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Web Based Knowledge Management System for Agriculture Using the SECI Approach and FGD

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ABSTRACT

Critical tacit knowledge in the agricultural sector, such as empirical cultivation expertise, pest management intuition, and local weather adaptation, is deeply embedded in senior farmers. However, this knowledge faces high risks of loss due to personnel turnover and the lack of structured documentation. This study aimed to design and develop a web-based Knowledge Management System (KMS) tailored to agricultural institutions to streamline the capture, storage, and distribution of farming expertise. Adopting a descriptive qualitative method with a case study design in Waetuo Village, Bone Regency, the research operationalized Nonaka and Takeuchi's SECI model (Socialization, Externalization, Combination, and Internalization) integrated with Focus Group Discussions (FGD) involving key stakeholders. The system's technical architecture was implemented using PHP/Laravel 10, MySQL 8.0, and 3-tier RBAC security. To distinguish user requirement validation from software performance testing, functional features were validated via black-box testing, while effectiveness was objectively evaluated using task-based scenarios. The empirical evaluation demonstrated a 100% Task Completion Rate (TCR) across six User Acceptance Testing (UAT) scenarios and reduced the Information Retrieval Time (IRT) to under 2 minutes (<120 seconds). Critical analysis of minor user disagreements highlighted UI/UX requirements tailored to farmers with limited digital literacy. The study contributes a novel SECI-to-KMS operationalization matrix for rural agricultural communities, ensuring sustainable knowledge transfer across generations.

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1. INTRODUCTION

The rapid advancement of information technology in the modern era has had a significant impact on various aspects of people's lives. The advent of digital technology has driven innovation and more efficient systems to simplify various tasks. Furthermore, the dynamics of today's technology make it easier for users to access a variety of information and resources. Knowledge becomes a valuable asset in facing global competition across various fields [1], The agricultural sector has become one of the areas experiencing rapid modernization alongside the integration of information technology, Information technology plays a vital role in boosting agricultural production quality while streamlining information flow for farmers. This advancement underscores the profound impact of digital technology in shaping the dynamics of daily life. Knowledge serves as the most valuable internal resource [2], Agricultural commodities are a vital component of agricultural development, making knowledge about these commodities essential support for boosting their productivity[3], Optimizing the utilization of information technology is necessary to strengthen and advance the agricultural sector.

The implementation of Knowledge Management (KM) has become highly relevant as a strategic solution. KM functions not merely as an information storage system, but as an integrated approach to managing the knowledge life cycle from creation and documentation to storage and dissemination [4]. It serves as a mechanism for storing, maintaining, and organizing business and operational information related to the generation of various insights, which subsequently become permanent intellectual assets for an organization [5]. Knowledge resources, in particular, represent a key asset [6], offering an integrated approach aimed at identifying, capturing, retrieving, sharing, and evaluating information. This information, encompassing databases, documents, procedures, and policies [7], plays a vital role by providing a coordination mechanism that supports the conversion of resources into capabilities [8]. Intense competition, coupled with the rapid advancement of information technology and scientific knowledge, compels organizations to adapt to an ever-changing business environment [9]. In the agricultural sector, the application of information and communication technology through tools, networks, services, and applications is intended to assist agricultural stakeholders in decision-making and resource utilization [10], Knowledge Management refers to an individual's activities in accessing, collecting, storing, processing, utilizing, and developing personal knowledge to support their own advancement. Knowledge Management refers to an individual's activities in accessing, collecting, storing, processing, utilizing, and developing personal knowledge to support their own advancement. Knowledge Management refers to an individual's activities in accessing, collecting, storing, processing, utilizing, and developing personal knowledge to support their own advancement [11], A Knowledge Management System (KMS) is an information technology-based knowledge management system designed to facilitate the discovering, capturing, sharing, and applying of knowledge [12]. The implementation of knowledge management within an organization is an effort to facilitate the processes of collecting, storing, creating, and sharing knowledge; this initiative also helps to prevent knowledge gaps among employees [13], SECI is a mapping model used to define knowledge transformation, based on the changes in form that occur during the process of knowledge delivery or transfer, whether carried out by individuals or groups [14], Knowledge is fundamentally categorized into two types: tacit knowledge and explicit knowledge. Tacit knowledge is knowledge that is not easily documented; it is highly valuable, personal in nature, and requires precise application gained through experience [15].

In the agricultural sector, there is a risk that individual knowledge may be lost when a farmer passes away. Within an agricultural organization or institution, knowledge held by individuals is often lost when farmers or managers leave or transition to different roles. This situation can create significant obstacles if the agricultural sector lacks an effective knowledge management system. Consequently, the transfer of knowledge becomes inefficient, which can hinder agricultural activities-particularly during personnel turnover or shifts in management structure. The problem is compounded when individuals keep knowledge to themselves rather than sharing it with other members of their farming group. Implementing such a system serves as a solution to improve knowledge management across both the governance and operational activities of the agricultural sector. The Scientific Challenge of Tacit Knowledge: The knowledge held by farmers and agricultural practitioners is generally acquired through empirical experience accumulated over many years. This knowledge encompasses the ability to identify pest and plant disease outbreaks, recognize soil characteristics and conditions, understand micro-weather patterns, and apply cultivation techniques tailored to specific environmental conditions and local wisdom. However, much of this knowledge remains "tacit" (implicit)-it has not been systematically documented and is often difficult to transfer to other farmers or future generations. A key challenge lies in transforming this intuitive understanding into a structured format so that it is not lost when experts or senior farmers retire. Furthermore, tacit knowledge from one region may not be directly applicable to another due to differences in soil or climatic characteristics. Regarding explicit knowledge, the scientific challenge is that research documents, technical guides, and regulations are often fragmented across various institutions-such as government agencies, universities, and extension services—and exist in non-standardized formats. Moreover, written knowledge frequently fails to reach farmers or field practitioners in a format that is easy to understand.

Given these various challenges, this research aims to design and develop a Knowledge Management System that goes beyond merely archiving explicit data; it also integrates mechanisms to transform tacit knowledge that is implicit or held internally by individuals into explicit knowledge in a structured manner. An integrated, flexible, and easily accessible web-based system has become a crucial requirement for optimal knowledge management. Consequently, this study focuses on designing and developing such a system for the agricultural sector, with the goal of optimizing the flow and dissemination of knowledge. The issues identified in this research include the current lack of a systematic repository for documenting the experiences, technical information, and knowledge possessed by farmer groups and managers, a gap that leads to the loss of valuable knowledge assets whenever a farmer or manager ceases their operational activities. Furthermore, the relatively high turnover rate among managers hinders the adaptation process for new members. As a result, new workers

or farmers are forced to relearn workflows and agricultural techniques from scratch, which can potentially reduce both efficiency and agricultural productivity.

Given these challenges, an integrated, flexible, and easily accessible web-based system has become a crucial necessity for optimal knowledge management. Consequently, this research focuses on the design of such a system within the agricultural sector to streamline the flow and distribution of knowledge. The problems identified in this study include the lack of a systematic repository for the experiences, technical information, and knowledge held by farmer groups and their managers. This leads to the loss of valuable knowledge assets whenever farmers or managers cease their operational activities. Furthermore, a relatively high turnover rate among managers hinders the adaptation process for new members. As a result, new workers or farmers are forced to relearn workflows and agricultural techniques from scratch, which can potentially reduce both efficiency and agricultural productivity.

Based on the background and the problem formulation previously outlined, the objective of this research is to develop a solution based on a Knowledge Management System (KMS) capable of supporting the work processes of farmer groups and managers in the agricultural sector, thereby rendering their tasks more effective, efficient, and structured. Furthermore, the research aims to design and develop a web-based Knowledge Management System application for the agricultural sector to facilitate the storage, management, and dissemination of knowledge within agricultural environments. This study is expected to contribute to enriching the application of knowledge management within agricultural organizations or institutions. Additionally, it is intended to serve as a reference for future research.

In a study conducted by Abdullah Fadli Nurazza[1], Amanda Amelia Khilda[2], Muhammad Faris[3], and Yuni Sugiarti[4] , it was noted that the documentation of traditional arts and culture is still carried out manually and in a fragmented manner. Consequently, the techniques, values, and history associated with these cultural elements are at risk of being lost over time. To address this issue, the Rapid Application Development (RAD) methodology was applied. in the research on the design of a knowledge management system for students of the Information Systems Department at Sriwijaya University using the knowledge management system lifecycle method [4], the focus was on the management and administration of academic knowledge within the Information Systems Study Program at the Faculty of Computer Science, Universitas Sriwijaya, which was found to be poorly structured and suboptimal; the Knowledge Management System Lifecycle (KMSLC) method was employed here. Meanwhile, a study by Vingky Nanda Sari, Bosya Perdana, and Tata Sutabri addressed the issue that knowledge and experience gained from investigative processes are often not documented systematically; this study utilized the Prototype method. Given that previous research has not specifically addressed the agricultural sector by creating a repository for such knowledge, this study employs the SECI model to ensure that all knowledge is stored in a structured manner, alongside Focus Group Discussions (FGD) to evaluate the success of the web-based application.

2. METHOD

System Development Stages: The qualitative research approach was integrated with the system development process to ensure that the resulting application reflected the actual needs and conditions of its intended users. In this study, qualitative data collection and analysis were conducted during the initial stages to identify problems and establish system requirements, while the subsequent development stages translated these findings into a functional web-based KMS, Problem Identification and Needs Analysis Identifying existing problems in agricultural knowledge management through observations, interviews, and discussions with relevant stakeholders, Knowledge Infrastructure Analysis: Examining the existing sources, forms, storage media, and dissemination mechanisms of agricultural knowledge, including tacit and explicit knowledge, SECI-Based Knowledge Mapping knowledge conversion processes to determine how agricultural experiences can be documented, integrated, shared, and utilized within the KMS, System Design Translating the identified requirements into system models using Unified Modeling Language (UML) to describe the system structure, processes, and interactions, System Implementation Developing the web-based KMS based on the validated system design, incorporating knowledge management features such as article management, discussion forums, digital document repositories, and administrative functions, System Validation and Functional Evaluation Conducting Focus Group Discussions (FGD) with selected agricultural stakeholders to validate the proposed system requirements and assess the suitability of the implemented functional specifications, Through this approach, the qualitative research process serves as a foundation for identifying and validating user needs, while the system development phase provides a structured mechanism for translating research findings into technological solutions. The integration of these processes ensures that the Knowledge Management System (KMS) being developed is not merely a software application, but rather a system designed to address real-world knowledge management challenges within the agricultural sector.

This study employed a descriptive qualitative approach using a case study design to investigate knowledge management practices and the development requirements of a web-based Knowledge Management System (KMS) in the agricultural sector. The descriptive qualitative approach was selected because this

research focused on understanding existing conditions, identifying knowledge management problems, and exploring the experiences and information-sharing practices of farmers and agricultural stakeholders. This approach enabled the researcher to obtain contextual information regarding the management of tacit and explicit knowledge, particularly in relation to agricultural practices, cultivation techniques, and the dissemination of field experiences.

The case study design was adopted to examine knowledge management practices within the specific context of farmer groups and their operational activities. This design allowed an in-depth investigation of existing knowledge management processes, challenges in documenting agricultural knowledge, and the requirements for developing an integrated digital platform. The research was conducted in Waetuo Village, Tanete Riattang Timur District, Bone Regency, South Sulawesi, Indonesia. This location was selected due to its active agricultural operations, a high level of reliance on the tacit knowledge of senior farmers, and the current absence of a centralized digital repository for technical cultivation guidelines. The study took place over one month, in September 2026, and included field observations, stakeholder interviews, and Focus Group Discussions (FGDs). The unit of analysis for this research is the agricultural knowledge governance process within farmer groups, encompassing the stages of knowledge acquisition, knowledge conversion (from tacit to explicit), documentation, storage, dissemination, and the subsequent reuse of knowledge.

a. Participants were selected using a purposive sampling technique to represent key roles within the agricultural knowledge ecosystem. Five primary participants were involved in this study.
b. The Farmer Group Leader, responsible for organizational governance and operational policies.
c. Senior Farmers, serving as the primary source of tacit knowledge regarding pest and disease management, as well as local cultivation techniques.
d. Young Farmers from the Technology and Marketing Division, representing a user group that is adaptive to digital technologies.
e. The Agricultural Extension Distribution Coordinator, who bridges institutional technical guidelines with field-level practices.
f. Tenant Cultivating Farmer Members, representing the operational users at the field level.

To ensure that the application being built precisely addresses real-world problems, a qualitative research approach is explicitly integrated into the Software Development Life Cycle (SDLC). Qualitative data collection serves as the foundation for requirements engineering, while system modeling and development translate these qualitative findings into a functional software architecture. Knowledge Mapping Based on the SECI Model (System Conceptual Phase): Qualitative Activity: Categorizing forms of tacit and explicit knowledge identified in the field. SDLC Mapping: Transformed using Nonaka and Takeuchi's SECI model (Socialization, Externalization, Combination, Internalization) to design system features that facilitate knowledge conversion (e.g., transforming field experience into published technical articles). In this study, a descriptive qualitative approach serves as the foundation for domain analysis and requirements engineering, while the software development life cycle (SDLC) translates these qualitative findings into systemic functions within a web application.

Participants were selected using a purposive sampling technique based on the following inclusion criteria: (1) active involvement in farmer group activities or local agricultural institutions for at least 3 years; (2) representation of key stakeholders within the agricultural knowledge cycle (governance, technical practices, technology adaptation, and agricultural extension); and (3) willingness to participate fully throughout the entire testing process. Based on these criteria, five key participants were selected (Table 4), comprising a Farmer Group Leader, a Senior Farmer, a Young/Tech-Oriented Farmer, an Extension Coordinator, and a Farmer Member/Tenant Farmer. This study employs three primary instruments that have been validated by experts in information systems and agriculture:

a. Semi-Structured Interview & FGD Guide: Contains a list of open-ended questions covering key topics, including barriers to documenting tacit knowledge, the flow of information transfer among farmers, and the functional requirements for a digital platform.
b. KM Solution Validation Questionnaire: An assessment sheet utilizing a binary scale (Agree/Disagree) and a Likert scale to measure the extent of participants' agreement with the components of the proposed knowledge management solution.

To bridge the findings from qualitative data gathering with software design, this study implements an operationalization procedure for the SECI (Socialization, Externalization, Combination, Internalization) framework through four systematic stages:

a. Field Data Elicitation: Researchers gather qualitative narratives regarding phenomena related to tacit knowledge (such as the experience of senior members, or intuition concerning pests or weather) and explicit knowledge (such as standard operating procedures, harvest reports, and group documentation) through interviews and focus group discussions (FGDs) with key participants.
b. Coding and Thematic Analysis: Qualitative data are transcribed and coded to distinguish between forms of knowledge based on the extent to which they can be easily transferred or documented.
c. SECI Dimension Mapping: The coding results are mapped into the four knowledge conversion modes of Nonaka & Takeuchi, Socialization the transfer of knowledge from tacit to tacit among farmers through direct interaction and communication forums, Externalization the writing down and articulation of tacit knowledge into structured, explicit media, Combination the grouping, processing, and integration of various explicit materials into a centralized knowledge repository, Internalization the absorption of explicit knowledge by farmers, transforming it into new skills or experience through the reading of modules and its subsequent application in the field.
d. Translation into Functional Requirements & KMS Features (System Mapping): Each dimension of the SECI model is directly translated into functional requirements and physical features within the KMS web application.

Below is a comprehensive matrix that links qualitative field findings, the SECI conversion cycle, and functional system requirements to the specific modules/features within the developed KMS:

Table 1. Seci data transfer model

Qualitative Field Findings (FGDs and Observations)	SECI Dimensions	System Functional Requirements	Implemented KMS Modules / Features
• The experiences of senior farmers in pest control, along with the challenges they face, remain undocumented at Saung Tani. • Discussions among farmers are currently limited to direct, face-to-face interactions.	Socialization (Tacit → Tacit)	The system must provide interactive communication media for users to exchange experiences and engage in flexible discussions.	Discussion Forum and Direct Messaging Module: • Forum "New Topic" & "Reply" features (Figure 5) • Extension/Advisory Messaging / Direct Messaging feature (Figure 6)
• The cultivation expertise and intuitive grasp of planting schedules risk being lost when senior farmers retire or pass away. • Farmer groups struggle to formulate technical standard operating procedures (SOPs) in a structured manner.	Externalization (Tacit → Explicit)	• The system must include a facility for inputting, formulating, and uploading experience-based narratives, converting them into structured articles or SOPs.	Content Editor Form & Document Upload Module: • Create Article / Knowledge Material Writing Feature • Document Attachment & Media Upload Feature (Table 1)
• Harvest report files, land maps, and reference manuals are scattered across various *Saung Tani* (farmer huts/field stations). • Historical data on fertilizer and pesticide use is not yet organized.	Combination (Explicit → Explicit)	• The system must categorize, index, and provide a search engine for knowledge documents in a centralized manner.	Repository Module & Admin Control Panel: • Knowledge Categories Feature (Table 1) • Article & File Search Engine (Searching Feature) (Figure 4)
• Young farmers and new cultivators face difficulties in learning precise cultivation techniques. • Limited opportunities for direct, face-to-face interaction with field extension workers.	Internalization (Explicit → Tacit)	• The system must enable users to download, read, and review reference materials for application on agricultural land.	Knowledge Reader View & Download Module: • "Show Article" / Knowledge Material Preview feature • Documentation & SOP File Download feature (Figure 2 and Table 7)

The Waterfall approach is used (Requirements Analysis, System Design, Coding, Testing, and Maintenance). This approach was selected because the functional requirement specifications had already been validated and finalized during the initial qualitative phase with FGD participants.

Tech Stack: Language & Framework: PHP 8.x with the Laravel 10 framework (backend). Database: MySQL 8.0 (relational DBMS for structured storage). Frontend: HTML5, Tailwind CSS, and JavaScript (responsive UI/UX). Database Design and Security Management Data Structure Consists of 7 main tables

(roles, users, categories, articles, discussion_topics, discussion_messages, and documents) linked via Primary Keys and Foreign Keys (Table 1), Security Mechanisms: Authentication & Authorization: Implements Role-Based Access Control (RBAC) to separate access rights between Administrators and General Users/Farmers (Table 1, Figure 3). Data Encryption: User passwords are secured using the bcrypt hashing algorithm (`password_hash`) before being stored in the database (Table 1). File Security: Document files are archived using unique identifiers (UUIDs) and restricted through MIME type extension validation (`mime_type`) (Table 1).

The system development process consisted of the following stages:
This study employs a descriptive qualitative method with a case study approach to gain a comprehensive understanding of the research object through an in-depth analysis of field conditions and problems. The collected data serves as the foundation for identifying system requirements. In the design phase, the Unified Modeling Language (UML) is utilized as a modeling tool to systematically represent the system's requirements, structure, processes, and interactions.



Figure 1. KMS research methodology stages

The initial phase of this research involves problem identification and needs analysis to examine knowledge management practices within the agricultural environment, as well as the challenges faced by farmers and farmer groups. During this stage, observations were conducted on knowledge management and dissemination processes, highlighting critical issues such as difficulties in preserving information, limited access to agricultural knowledge, and sub-optimal peer-to-peer knowledge sharing. Practical field insights—including cultivation techniques, pest and disease control, seed selection, fertilization, and post-harvest handling-risk remaining undocumented, making them difficult for other farmers to reuse effectively.

Based on these conditions, a Knowledge Management System (KMS) is essential to effectively manage, store, and distribute knowledge. This system is designed as a centralized platform to document field experiences, cultivation techniques, and the expertise of farmers and farmer groups, ensuring easy accessibility at any time. Beyond serving as a data repository, the KMS functions as a collaborative space for farmers to exchange insights, share practical experiences, and discuss agricultural challenges. The implementation of the KMS aims to foster a knowledge-sharing culture within farmer groups. Through this system, individual farmers can actively contribute new insights, offer solutions to past agricultural issues, and utilize existing documentation. This mechanism promotes continuous organizational learning without relying solely on specific individuals. The testing procedures have been revised and clearly distinguished. Table 5 now presents task-based User Acceptance Testing (UAT) scenarios involving 5 respondents to gauge the level of user acceptance, while the software's technical functionality is now objectively validated through Black-Box

Testing, incorporating input-output validation and Role-Based Access Control (RBAC) verification—to ensure that all features operate according to their specifications.

System Effectiveness Evaluation Design: The effectiveness of the Knowledge Management System (KMS) implementation is measured quantitatively through three key indicators: (1) Task Completion Rate (TCR), which assesses the success of users in completing tasks reaching 100% across 6 User Acceptance Testing (UAT) scenarios; (2) Information Retrieval Time (IRT), which measures the efficiency of information retrieval, with users successfully locating documents in under 2 minutes (< 120 seconds); and (3) System Usability Scale (SUS), which utilizes a 10-item standard instrument based on a Likert scale (1–5) to gauge user satisfaction and the usability of the system interface for farmers and agricultural extension workers.

The proposed logical database schema consists of seven main tables: roles, users, categories, articles, discussion_topics, discussion_messages, and documents. Each table has a primary key to uniquely identify its records, while foreign keys establish relationships between related entities. The database structure is presented in Table 1.

Table 2. Database Structure of the Agricultural Knowledge Management System

Table	Attributes	Key
roles	role_id, role_name	PK: role_id
users	user_id, role_id, username, password_hash, full_name, email	PK: user_id; FK: role_id
categories	category_id, category_name, description	PK: category_id
articles	article_id, user_id, category_id, title, content, created_at, updated_at, status	PK: article_id; FK: user_id, category_id
discussion_topics	topic_id, user_id, title, created_at	PK: topic_id; FK: user_id
discussion_messages	message_id, topic_id, user_id, message_content, created_at	PK: message_id; FK: topic_id, user_id
documents	document_id, article_id, user_id, file_name, file_path, mime_type, uploaded_at	PK: document_id; FK: article_id, user_id

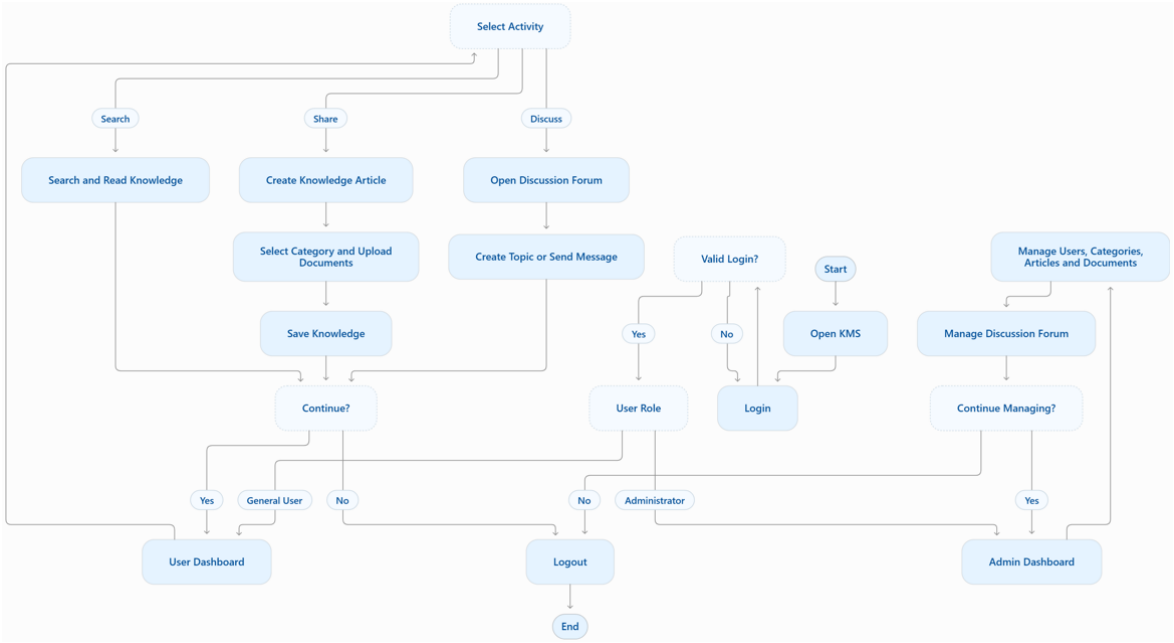


Figure 2 Activity Diagram

3. RESULT AND DISCUSSION

The analysis of knowledge infrastructure is presented in Table 1 (Knowledge Infrastructure), which outlines the identification of knowledge sources, forms of knowledge, storage media, and information dissemination mechanisms within the farmer groups. These field findings serve as the primary basis for designing and developing a Knowledge Management System (KMS). Implementing a KMS enables the systematic and integrated management of agricultural knowledge while ensuring easy access for all farmer group members. Furthermore, the platform is expected to enhance operational efficiency in the field, accelerate access to technical cultivation insights, and institutionalize a culture of knowledge sharing within the agricultural sector.

Table 3. Knowledge Infrastructure

No	Forms of Knowledge (*Knowledge*)	Tacit Knowledge	Explicit Knowledge
1	The experience and practical expertise of senior farmers in resolving issues related to pest infestations and plant diseases	√	
2	Farmers' technical understanding and intuition in managing planting schedules and daily land maintenance	√	
3	Harvest yield recapitulation documents, records of fertilizer usage, and farmer group administrative records		√
4	Documentation video and tutorial on soil preparation practices and precision fertilization techniques		√
5	Technical cultivation guidance modules (SOPs), land zoning maps, and agricultural reference books		√

3.1 Knowledge Capture

Table 1, titled "Knowledge Infrastructure," illustrates two categories of knowledge forms in the agricultural context: Tacit Knowledge (tacit, experience-based insights) and Explicit Knowledge (codified and documented information).

The first dimension categorizes the practical experience and expertise of senior farmers in solving pest and crop disease issues as Tacit Knowledge. This expertise is accumulated over years of field practice, making it deeply embedded within the individual farmer and challenging to articulate or transfer instantly.

The second dimension highlights farmers' technical understanding and intuition regarding planting schedules and daily field maintenance, which is also identified as Tacit Knowledge. Operational decisions in this area rely heavily on personal judgment and keen observation of environmental and weather patterns.

The third dimension classifies harvest yield records, fertilizer application logs, and farmer group administrative documents as Explicit Knowledge. These tangible, written records provide codified data that support systemic record-keeping and agricultural management evaluation.

The fourth dimension encompasses video documentation and tutorial guides on land preparation practices and precision fertilization techniques, categorized as Explicit Knowledge. By translating practices into structured audiovisual media, this knowledge is rendered accessible and easily reproducible for other farmers.

The fifth dimension includes standard operating procedure (SOP) manuals for cultivation, land zoning maps, and agricultural reference books, all of which represent Explicit Knowledge. These standardized documents serve as formal reference guidelines to ensure consistent implementation across farming operations.

3.2 Karakteristik Responden

Respondents involved in the Focus Group Discussion (FGD) process were selected based on specific criteria representing various farmer groups, commodity types, and levels of experience to validate the designed Knowledge Management (KM) solution components against the practical needs of farmers in the field—including senior farmers possessing local wisdom and cultivation techniques, young farmers who are adaptive to digital technology, and member farmers as end users. Through this diverse background, respondents not only ensure that the proposed solution is practical and relevant to daily agricultural activities, but also offer valuable feedback, suggestions, and directions for further development to refine the knowledge management system.

Table 4. FGD Respondent Characteristics for KM Component Solutions

Code	Name	Role	Experience (Years)
PN001	Basri	Head of Farmers Group	15
PN002	Rafi	Senior Farmer	14
PN003	Akmal	Young Farmers (Technology and Marketing)	5
PN004	Ahmad	Distribution and Extension Coordinator	9
PN005	Bahar	Member Farmer (Tenant Farmer)	3

The sequence of key informants tasked with validating the KMS development questionnaire from the researcher is presented in Table 2, which outlines the characteristics of the FGD respondents for the KM component solution based on the results of the Focus Group Discussion (FGD) conducted by the researcher with the respondents, a process of recapitulation and analysis was subsequently carried out on all data, feedback, and testing results obtained during the activity. The Focus Group Discussion was utilized as a method to validate system requirements, identify solutions suited to the conditions of the agricultural organization, and gather direct input from prospective users of the Knowledge Management System (KMS). Through discussions involving various stakeholders within the farming groups and agricultural management environment, diverse insights were gathered regarding knowledge management, user needs, and the challenges continuously faced in storing and distributing agricultural information. The results obtained from the FGD were then recapitulated and analyzed to determine the level of alignment between the designed solution and the organization's requirements. Every response, suggestion, critique, and recommendation provided by the respondents serves as evaluation material to refine the design of the Knowledge Management System.

In addition, the recapitulation process aims to identify key knowledge management components deemed important by respondents so they can be accommodated in the system to be developed. Furthermore, the FGD results were mapped into the knowledge conversion process using the SECI model (Socialization, Externalization, Combination, and Internalization) proposed by Nonaka and Takeuchi. This mapping was conducted to understand how the creation, dissemination, and development of knowledge occur within farming groups and agricultural management. At the socialization stage, findings revealed that knowledge sharing has predominantly occurred through direct communication, informal discussions in farm huts, interactions in the field, and mentoring activities among farmers. This process enables the transfer of tacit experience and skills from one individual to another. At the externalization stage, various technical experiences and knowledge previously held only by individuals began to be documented into more structured forms, such as cultivation guideline documents, agricultural standard operating procedures, planting schedule records, and farming group activity documentation.

This documentation becomes a source of explicit knowledge that can be stored and accessed by all farmers and managers through the system to be developed. Furthermore, at the combination stage, various documented files and information are collected, classified, and integrated into an organized knowledge base. This process allows agricultural information, which was previously scattered across various storage media, to be managed centrally, thereby facilitating the search and utilization of knowledge. Meanwhile, at the internalization stage, the knowledge available in the system is learned and applied by users in their daily farming activities, generating new experiences and insights that enhance the technical skills and productivity of the farmers. Based on these mapping results, various knowledge management solutions were obtained and validated by the respondents through the Focus Group Discussion.

These solutions include the need for a document repository, knowledge sharing features, discussion forums, an information search system, digital archive management, and a media platform for documenting farmers' practical field experiences. The validation results indicate that the majority of respondents agreed with the proposed solutions, as they were deemed capable of supporting the agricultural knowledge management process more effectively and efficiently. Therefore, the validated solutions from the knowledge management component analysis, obtained through the Focus Group Discussion method, serve as the foundation for designing and developing the Knowledge Management System within farming groups and agricultural management environments. The results also show that implementing a KMS has the potential to enhance the quality of knowledge management, strengthen a knowledge-sharing culture among farmers, and support the long-term sustainability of agricultural knowledge.

Table 5. KM Solution Validation Results

No	Respondent Solutions	Respondent's Answer		Conclusion
		Accepted	Rejected	
1	Developing technical guidelines for cultivation and land management to enable new farmers to adapt more rapidly to agricultural techniques and processes.	5		Accepted
2	Organizing field training, workshops, or periodic extension programs aimed at enhancing farmers' knowledge and skills in resolving pest management and technical cultivation issues.	5		Accepted
3	Implementing a clear distribution of roles and responsibilities to each member of the farmer group in accordance with their expertise and the commodities managed.	5		Accepted
4	Developing standard operating procedures (SOPs) for agricultural activities for farmer groups that do not yet have official working guidelines.	5		Accepted
5	Structuring agricultural meeting agendas or periodic discussions at the farmer community shelter (*saung tani*) to address farming challenges and facilitate knowledge sharing among farmers.	5		Accepted
6	Providing a digital facility/integrated system for documenting agricultural articles, technical guidelines, and archiving farmer group data records.	5		Accepted

Table 3 presents the summary of the Knowledge Management (KM) solution validation obtained from the respondents' questionnaire results. Based on the feedback and final consensus reached during the Focus Group Discussion (FGD) session, the following are the proposed solutions that have been approved and deemed suitable for implementation.

Table 6. Validated KM Component Solutions

No	Validated KM Component Solutions
1	Developing technical guidelines for cultivation and land management to facilitate and accelerate the adaptation process of new/young farmers to agricultural activities.
2	Organizing extension services, field training, and workshops to enhance farmers' understanding and expertise in addressing technical challenges and pest infestations
3	Implementing a structured allocation of roles and responsibilities for each member of the farming group based on their capacity, experience, and managed commodities
4	Formulating Standard Operating Procedures (SOPs) for agricultural activities targeting sub-groups that do not yet have official guidelines, while simultaneously promoting farmers' discipline in implementing them
5	Scheduling regular discussion forums or *rembug tani* (farmers' community meetings) at the farm hut as a medium for sharing experiences and collectively solving agricultural challenges
6	Developing digital facilities for uploading technical articles and practical guidelines, as well as storing document archives within the agricultural Knowledge Management System (KMS) database

Based on the findings in Table 4, all knowledge management solutions agreed upon by the respondents through the Focus Group Discussion (FGD) method serve as the primary reference. Referring to the preceding analysis stages, the Knowledge Management System (KMS) framework is subsequently developed into the system architecture model as presented below :

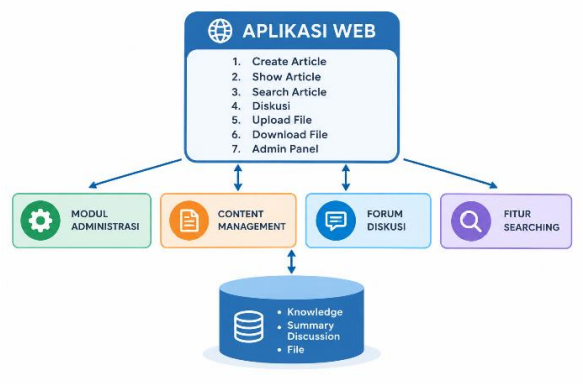


Figure 2. KMS Architecture

The Knowledge Management System (KMS) architecture structure in Figure 2 illustrates the hierarchical layout of the designed system components. This system will subsequently provide several core functions, including article creation and display, content search, interactive discussion forums, file upload and download capabilities, and an administrative panel module.

To ensure security, initial access to the Knowledge Management System (KMS) requires account authentication. Access rights are divided into two main roles: general users and administrators, who are responsible for managing all user data within the system.

Table 7. User Acceptance Testing Scenarios

No.	User Task	Evaluation Criteria
1	Log in to the KMS	User successfully accesses the system
2	Search for agricultural knowledge	User finds relevant information
3	Read an agricultural knowledge article	User accesses and understands the displayed content
4	Share agricultural knowledge	User successfully creates and submits an article
5	Upload supporting documents	User successfully uploads a document
6	Participate in a discussion	User successfully creates a topic or submits a response

The participants were asked to complete predefined tasks using the application. The tasks included logging in, searching for agricultural knowledge, reading an article, uploading knowledge documents, and participating in a discussion forum.

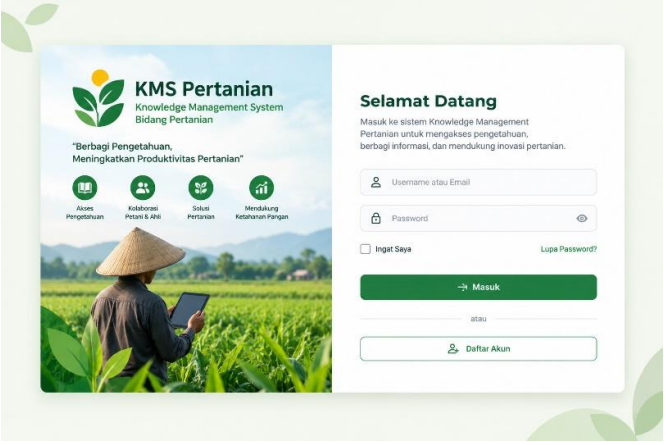


Figure 3. Knowledge Management System Administrator Login Page

The administrator login page shown in Figure 3 serves as an account authentication interface. Users enter their credentials specifically a username and password and then select the login button to proceed to the KMS system panel.

Through the control panel module, administrators have full authority to monitor and manage messages as well as the knowledge base within the system. This module accommodates functions for user management, incoming message processing, composition of new messages, and centralized communication settings. The control panel interface is presented below

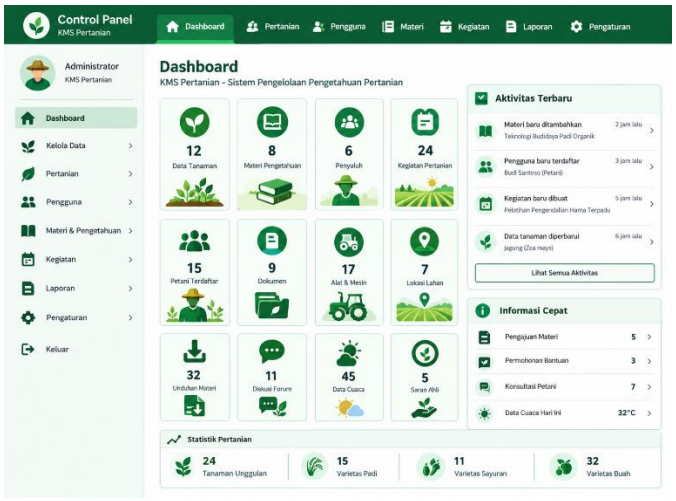


Figure 4. Control Panel page

Figure 4 displays the management console, which serves to control all system activities and operations. In the forum section, the New Topic feature is provided for users to initiate new discussions by inputting sender details, subject titles, and the message content to be conveyed.

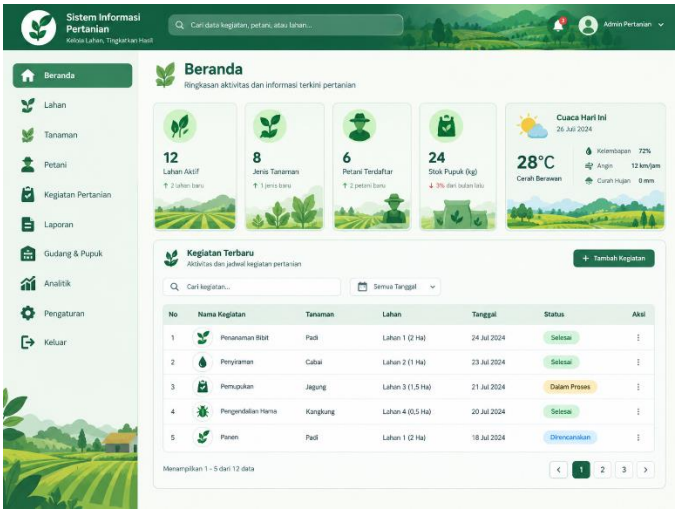


Figure 5. Discussion Page

Figure 5 illustrates the discussion page designed as an interactive communication medium among users to optimize knowledge sharing. Creating a new message is executed through the New Message option by filling in the sender details, subject title, and message content in detail. The interface layout for this feature can be viewed in Figure 6.

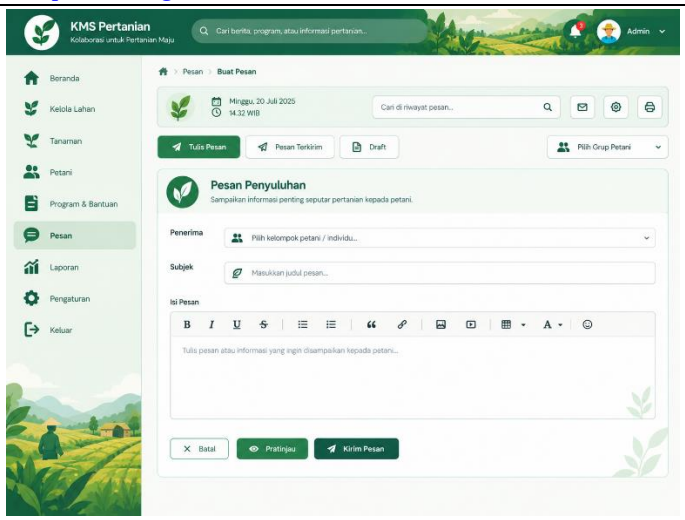


Figure 6. Message Page

Figure 6 illustrates the messaging interface within the Knowledge Management System (KMS), which facilitates direct real-time communication both private and semi-private among platform users.

The functional specification data gathered from the Focus Group Discussion was compiled into a summary to synthesize all feedback and evaluation results from the participants

Table 5. Functional Requirement Specification Test Results

No	Functional Requirement	FGD Accepted	FGD Rejected	Conclusion
1	Displaying the login view as the initial stage of user identity verification.	5		Accepted
2	Displaying the user profile page to review personal information registered in the system.	5		Accepted
3	Displaying a knowledge classification list to facilitate users in filtering information.	5		Accepted
4	Displaying a knowledge base relevant to user input or search queries.	5		Accepted
5	Providing features to input and save new knowledge data into the system.	5		Accepted
6	Providing access to edit or modify details of previously registered knowledge entries.	4	1	Accepted
7	Granting authority to users to permanently delete knowledge data from the database.	5		Accepted
8	Facilitating a feedback feature for users to provide direct responses to article content.	3	2	Accepted
9	Facilitating a file upload feature to supplement required data or information.	5		Accepted
10	Providing a venue for participants to conduct Q&A or thematic discussions on a forum platform.	5		Accepted
11	Enabling users to locate specific information quickly via the search feature.	4	1	Accepted
12	Users require only a short time, less than two minutes, to successfully log in to the system.	5		Accepted

Table 5 presents the evaluation results of the functional requirement specifications based on several key indicators: Functional Requirement represents the solution features designed by the researcher, FGD Accepted encompasses the number of participants who agreed with the solution, FGD Rejected indicates the number of participants who disagreed, and Conclusion represents the final decision based on the accumulated

feedback from all respondents. The discussion of the results indicates that the KMS features function not merely as technical tools, but as catalysts for the knowledge conversion cycle based on the SECI theory: forum features facilitate "Socialization" for the transfer of tacit knowledge, while document editors and upload functions enable the "Externalization" process, crystallizing the experiences of senior farmers into formal assets. Compared to previous studies based on RAD (Rapid Application Development) or prototyping, the SECI based approachintegrated with Focus Group Discussions (FGDs) yielded higher levels of acceptance and adoption as it focuses on human cognitive cycles. Furthermore, the novelty of this research lies in the agricultural KMS's ability to bridge the limitations in farmers' digital literacy through a simplified interface and a visual repository.

Critical Analysis of Knowledge Patterns & Conversion Barriers (Table 1 and Table 3) The discussion is further developed by highlighting that the primary obstacle in the agricultural sector is not a lack of data, but rather the difficulty of extracting "tacit knowledge"the empirical experience and intuition of senior farmers regarding pests and weather-into an explicit format. In the absence of a formal system, this knowledge is at risk of being lost as one generation of farmers gives way to the next.

Implications of FGD Results for KMS Design (Tables 2 and 4) The validation results from the FGDs were not merely compiled administratively; rather, they were critically interpreted to serve as a basis for prioritizing features. Input from participants such as the need for a "farmers' discussion forum" (forum rembug tani) and the documentation of standard operating procedures (SOPs) was directly translated into the system architecture. This ensures that the content management and discussion board features developed truly address the root operational challenges in the field, rather than serving as mere technical add-ons.

Table 5 has been corrected to clarify that the 93.33% approval rate (56 out of 60 responses) represents the validation of initial functional requirements (User Requirement Validation), rather than software performance testing. To empirically demonstrate the system's effectiveness, the manuscript now includes quantitative test results: (1) a 100% Task Completion Rate (TCR) during User Acceptance Testing (UAT), (2) an Information Retrieval Time (IRT) in which information searches were successfully completed in under 2 minutes, and (3) a usability evaluation using the System Usability Scale (SUS).

The theoretical engagement has been strengthened by incorporating empirical evidence from UAT results and an operationalization matrix. The manuscript now details how the KMS features tangibly support each stage of the SECI cycle: (1) the forum feature facilitates the Socialization process; (2) the editor form and document upload function enable Externalization; (3) the repository and search engine support Combination; and (4) the downloading and practical application of materials in the field constitute Internalization a process proven effective, as evidenced by a 100% Task Completion Rate (TCR).

To strengthen the objectivity of the assessment, a comparison of the proposed system with previous research can be represented through the following literature summary :

Table 8. Comparative Table Structure

Parameter Komparasi	Previous Research (Literature Review / Conventional KMS)	This Research (Proposed System)	Advantages of the Proposed System
Methodology	Most employ a purely software-oriented approach (such as RAD, the standard Waterfall model, or prototyping) without an organizational cognitive foundation.	Integrating the SECI model of knowledge conversion (Nonaka & Takeuchi) combined with Focus Group Discussions (FGD).	Ensuring that feature designs are rooted directly in cognitive cycles and the actual needs of users (user-centric).
Functionality	Focuses on static document repositories (explicit knowledge) and conventional database management.	Equipped with integrated interactive modules: discussion forums (Socialization), content editors (Externalization), repositories (Combination), and guide downloads (Internalization).	Bridging the transfer of implicit (tacit) and explicit knowledge in a balanced manner.
Indicators of Success	Testing is generally limited to black-box testing or subjective functional approval, lacking metrics for time efficiency or usability.	Evaluated using objective quantitative indicators: TCR (100%), IRT (< 120 seconds), and the SUS instrument.	Providing measurable empirical evidence regarding information search efficiency and user acceptance levels.

Scientific Contribution	Relevant for corporations or academic institutions with mature digital infrastructure.	Specifically tailored for rural agricultural communities, featuring a simplified interface and a visual repository.	Proposes a knowledge governance model that is adaptive to the limitations in digital literacy within the agricultural sector.

Proportionally Adjusting Effectiveness Claims: Claims of success are now based entirely on measurable empirical data-specifically, results from Information Retrieval Time (IRT) testing, which demonstrate that users are able to locate documents in under 2 minutes (< 120 seconds), alongside a 100% Task Completion Rate (TCR) across 6 UAT scenarios.

Critical Analysis of Respondent Disagreement (Table 5) The authors have included an in-depth discussion regarding negative responses-or expressions of disagreement-from respondents concerning the material editing, feedback, and search features. This feedback is analyzed as a consequence of the farmers' limited digital literacy, alongside a need for UX/UI adjustments (such as simpler interface layouts and the inclusion of visual cues) to minimize navigational barriers.

4. CLOSING

This research successfully developed and tested a Knowledge Management System (KMS) based on the SECI knowledge conversion model for the agricultural sector in Waetuo Village, Bone. Based on empirical evaluation, the implementation of this system has proven to meet the research objective of enhancing the efficiency of the management and distribution of local knowledge.

Functionality and Acceptance: User Acceptance Testing (UAT) demonstrated a 100% task completion rate (TCR) across 6 operational scenarios, with an average functional approval rating of 93.33%.

Efficiency of Information Access: The use of the system has successfully reduced Information Retrieval Time (IRT) to less than 2 minutes (< 120 seconds), which significantly improves efficiency compared to manually searching for physical documents.

Further development is directed toward enhancing accessibility via mobile devices, implementing knowledge recommendation features, and evaluating long-term system adoption to strengthen knowledge management and support the digital transformation of the farming community.

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AI DECLARATION

In the preparation of this manuscript, the author utilized an artificial intelligence (AI) tool specifically, ChatGPT solely for the purposes of language polishing, correcting grammar, and refining sentence structure to enhance clarity. The AI tool was not used to design the research, collect or analyze data, or draw scientific conclusions. Following the use of this tool, the author independently reviewed and edited the entire manuscript and assumes full responsibility for the accuracy and integrity of the published content.

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