fertilizer name, plants species, fertilizer dosage, and application time. [18] Fertilizer data that was obtained tacitly and explicitly from book and fertilizer expert from Kujang and fertilizer book and fertilizing. Sutedjo (2010), Lingga, (2011), Setyaningrum and Saparinto (2011). Suwarto and Octavianty (2012) is presented in Figure 2.

2. Knowledge Production Rules representation is a popular form of tacit knowledge. The rule being used is a statement that will decide an action taken for a certain case. The syntax is: IF (premise), THEN (action) is presented in Table 5.

3.4.2. Knowledge Management System Architectural Design
The result on Knowledge Management System Architectural Design is presented in seven layers designed in the development of fertilizer selection knowledge management system. Knowledge management system architecture refers to Knowledge Management System Architectural Design Awad and Ghaziri (2010) that consists of seven layers i.e. User Interface Layer, Authorized Access Control, Collaborative Intelligence and Filtering, Knowledge Enabling Applications, Transport Layer, Middleware, The Physical Layer is presented in Figure 3.
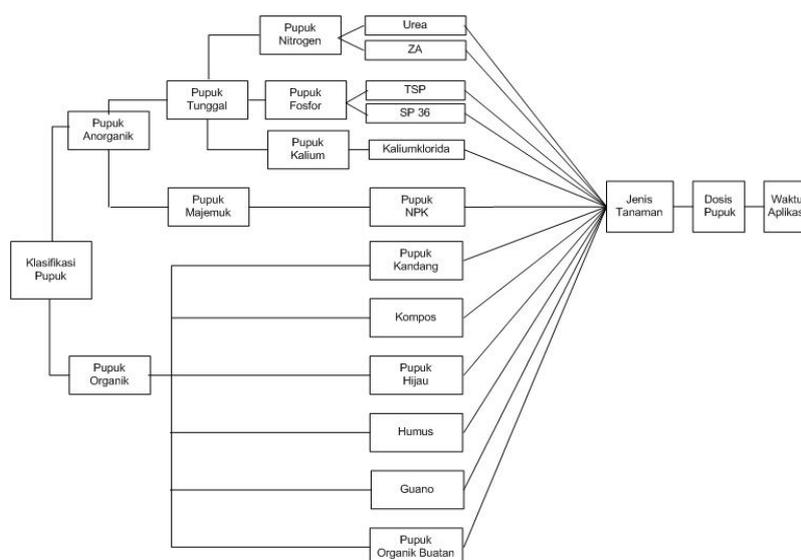

Figure 2. Knowledge Map Fertilizer Selection Result

Table 5. Production Fertilizer Selection Rule Result

| No	Premise IF			Action THEN		
	Attribute	Object	Value	Attribute	Object	Value
1	Classification	Chemical	Inorganic	Name	Plant	Name of plant
	Type	Compound	Single	Measurement	Dosage	Dosage quantity
	Name	Fertilizer	Name of fertilizer	Level	Age	Application time
2	Classification	Chemical	Inorganic	Name	Plant	Name of plant
	Type	Compound	Composite	Measurement	Dosage	Dosage quantity
	Name	Fertilizer	Name of fertilizer	Level	Age	Application time
3	Classification	Chemical	organic	Name	Plant	Name of plant
	Type	Compound	organic	Measurement	Dosage	Dosage quantity
	Name	Fertilizer	Name of fertilizer	Level	Age	Application time
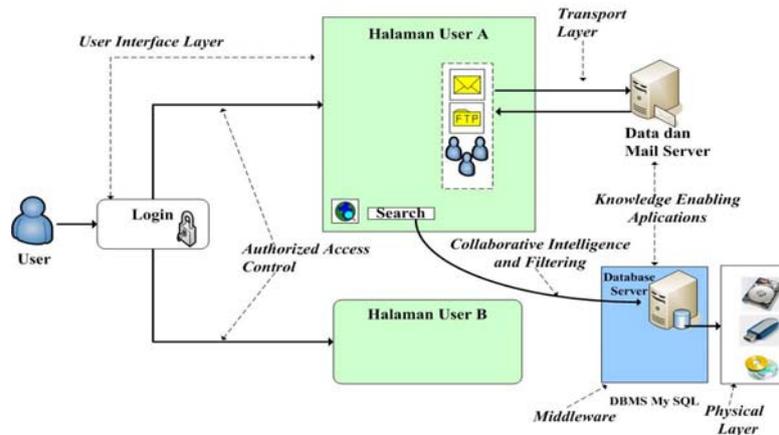
Figure 3. Knowledge Management System Architectural Design Result

3.4.3. Modeling System Design

The represented design result:
1.   Usecase Diagram

Consists of one or more actor and uses case i.e. four actors and nine use case and has use case interaction i.e extend and include is presented in Figure 4.
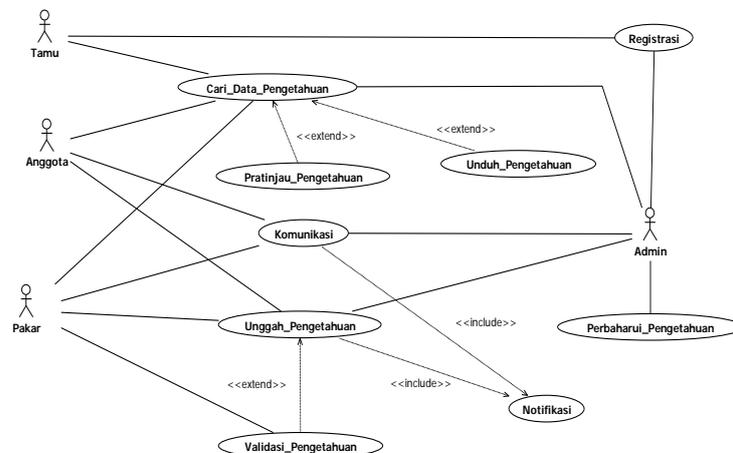

Figure 4. Use Case Fertilizer Selection

2.   Domain Model Class Diagram
Describe connection diagram between class date that has attribute is presented in Figure 5.
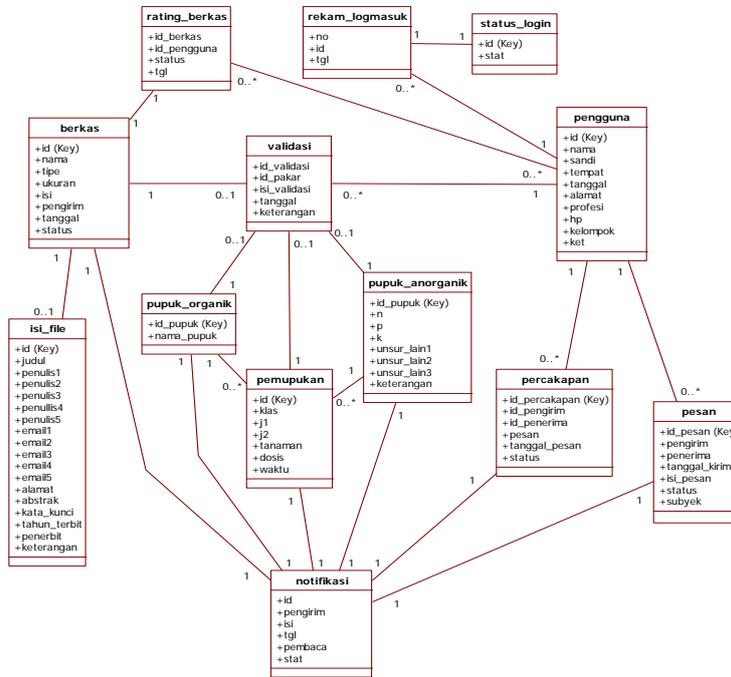

Figure 5. Domain Model Class Diagram Fertilizer Selection

3.   Class Diagram
Describe the system structure classes definition view that is going to be established is presented if Figure 6.
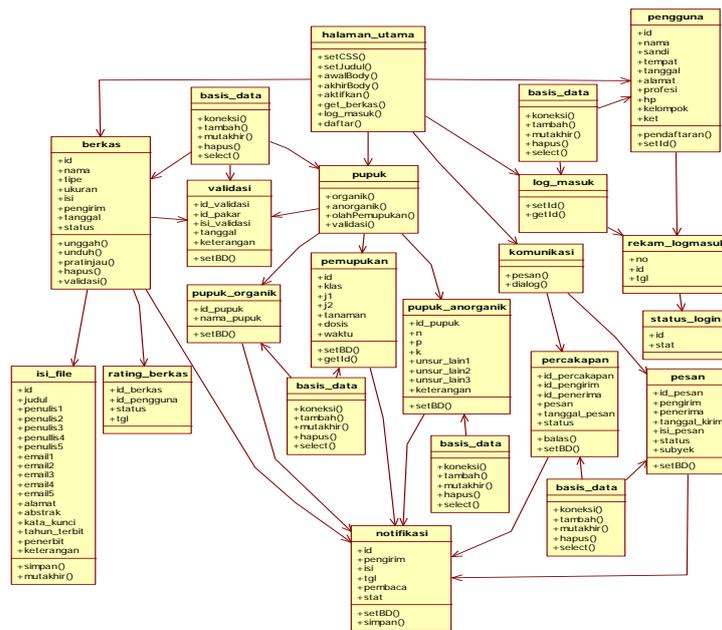

Figure 6. Class Diagram Fertilizer Selection

4. Sequence Diagram

Describe the event and time sequence of an inter object message is presented in Figure 7 (The sequence diagram is not completely presented)
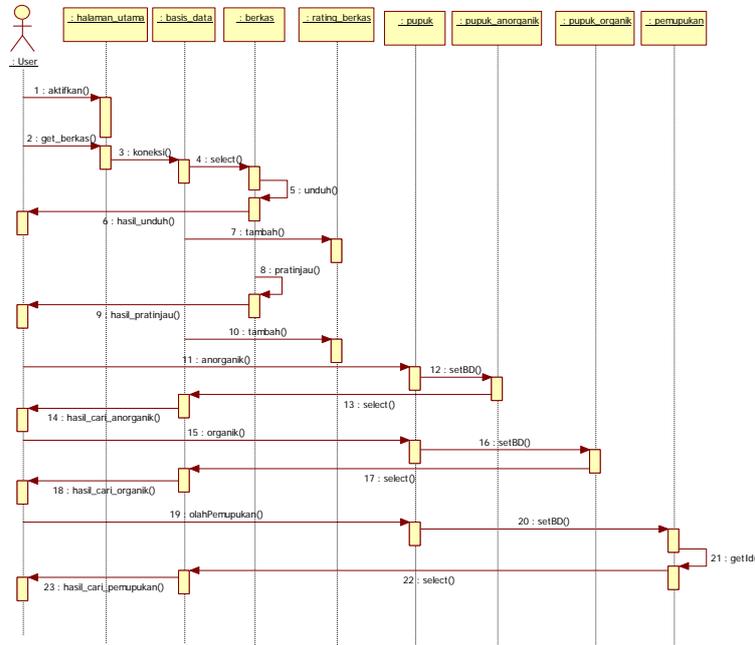

Figure 7. Diagram Sequence Search Knowledge Fertilizer Selection (Member, Administration, Fertilizer Expert, Guests)

5. User Interface Design

The result of User Interface Design is an interface design of application system that connect user and the system. The performance of the interface is differentiate based on user group, this cover the menu structural difference and available system function is presented in Figure 8 and 9.
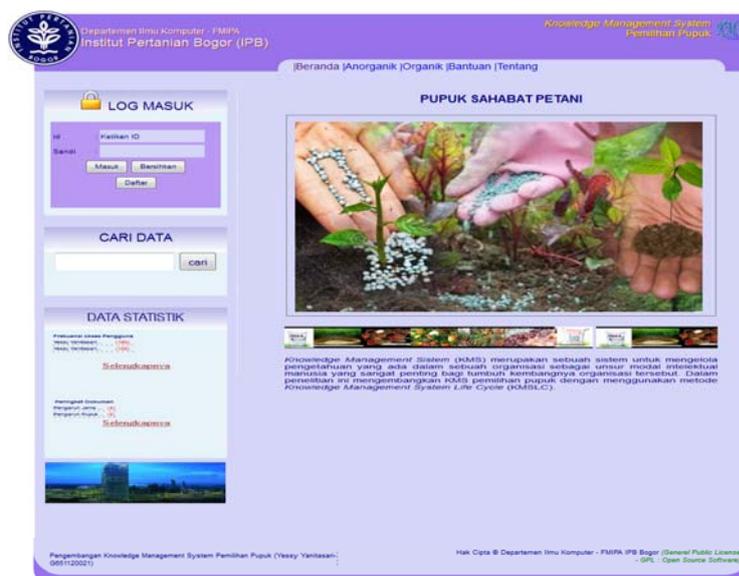

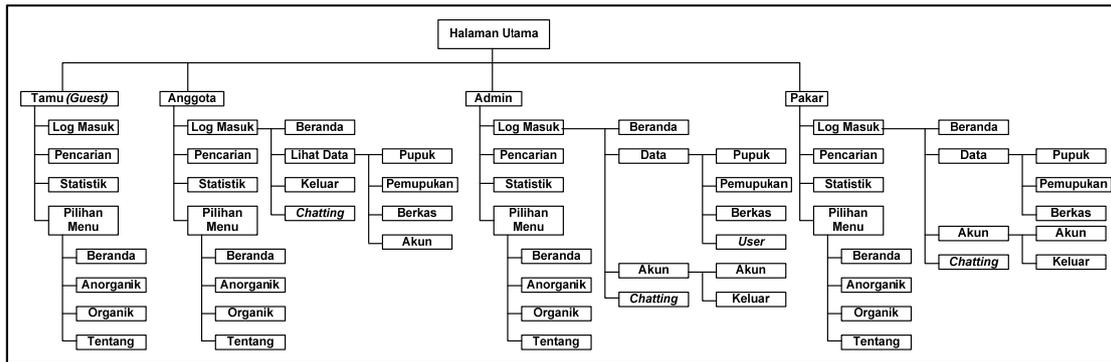Figure 8. User Interface Design Application KMS Fertilizer Selection

Figure 9. Site Map KMS Fertilizer Selection

3.5. Verify and Validate the KM System

The result of KMS verification and Validation towards the system with two tests

1.   Logical testing covers KMS program syntaxes test as well as explicit and tacit knowledge codification analyst. The test is carried out by having verification on logical application attribute that consists of seven logical attribute i.e. circular rule, redundancy, completion, consistency, truth, confidence, and dependable from the seven logical attribute tested, resulting in the entire logical attribute is tested.

2.   User acceptance testing is test given to KMS application through black box carried out by the KM Team that consists of accuracy, adaption capability, sufficiency, appeal, availability, user convenience, face validity, performance, dependable, robustness, operationally tested, of the criteria that has been tested, one criteria that has not been tested i.e. dependable criteria because it needed longer testing time.

3.6. Implement the KM System

The KMS implementation is carried out in two sides i. e. the client and server, because the developed application take the client-server system.

1.   Main installation on server side

From the server side some applications needed to be done that is differentiate into three major group i.e. Web Server using Apache 2.2. while DBMS Server using MySQL and Script Server using PHP Hypertext Preprocessor.

2.   Installation on client side

Carried out Web Browser installation as an interface when accessing data at the server. To get optimal result from the system performance side it is advised to use mozilla Firefox web browser, while for another web browser it is also allowed because   it does not affect the system function.

4. Conclusion

The research has succeeded in developing the fertilizer knowledge based system using KMSLC method, which is client-server web based application. This application could give a recommendation on effective fertilizer selection based on fertilizer knowledge that is obtained from the expert as tacit knowledge and explicit available knowledge. For optimal result the browser should be operated at personal computer, whereas at browser smartphone the performance result is not yet optimal.

Fertilizer selection knowledge management system development is recommended to enhance the knowledge on the existing fertilizer and   knowledge sharing be developed into knowledge discovery. Interface Application could be more developed for mobile ware with relatively small screen resolution.

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