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A COLLABORATIVE KNOWLEDGE SHARING MODEL FOR STAKEHOLDER-DRIVEN DIGITAL KNOWLEDGE PORTALS IN PADDY FARMING

Fadhilah Mat Yamin[1], Wan Hussain Wan Ishak[2*], Noor Hidayah Abu[3], Zakirah Othman[4], Arif Imam Suroso[5], Febriantina Dewi[6], Lokita Rizky[7], Khariyah Kamilla[8], Hansen Tandra[9]

[1] School of Technology Management & Logistics, Universiti Utara Malaysia (UUM), Malaysia
fmy@uum.edu.my https://orcid.org/0000-0002-4735-029X
[2] School of Computing, Universiti Utara Malaysia (UUM), Malaysia
hussain@uum.edu.my https://orcid.org/0000-0003-0942-4339
[3] School of Technology Management & Logistics, Universiti Utara Malaysia (UUM), Malaysia
dayah@uum.edu.my https://orcid.org/0009-0000-8147-829X
[4] School of Technology Management & Logistics, Universiti Utara Malaysia (UUM), Malaysia
zakirah@uum.edu.my https://orcid.org/0000-0002-5307-2548
[5] Institut Pertanian Bogor Indonesia, Indonesia
arifimamsuroso@apps.ipb.ac.id https://orcid.org/0000-0002-4080-8106
[6] Institut Pertanian Bogor Indonesia, Indonesia
febriantinade@apps.ipb.ac.id https://orcid.org/0009-0009-6257-3502
[7] Institut Pertanian Bogor Indonesia, Indonesia
lokita.rizky@apps.ipb.ac.id https://orcid.org/0009-0005-6861-4484
[8] Institut Pertanian Bogor Indonesia, Indonesia
khairiyah-kamilah@apps.ipb.ac.id https://orcid.org/0009-0008-8532-9177
[9] Institut Pertanian Bogor Indonesia, Indonesia
hansen75tandra@apps.ipb.ac.id https://orcid.org/0009-0007-2820-4776
*Corresponding Author

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Abstract:

Knowledge sharing within paddy farming ecosystems remains constrained by fragmented information sources, limited accessibility, and weak coordination among stakeholders. While various digital agricultural platforms have been introduced, many fail to achieve sustained adoption due to unclear stakeholder roles and insufficient mechanisms for collaborative knowledge exchange. This study

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develops a Collaborative Knowledge Sharing Model (CKSM) to support stakeholder-driven digital knowledge portals for paddy farming. The research adopts a Design Science Research (DSR) approach involving problem identification, systematic literature analysis, stakeholder consultations, model development, and validation. Empirical insights were obtained through consultations with key agricultural organizations in Kedah, Malaysia, including the Kedah Department of Agriculture, the Muda Agricultural Development Authority (MADA), and Lembaga Zakat Negeri Kedah (LZNK), ensuring the contextual relevance of the model. The proposed CKSM consists of three integrated components: the Central Knowledge Hub (CKH) for structured knowledge storage and dissemination, the Stakeholder Collaboration Layer (SCL) for facilitating multi-stakeholder interaction and co-creation of knowledge, and the Monitoring and Feedback Mechanism (MFM) for continuous evaluation and improvement. Within a collaborative knowledge ecosystem, the proposed model also defines the roles of six stakeholder groups: farmers, agricultural agencies, research institutions, financial institutions, agri-tech providers, and community organizations. By integrating digital infrastructure with clearly defined governance and participation mechanisms, CKSM enhances knowledge accessibility, coordination, and collective learning within the paddy farming sector. The model provides a scalable framework for developing inclusive agricultural knowledge systems and supporting evidence-based decision-making in digital agriculture initiatives.

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Keyword:

Collaborative Model, Digital Agriculture, Knowledge Management, Paddy Farming, Stakeholder Engagement

Introduction

Paddy farming is a cornerstone of food security and rural livelihoods across much of Southeast Asia. Despite its critical role, the sector continues to face long-standing challenges, especially in how knowledge is generated, shared, and applied within the farming ecosystem. Many farmers still depend on informal, experience-based knowledge or unstructured advice from extension agents, with limited access to scientific research, financial support, or modern agricultural technologies (Ali, Man, & Muharam, 2019; Assefa et al., 2011). These knowledge gaps reduce farmers' ability to make informed decisions, leading to inefficiencies and lower productivity.

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In many regions, the agricultural knowledge landscape remains highly fragmented, with information dispersed across multiple institutions and often confined within organizational silos. As a result, critical knowledge rarely reaches farmers in a timely and usable form. The stakeholders including agricultural research institutes, government agencies, financial institutions, and NGOs tend to operate independently, with limited coordination mechanisms to support effective knowledge sharing and reuse (Abbas, 2016; Tumwebaze, Walsh, & Lannon, 2024). This fragmentation is further compounded by the absence of integrated governance–technology models that can align institutional roles with digital platforms, as well as the lack of stakeholder-driven design approaches that reflect the real needs of end users. Consequently, many existing systems fail to sustain meaningful collaboration and long-term engagement. Moreover, indigenous and experiential knowledge, which is critical for local adaptation, is frequently overlooked and insufficiently incorporated into formal agricultural knowledge systems (Ali & Avdic, 2015).

These issues are even more pressing in today's digital age. Technologies such as mobile apps, cloud-based platforms, and big data analytics offer new ways to connect stakeholders, share real-time information, and enable two-way communication (Petana & Rosa, 2020; Panitz & Glückler, 2024; Yamin et al., 2024). However, technology alone is not enough. Without a collaborative framework that clearly defines stakeholder roles and governance, digital initiatives risk becoming top-down, underutilized, or eventually abandoned (Chatterjee & Samanta, 2022; Ahmad & Karim, 2019). The success of digital knowledge systems in agriculture depends as much on stakeholder engagement and coordination as it does on infrastructure.

The idea of Collaborative Knowledge Sharing is central to overcoming these barriers. As noted by Alavi and Leidner (2001), knowledge management systems must go beyond data storage to support meaningful interaction. Amayah (2013) adds that trust, role clarity, and mutual benefit are key to effective sharing. In paddy farming, this means developing systems where farmers are not only recipients of knowledge but also contributors and validators, working alongside agencies, researchers, financial institutions, and NGOs through shared platforms with common goals.

This article highlights the importance of structured collaboration in knowledge sharing and introduces the Collaborative Knowledge Sharing Model (CKSM) as a strategic solution to these ongoing challenges. CKSM builds on the previously proposed Collaborative Knowledge Portal Model for Paddy Farming (Fadhilah et al., 2025), expanding its scope to include clearly defined stakeholder roles and interaction mechanisms. The model aims to enable co-creation, exchange, validation, and application of knowledge in a unified digital environment. By combining human expertise with digital infrastructure, CKSM supports evidence-based decision-making, reduces redundancy in knowledge delivery, and promotes inclusive development in the paddy farming sector.

Literature Review

A growing body of research highlights the importance of stakeholder collaboration in the design and implementation of agricultural knowledge systems. Rather than focusing solely on information dissemination, recent studies stress the need to actively involve multiple actors such as farmers, extension agents, researchers, financial institutions, and technology providers in the co-creation and validation of agricultural knowledge. For example, Bernardi et al. (2021)

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explored how community-based business models, when supported by shared knowledge practices, can promote more sustainable agricultural behaviors. Their study emphasizes the concept of knowledge as a shared resource, collectively managed by stakeholders, and offers a strong theoretical foundation for participatory governance.

The role of digital platforms in supporting multi-stakeholder knowledge sharing has also received increasing attention. Ali and Avdic (2015) proposed a knowledge management framework for rural development that recognizes the importance of tailoring knowledge to the specific needs of various actors. Their framework includes components for integrating local knowledge and encouraging community participation. However, their work focuses on rural development more broadly and does not address the unique challenges faced with paddy farming. This presents an opportunity to develop a more targeted model that reflects the high level of interdependence among stakeholders in the paddy sector.

In the context of public sector knowledge sharing, Amayah (2013) identified organizational trust and role clarity as key factors enabling effective knowledge exchange. This insight is particularly relevant in agriculture, where overlapping institutional responsibilities often hinder collaboration. Although Amayah's study was limited to a single public organization, its findings can be applied to broader, more informal agricultural networks. Incorporating these elements into the proposed model can help address structural barriers by making stakeholder engagement more explicit and systematic.

While digital transformation is often promoted as a solution to agricultural knowledge gaps, researchers such as Chatterjee and Samanta (2022) caution that technology alone is not enough. Their study on knowledge management tools showed that systems built without adequate human coordination risk being underused. This highlights the need for models like CKSM, which go beyond infrastructure to embed human-centered design principles, ensuring that stakeholders actively shape how knowledge is created, shared, and applied.

Additionally, Tumwebaze, Walsh, and Lannon (2024), in their systematic review of agricultural knowledge management, found that many initiatives lacked mechanisms for continuous feedback and real-time collaboration among stakeholders. Most systems focused on pushing information rather than supporting collaborative learning or adaptive decision-making. These gaps support the case for a dynamic, stakeholder-driven model like CKSM, where roles evolve based on feedback, usage, and changing agricultural conditions.

Methodology

This study adopts a Design Science Research (DSR) methodology (Brocke et al., 2020) to develop and validate the CKSM. The model aims to strengthen stakeholder engagement in agricultural knowledge management, with a specific focus on paddy farming. DSR was chosen for its iterative nature, allowing continuous refinement through phases that include problem identification, stakeholder engagement, model design, and validation. This approach ensures that CKSM is both theoretically grounded and practically applicable within its real-world context.

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Problem Identification and Literature Review

A comprehensive literature review was conducted to identify gaps in existing digital agricultural knowledge systems, particularly in areas lacking structured stakeholder engagement and inclusive feedback mechanisms. The review also evaluated the limitations of prior models, including our earlier work (Fadhilah et al., 2025; Ishak et al., 2026), which highlighted issues such as undefined stakeholder roles and passive knowledge flow. Additional studies (Chatterjee & Samanta, 2022; Tumwebaze et al., 2024) helped identify common challenges in agricultural knowledge management, including limited stakeholder ownership, low adoption of digital tools, and weak community involvement.

Stakeholder Engagement and Field Consultations

To ensure the model's contextual relevance, field consultations were conducted with key stakeholders in the paddy farming ecosystem in Kedah, Malaysia. Initial discussions were held with:

- Kedah Department of Agriculture – to understand knowledge-sharing practices in non-granary areas,
- Muda Agricultural Development Authority (MADA) – to gain insights into coordination and dissemination efforts in granary zones,
- Lembaga Zakat Negeri Kedah (LZNK) – to explore the role of funders and managers in estet paddy schemes and their perspectives on structured knowledge sharing.

These consultations involved semi-structured interviews and group discussions that helped surface challenges, identify knowledge gaps, and explore opportunities for improved digital collaboration.

Role Definition and Model Design

Based on feedback from field engagements, the CKSM was designed as a multi-layered model composed of three integrated components:

1. Central Knowledge Hub (CKH): A cloud-based repository that stores validated and categorized knowledge resources.
2. Stakeholder Collaboration Layer (SCL): A digital environment that enables stakeholders to interact, co-create, and exchange knowledge.
3. Monitoring and Feedback Mechanism (MFM): A system for capturing usage trends, collecting stakeholder feedback, and guiding ongoing model refinement.

Six stakeholder groups were defined that are farmers, government agencies, research institutions, financial institutions, agri-tech providers, and NGOs/community-based organizations. Each group was assigned with specific roles, responsibilities, and methods of engagement to ensure inclusivity and sustainability.

Model Validation and Feedback

To validate the CKSM, a second round of visits was conducted with the previously engaged stakeholders: Kedah Department of Agriculture, MADA, and LZNK. During these sessions, the full model structure, its components, and the defined stakeholder roles were presented.

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Open discussions followed to gather feedback, assess feasibility, and confirm alignment with operational realities. Stakeholder input played a critical role in refining the model to better reflect the practical workflows across granary, non-granary, and estet paddy areas.

Proposed Model: Collaborative Knowledge Sharing Model (CKSM)

The development of CKSM is grounded in the understanding that effective knowledge management in agriculture extends beyond content dissemination, requiring active collaboration and shared responsibility among stakeholders across the paddy value chain. Accordingly, CKSM proposes a multi-layered conceptual framework that facilitates structured knowledge exchange through stakeholder participation, supported by digital infrastructure, and iteratively refined through feedback mechanisms.

At the core of the model is a central digital platform (Knowledge Hub) that serves as a repository for validated information. Surrounding this hub are collaborative engagement spaces and moderation structures, which depend on the active involvement of key stakeholders, each with clearly defined roles and responsibilities.

The model identifies six primary stakeholder groups, each playing a distinct role in supporting sustainable and inclusive knowledge sharing:

- Farmers serve as both end-users and contributors, sharing local knowledge and field experiences while applying validated information in practice.
- Agricultural extension agencies and government departments act as facilitators, translating research into practical guidelines, supporting implementation, and moderating platform content.
- Research institutions contribute by generating new knowledge and validating existing practices, using real-world feedback to improve research relevance.
- Financial institutions and cooperatives provide education and digital tools to improve access to credit, insurance, and financial literacy, while also using data to offer customized financial services.
- Agri-tech providers are responsible for maintaining the digital platform, ensuring its usability, integrating real-time data (e.g., weather, pest alerts), and providing technical support.
- Non-governmental organizations (NGOs) and community-based organizations focus on inclusion, working to close the digital divide by supporting marginalized groups, promoting localized content, and building community trust.

Together, these stakeholder groups create a collaborative ecosystem that fosters engagement, transparency, and continuous improvement in agricultural knowledge systems. The CKSM promotes shared ownership of knowledge, making it more adaptable, scalable, and responsive to changing agricultural conditions. Table 1 provides a detailed overview of each stakeholder group, outlining their roles, responsibilities, and methods of engagement within the CKSM framework.

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Table 1: Stakeholders Role and Responsibilities

Stakeholder Group	Role	Responsibilities	Modes of Engagement
1. Farmers (End Users and Local Knowledge Contributors)	Primary beneficiaries and sources of local, experiential knowledge	Share field-level experiences, seasonal observations, and traditional practices- Participate in training and provide feedback- Apply shared knowledge and report outcomes	Access platform via mobile devices- Engage in peer-to-peer forums- Participate in surveys and feedback sessions
2. Agricultural Extension Agencies and Government Departments	Knowledge brokers and facilitators	Translate research into actionable guidelines- Monitor field-level implementation- Provide feedback to researchers and policymakers	Moderate discussion forums- Conduct virtual/on-site trainings- Upload policies, guidelines, and advisories
3. Research Institutions and Universities	Knowledge generators and validators	Contribute research findings and innovations- Contextualize research with extension agencies- Use farmer feedback to refine research	Upload summaries and guides- Host webinars and Q&A sessions- Collaborate on impact studies
4. Financial Institutions and Cooperatives	Financial enablers and risk managers	Share knowledge on financing, insurance, subsidies- Analyze data to develop financial products- Educate on credit access and repayment	Offer financial literacy modules- Use consented data to assess risks- Provide live chat/support for inquiries
5. Agri-Tech Providers and ICT Developers	Technology enablers	Design and maintain the platform and apps- Ensure usability and accessibility- Integrate real-time data (weather, pests, soil)	Conduct usability testing- Publish system updates and logs- Respond to technical issues
6. NGOs and Community-Based Organizations	Community facilitators and inclusion advocates	Train marginalized farmers in digital tools- Promote gender, youth, and indigenous inclusion- Mediate trust among stakeholders	Organize local workshops- Submit community feedback and assessments- Translate content into local languages/dialects

Figure 1 illustrates the proposed conceptual framework for a knowledge portal specifically designed for paddy cultivation. This portal functions as a centralized knowledge hub (CKH) that is one-stop reference center for paddy cultivation. Figure 2 presents the CKSM, which

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detailed the roles of various stakeholders and their interactions within the knowledge portal. The CKSM comprises three integrated components, each aligned with specific stakeholder responsibilities to ensure accountability and sustained participation:

1. Central Knowledge Hub (CKH) - This core component is a cloud-based repository that stores validated knowledge resources, including scientific research, policy guidelines, financial tools, and user-generated content.
2. Stakeholder Collaboration Layer (SCL) - A digital platform enabling stakeholders to interact, coordinate, and co-create knowledge through discussion forums, live sessions, and content review features.
3. Monitoring and Feedback Mechanism (MFM) - An analytical system that tracks engagement metrics, gathers stakeholder feedback, identifies knowledge gaps, and supports continuous improvement of the model.

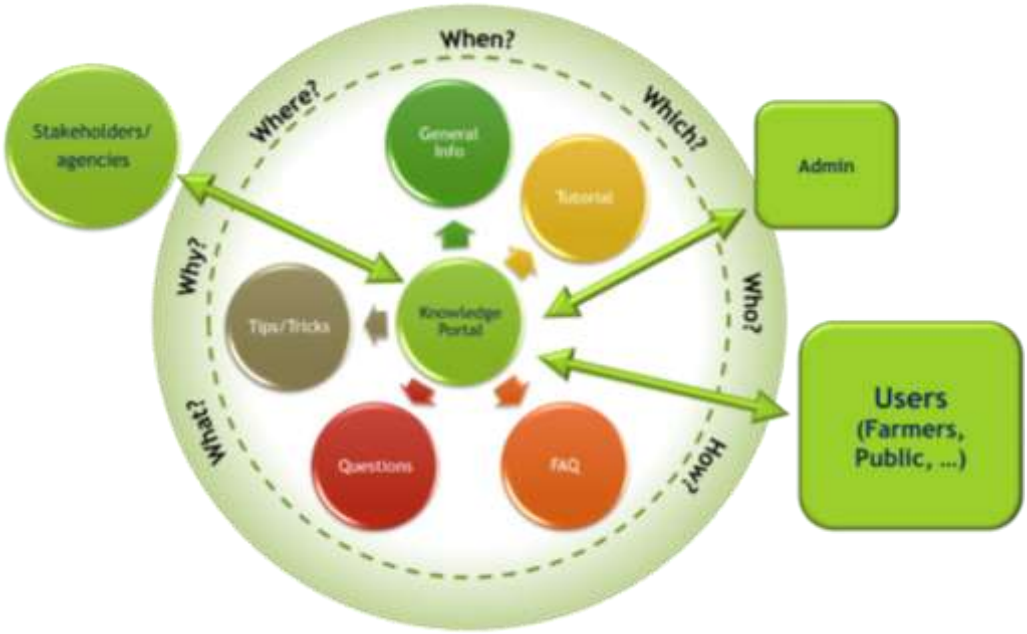

Figure 1: Conceptual Framework of Collaborative Knowledge Portal for Paddy Farming

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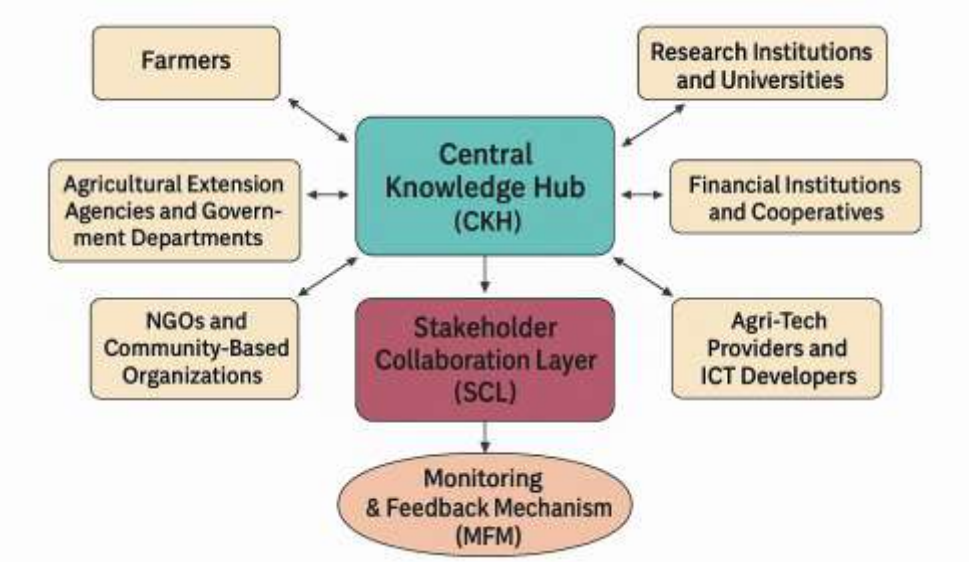

Figure 2: Collaborative Knowledge Sharing Model (CKSM) - Multi-layer Structure and Stakeholders Interaction

Discussion

The development of the Collaborative Knowledge Sharing Model (CKSM) addresses a critical gap in agricultural knowledge management—namely, the lack of structured stakeholder engagement within digital platforms. While earlier models focused primarily on centralizing information (Fadhilah et al., 2025), CKSM advances this approach by embedding clear stakeholder roles, responsibilities, and interaction mechanisms into the knowledge-sharing process. This ensures that knowledge is not only accessible but also co-created, validated, and continuously refined based on real-world use (Amayah, 2013; Ali & Avdic, 2015).

A key strength of CKSM lies in its multi-layered structure. The Central Knowledge Hub (CKH) consolidates validated content, providing farmers with reliable access to relevant agricultural knowledge (Ali, Man, & Muharam, 2019). The Stakeholder Collaboration Layer (SCL) facilitates dynamic engagement among diverse actors, enabling a two-way flow of information. This design recognizes farmers as active contributors, sharing local wisdom and adapting knowledge to their specific contexts (Assefa et al., 2011; Alavi & Leidner, 2001). Additionally, the Monitoring and Feedback Mechanism (MFM) supports continuous refinement of the model, which is essential to maintaining its relevance amid evolving environmental and market conditions (Tumwebaze, Walsh, & Lannon, 2024).

Validation feedback from key stakeholders—including MADA, LZNK, and the Kedah Department of Agriculture—confirmed the model's practical alignment with real-world workflows. These agencies valued the model's focus on shared accountability and noted its potential to reduce redundancy, enhance coordination, and strengthen relationships between farmers and agencies. However, challenges persist around digital inclusion, particularly for marginalized communities with limited ICT skills or access. In this regard, NGOs and community-based organizations play a crucial role, not only in facilitating access but also in translating and contextualizing information for local use (Ali & Avdic, 2015; Bernardi et al., 2021).

By integrating both technological and human elements, CKSM offers a governance-oriented framework that transcends traditional knowledge portals. It addresses shortcomings identified in previous studies where digital tools were deployed without sufficient human coordination, resulting in underutilization (Chatterjee & Samanta, 2022). Through aligning knowledge infrastructure with participatory mechanisms, CKSM promotes inclusivity, trust, and adaptability. This sets the foundation for adaptive knowledge systems that are not only informative but also participatory and resilient (Amayah, 2013; Panitz & Glückler, 2024).

Nonetheless, successful implementation will require sustained institutional support, robust digital infrastructure, and ongoing capacity building for all stakeholders. As CKSM progresses toward field deployment, monitoring its real-time impact and refining its governance mechanisms will be critical to ensuring long-term sustainability and relevance.

Conclusion

CKSM advances agricultural knowledge management by shifting the focus from one-way information dissemination to collaborative stakeholder engagement. By involving farmers, agencies, researchers, financial institutions, agri-tech providers, and NGOs within a structured digital ecosystem, the model fosters shared ownership, mutual learning, and inclusive decision-making. This positions CKSM as a scalable and adaptable solution to enhance agricultural productivity, sustainability, and resilience.

Future work will focus on developing a prototype digital platform based on the CKSM framework and piloting it within selected farming communities. This will enable empirical evaluation of usability, impact, and adaptability across diverse agricultural contexts. Ultimately, CKSM represents a promising step toward creating more equitable, effective, and collaborative knowledge ecosystems in agriculture.

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Ethics Statement: This study was conducted in accordance with accepted ethical research standards. The research involved consultations with stakeholders through interviews and group discussions. Prior to participation, all respondents were informed about the purpose of the study, and their informed consent was obtained. Participation was voluntary, and respondents were assured that their responses would be treated confidentially and reported anonymously. No personally identifiable information was disclosed, and all data collected were used solely for academic and research purposes.

Author Contribution Statement: All authors contributed significantly to the development of this manuscript. Fadhilah Mat Yamin and Arif Imam Suroso led the conceptualization, research design, and overall supervision of the study. Wan Hussain Wan Ishak was responsible for methodology development, modelling, and manuscript preparation. Noor Hidayah Abu and Zakirah Othman contributed to data collection, stakeholder engagement, and analysis. Febriantina Dewi, Lokita Rizky, Khariyah Kamilla, and Hansen Tandra supported the model validation process, and critical revision of the manuscript. All authors reviewed, revised, and approved the final version of the manuscript prior to submission.

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