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Empowering Agriculture: Unveiling the Paddy Knowledge Portal's User Requirements and Use Cases

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ABSTRACT

Agriculture, a pivotal sector sustaining human life, confronts diverse challenges that demand innovative solutions for enduring viability. Paddy cultivation, an integral facet of global agriculture, grapples with issues affecting productivity, sustainability, and economic feasibility. This paper underscores the significance of knowledge management in tackling these challenges and introduces the Paddy Knowledge Portal as a transformative tool. The Paddy Knowledge Portal, functioning as a centralised hub for rice cultivation information, caters to a varied audience, including farmers, researchers, and experts. Leveraging knowledge management principles, the portal facilitates the dissemination of best practices, research findings, and cutting-edge technologies. By encouraging active user participation, it cultivates a collaborative environment essential for continuous learning and growth. This paper discusses the user requirements and use cases for the knowledge portal. The user requirements were compiled from two primary sources: a literature review and direct stakeholder feedback. The delineation of user requirements and associated use cases serves as a valuable reference for researchers. The Paddy Knowledge Portal will emerge as a pivotal resource, contributing to the sustainability and resilience of paddy cultivation amid the dynamic landscape of agriculture.

1. Introduction

Agriculture is a vital sector that plays a crucial role in sustaining human life by providing food, fibre, and various raw materials. It involves the cultivation of crops, livestock farming, and other activities related to the production of food and agricultural products. Agriculture has developed dramatically throughout the ages, affected by technological improvements, environmental variables, and human requirements. Paddy cultivation is an integral part of the broader agricultural landscape.

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It exemplifies the diversity of crops, the importance of sustainable practices, and the cultural and economic dimensions that characterise agriculture worldwide. Understanding paddy cultivation enriches our comprehension of the intricate web of agricultural practices that sustain societies and contribute to global food security.

Paddy cultivation faces various challenges and issues that impact the productivity, sustainability, and economic viability of rice production [1,2]. Addressing these issues in paddy cultivation requires a holistic approach involving research and development, extension services, policy support, and the active participation of farmers and stakeholders. Sustainable and resilient agricultural practices are crucial for overcoming these challenges and ensuring the long-term viability of paddy cultivation. Knowledge management is relevant in the context of addressing issues in paddy cultivation. Applying knowledge management principles to paddy cultivation helps empower farmers with information, skills, and collaborative networks. This, in turn, enhances their ability to address challenges, adopt best practices, and contribute to the overall improvement of the agricultural sector. In today's fiercely competitive market environment, harnessing knowledge as a driver of innovation is paramount [3-6]. Consequently, knowledge portal-based application systems, such as the Paddy Knowledge Portal, play a fundamental role in the success of their organisational operations and strategies in diverse agricultural contexts [7,8].

The Paddy Knowledge Portal serves as a centralised hub for information and expertise concerning rice cultivation, catering to a diverse audience including farmers, researchers, agricultural experts, and the general public. Operating as a vital resource, the portal plays a crucial role in the widespread dissemination of knowledge within rice farming communities, offering a range of features and functionalities. As highlighted by Maidin *et al.,* [9], knowledge sharing is vital to support management and decision-making. These include the sharing of best practices, the dissemination of research findings, the presentation of innovative agricultural technologies, and the provision of practical advice. Users are encouraged to actively participate in discussions, share their experiences, and contribute insights, fostering a collaborative environment conducive to learning and growth. This paper discusses the Paddy Knowledge Portal and delineates the user requirements and associated use cases. The detailed presentation of these aspects serves as a valuable reference for fellow researchers in the field.

2. Literature Review

The importance of agricultural knowledge management cannot be overstated. In an era characterised by rapid population growth, climate change, resource constraints, and global food security challenges, the effective management of knowledge has become a cornerstone for the agricultural sector [10]. Agricultural knowledge management empowers farmers, researchers, policymakers, and stakeholders to make informed decisions, adapt to changing conditions, and drive innovation in farming practices [11,12]. It serves as a catalyst for improving crop yields, resource efficiency, and the overall sustainability of agriculture. The application of knowledge management in agriculture is transformative, leading to improved efficiency, sustainability, and innovation.

i. Best practices sharing [7,8,12,13]: Agricultural knowledge repositories and platforms facilitate the sharing of best practices among farmers. This includes techniques for soil management, pest control, irrigation, and crop rotation. By tapping into collective wisdom, farmers can make informed decisions and enhance their yields.
ii. Crop and soil monitoring [14,15]: Knowledge management systems integrate data from various sources, such as sensors and satellite imagery, to monitor crop health and soil

conditions. This real-time information empowers farmers to make precise decisions regarding irrigation, fertiliser application, and disease management.

iii. Research collaboration [7,16]: Knowledge management fosters collaboration among agricultural researchers and institutions. It enables the sharing of research findings, methodologies, and innovations. This collaboration accelerates the development of new crop varieties, pest-resistant strains, and sustainable farming practices.

iv. Market intelligence [17]: Agricultural knowledge systems provide farmers with market intelligence, including pricing trends, demand forecasts, and export opportunities. This information enables farmers to make informed decisions about crop selection and the timing of harvest.

v. Education and training [7,18]: Knowledge management platforms in agriculture often serve as educational hubs. They offer training materials, tutorials, and webinars that empower farmers with the latest agricultural knowledge and techniques.

Several knowledge portal models have been developed within the field of agriculture. These portals play a crucial role in facilitating collaborative engagement among a diverse range of agricultural stakeholders, with the primary goal of accumulating and sharing agricultural knowledge. By enabling the exchange and contribution of a wealth of agricultural knowledge, this model acts as a catalyst for promoting innovation, sustainability, and informed decision-making in the agricultural domain. Its overarching objective is to enhance the prosperity of farming communities and further the progress of broader agricultural initiatives.

A study by Van-Baalen *et al.,* [8] delves into the formation of networks of practice and the role of knowledge sharing through knowledge portals. It challenges the conventional belief that shared knowledge is a prerequisite for these networks and investigates how knowledge portals facilitate knowledge dissemination in loosely connected organisational contexts. The research is set in the Netherlands' agricultural industry, which is currently transitioning from product-oriented to problem-oriented innovation.

It uncovers that knowledge portals impact how projects exchange knowledge and contribute to the creation of networks of practice. The study underscores the significance of a sense of urgency and fragmented awareness, as well as the pivotal role played by knowledge brokers in these networks. The Van-Baalen *et al.,* [8] study also delves into the design and management of interactive information and communication systems for online knowledge exchange. It advocates for a relational and rich information system design that considers the triadic expectations of potential social networks. The design should offer diverse spaces for knowledge sharing, support different modes of communication, and dynamically adapt to evolving social profiles within the network. The study explores the role of knowledge portals in facilitating emergent knowledge processes, particularly in contexts where decentralised, open-ended technologies are utilized. The design of the knowledge portal is structured into three levels: project, platform, and public, each serving specific information-sharing purposes.

FisOmics, developed by the Centre for Agricultural Bioinformatics in India, is a knowledge portal dedicated to the fields of agricultural bioinformatics and agricultural biotechnology [19]. This portal serves the critical function of storing, analysing, and sharing data and research outcomes generated by biologists, thereby creating a structured and advanced electronic database. It offers a valuable resource for researchers in these fields, particularly in a country like India, where limited resources and funding often hinder research and development efforts. FisOmics' Home Page features a database encompassing diverse genomic information about fish, analyses, activities, and links to explore specific biological aspects of fish through documentation, publications, and related articles. The portal's audience extends beyond academics to include direct beneficiaries like fishermen, who

can access data about fish types and their habitats. However, despite its utility, FisOmics has room for improvement. Notably, it lacks information about the various departments, institutions, and agencies involved in agricultural bioinformatics and biotechnology in India, which is crucial for users seeking to establish direct contact with or assess the source of specific research activities.

Alemu *et al.,* [12] proposed the development of a knowledge management system (KMS) within the context of agricultural transformation. Three key social groups are identified: agricultural researchers, extension agents, and local farmers. Extension agents are highlighted as crucial knowledge brokers, playing roles that include facilitating communication between researchers and farmers, encouraging participation, building networks, and translating knowledge between scientific and local contexts.

The study also emphasises the concept of "boundary objects," which are artefacts that facilitate knowledge sharing among different social groups. In this research, the KMS is designed as a boundary object, using Web 2.0 tools to enhance communication and interaction among participants from diverse backgrounds. The shared KMS effectively promotes knowledge sharing and integration among agricultural researchers, extension agents, and local farmers, ultimately improving collaboration and the exchange of valuable insights in the agricultural development process. However, ensuring the long-term sustainability of the shared KMS boundary object remains a future research priority. Kumari and Rani [18] delve into the significance of e-KrishiShiksha, an e-learning platform for agricultural education in India. This e-learning portal has made substantial contributions to the advancement of India's agricultural research and extension programs. Notably, the study reveals that a majority of undergraduate students across various agricultural disciplines have registered for courses on the e-KrishiShiksha platform.

The e-KrishiShiksha portal acts as a vital tool for managing online courses in a wide range of agricultural fields, eliminating the need for physical distribution of course materials. Expert faculty from prominent agricultural institutions have developed course content in alignment with ICAR-approved syllabi. This accessible platform is available for academic staff, educators, students, and anyone passionate about agriculture and related fields, and registration is required for access. This study underscores the positive impact of e-KrishiShiksha on agricultural education in India, enhancing the reach and quality of education, and ultimately contributing to the improvement of the agricultural sector in the country.

Gardeazabala *et al.,* [16] explore the critical role of knowledge management in agri-food innovation systems (AIS). They introduce a novel framework called Agricultural Knowledge Management for Innovation (AKM4I) to address the limitations of existing agricultural knowledge management models. The study highlights the deficiencies in integrating innovation into these frameworks and focuses on rectifying this issue. AKM4I emphasises knowledge creation, acquisition, storage, integration, and analysis as essential processes for fostering innovation within the agricultural sector. The framework aims to facilitate more equitable, rapidly evolving, and actionable knowledge generation while considering practical and relational barriers. The research contributes significantly to our understanding of how knowledge management can drive transformative changes in the agri-food industry, making it a valuable resource for policymakers, researchers, and practitioners.

3. Methodology

In this study, requirements were compiled from two primary sources: an exhaustive literature review and direct stakeholder feedback. The literature review establishes theoretical foundations, revealing best practices and challenges, while stakeholder interactions offer a practical, real-world

perspective. The resulting requirements, derived from both academic insights and the genuine needs and expectations of agricultural stakeholders, undergo a rigorous categorization process.

The key stakeholders in this study include the MUDA Agricultural Development Authority (MADA), the Kedah State Department of Agriculture (DOA), and the Lembaga Zakat Negeri Kedah (LZNK). MADA oversees the granary region of Kedah, concentrating on efficient water resource management, infrastructure maintenance, and support for paddy farmers. DOA plays a central role in nurturing Kedah's agricultural sector, ensuring its expansion, sustainability, and adherence to agricultural practices, with a specific focus on regulating non-granary fields related to paddy cultivation. LZNK, the Kedah State Zakat Board, primarily concentrates on collecting and distributing Zakat for charitable and welfare activities, extending its role to support and uplift the welfare of paddy farmers in Kedah.

The identified requirements are categorised into three distinct groups: essential, desirable, and optional features. Essential features encompass non-negotiable elements crucial for the portal's core functionality, addressing the most pressing agricultural challenges. Desirable features, while not critical, enhance the user experience and overall quality. Optional features provide additional value and are considered based on available resources and the project scope. Prioritisation aligns with this categorization, ensuring focus on the most critical and impactful components essential for effective knowledge dissemination. This approach is to ensure that the resulting knowledge portal is not only technically robust but also intricately responsive to the specific and evolving demands of the agriculture domain.

4. Results

4.1 Requirements for Effective Knowledge Portals

Based on the literature review, the essential requirements for an agricultural knowledge portal are as follows:

i. Comprehensive content: A successful knowledge portal in agriculture should offer a comprehensive range of content that caters to the diverse needs of its users. This content includes information on crop cultivation, pest and disease management, soil health, market trends, and sustainable farming practices. Additionally, it should encompass various formats, such as articles, videos, webinars, and downloadable resources, to accommodate different learning preferences.
ii. Accessibility and usability: User-centric design is paramount. The portal should be accessible to users with varying levels of technological expertise. It should have an intuitive interface, clear navigation, and a responsive design that adapts to different devices. Usability testing and feedback from the portal's target audience can help refine its design for an optimal user experience.
iii. Search functionality: A robust search feature is essential for users to find specific information quickly. Implementing an efficient search algorithm and incorporating filters and tags can enhance the portal's usability. Furthermore, a well-organised taxonomy and content categorization system can aid users in discovering relevant resources.
iv. Interactivity and collaboration: Encouraging interactivity and collaboration among users is vital. Features such as discussion forums, chat support, and comment sections enable users to engage with one another, share their experiences, and seek advice. This collaborative environment fosters a sense of community and enriches the portal's content.

v. Regular updates: Agriculture is an ever-evolving field, and an effective knowledge portal must provide up-to-date information. Regularly updating content, including the latest research findings, emerging technologies, and market trends, ensures the portal remains relevant and valuable to its users.
vi. Data security and privacy: Safeguarding user data and ensuring privacy are paramount. Implement robust security measures to protect user information and maintain user trust.
vii. Scalability: As the portal's user base grows, it should be scalable to accommodate increased traffic and content. Scalability ensures that the portal remains responsive and accessible, even with a growing user community.
viii. Feedback mechanism: Implementing a feedback mechanism allows users to provide input, report issues, and suggest improvements. Regularly monitoring user feedback and making necessary adjustments demonstrates a commitment to meeting user needs.

4.2 User Requirement for the Knowledge Portal

Based on the discussion with the stakeholders, the functional requirements and the non-functional requirements of the knowledge portal are outlined in Tables 1 and 2. Within these tables, M denotes mandatory requirements that the system must meet, D represents desirable requirements that should be prioritised, and O designates optional requirements that can be implemented at the system's discretion.

Table 1
Functional requirements

No.	Requirement ID	Requirement description	Priority
	PKP_01	Public user registration.	
1.	PKP_01_01	Allows public user to register an account.	M
	PKP_02	Public user authentication.	
2.	PKP_02_01	Allows public user to login into website.	M
3.	PKP_02_02	Provides password reset option for public user's account.	M
	PKP_03	Public user view website's content.	
4.	PKP_03_01	Allows public user to access and view general information, tutorial, FAQ, and tips/tricks.	M
	PKP_04	Public user search website's content.	
5.	PKP_04_01	Allows public user to search, view and access general information, tutorial, FAQ, and tips/tricks.	M
	PKP_05	Public user submits questions to agencies.	
6.	PKP_05_01	Allows public user to view, ask, delete questions to selected agencies.	M
	PKP_06	Agencies registration.	
7.	PKP_06_01	Allows agencies to register an account.	M
8.	PKP_06_02	Send account registration approval authentication to admin via e-mail.	M
	PKP_07	Agencies authentication.	
9.	PKP_07_01	Allows agencies to login into website.	M
10.	PKP_07_02	Provides password reset option for agencies' account.	M
	PKP_08	Agencies manage general information.	
11.	PKP_08_01	Allows agencies to manage general information.	M
12.	PKP_08_02	Allows agencies to add information.	M
13.	PKP_08_03	Allows agencies to edit information.	M
14.	PKP_08_04	Allows agencies to delete information.	M
15.	PKP_08_05	Allows agencies to disable information.	M
	PKP_09	Agencies manage tutorial.	
16.	PKP_09_01	Allows agencies to manage tutorial.	M
17.	PKP_09_02	Allows agencies to add tutorial.	M

Table 1
Functional requirements

No.	Requirement ID	Requirement description	Priority
18.	PKP_09_03	Allows agencies to edit tutorial.	M
19.	PKP_09_04	Allows agencies to delete tutorial.	M
20.	PKP_09_05	Allows agencies to disable tutorial.	M
	PKP_10	Agencies manage FAQ	
21.	PKP_10_01	Allows agencies to manage FAQ.	M
22.	PKP_10_02	Allows agencies to answer FAQ.	M
23.	PKP_10_03	Allows agencies to add FAQ.	M
24.	PKP_10_04	Allows agencies to edit FAQ.	M
25.	PKP_10_05	Allows agencies to delete FAQ.	M
26.	PKP_10_06	Allows agencies to disable FAQ.	M
	PKP_11	Agencies manage questions	
27.	PKP_11_01	Allows agencies to view questions.	M
28.	PKP_11_02	Allows agencies to respond to questions by answering.	M
29.	PKP_11_03	Allows agencies to respond to questions by pending questions (KIV).	M
	PKP_12	Agencies manage tips/tricks	
30.	PKP_12_01	Allows agencies to manage tips/tricks.	M
31.	PKP_12_02	Allows agencies to add tips/tricks.	M
32.	PKP_12_03	Allows agencies to edit tips/tricks.	M
33.	PKP_12_04	Allows agencies to delete tips/tricks.	M
34.	PKP_12_05	Allows agencies to disable tips/tricks.	M
	PKP_13	Admin authentication	
35.	PKP_13_01	Allows admin to login into website.	M
	PKP_14	Account management ‘public user’	
36.	PKP_14_01	Allows admin to manage public users accounts.	M
37.	PKP_14_02	Allows admin to view public users accounts.	M
38.	PKP_14_03	Allows admin to add public users accounts.	M
39.	PKP_14_04	Allows admin to edit public users accounts.	M
40.	PKP_14_05	Allows admin to delete public users accounts.	M
41.	PKP_14_06	Allows admin to disable public users accounts.	M
	PKP_15	Account management ‘agencies’	
42.	PKP_15_01	Allows admin to view, add, edit, delete, and disable agencies accounts.	M
43.	PKP_15_02	Allows admin to approve account authentication by agencies.	M
44.	PKP_15_03	Allows admin to view agencies accounts.	M
45.	PKP_15_04	Allows admin to add agencies accounts.	M
46.	PKP_15_05	Allows admin to edit agencies accounts.	M
47.	PKP_15_06	Allows admin to delete agencies accounts.	M
48.	PKP_15_07	Allows admin to disable agencies accounts.	M
	PKP_16	Content management.	
49.	PKP_16_01	Allows admin to delete and disable public user’s responses.	M
50.	PKP_16_02	Allows admin to delete and disable general information.	M
51.	PKP_16_03	Allows admin to delete and disable tutorial.	M
52.	PKP_16_04	Allows admin to delete and disable FAQ.	M
53.	PKP_16_05	Allows admin to view, delete, and disable questions.	M
54.	PKP_16_06	Allows admin to delete and disable tips/tricks.	M
	PKP_17	Report generation,	
55.	PKP_17_01	Allows admin to generate, view and download report of public user and agencies details.	D

Table 2
Non-functional requirements

No.	Requirement ID	Requirement description	Priority
	PKP_18	Usability	
1.	PKP_18_01	The system should have an intuitive and user-friendly interface to facilitate easy navigation and interaction for both admins and users.	M
2.	PKP_18_02	The system should provide clear and understandable error messages to assist users and admin in troubleshooting issues.	M
	PKP_19	Performance	
3.	PKP_19_01	The system should respond to user actions in a timely manner, with minimal delay in loading pages or processing requests.	M
4.	PKP_19_02	The system should be able to handle a reasonable number of concurrent users without significant performance degradation.	M
	PKP_20	Security	
5.	PKP_20_01	The system shall ensure secure admin authentication and protect admin data from unauthorized access.	D
6.	PKP_20_02	The password can be re-entered 3 times. Once the admin fails to login 3 times, the admin will be unable to login within 15 minutes.	D
7.	PKP_20_03	The password shall never be viewable at the point of entry or at any other time.	M
	PKP_21	Reliability	
8.	PKP_21_01	The system shall operate reliably, minimizing crashes or system failures.	O
9.	PKP_21_02	The system shall have backup mechanisms in place to prevent data loss in case of unexpected incidents	O
	PKP_22	Scalability	
10.	PKP_22_01	The system shall be designed to accommodate potential future growth, supporting an increasing number of information.	O
11.	PKP_22_02	The system shall handle a growing database and support an expanding user base without significant performance impact.	O

The requirements for the knowledge portal are structured into three key actors: public users, agencies, and administrators, ensuring that the portal effectively serves its purpose of disseminating valuable agricultural knowledge.

4.2.1 Public users

Public users form the foundational user group of the knowledge portal. They typically include farmers, students, or anyone seeking information related to agriculture. The use case diagram is depicted in Figure 1. Their primary functionalities include:

i. Register: Public users can register accounts on the portal, allowing them to personalise their experience and access certain features.
ii. Login and change password: Once registered, they can log in to their accounts and change their passwords for security and personalisation.
iii. View: Public users can access and view various resources available on the portal, such as general information, frequently asked questions (FAQs), tutorials, and tips and tricks.
iv. Search: They have the ability to perform searches within the portal, making it easier to find specific information or resources.
v. Consult/ask questions: Public users can engage with agricultural agencies by asking questions or seeking consultations, enhancing their interaction with experts in the field.

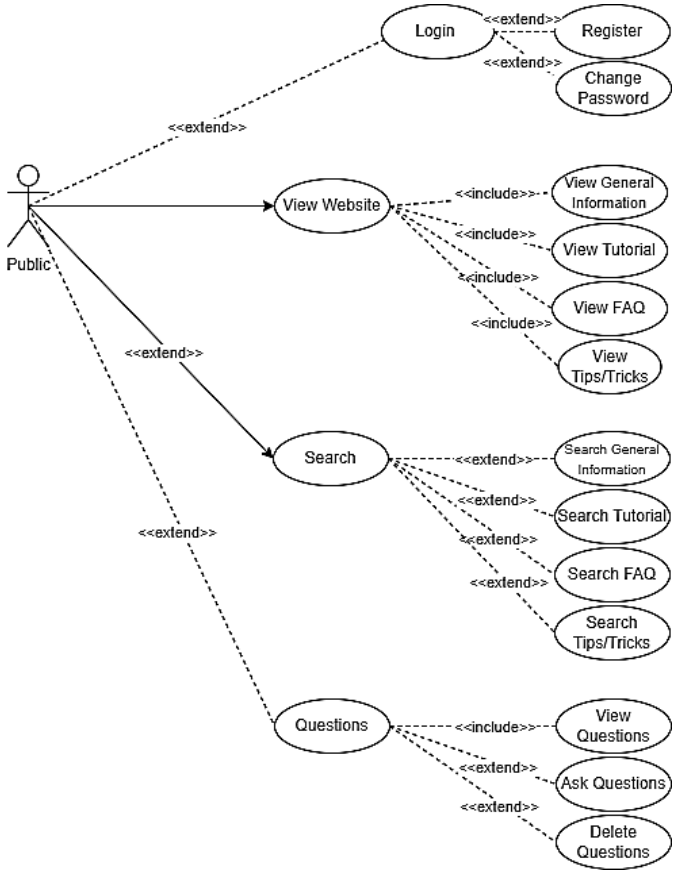

Fig. 1. Use case-public user

4.2.2 Agencies

Agencies play a critical role in contributing content and expertise to the knowledge portal. They often include governmental agricultural departments, research institutions, or agricultural experts. The use case diagram is depicted in Figure 2. Their functionalities encompass:

i. Signup/register: Agencies can sign up on the portal to provide their expertise and information. After registration, an email is sent to the admin for approval, ensuring the credibility of the agencies.
ii. Login and change password: Similar to public users, agencies can log in to their accounts and manage their passwords.
iii. General info: Agencies can manage their profiles, allowing them to add, edit, delete, or disable their general information to provide up-to-date insights.
iv. FAQ: Agencies can set up and manage FAQs, making it easier for users to find answers to common questions.
v. Tutorial: Agencies can offer and manage tutorials to educate users on various agricultural topics.
vi. Tips and tricks: Agencies can provide practical tips and tricks to assist users.
vii. Questions: Agencies can view user questions and respond to them, either by providing answers or marking questions as "KIV" for further consideration. This interaction helps users receive expert guidance.

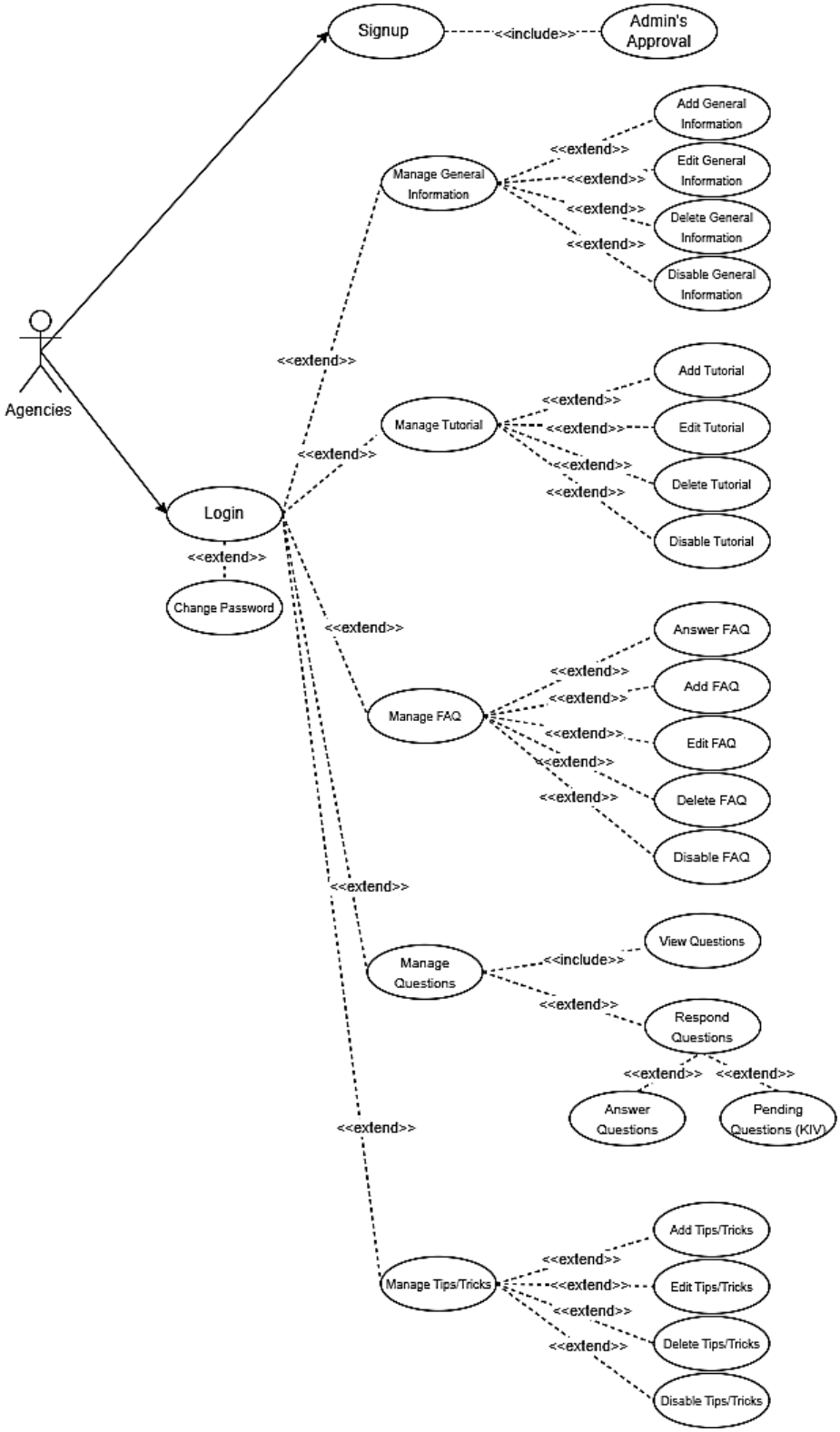

Fig. 2. Use case-agencies

4.2.3 Admin

The administrator serves as the central authority for managing and overseeing the entire knowledge portal. The use case diagram is depicted in Figure 3. Their functions encompass:

i. Login: Admins log in to access the portal's administrative functions, including user management and content oversight.
ii. Public users: Admins have control over public user accounts, allowing them to add, view, edit, delete, disable, or block these accounts as necessary.
iii. Agencies: Admins manage agency profiles, covering tasks like adding, viewing, editing, deleting, approving, or disabling them to ensure quality and relevance.
iv. Content management: Admins oversee the portal's content, which includes general information, FAQs, tutorials, and tips and tricks. They can delete or disable content when required.
v. Questions: Admins can manage user questions by deleting, disabling, or blocking users if needed, and viewing questions to monitor the portal's interactions.

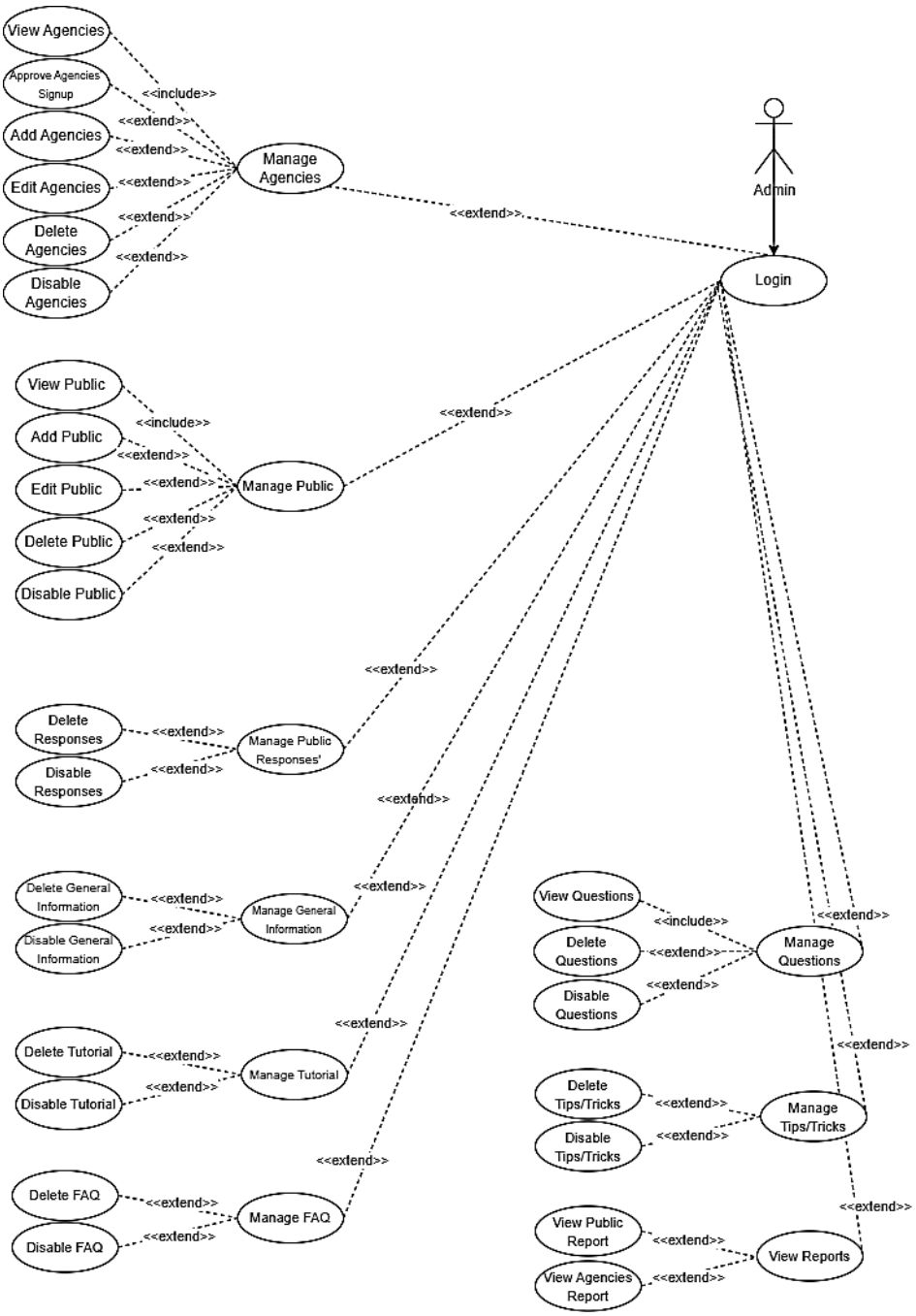

Fig. 3. Use case-admin

5. Conclusions

The proposed knowledge portal holds significant promise in addressing the multifaceted challenges faced by the agricultural sector in these nations, emerging as a pivotal tool for the widespread dissemination of agricultural knowledge, fostering collaboration, and promoting innovation. This comprehensive portal provides a myriad of benefits. Firstly, it empowers rice farmers by delivering up-to-date information and innovative techniques to enhance crop yields and overall farm management [7,20]. Concurrently, it cultivates a sense of community and collaboration among individuals passionate about paddy cultivation, facilitating the exchange of both traditional wisdom and modern innovations [8]. Furthermore, it serves as a channel through which researchers and experts efficiently disseminate their findings [10], ensuring that advancements in rice farming reach a broader audience in these nations. Additionally, it proves to be a valuable resource for policymakers and organisations dedicated to enhancing the sustainability and productivity of rice farming practices.

Over time, the Paddy Knowledge Portal has the potential to significantly impact rice farming communities, progressively enriching the collective knowledge base and facilitating the adaptation of the rice farming industry to evolving needs and challenges. As more users actively contribute and engage with the platform, it is poised to evolve and grow, ensuring that rice farming remains resilient and capable of meeting the changing global demands and environmental considerations ahead. Upon successful development, the portal holds the potential for integration with emerging approaches such as artificial intelligence, machine learning, and data analytics in the future. The diverse array of machine learning models [21] that leverage human knowledge [22] can significantly enhance the portal's capabilities. This integration is poised to offer predictive insights and advanced decision-support tools for farmers. To further enhance the user experience, the recommender system can be seamlessly integrated into the portal to deliver personalised recommendations [23].

Moreover, as digital technology plays an important role in various human activities [24], expanding the platform's accessibility is a priority. One of the strategies is a mobile application version of the portal. This initiative can be designed to cater to users who heavily rely on mobile devices, aiming to broaden the platform's reach and usability. Furthermore, as highlighted by Hua [25], mobile applications are essential for those who are constantly on the move. This becomes especially crucial in regions with limited access to traditional computing devices.

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