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SMS-Based ICT Tool for Knowledge Sharing in Agriculture

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***Abstract*— Agriculture is the world's major industry with 60% of the global population depending on it. Being the major source of livelihood, agriculture is challenged by issues such as food shortage, food security problems, climate change affecting crop yield, land degradation, decrease of crop varieties and others. There is a huge amount of knowledge products generated by the government agencies, local universities, private civic groups, local government units and non-government organizations (NGOs) to address these issues however the information has difficulty reaching the intended farm practitioners as end-user. With this aforesaid challenge, a technology based information sharing and access among stakeholders such as agricultural knowledge experts (academe) and knowledge end-users (farmers) is a dire need. Information and Communications Technology (ICT) has always been an indispensable tool that can provide an environment where knowledge generators and knowledge users can use to exchange information any time and place. Retooling and scaling up the process how information and knowledge products is being accessed and shared is indeed a critical consideration. Using descriptive research and qualitative approach, this study determined an ICT tool, a managed SMS-based system to be highly acceptable to the identified stakeholders as an information sharing medium and model and is therefore recommended for use. The result of this research shall serve as an implementation guide for government, non-government organizations(NGOs), extension service providers, system integrators, researchers, and other related groups offering or planning to engage in similar service.**

***Keywords*— knowledge exchange and sharing; ICT tool in agriculture; short messaging system; SMS; text messaging.**

I. INTRODUCTION

Agriculture is the world's major industry contributing one-third of gross-domestic-product (GDP) to the global economy [1] with sixty percent of the global population depends on it for livelihood [2]. Agriculture is challenged by various factors such as climate change, global warming, land degradation, and other related factors. In the Philippines, 11.29 million out of 38.74 million workers are employed in the agriculture sector [3]. The Cordillera Administrative Region (CAR) has 51.9% of its population (365,000 out of 759,000) employed in agriculture. Countrywide, CAR is producing more than 83% (262,283 metric tons) of major crops such as cabbage, carrots, and potatoes among others [4] making it a major producer of various vegetables supplying markets in neighboring communities including Metro Manila, Visayas, and the Mindanao provinces.

A. Background and Motivation

As major stakeholders in agriculture, it is a challenge for knowledge experts (KE) as well as farmers to access and share critical information as input to the maintenance of the agri-based economy. These include pest and disease control and management, crop management, fertilizer management, farm inputs management, price information, climate change mitigation measures, and other related information. Government agencies, local universities, local government units and NGOs as knowledge generators have initiated ICT systems including Knowledge Sharing Systems (KSS) such as social media, websites, mobile apps, digital libraries, and radio programs among others to address these issues. Most of these initiatives, however, are not progressive because farmers are not exposed with these technologies and besides, it requires technical skills, ICT equipment, decent internet connectivity, and a good ICT infrastructure support for it to work [5]. While media reported that the Philippines has the slowest average internet speed in the Asia Pacific region

with only 5.5 Mbps speed [6], it has an explosive growth for cellular phone service subscriptions totaling to 130,319,459. Among these subscriptions are farmers engaged in using cell phones for communication, access and sharing information through Short Messaging System (SMS) [7]. Despite its known limitation over other media, SMS is still the most practical, cheap, and highly available technology to share and exchange knowledge and ideas [8]-[11] not only for developing countries. Thus, this study aimed to find out how knowledge experts could use this same technology in knowledge sharing (KS).

B. Related Work

There is no shortage of knowledge in the horticulture sector. It has faced problems on recording, organization, and handover of huge knowledge database to the agronomists, that is, ultimate consumer [12]. KM is getting the correct information before the right individuals at the ideal time [13]. ICT have assumed the key part in the process of agrarian KM particularly in extension service delivery [14] and have demonstrated its value through the diverse small scale projects [12] that utilizes different strategies and procedures. ICT improves knowledge sharing by bringing down temporal [15]-[17] and spatial hindrances between knowledge specialists [15] and enhances access to information about knowledge [15], [16]. It upgrades the dissemination of explicit and tacit knowledge [18], and it enhances food security [19].

KS is the urgent action of successful KM [13] that support the process through which explicit or tacit knowledge is imparted to different people through a KSS utilized by communities of practice [20]. It has socialization and exchange as its sub processes [20]; has key drivers of interest in sharing information [12] and financial rewards [21], [22]; and has significant barriers of lack of trust and lack of time [22]. Amongst the illustrative KSS includes but not limited to video conferencing, electronic discussion groups, e-mail, team collaboration tools and web-based access to knowledge repositories [20].

The more significant part of the youthful agriculturists gets information from the Internet [23]. Agricultural KSS should be created given the mass communication technology such as mobile systems [24] since phones are generally utilized for communication and sharing knowledge [25]. Most farmers have access to it [26], prefers it in seeking information [27], and they have utilized it for their daily activities [18], [26]. Young agricultural specialists have skills in mobile use for sending text messages [28]. There is a quick development in cellphone entrance in the public arena with continually expanding abilities that displays a unique chance to help support a change in agricultural development and food systems [29]. A chance to give specialists new data gathering devices and alternative sources of information to augment or, at times, give alternatives to more conventional data-collection methods [30]. A chance to fortify social network [16],[31] allowing agriculturists to share their knowledge from their exploratory outcome [32]. Besides, the utilization of cell phones have demonstrated its value in the agrarian sector; it has likewise been helpful in healthcare service delivery [33], [34], governance [35], education [36], [37] and human development as a whole [38].

Table I shows a comparison of several KS models of their advantages against their limitations focusing on knowledge sharing and exchange capabilities [7].

TABLE I
COMPARISON OF KS MODELS OM THEIR KS AND EXCHANGE CAPABILITIES

KS Models	Advantages	Limitations
Web Portal	Stores a collection of relevant websites with easily accessible, compressive and detailed agricultural knowledge	No customization of information
Voice-Based (Phone) Service	Disseminates knowledge in a direct two-way verbal communication	Tedious and requires human involvement
Voice-Based (Radio) Service	Disseminates knowledge far more quickly to rural farmers	Inflexible, one-way commutation, and requires human involvement and radio programming
TV Broadcasting Service	Disseminates knowledge to an extensive local and global audience and allows for the active demonstration of spectacular knowledge	Messages have short life plus time shifting and cannot provide detail information
Text (SMS)-Based Service	Disseminates knowledge in short and timely messages effectively and efficiently	Cannot provide comprehensive and in-depth information
Online Community	Disseminates knowledge and allows end user's participation to an interactive communication	Requires active user participation, efforts and good management and service is only available to members
Interactive Video Conferencing Service	Disseminates easy to understand knowledge interactively to end users in real time	Requires human experts involvement and can be time consuming and less efficient
Mobile Internet-Based Service	Ubiquitous, easy access, and can incorporate GPS technology to provide location-related service	Requires adequate infrastructure, the use of the smart device and higher IT skills to use new technologies

The KS models presented in Table I have shown their reputation in knowledge sharing, there are likewise incredible possibilities in using ERP-cloud based services [39], video-based messages [40], animated videos [41], and mobile phone sensors [42] to provide advanced agricultural solutions.

Technology can address a few obstructions confronted by agriculturists [43] and no single source for adequate knowledge [27]. It is commendable to consider some benchmarks whichever technology is utilized. Firstly, establish a supportive and dedicated effort over various stakeholders [44]-[46]. Secondly, the gamification of the system [32] with a quota-based reward instrument [47]. Thirdly, advance the youthful horticultural specialists as they can create better outcomes with the utilization of ICT in the spread of farming innovations [28]. Fourthly, employ horticultural specialists and agronomists who have the indigenous knowledge in extension services for farmers can easily relate to them [45]. Fifthly, utilize agriculturists' particular dialects in the services for it increases chances of

adoption [48] and uses appropriate, relevant and affordable services [49].

II. Material and Method

This study uses descriptive research and unstructured survey method. It focused and investigated on the following components and their elements in deriving the SMS-based knowledge sharing system which was evaluated by the KEs based on the factors in the acceptance of SMS-based e-government service [9] (see Fig.1):

1) Knowledge Experts. The KEs ICT capabilities in terms of internet use and navigation of ICT-based information systems; the KEs perception on the advantages of SMS-based systems based on the 6 levels of SMS-based e-government services [8] enumerated as communication, listen, notification, pull-based, integration, and transaction; the barriers of knowledge sharing; and the KEs perception on the level and outcome of knowledge sharing engagement.

2) External Factors. The capability of knowledge end-users, referring to the farmers, participating in SMS-based knowledge sharing, was cited from the initial study conducted [11] following this study; the ICT infrastructure to support the SMS-based information system, and the SMS technology features for integration in the system. Government telecommunications regulations is also a major consideration for integration.

Thirty one (31) out of forty three (43) participants composed of faculty, researchers and scientists from Benguet State University, La Trinidad, Benguet, Philippines was selected because of their engagement in sharing agri-based information to the neighboring farming communities of Ifugao, Benguet, Baguio, Mt. Province including La Union and Viscaya. These participants were represented almost equally by both sexes (52% male and 48% female). Mostly with a master's degree (40%). They consist of expertise on regional agriculture and fisheries, agricultural economics and agribusiness management, development communication, tissue culture, economics and business management, marketing and mycology, agricultural engineering, horticultural crops, environmental science, highland agriculture, and resources research and development. They are who can speak all the local dialects such as Kankanaey, Ilocano, Ibaloi, Tuwali, Ayangan, Kalanguya, Tagalog, and English which are essential in interacting with the farmers in the SMS platform. In summary, the pool of experts represents the different knowledge and fields in agriculture with the ability to communicate with the local people.

The collected data was analyzed using office productivity tools and Statistical Package for the Social Sciences. Interviews, document analysis, and review of related studies were conducted in gathering additional and confirmatory data. Prototyping model was used to come up with an SMS-based knowledge sharing system.

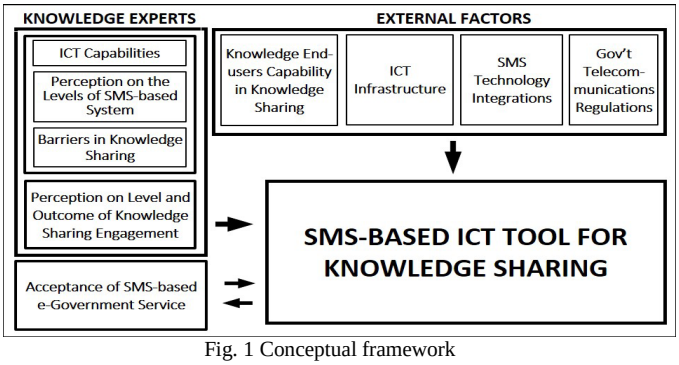

Fig. 1 Conceptual framework

III. Results and Discussion

A. Capabilities of Knowledge Experts

1) Knowledge Experts' ICT Capabilities and SMS Utilization. Findings reveal that the knowledge experts are ICT capable since they are equipped with the necessary knowledge and skills to use the internet and navigate through web-based information systems. They have the proper IT facility and resources, and time to use the Internet in various places they prefer. This confirmed their capability to use ICT- based knowledge sharing tools.

Detail shows that 100% of KEs use the internet with "Excellent" self-rated skill in most of the applications. Internet access is done mostly in office (100%), followed by home (78.6%), mobile data (78.6%), internet café (64.3%) and public Wi-Fi (57.1%). Fifty percent (50%) of the respondents have Internet access of 5-8 hours, 2-5 hours (37.5%) and more than 8 hours a day (14.3%). One respondent rated himself "poor" in the navigation of online services thus training in using the SMS system is needed before its implementation.

One hundred percent (100%) of the respondents own smartphones, and almost majority of the respondents are excellent in using the device which means they are confident in configuring, updating, installing apps, and in using its advanced functionalities. Both GSM service providers in the Philippines namely Smart and Globe are available in the locality and has almost equal share among subscribers. The respondents' preference in choosing a provider is based on signal quality (50%) and the person they communicate with. Attractive call/text promos and rates also influence the respondents to choose a provider. The subscribers (28.6%) spend more than P1,000.00 (20 USD) monthly load credit, P301.00 - P500.00 (6-10 USD) at 28.6% and the remaining spend P1.00 - P300.00 (<6 USD). Most of the subscribers (78.6%) use pre-paid loads, and the rest uses monthly plan subscriptions. The majority (78.6%) avail prepaid promos for unlimited text/call. Subscribers (42.9%) send at least 11-20 message daily followed by 35.7% at 1-10 messages. Fifty percent (50%) receive 11-20 daily SMS message followed by 42.9% at 1-10 messages. Subscribers (78.6%) make at least 1-5 calls daily while 85.7% receive 1-5 calls. The majority (51.1%) of the respondents are willing to pay for extra SMS cost for text messages that they have opted to receive. The majority (57.1%) said that texting is the service they do most follow by calling (14.3%), then by games, music, and radio (14.3%) followed by the rest of the application. These data confirm the KEs utilization of

cellphone in communication and other related applications. Thus, the managed SMS bases knowledge sharing tool was easily adopted by them.

2) Knowledge Experts' Perception of the Levels of SMS based System. Table I shows that all of the six levels of SMS based services are reported advantageous by the majority of the KEs. It also shows that communication level has the highest number of participants (93.55%) who reported it as advantageous which implies that most participants are engaged in applications that integrate communication level features. The presence and availability of these levels indicate advantages that users can acquire; the higher the level of the available service, the higher its advantage.

TABLE II
PERCEIVED ADVANTAGES OF SMS SERVICE

Level of Service	Average	Interpretations
1. Communication Level	29 (93.55%)	Advantageous
2. Listen Level	28 (90.32%)	Advantageous
3. Notification Level	28 (90.32%)	Advantageous
4. Pull-based Level	25 (80.65%)	Advantageous
5. Integration Level	23 (74.19%)	Advantageous
6. Transaction Level	22 (70.97%)	Advantageous

The following are definitions of the six levels of SMS based services [8]. 1) Listen - texters can send SMS inquiries or comments in an unformatted or keyword-based message, received and stored in a platform via Google sheet depending on the configuration, then the platform operator replies to it later. 2) Notification - the SMS platform can send notifications to the public with known contact information triggered by an event, a schedule, or a subscriber's profile. 3) Pull-based - the SMS platform can reply to a personalized request for information. The texter sends a formatted SMS message, and the SMS service sends back the reply to the sender's cellphone. 4) Communication - texters and SMS platform operator can interact using the platform through a cellphone to platform or vice versa using the general format of texting. 5) Transaction - payment is possible through the use of virtual mobile wallets. 6) Integration - the platform can integrate several services.

The integration of these six levels of SMS based services into the model are described as follows. Listen level allows texters to send unformatted or keyword-based messages to the SMS platform as inquiries or comments then the platform operator can reply the texter later. Notification level allows the SMS platform to send notifications to the public with known contact information triggered by an event, a schedule, or a subscriber's profile. Pull-based level allows texters to send formatted SMS messages requesting for information from the platform and the platform can reply to these request through the sender's cellphone number. Communication level allows the texters and the SMS platform operator to interact with each other using the general format of text messages. Transaction-level allows payment transactions through SMS like GCASH in the Philippines. Users just do self-registration to send cash to another mobile with the format AMOUNT<space>4-digit PIN and send to 2882<receiver's ten-digit SIM>. In the integration level, the platform can integrate several services. For the system that was developed, however, integration is not possible.

3) Knowledge Experts' Perception of the Barriers of Knowledge Sharing. Figure 2 shows a consolidated view of responses for all personal barriers. 2 out of 9 (22%) only barriers were reported critical by the majority of the respondents. Fifty-three (53) percent of respondents perceived that being from different cultures, languages, and backgrounds is a critical level problem. Fifty-nine (59) percent of respondents also perceived that lack of time to share knowledge is a critical level problem. This result confirms the finding of other studies that lack time significantly hinders knowledge sharing. It was also revealed from questionnaire findings that many of the knowledge sharing only barriers are almost at a critical level.

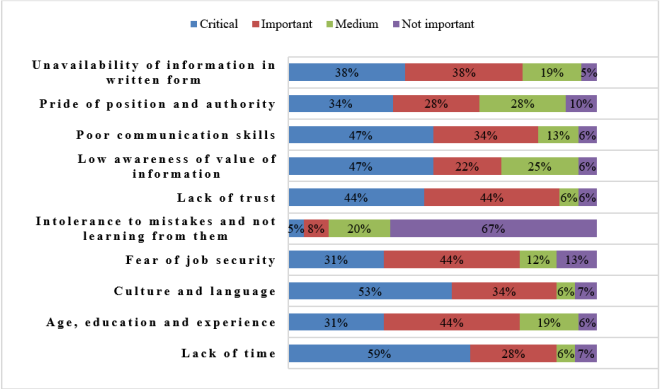

Fig. 2 Questionnaire Responses for Individual Barriers

Findings revealed that 1 out of 5 (20%) technology barriers were reported critical by the respondents. Figure 3 shows a consolidated view of responses for all technology barriers. Fifty (50) percent of the respondents perceived that they do not know how to use technology for information sharing. It seems to be that their ICT enabled knowledge sharing is not very well established. With these results, it is expected that the use of an SMS-based ICT tool for knowledge sharing should be able to lessen the severity of all the identified individual and technology barriers.

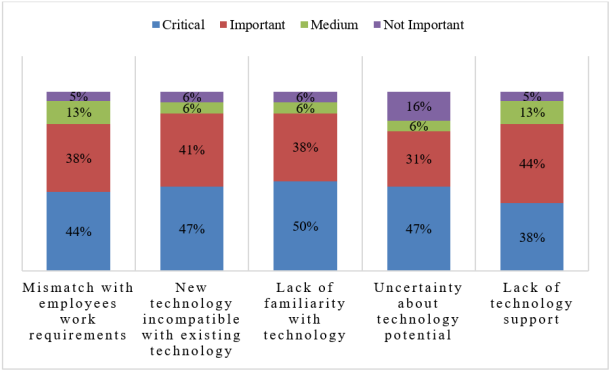

Fig. 3 Questionnaire Responses for Technology Barriers

4) *Knowledge Experts' Perception of the Level and Outcome of Knowledge Sharing Engagement.* Themes contributing to KS [50] has been regarded as one of the enablers of KS, the majority of the KE can socialize and talk about agricultural issues openly. They can watch, imitate,

learn, and benchmark best practices shared by peers; they can find and build trusted relationships with like-minded individuals over the globe; they can write and share their agricultural stories; and they can document and retrieve the explained and shared knowledge using a knowledge sharing tool (see Table III). Research finding also shows that Facebook, SMS, phone call, YouTube and Google+ respectively are the top five application software used by the respondents to share and manage knowledge.

The result of the analysis of the KEs level of engagement also shows that KEs who write and share their agricultural stories tends to find and build trusted relationships with like-minded individuals over the globe. These holds are right when they socialize and talk about agricultural issues openly. It also shows that KEs who document and retrieve the explained and shared knowledge using a KSS tends to realize the benefit and importance of sharing knowledge effectively completely.

TABLE III
KNOWLEDGE EXPERTS' LEVEL OF ENGAGEMENT TO KNOWLEDGE SHARING

Knowledge Sharing Themes	Frequency/ percentage (Agree)	Frequency/ percentage (Disagree)
1. Socializing	29 (94%)	2 (6%)
2. Encountering	29 (94%)	2 (6%)
3. Practicing	28 (90%)	3 (10%)
4. Networking	26 (84%)	5 (16%)
5. Storytelling	23 (74%)	8 (26%)

From questionnaire findings, it revealed that the majority of the KE agreed that their engagement to KS has a positive outcome (see Table IV). Further analysis from the data using correlation formula to find out any statistically significant relationship among the outcomes of their engagement in KS shows that KEs who thoroughly understand the importance and benefit of KS tends to increase their comfort ability of sharing knowledge. It was also found out that KEs who intensely believe that there is strong support among the farming communities will likely feel more comfortable to share knowledge. This explains why most studies recommend establishing a supportive and dedicated effort over various stakeholders [44]-[46] when introducing a KSS.

TABLE IV
KNOWLEDGE EXPERT'S OUTCOME OF KNOWLEDGE SHARING ENGAGEMENT

The outcome of KE Engagement in Knowledge Sharing	Frequency/ percentage (Agree)	Frequency/ percentage (Disagree)
1. KE understand the importance of sharing knowledge effectively.	29 (94%)	2 (6%)
2. KE know how sharing knowledge benefits them.	29 (94%)	2 (6%)
3. KE can easily share knowledge.	28 (90%)	3 (10%)
4. KE believe that there is strong support for sharing knowledge among KE and knowledge end-users.	28 (90%)	3 (10%)
5. KE feel comfortable in sharing knowledge.	26 (84%)	5 (16%)

5) Knowledge Experts' Perceptions of the System Features

Majority of the knowledge experts agreed that system features from "ease of use" up to "risk to money" (items 1 to 13) are an advantageous while (48%) agreed for "trust in the government and quality of public service" and "compatibility" (see Table V).

TABLE V
KNOWLEDGE EXPERTS' PERCEPTION TO SMS-BASED SYSTEM FEATURES

Factors	Frequency/ percentage (Agree)	Frequency/ percentage (Disagree)
1. ease of use	29 (94%)	2 (6%)
2. efficiency in time and distance	28 (90%)	3 (10%)
3. relevance, quality, and reliability of the information	27 (87%)	4 (13%)
4. value for money	26 (84%)	5 (16%)
5. self-efficacy	26 (84%)	5 (16%)
6. convenience	24 (77%)	7 (23%)
7. trust in the SMS technology	24 (77%)	7 (23%)
8. usefulness	23 (74%)	8 (26%)
9. risk to user privacy	22 (71%)	9 (29%)
10. reliability of the mobile network and the SMS-based system	21 (68%)	10 (32%)
11. responsiveness	20 (65%)	11 (35%)
12. availability of device and infrastructure	20 (65%)	11 (35%)
13. risk to money	18 (58%)	13 (42%)
14. Trust of the government and quality of public services	15 (48%)	16 (52%)
15. compatibility	15 (48%)	9 (29%)

B. Knowledge End-users' Capability in Knowledge Sharing

Based on the findings of the first part of this study [11], it revealed that 100% of the knowledge end-users, referring to the farmers, own cellular phones and possess the necessary skills to utilize them. They have the prime airtime for texting and calling. Sixty-three percent of the farmers send at least 1-20 message daily while the rest are sending more. Majority of the farmers (52%) said that texting is the service they do most follow by calling (18%), and the rest are other common mobile applications. They share and receive information mostly on the price of vegetables, farm supplies, vegetable transportation, pest management, farm labor, pesticide/insecticide/weedicide management, other general inquiry on farming, and weather updates. Other means of acquiring similar information were through local radio programs, other farmers, local agriculture officers, family members, friends, and from the internet.

C. ICT Infrastructure

The significant ICT support for the SMS-based knowledge sharing system is the internet and global system for mobile communication (GSM) infrastructure. Findings reveal that 100% of knowledge experts have access to the internet and SMS service in various locations signifying the presence and availability of these services. GSM services particularly Smart and Globe has an excellent signal and high availability in the locality [11] thus ICT infrastructure as a whole can support the SMS-based knowledge sharing system.

D. SMS Technology Integrations

The SMS platform was able to integrate most of the recommended features of SMS system (see Table VI) identified by a UNCHR commissioned research on technology integrations for SMS platforms [51] and it means that the prototype SMS-based knowledge sharing tool complies to standards.

TABLE VI
SMS-BASED SYSTEM FEATURES

SMS System Feature	Description
Broadcast messages	The message can be broadcasted immediately to a predefined group earlier classified by the system.
Communication	It can send and receive messages to/from individuals.
Contact Trigger	The SMS platform can be triggered by known or unknown contact, registered or non-registered.
Message templates	There is no readily available template in the default configuration.
Personalization through variables	The platform can send a personalized message to a subscriber.
Location-based	Send message based on the recipient's current location – the platform has to be linked to the GSM providers to attain this feature, it is not currently available within the service.
Scheduling	The platform can send a message whether specific, relative or recurring schedule.
Surveys/polls via SMS	The platform can integrate single or multiple questions in chat-based communication.
Input via forwarded messages	The platform accepts messages in a format which can be interpreted accordingly. For example, the texts "no," "nope," "not" or "ney" can be interpreted all in all as "NO."
Input via guided questions	The platform can integrate a question and answer guiding a texter for proper or correct answers during the interaction.
Missed call input	An interaction can be triggered by a missed call from a texter. For example, a missed call will initiate a specific flow for the texter.
Skip logic	The platform has a great feature that implements a skip logic. For example, if a texter answers NO to a question, he will be redirected to another flow.
Emulator	The platform can simulate an SMS flow giving an idea to the platform operator how it works in the actual application. Errors will be checked before the actual flow is put into actual use.
Offline mobile data collection	The platform can collect data on an Android device and send it to the platform when a connection is available.
Audio Messages/Interactive Voice Response	The platform has an option to use voice responses aside from SMS. Voice messages can convey much information as compared to SMS usually at a higher cost.
Contact management	The platform has very good management of contacts. Also, the platform can automatically group a texter based on rules. Telecommunication policies usually require this feature.
Visualization Tools	The platform has built-in data analytics but can integrate third-party tools. The service records traffic and system usage.

E. Government Telecommunications Regulations

The National Telecommunication Commission (NTC) is the Philippine's regulating in terms of telecommunications. The following are some of the regulations based on memorandum circular (MC) No. 03-03-2005A as amended by MC No. 04-07-2009 [52] and Cybercrime Prevention Act of 2012 [53]. All of these are adaptable to the system model although some are to be manually implemented by the platform operator. Opt-in and Opt-out - SMS subscribers, should be given an option to confirm if they wish to receive SMS (opt-in) for example by texting YES to <access code> and an option to discontinue (opt-out) for example by texting STOP to <access code>.

Commercial and promotional advertisements, surveys and broadcast messages are allowed with the consent of a subscriber. A subscriber or recipient should not be charged in receiving SMS or MMS unless it was opted-in by the same. Broadcast or push messages is allowed only from 7:00 AM to 9:00 PM except for paid subscription services. Broadcasted messages display the name of the content provider or company with a valid address or contact numbers. This can be addressed during the creation of the message. Lastly, SMS spamming which is sending of unsolicited text messages is a criminal offense under the Cybercrime Prevention Act of 2012 of the Philippines.

F. The Managed SMS-based System

1) SMS-based System. The SMS-based system prototype was demonstrated using an online SMS platform Text. In (http://textit.in/). It is an online platform for visually building interactive SMS and voice applications. It can be implemented immediately without the need for capital outlay expenses since it is an account based online platform. Monthly subscription fees for the online platform and GSM service provider has to be considered. With lots of SMS-based online platform, text.in is selected based on the comparative study commissioned by the United Nations Commission on Human Rights (UNCHR) [51] besides, it is available in the Philippines. See Figure 4 for the SMS-based infrastructure diagram and Figure 5 for a sample of SMS interaction.

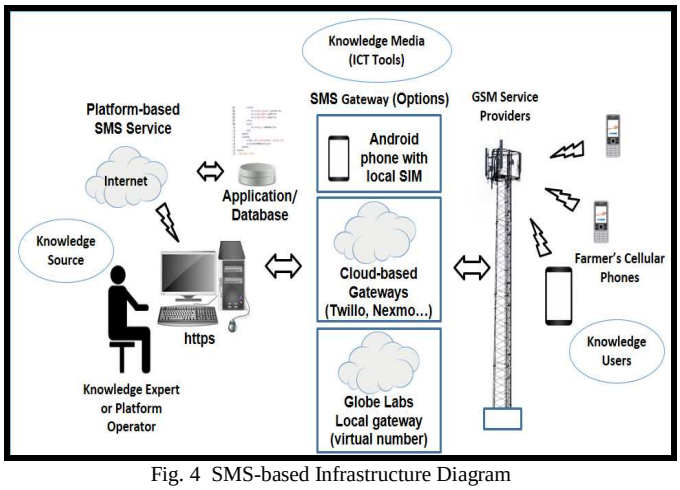

Fig. 4 SMS-based Infrastructure Diagram

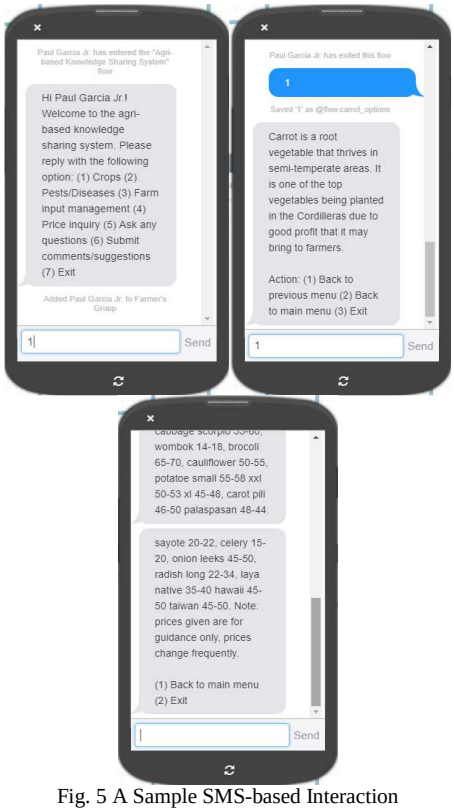

Fig. 5 A Sample SMS-based Interaction

2) Levels of Services in the SMS-based System. A model for SMS-based e-government services [8] with six levels is adopted for integration to the system. Higher levels integrated to the system makes the system more complicated, but more benefits are received by citizens [51]. The six levels: listen, notification, pull-based level, communication, transaction, and integration was previously discussed in detail. The SMS-based system prototype was able to integrate almost all levels of SMS service except for the integration level since at this point of the research; the system is only focused on knowledge sharing.

IV. Conclusion

The various failures of ICT-based knowledge sharing systems can be addressed. The ICT-based knowledge sharing tool should be highly accessible for both the knowledge source and knowledge end-users. The IT infrastructure is practical and sustainable; the knowledge source and the target knowledge end-users have the capability to use the system. The ICT-based knowledge sharing tool should comply with standards and authority regulations for each country. For this research, the SMS-based knowledge sharing system is highly available for the knowledge source (experts). The end-users (farmers) likewise have immediate access to the information by simply using their cellular phones (GSM service) even in the remote areas. It is recommended that the system is adopted and that future similar studies will conduct an impact study where the system will be implemented in a longer period for better evaluation results.

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