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A Review of Chatbot development for Dynamic Web-based Knowledge Management System (KMS) in Small Scale Agriculture

R. J. Ong¹, R. A. A. Raof^{1,2}, S. Sudin^{1,2} and K.Y. Choong¹

¹School of Computer and Communication Engineering, Universiti Malaysia Perlis, Kampus Pauh Putra, Malaysia.

²Sports Engineering Research Centre, Universiti Malaysia Perlis, Kampus Pauh Putra, Malaysia.

E-mail : rafikha@unimap.edu.my

Abstract. Market data indicates that the average age of Malaysian farmers to be 50 years old and that the majorities are in the B40 group. Malaysia have so much of land with a small population of over 30 million compared with neighbours country and yet still need to import over 50 billion in food commodities annually to feed the nation. Small-scale farmers are having issues in communicating with each other and usually lack of Standard Operating Procedure (SOP) compare to industrial farming. An information sharing platform is prominent to disseminate information and knowledge between farmers especially for most of the young farmers who having issues when they newly start to involve in agriculture field. This paper is about to design and develop a framework of dynamic web-based knowledge management system with Chatbot application in order to utilize the information sharing platform to disseminate knowledge and build networks among small-scale farmers and related experts. Thus, information sharing and working together with a related expert will effectively improve both the quality and quantity of the product and also against the diseases on the spot.

1. Introduction

Hari Peladang, Penternak Dan Nelayan Kebangsaan (HPPNK) 2019 has been held in Johor Bahru from 28 November to 2 December 2019. This festival was first introduced by Tun Haji Abdul Razak, second Prime Minister of Malaysia since 6 August 1975. In 2019, the festival have recorded nearly RM30 millions transaction within 4 days of event [1]. This achievement shows that the economic value of Malaysia agricultural products and also with the festival's slogan "Our Foods, Our Future", again remind us how important agriculture mean for all Malaysians.

Minister of Agriculture and Agro-based Industry, Datuk Seri Salahuddin Ayub mentioned about farmers was one of the main contributors in economic Malaysia [2]. This sector has been the backbone of Malaysian economy since many years ago by producing agricultural products, as earner of foreign exchange [3]. However, there is a serious factor which the farmers' incomes are not sufficient to attract younger generation to involve in agricultural field, while the middlemen continue to make the most significant profits. Furthermore, pests and diseases are also common and persistent problems that hinder agricultural product [4].

Agriculture in Malaysia, in terms of food production, is in a neglected state and disorganized [5]. Market data indicates that the average age of Malaysian farmers to be 50 years old and the majorities are in B40 group. Malaysia population is expected to grow substantially year by year. Thus, Malaysia should be ready and attract younger generations to take part in agriculture development. There is good potential in agriculture development can be seen clearly where Malaysia still depend on about RM50 billions of food imported from all over the world [6].

Farmers need to learn constantly and seek for solution to run their farm more efficient. Recently, there is lots of knowledge from Information and Communication Technologies (ICT) has been contributed in agricultural field. There are many open resources all over the internet such as bloggers, websites and academic papers published from different university. In addition, some farmers also make use of social media like WhatsApp and Facebook to discuss farming matters. However, too many different platforms will make the lack of interest to follow [7].

This research is about creating a platform for farmers themselves and also expert in agricultural field to exchange information and forming a network to be joined by people who involved in agricultural development all over Malaysia. This platform will serve for several purposes. First, farmers can get to know each other and sharing their experiences. Secondly, farmers can easily approach the experts in agriculture in order to solve their problem and seek for recommendation. Thirdly, expert in agriculture can also working together with farmers in helping their own research and explore more possibility of agricultural products.

2. Literature review

In 2010, there are approximately 250, 000 productive farmers out of 600, 000 registered farmers all over Malaysia[8]. In other words, total number of registered farmers in Malaysia is less than 2% of total population (approximately 30, 000, 000) during 2010 and the number of farmers is continue to drop gradually year by year. In fact, Malaysia total population have been recoded 32, 365, 999 people in 2020. Hence, in term of food production and future development of agriculture will be a huge challenge.

Since when farmer is consider as one of the 3Ds job which mean dirty, dangerous and demeaning. Most of the youth will not consider farmer as their dream job and also many senior farmer not recommend their child to inheritance. In addition, farming is rarely portrayed in the media as a young person's game and can be seen as outdated, unprofitable and hard work. Growing youth unemployment, ageing farmers and declining crop yields under traditional farming systems mean engaging youth in agriculture should be a priority.

The domain expert should be able to create and manage the necessary information by the system, but it is not fair to expect farmers to have a high degree of technological or linguistic analysis skills [9]. Unlike industrial farming, small-scale farming usually lack of standard operating procedure (SOP) since most of the farmers are aging and absence of information sharing platform causing difficulty in knowledge exchange between senior farmers and newcomers.

At this point, the importance of Knowledge Management System (KMS) is obvious. Knowledge accessibility is becoming prominent as a consideration in this era of technology. A knowledge management system is a system that stores and retrieves knowledge to improve understanding, collaboration, and process alignment. Knowledge management systems can exist within organizations or teams, but they can also be used to focus the knowledge base on users or customers. It is an essential platform in all collaborative work, and helps to bind groups and communities together.

However, as mentioned earlier, most of the farmers in Malaysia are ageing which tend to not familiar and more difficult to accept new technologies. According to [10], Chatbot was highly recommended by a group of elderly in term of user friendly and easy to learn. Moreover, Chatbot is proved that able to soothe loneliness of elderly and willing to ask more to a virtual conversation agent.

A Chatbot is used for matching to give desired or predefined acknowledge. As mentioned in [11], Chatbot considered as a form of an information system. Chatbot application is an Artificial Intelligent (AI) computer program that impersonates human communication included text or spoken language

using a technique such as Natural Language Processing (NLP), image processing or video processing along with the end task completion as instructed by the user [12].

Chatbot simplifies the job by providing out of context information, streamline information, avoid repetitive work and help users by saving time and answering the questions that are hard to find. Therefore, Chatbot application has been designed to cater to a large number of users, in a cost-effective manner and overcome the irrationalities and erroneous decision caused by human behavior.

2.1. Chatbot application

Chatbot also known as “conversational agents” are software applications that are backboned on Artificial Intelligence, Machine Learning and Natural Language Processing. Chatbot will process human speech either in text or voice form, for the purposes of simulating a conversation or interaction with a real person. There are two primary ways Chatbot are offered to visitors: via web-based applications or standalone apps. Today, Chatbot are used most commonly in the customer service space.

A Chatbot is able to transport data from a computer in a simple way by searching for proper keywords to collect information. Pattern Matching is a technique of AI used in the design of a Chatbot [13]. The inputs are matched with the inputs saved in the database and the corresponding response is returned as the stage of compare string as shown in Figure 1. The program selects the closest matching response by searching for the closest matching known statement that matches the input, and then chooses a response from the selection of known responses to that statement.

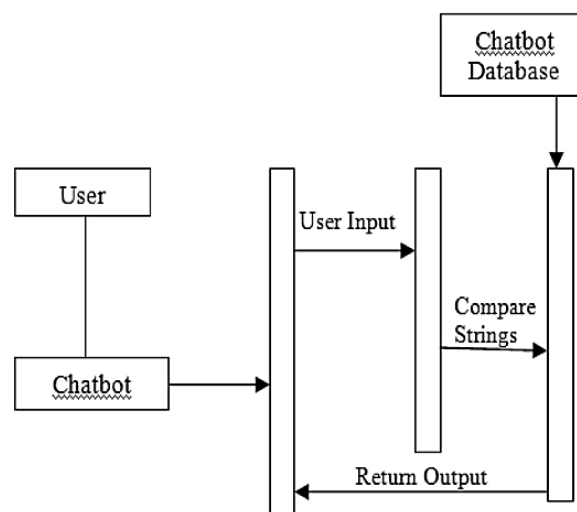


Figure 1 : Sequence diagram representing the design of a Chatbot [13]

A Chatbot is a domain-specific conversational interface that uses the messaging platform, social network or chat solution for the conversations. AI Chatbot can use NLP to create responses and conversations and actively learn from conversations they have with customers. NLP helps the computer to understand human language as it is spoken. For instance, NLP is applied to check spelling like Grammarly and Google search’s predictive typing helps in suggesting the next word. The efficiency and response time is improved by remembering previous commands [14].

2.1.1. Rule-based Chatbot

A rule-based Chatbot application is programmed with predefined rules such as pattern recognition, certain words or phrases. Once the rules are drawn up, the bot instantly understands all the languages supported by the engine. The advantage of these rules are more reliable and allow developers to build and remove rules for handling new situations and fixing bugs with certainty [15]. Rule-based Chatbot applications do not learn by interaction but can guarantee the user experience, whereas Chatbot based on Machine Learning (ML) is less reliable.

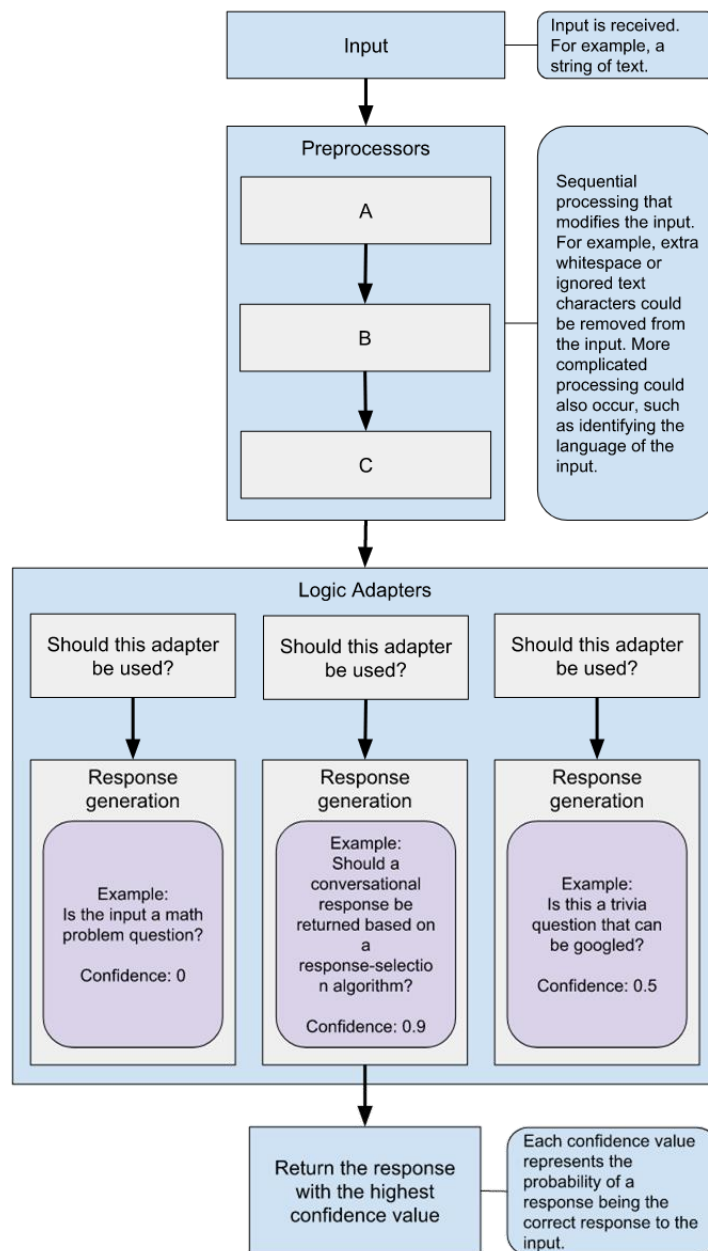


Figure 2 : Flowchart of Chatbot application

Pre-processors are simple functions that modify the input statement that a Chatbot receives before the statement gets processed by the logic adapter as shown in Figure 2. Logic adapters define the logic about how the Chatbot decides to reply to the input. Any number of logical adapters can be introduced into a Chatbot. When several adapters get used, the Chatbot will return an answer with the highest confidence value determined. When multiple adapters return the same credibility, the priority is being given to the adapter that is entered in the list first.

2.1.2. Machine learning Chatbot

In fact, ML-based Chatbot is not magically self-learning from a few sample questions or learning from every new sentence through interaction and getting better over time. The Chatbot application has no knowledge whatsoever of words and only sees character sequences. Hence, same as Rule-based

Chatbot application, the ML-based Chatbot application also need to spoon-feed every possible variation in the way a question can be worded.

ML-based Chatbot applications learn from information gathered and continuously improve as more data comes in. However, ML-based approach is more difficult to course-correct when things go wrong. In term of development cost, ML-based approach need to gather lots of character sequences until the Chatbot application learned and observed enough and abstract from original training sentences.

2.2. Knowledge management system (KMS)

Knowledge management system (KMS) has developed from a premature concept into a mainstream organizational necessity about three decades ago. It has moved beyond an academic theory to an essential component of organizational life. In general, KM is the process of creating, sharing, using and managing the knowledge and information of an organization [16].

In other words, KM is a way to provide effective help to user who search for the correct answer. KM is basically to spread and make knowledge accessible and usable within or between chosen organizations. So, in order to further understand about knowledge management (KM) there are three important terms should be keep in mind which are; knowledge transfer (KT), knowledge sharing (KS) and knowledge barrier (KB).

KT and KS are sometimes considered to be synonym. According to D. Paulin and K. Suneson [17], the authors clearly differentiate both terms into two separate concepts. KT is a fundamental process of information disseminate from one group of people into another while KS is a process that information sharing within a group of people. For example, the process of a teacher to teach knowledge to students in class is a process of KT. On the other hand, the KS process is when students have their own group discussion.

KB is usually due to lack of understanding about certain topic and how to implement the knowledge in an organizational setting. The knowledge gap between generations always causing difficulty in working together especially there is a newcomer in the group. Hence, KMS is essential platform to get the right knowledge to the right people at the right time and helping people share and put information into action to improve organizational performance.

2.2.1. WIIG model (1993)

WIIG knowledge management cycle introduce how knowledge is built and used by individuals or organizations. There are four stages of WIIG's model as shown in Figure 3. First, knowledge is obtaining from either primary or secondary knowledge sources and follows by storing the information in an easily retrievable format. Next, a knowledge management system should be used to ensure information sharing between groups of people so that knowledge to be useful and valuable for different perspective.

SUMMARY OF THE KEY WIIG KM CYCLE ACTIVITIES

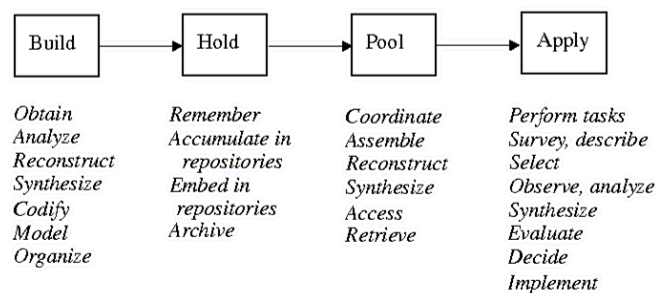


Figure 3 : Four stages of WIIG model

On the other hand, WIIG model also categorized people according to different degree of internalization as shown in Table 1. According to WIIG model, there are four characteristics to categorize people based on their knowledge: (1) completeness refers to how much relevant knowledge is available on specific topic; (2) connectedness refers to the well-defined relations between the different knowledge; (3) congruency is the alignment between the organization's objective and utility; and (4) purpose is to glean information from a particular point of view and increase relevancy to the user.

WIIG KM MODEL—DEGREES OF INTERNALIZATION

Level	Type	Description
1	Novice	Barely aware or not aware of the knowledge and how it can be used.
2	Beginner	Knows that the knowledge exists and where to get it but cannot reason with it.
3	Competent	Knows about the knowledge, can use and reason with the knowledge given external knowledge bases such as documents and people to help.
4	Expert	Knows the knowledge, holds the knowledge in memory, understands where it applies, reasons with it without any outside help.
5	Master	Internalizes the knowledge fully, has a deep understanding with full integration into values, judgments, and consequences of using that knowledge.

Table 1 : Degree of internalization

2.2.2. SECI model (1995)

The SECI model distinguishes four knowledge dimensions – socialization, externalization, combination, and internalization. Socialization is the process of sharing tacit knowledge through observation, imitation, practice, and participation in formal and informal communities. Externalization is the process of articulating tacit knowledge into explicit concepts. Combination is the process of integrating concepts into a knowledge system. Internalization is the process of embodying explicit knowledge into tacit knowledge.

As mentioned earlier there are two types of knowledge: the explicit knowledge which is knowledge that can be readily articulated, codified, stored and accessed while tacit knowledge which is the kind of knowledge that gained from personal experience that is more difficult to express. For instance, socialization refer to knowledge is share during the conversation between two or more person. This kind of knowledge may not easy to capture by the audiences and hard to store or document it. However, this kind of knowledge is good for initial stage or planning stage of a project because some new idea may get when someone is sharing experiences as shown in Figure 4.

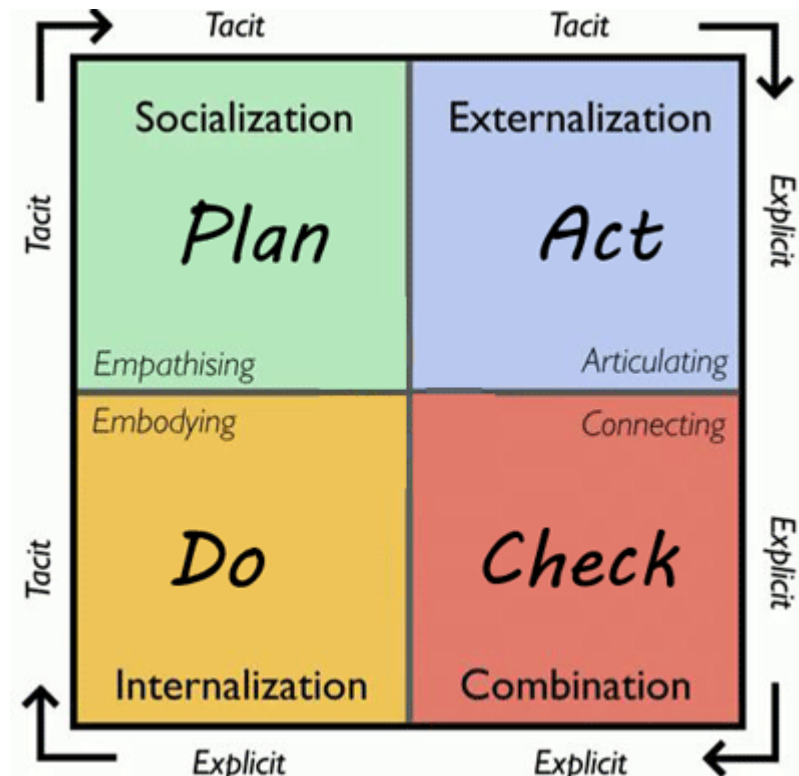


Figure 4 : SECI model of knowledge dimension [18]

2.2.3. Meyer and Zack model (1999)

Meyer and Zack introduce a knowledge cycle with various stages from information collection to conversion into usable knowledge have been enumerated as acquisition, refinement, storage, distribution and presentation or use as shown in Figure 5. In acquisition, the guiding principle is “garbage in garbage out” which mean the data capture needs to make sure the information is standardised and only comparable data. Refinement is the process of conversion of information into a format that helps storage and retrieval easily in the future. The process of distribution will be concern about the way and frequency that recipients will receive specific information. The final step will be how to make use of those information that have been processed.

Meyer and Zack



Figure 5 : Meyer and Zack model

2.2.4. Bukowitz and Williams model (1999)

Bukowitz and Williams model is about a strategic for organisations build and develop appropriate information sustainably. Figure 6 shows a schematic diagram the “Get”, “Use”, “Learn” and

“Contribute” stages. “Get” stage refers to an individual tries to get information to make decision or solve problems. In “Use” stage, information shall be collected by individuals or organizations in different ways to make the information usable. The new knowledge is learned to boost the competitive advantage so that the same mistakes are not replicated. The final "Contribute" stage is pursued for continuous updating of the database and repositories.

Bukowitz and Williams

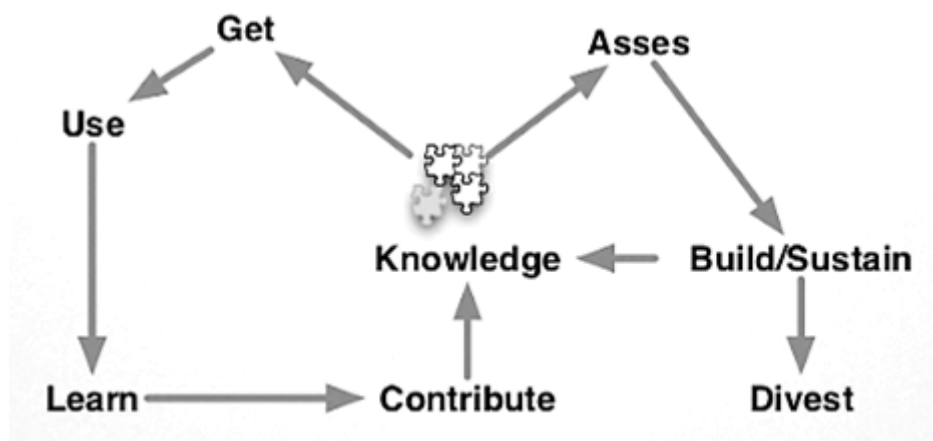


Figure 6 : Bukowitz and Williams model

Table 2 : Summary of Chatbot application literature review

	Authors	Title	Aim	Limitation	Method
1	Dahiya (2017)	A Tool of Conversation: Chatbot, International Journal of Computer Sciences and Engineering	This paper addresses the design and implementation of a Chatbot system.	1. Just a simple conversation Chatbot. (Task focus Chatbot should be developed for different domain) 2. Single language design.	Pattern matching
2	Nadarzynski, T., Miles, O., Cowie, A., & Ridge, D (2019)	Acceptability of artificial intelligence (AI)-led Chatbot services in healthcare: A mixed-methods study	This research aimed to explore participants' willingness to engage with AI-led health Chatbot.	1. The awareness and experience of task focus Chatbot were low amongst public. 2. User-centred and theory-based approaches should apply in Chatbot development in order to address user concerns.	Case study
3	Patil, K., & Kulkarni, M. S (2019)	Artificial intelligence in financial services: Customer Chatbot advisor adoption	The purpose of the paper was to examine what are the drivers for Chatbot advisor services adoption (CBA), focusing on financial services.	1. The study is limited to the Chatbot in the financial services sector in Pune and Pimpri Chinchwad area. 2. Conclusion might not be generalized to a larger sample.	Technology acceptance model (TAM)
4	Aggarwal, Jain, Khatter, & Gupta (2019)	Evolution of Chatbot for Smart Assistance	This study focus is on the smart software which takes input and performs pre-processing, processing on raw data	1. Chatbot must be straight forward. 2. Chatbot is not widely used for information distribution.	Natural Language Processing
5	Trivedi, J (2019)	Examining the Customer Experience of Using Banking Chatbot and Its Impact on Brand Love: The Moderating Role of Perceived Risk	This research looks at Chatbot as a form of an information system.	1. This study only focuses on banking Chatbot. 2. Information accessibility still poor in rural area.	Case study

6	Van Cuong, T., & Tan, T. M (2019)	Design and implementation of Chatbot framework for network security cameras	This paper present a Chatbot framework to help user get the human detection information from the cameras via Facebook messenger instead of observing 24/7 called Security Bot (Sbot).	1. Author expect to develop Chatbot which can process natural language processing and friendly with human in the future.	SSD-MobileNet
7	Yadav, D., Malik, P., Dabas, K., & Singh, P (2019)	FeedPal: Understanding opportunities for Chatbot in breastfeeding education of women in India	This study is about to understand the potential of Chatbot for breastfeeding education by conducting the Wizard-of-Oz experiment with 22 participants.	1. Information accessibility still poor in rural area. 2. Information reliability is a challenge.	Wizard-of-Oz experiment
8	Sarosa, M., Kusumawardani, M., Suyono, A., & Wijaya, M.H (2020)	Developing a social media-based Chatbot for English learning	This study aims to develop an application inside Facebook as an English learning media to help students learn English more efficiently.	1. No database in this design. (Knowledge is not manage properly) 2. Absence of discussion function. (User will lack of interest if facing problem)	Natural Language Processing
9	Sinha, Sharob Basak, Shyanka Dey, Yajushi Mondal, Anupam (2020)	An Educational Chatbot for Answering Queries	In this paper, authors show how to convert documents into the knowledge of a chatter robot.	1. The potential of Chatbot in knowledge transfer and knowledge sharing is omitted.	Machine Learning

Table 3 : Summary of KMS literature review

	Author	Title	Aim	Limitation	Method
1	John C. Spender (2015)	Knowledge Management: Origins, History, and Development	Discuss the challenges and the opportunities of implementing Knowledge Management.	There has been too much focus on technology, too little on knowledge.	Theory of the Firm (TOF)
2	Halim, E., Hsduwphqw, Q. V., & Halim, P. P (2017)	Indonesia medical knowledge management system A proposal of medical KMS	Proposing a knowledge management system prototype for medical record collection.	1. IT infrastructure requirement should be update (e.g. Wi-Fi coverage) 2. Data security 3. Data accessibility	SECI model
3	Masmoudi, A., Mezghani, E., Bellaaj, H., Drira, K., & Jmaiel, M (2017)	A web-based knowledge management system for scientific research team	Knowledge management system offers an annotation service for researchers' contributions by including some natural language processing techniques.	1. Existing knowledge management system seldom provides task classification. 2. Knowledge reuse practice is omitted.	1. Natural Language Processing (NLP) 2. BabelNet
4	Pierce, Heather H. Dev, Anurupa Satham, et al. (2019)	Credit data generators for data reuse	Promote effective sharing and create an enduring link between people who generate data and its future uses.	1. Knowledge sharing and data reuse practice is omitted.	Virtuous Cycle
5	Rafflesia, S. P., Pamosoaji, A. K., Nurmaini, S., Firdaus, & Lestarini, D (2019)	Conceptual Modeling for Intelligent Knowledge-Based System in Agriculture: Case Study of Indonesia	Proposed an intelligent knowledge- based model which can support the current IT-based agricultural information dissemination in Indonesia.	1. Single language system design 2. Data accessibility	1. Geo-fencing technique 2. Machine learning
6	Science, E (2019)	Development of KMS to support quality shoes production	Create a knowledge management system in the shoes production section.	1. SQL database is used. (Data schema is fixed and not allow horizontal scaling unless using middleware but the system will more complex and less stable)	1. Knowledge Management System Life Cycle (KMSLC) 2. Black box testing

7	Soleh, O., Wuryani, R., & Mahmudi, T. H (2019)	Semangka is an Islamic Study Information System Application as a Real-Time Information Sharing Media for Muslims Semangka is an Islamic Study Information System Application as a Real-Time Information Sharing Media for Muslims.	Solve the problems faced by the pilgrims and the community to obtain information about the activities to be held.	1. SQL database is used. (Data schema is fixed and not allow horizontal scaling unless using middleware but the system will more complex and less stable)	1. Business Canvas (BMC) 2. Unified Modelling Language (UML)
8	Martínez-Sastre, R. García, D. Miñarro, M et al. (2020)	Farmers' perceptions and knowledge of natural enemies as providers of biological control in cider apple orchards	1. Fostering traditional farming systems that contribute to preserving local ecological knowledge of biological control. 2. Establishing networks of farmers so they can learn from each other and share local knowledge.	1. Absence of local knowledge sharing platform 2. Traditional farming knowledge should be utilised and disseminate to the public through Information Technology.	Case study
9	Wan Mohd Rusydan Wan Ibrahim et al. (2020)	The roles of ICT for Knowledge Management in Agriculture	Advancement of ICT especially in mobile device and internet connectivity can help the Knowledge Management in agriculture sector.	1. Knowledge management practice in Malaysia agriculture field is limited. 2. Too many different App will make the lack of interest to follow. (One-stop solution should be provided)	Case study

2.3. The gap in the existing knowledge

In Wan Mohd Rusydan Wan Ibrahim et al. [7], stated that knowledge management practice in Malaysia agriculture field is limited. For example, new workers have trouble learning about the method used in manufacturing. Thus, in the agricultural field, most of the farmers are aging in Malaysia and all their experiences and knowledge are not well documented and absence of an information sharing platform so that young farmer can learn from them. In addition, numbers of authors mentioned that knowledge sharing and data reuse practice is omitted.

On the other hand, according to S. Sinha et al. [19], the potential of Chatbot in knowledge transfer and knowledge sharing is omitted. Also, information accessibility still poor in rural area and information reliability are a challenge.

2.4. Conclusion

Information technology is useful for an application to provide accessibility to the public so that interaction between organizations and the public can be effected virtually through the web-based information sharing platform. As mentioned earlier, the transfer of employees from one part to another cause a loss of knowledge from experienced employees before knowledge has been properly stored and documented. In addition, new employees also have difficulty in learning the used process in production.

Owing to the huge number of species observations that can be collected by non-professional scientists “citizen science” has great potential to contribute to scientific knowledge on invasive alien species (IAS). Therefore, a web-based interface for citizen training and data generation has led to a massive surge in popularity, mainly due to reducing geographic barriers to citizen participation. As mentioned earlier, a web-based information sharing system is an absence in Malaysia agricultural field in order to build network among farmers and related expert.

This paper is discussing the importance of a framework of web-based knowledge management system with Chatbot application in order to utilize the information-sharing platform to disseminate knowledge. Based on the research above, a web-based information sharing platform is proposed by involving a database with Python using MongoDB. All data or information collected will be stored in the database and classify by applying data segmentation technique. Additionally, an rule-based Chatbot application is implemented by involving NLP, sorting algorithms and searching algorithms in order to make the user convenient when interacting with the Chatbot and looking for information

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