

Web 2.0 – Based Agricultural Knowledge and Information Systems (AKIS 2.0)

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The study investigates how the media richness of web 2.0 technologies impact on their use for knowledge sharing among the primary knowledge actors in the Agricultural Knowledge and Information Systems as evidenced from the Cocoa Industry in Ghana. Three theories- Agricultural Knowledge and Information Systems (AKIS) model, SECI model, and the Media Richness Theory (MRT) were combined to establish that there exists a positive relationship between the tacitness of knowledge and media richness which can be used as the basis for selecting appropriate social media technologies for different types of the SECI processes for effective knowledge sharing

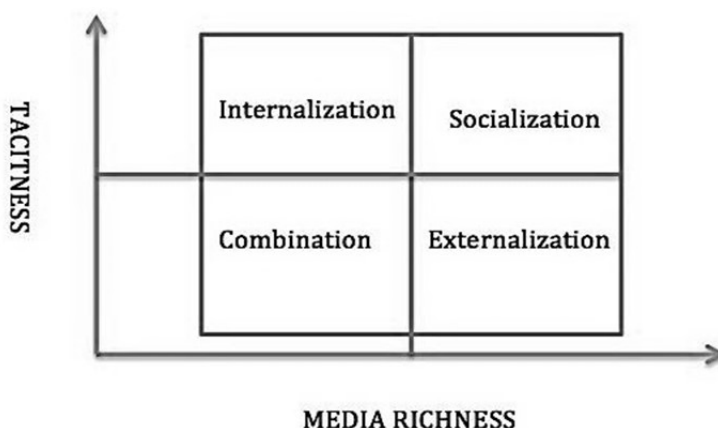
Keywords: Web 2.0 applications, media richness, knowledge management systems, knowledge creation, knowledge sharing

INTRODUCTION

This paper is relevant in the digitization of agricultural extension activities. Social media technologies have potential in facilitating knowledge sharing through farmer-farmer networking which in turn can reduce social isolation for farmers, enable farmers and agribusiness interactions both locally and globally, and provide a wealth of knowledge from different sources (Stanley, 2013). However, the applications of these technologies in agriculture knowledge sharing are not widely accepted as in other business and consumer practices. The limited research in this arena is centered on how to use social webs to guard against anti- agricultural activists such as using social media platforms to portray a negative imagery of factory farming (Cline, 2011; Payn-Knoper, 2013; Stanley, 2013). Consequently, there still remains a lack of understanding on how web 2.0 applications could facilitate knowledge sharing in the Agricultural Knowledge and Information Systems (AKIS) landscape, to enhance interactive communication among the key knowledge actors in the cocoa industry in Ghana. Therefore, in order to have a further understanding of the phenomenon of web 2.0 usage for knowledge sharing across the agricultural landscape, this study is designed to make theoretical linkages among media characteristics (media richness) and knowledge sharing through the interplay between tacit and explicit knowledge (SECI processes) to determine the potential of social media technologies in facilitating interactive communication among knowledge actors across the AKIS platform. The research model is primarily based on the Media Richness Theory (R L Daft & Lengel, 1986) and the SECI model from the Dynamic theory of Organizational Knowledge Creation (Nonaka, 1994)(Nonaka & Krogh, 2009). According to (Nonaka, 1994)(Nonaka & Krogh, 2009), each of the four knowledge transfer modes takes place in a specific context called Bas, defined as common place or space for creating knowledge. The major underlying feature of Ba is interaction. The

different levels of interaction needed for each type of transfer require a communication medium of appropriate richness, for its participants. The choice of the appropriate media for a specific transfer type is therefore important for effective knowledge sharing [5][6]. The choice of appropriate media for a given communication task, as postulated in the MRT, depends on the characteristics of the communication task and the richness of the media used for the task (Richard L. Daft et al., 1987). Communication tasks that involve the conversion and transfer of tacit knowledge requires media with high degree of richness whereas media with low degree of richness are suitable for the conversion that involve explicit knowledge (Murray & Peyrefitte, 2007). Different tasks performed within the organization may also require the use of different modes of knowledge transfer for their accomplishment (Anothayanon, 2006; Becerra-Fernandez & Sabherwal, 2001). In this study, the relationships among media richness, the SECI processes and how they facilitate interaction among knowledge actors in the AKIS model are discussed as a conceptual framework of a web 2.0 based Agricultural Knowledge and Information Systems (AKIS 2.0) model.

FIGURE 1
INTERACTION BETWEEN KNOWLEDGE TACITNESS AND MEDIA RICHNESS



The Main Aim of the Paper is Four-fold:

- To explore the relationship between tacitness of knowledge and ICT usage for SECI processes
- To examine how media richness, affect the selection of web 2.0 technologies for knowledge sharing via the SECI processes
- To understand how the use of web 2.0 technologies for SECI processes could enhance the interaction between knowledge actors in the AKIS framework
- To illustrate these relationships as a conceptual AKIS

2.0 framework used to investigate the sharing of knowledge among knowledge actors in the Ghanaian Cocoa sector.

THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

The SECI-Model

Although the SECI model was originally developed as a knowledge creation model, it has emerged as an eminent theory that has been applied extensively in the study of knowledge transfer (Alavi & Leidner, 2001; Cummings & Teng, 2003; Dinur, 2009). Each mode of knowledge conversion could also be considered as a type of knowledge transfer because they involve the transfer of a specific type of knowledge: tacit or explicit. It is the transfer of knowledge that triggers the knowledge creation process.

For example, if an individual A transfers tacit knowledge to individual B, the knowledge creation in individual B could be triggered upon receiving the knowledge from individual A, which may lead to the creation of new tacit knowledge in B. Thus, the creation of new knowledge in B is as a result of the knowledge transferred from A. The interplay between the tacit and explicit dimensions of knowledge leads to four modes of knowledge creation derived from the SECI model as: socialization, combination, externalization and internalization as stated previously.

The Use of ICT for Knowledge Transfer

A key challenge regarding ICT usage for knowledge transfer is related to tacit knowledge transfer. In order to fully grasp the relationship between tacit knowledge sharing and ICT usage, scholars have conceptualized tacit knowledge as having varying degrees of tacitness, which may be classified as high degree of tacitness, medium degree of tacitness, and low degree of tacitness (Ambrosini & Bowman, 2001; Chennamaneni & Teng, 2011a). (Ambrosini & Bowman, 2001) refers to the highest form of tacit knowledge as deeply ingrained tacit skills, followed by imperfectly articulated tacit skills, and articulable tacit skills in decreasing order of tacitness, with explicit knowledge having the lowest degree of tacitness. Thus, ICT can facilitate the transfer of tacit knowledge even though the degree of the richness of such interactions might not be as high as face-to-face interactions (Alavi & Leidner, 2001; Murray & Peyrefitte, 2007; Panahi et al., 2013). Knowledge is, thus, viewed in this study as being in continuum with varying degrees of tacitness, from high degree of tacitness, through medium degree-tacitness to low-degree tacitness (Chennamaneni & Teng, 2011b). From this standpoint, we argue that ICTs can easily facilitate the transfer of knowledge of medium-to-low degrees tacitness and moderately support the transfer of knowledge with high degree tacitness, though not as rich as face-to-face interaction (Panahi et al., 2013). The study, thus, proposes that there exists a positive correlation between the degree of knowledge tacitness and the degree of the richness of the media in such a way that if such relationship is well managed it could be used as a basis for the selection of appropriate media for the different modes of SECI processes (see figure 1).

ICT and SECI Processes

Although many scholars have alluded to the fact that ICT-based mechanisms can support all the four types of knowledge transfer, there seems to be a partial support for ICTs usage for socialization and externalization. From the Ba context, (R L Daft & Lengel, 1986; Nonaka et al., 2000) argues that internalization and combination can be associated with systemizing and exercising Bas respectively and can take place in virtual space or ICT supported medium. However, externalization and socialization, which are linked to originating and dialoguing Bas respectively, require the support of face-to-face interactions. (Lopez-Nicolas & Soto-Acosta, 2010) in their study on the adoption and use of ICT for the SECI processes found that the adoption of ICTs by organizations enhances knowledge creation and organizational learning through their positive influence on socialization, externalization, combination and internalization. However, the influence of ICT adoption on combination and internalization was found to be higher than on externalization and socialization. (Sarkis & Krikorian, 2005) share in this view that the negative influence of ICT on social relations reduces its effectiveness for socialization and externalization. In a similar vein, (Marwick, 2001) agrees that even though ICT can support all the knowledge conversion types, its support for externalization and socialization is weaker in the sense that, these forms of knowledge transfer are grossly based on shared experience and trust which favors co-presence and co-location through face-to-face meetings. This view of developing interpersonal trust and shared experience makes the support of ICT for socialization and externalization weaker. On the contrary, (Boisot, 1999) contends that co-presence and co-location requirements for developing interpersonal trust and shared experience was in the era prior to microelectronic revolution. In the advent of electronic communication technologies such as video conferencing, it is possible to establish co-presence without co-location making it possible to build a strong 'trusting' relationship irrespective of the constraints of time and space. It is therefore possible to build a productive relationship necessary for interpersonal trust without having to share the same room or building (Boisot, 1999). (Marwick, 2001) then shares a similar

view that it is possible to achieve a rich kind of shared experience, which is required for socialization, through virtual space and real-time online meetings. The use of virtual space for experience sharing is enhanced when teams are geographically dispersed and are unable to meet face-to-face. ICTs such as emails, telephones, Instant Messaging (IM), audio and video conferencing technologies have been found to have the potential of bridging distances to enable quasi-real person-to-person socialization (Sian Lee & Kelkar, 2013). As a conclusion of their study, they observed that their finding on the individuals' reliance on multiple types of ICT mixes have important implication on future research and advocates for further research on how new media such as web 2.0 and social media could co-exist with traditional ICTs to support KM practices in organizations as discussed in the next section.

WEB 2.0 Usage for SECI Processes

In order to fit in the social media space, the SECI model has gone through different modifications by other scholars. In a study to investigate personal knowledge development (PKD) in online learning, (Haag, 2010) proposed a modified version of the SECI model to extend its applicability from the organizational level to the individual level. The main argument is that the proposed PKD model is more suitable in describing the personal knowledge development at the individual level. Furthermore, the study argued that socialization shouldn't form part of a PKD model because it requires a strong face-to-face interaction, including feelings, and empathy, only available through telepresence online applications, which makes it irrelevant for the PKD model.

In their framework for web 2.0 driven learning, (Chatti et al., 2007) demonstrated how social web tools could support socialization, externalization, combination and internalization for blended learning environment. Sharing of tacit forms of knowledge requires the building of a "space" for social interaction and social media technologies provide opportunities for the creation of such a social interaction space to allow individuals to share knowledge through socialization, externalization, combination and internalization.

In their analysis of the various service model of web 2.0 (Shang et al., 2011) observed that the various existing social media websites have been designed to support the different stages of the knowledge conversion processes from socialization through to externalization and combination to internalization. By defining web 2.0 service model using three dimensions: type of knowledge creating cycle enabled, control mechanism, and customer value, (Shang et al., 2011) differentiated the existing web 2.0 service models into four categories: exchangers, aggregators, collaborators and liberators. By conceptualizing the link between web 2.0 technologies and organizational learning, (Boateng et al., 2009) developed a framework for assessing the adaptability of web 2.0 technologies as a learning tool for organizations. The study differentiated Web 2.0 applications into five categories: communicative, collaborative publishing, documentative (content management), generative and interactive. In spite of their enormous contribution to literature on knowledge sharing via web 2.0, none of these models brought to attention, the impact that media richness of the various web 2.0 applications could have on the SECI processes. The current research focuses on helping to gain further clarity in that direction. The study thus proposes that there is a direct relationship between the usage of web 2.0 technologies for the SECI processes and knowledge sharing as discussed further on in this sub-section.

Hypotheses Development of Web 2.0 Usage for SECI Processes

Socialization: Socialization is the mode of conversion that allows an individual to transfer tacit knowledge to the tacit knowledge base of another individual through social interactions. Socialization require direct transfer of tacit knowledge in an informal cultural environment where individuals can share experiences by spending time together. It has been theorized that this mode of knowledge transfer is supported within the environment, which provides space for individuals to share experiences, emotions, feelings, and mental models. These emotional attributes of socialization could be best expressed through face-to-face interactions making the use of ICT and new media very limited if not impossible. Contrary to the views expressed above, (Haefliger et al., 2005) argue that transferring tacit knowledge is possible over a distance via ICT usage. Using theories of signal intelligence and micro-communities of knowledge, it

was explained in Haefliger et al., (2005) that socialization takes place in a web-based Open Source software development community where distance impedes the possibility of experiential sharing through direct contact. Socialization occurs on the web 2.0 platforms by allowing individuals or groups to share methods, understanding, experience, and skills through observation, imitation, practice and participation in different social communities. Web 2.0 facilitates socialization by providing an interactive space, which brings knowledge seekers and knowledge keepers closely together to satisfy their knowledge needs. For the knowledge seekers, this will help them to know who possesses the knowledge they are searching for. And the knowledge keepers will also find out who is in need of their knowledge. Previous research on web 2.0 technologies has found positive relationship between the use of web 2.0 technologies and tacit knowledge transfer (Murphy & Salomone, 2013).

H1. The use of web 2.0 for socialization is positively related to knowledge sharing among knowledge actors.

Externalization: Externalization requires a space where collective mental models of individuals could be shared and articulated through dialogue and interactions. These forms of dialogues and discussions trigger the process of concept creation by capturing context-rich knowledge expressible through face-to-face interaction. Basically, externalization involves the diffusion of knowledge from an individual to a group of individuals. This requires a space where collective mental models of individuals could be shared and articulated through dialogue and interactions. On the web 2.0 platform dialoguing is facilitated among users through the use of technologies such as e-mail, Instant Messaging (IM), tagging, VoIP and voice/video-conferencing and may occur through spoken or written words, images, and videos (Shang et al., 2011; Boateng et al., 2009). Through the information they receive on the web 2.0 platforms, individuals are able to create metaphors and analogies necessary for the conversion of tacit knowledge into explicit concepts. Web 2.0 platforms, which have the capacity for supporting the externalization process, include exchangers (Skype), aggregators (Facebook and YouTube) and collaborators (Wikipedia).

H2. The use of web 2.0 for externalization is positively related to knowledge sharing among knowledge actors.

Internalization: The internalization mode of knowledge transfer involves personifying explicit knowledge into tacit knowledge. When individuals internalize knowledge, it becomes part of their tacit knowledge base in the form of technical know-how. This form of knowledge can then trigger a new spiral of knowledge creation when shared with other individuals through socialization. Web 2.0 technologies like social networking, tagging, and RSS can be useful for supporting internalization. Applications such as Wikipedia provide a collaborative learning platform appropriate for internalization. The control mechanism is relatively high on such a platform involving standardization, systematization, authorization and review process for ensuring quality of the content. These qualities make the knowledge obtained from collaborators such as Wikipedia relatively reliable and also, they give opportunity for learners to give feedback and that makes it suitable for internalization. Internalization mode of transfer allows individuals to solve problems through learning-by-doing activities and experimentation.

H3. The use of web 2.0 for internalization is positively related to knowledge sharing among knowledge actors.

Combination: Knowledge sharing through combination involves the transfer of explicit knowledge from individual A to B's explicit knowledge base through social processes and exchange mechanisms such as meetings and telephone conversations. For example, when A sends a document, he/she created or an email to B, it may lead to reconfiguration of B's existing explicit knowledge through sorting, adding and categorizing resulting in the creation of new body of explicit knowledge. Combination mode of

knowledge transfer, thus, involves acquisition and integration, where managers engage to plan and strategize on how to assemble both internal and external data. It also involves a second stage of synthesis and processing where managers build and create systems that capture information from all over the organization. Lastly, the combination phase also includes the dissemination stage where managers plan and transmit the newly created knowledge.

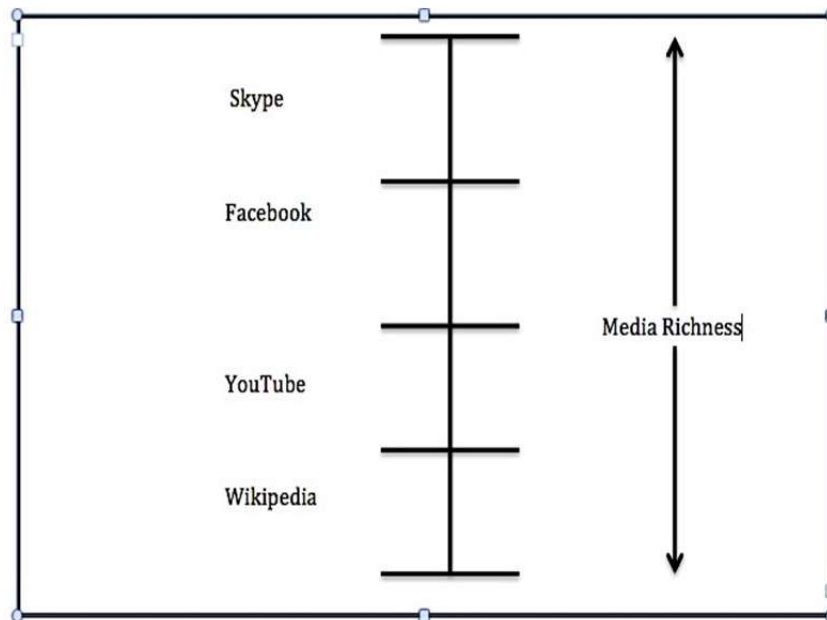
At the combination phase both internal and external knowledge, are collected, combined, edited or processed by using published literature, computer simulation, manuals, groupware, databanks and databases to create new knowledge. Combination is associated with systemizing Ba defined by collective interaction in a virtual environment. The virtual collaborative environment needed for the creation of systemizing Ba can be achieved through the use of web 2.0 technologies. Combination occurs on the web 2.0 platform when various components of explicit knowledge are put together, systematized, and then entered into a community knowledge system. With innovative technologies like RSS, Folksonomies, Mashups, Wikis, and social bookmarking, different bodies of explicit knowledge in multiple formats including text, audio, and video are integrated and remixed into new knowledge for the community.

***H4.** The use of web 2.0 for combination is positively related to knowledge sharing among knowledge actors.*

Media Richness Theory

Media has been identified as a key factor that affects knowledge sharing. Media is considered very important because the process of knowledge sharing has been described as a social process. And the underlying feature for every social process is interaction, which requires a medium for its participants (Nonaka, 1994). In fact, the choice of appropriate media for knowledge sharing is deemed as important as the process itself (Joia & Lemos, 2010; Murray & Peyrefitte, 2007; Panahi et al., 2013). The use of appropriate media becomes especially necessary when different types of knowledge with varying degrees of tacitness and complexities are being shared. According to the Media Richness Theory (MRT), communication media differ in their ability to process information and facilitate understanding regarding situations in communication characterized by uncertainty and equivocality (Suh, 1999). Based on the capacity to facilitate shared understanding and insight, media channels can be classified as low or high in richness.

FIGURE 2
PROPOSED MEDIA RICHNESS HIERARCHY OF WEB 2.0 TECHNOLOGIES



The richness of media is the capacity of the media to process rich information and depends on a combination of four characteristics:

- Ability to receive instant feedback
- Multiple cues related to face-to-face communication, e.g. tone of voice and body language
- Availability of different language types
- Personal focus-Level of conveyance of feelings and emotions

These media characteristics place face-to-face communication at the highest position on the media richness hierarchy followed by telephone, letters or memos, impersonal written documents, and numeric documents in that order]. Among the shortcomings of the MRT is the exclusion of new media such as e-mail and video conferencing technologies.

Media Richness of WEB 2.0 Technologies

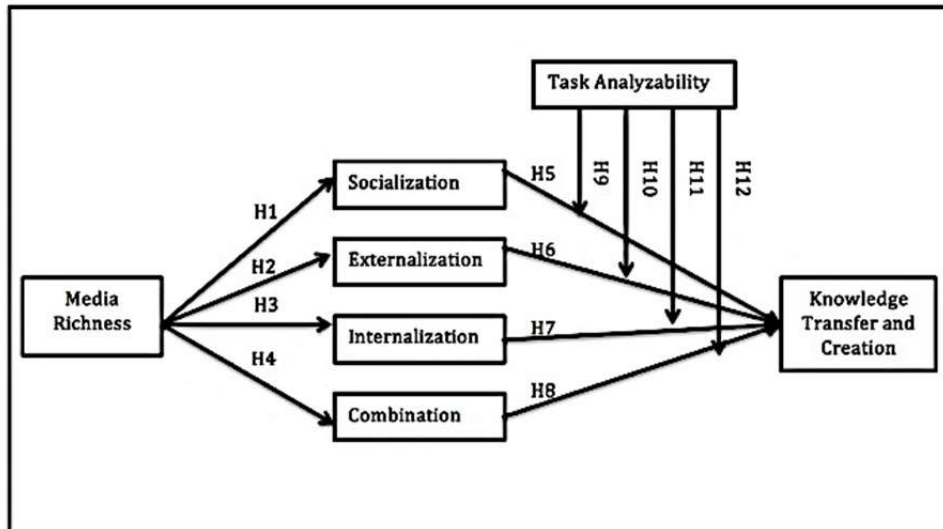
Applying MRT with other leading CMC theories, (Schwartz, 2007) postulated the media richness hierarchy for CMC modalities that included E-mail, Instant Messaging (IM), Video and Voice over Internet Protocol (VVOIP), Voice over Internet Protocol (VoIP), forums, and portals. Among these CMC modalities VVOIP was rated as having the highest level of media richness, followed by VoIP, chat, IM, portal, forum, and email in that order. Following this line of argument, the current study proposes that Web 2.0 applications like Skype which has VVOIP modalities rates highest on the media richness hierarchy, followed by Facebook with the chat technology, YouTube with the video capability comes next and Wikipedia follows (see Figure 2).

Media Richness and SECI Processes

The objective of information processing is either to reduce uncertainty or remove equivocality. To accomplish a task, information has to be exchanged or processed to deal with either of these factors. A situation is regarded as uncertain when there exists a deficit in the amount of information needed to resolve the issue or there is a difference in the amount of information required for resolving the issue and the amount of information already available. When there is uncertainty then there is insufficient amount

of information needed to resolve issues relating to accomplishing a task. When there is equivocality, it indicates the presence of conflicting interpretations or ambiguity regarding an organizational situation.

FIGURE 3
RELATIONSHIPS AMONG MEDIA RICHNESS, SECI AND KNOWLEDGE SHARING IN WEB 2.0 SPACE



Reducing uncertainty through the transfer of explicit knowledge with ICT-based systems is not problematic since it involves the acquisition of information and data through periodic reports, rules, operational standards and data analysis.

However, issues of ambiguity are resolved by pooling opinions and overcoming disagreements until a shared understanding and social agreement on the matter is attained. A situation that calls for discussions and exchange of subjective opinions, which are tacit in nature to help clarify what the real issues are and resolve disagreements. Thus, while uncertainty requires the transfer of objective information or explicit knowledge, equivocality demands the exchange of subjective views or tacit knowledge. Meanwhile, communication media differ in their richness to process information and so the richness of the media should match the degree of ambiguity in the message. When equivocality is high, managers would prefer to use face-to-face interaction to resolve such issues since it would involve the sharing of tacit knowledge. Similarly, explicit knowledge, which has low ambiguity, requires the use of media with low richness to facilitate clarity and understanding and to avoid information overload]. In other words, high equivocality requires knowledge of higher degree of tacitness, which in turn demands media with higher degree in richness. Similarly, low ambiguity, requires knowledge of low tacitness and low media for resolution.

Hypotheses Development of Media Richness and SECI Processes

Socialization involves tacit-tacit conversion and therefore involves knowledge with a higher degree of tacitness, which requires media with high degree of richness.

H5. Media richness of Web 2.0 applications is positively related to their usage for the socialization.

Externalization involves the conversion of tacit knowledge to explicit knowledge and therefore requires the use of rich media to match the high degree of tacitness.

H6. Media richness of Web 2.0 applications is positively related to their usage for the externalization.

Combination involves the conversion from explicit knowledge to explicit knowledge and therefore requires media of low richness since the tacitness is very low.

H7. Media richness of Web 2.0 applications is positively related to their usage for the combination.

Internalization requires low media for low tacitness for the explicit-tacit conversion.

H8. Media richness of Web 2.0 applications is positively related to their usage for the internalization.

Moderating Effect of Task Analyzability

There is a relationship between the use of rich media for socialization and unanalyzable task. When task is unanalyzable, then there are no exact laid down procedures and so people have to rely on their own judgments, and experiences rather than on computational routines. Resolving unanalyzable work situation would, thus, require the sharing of tacit knowledge between individuals through personal contacts and occasional visits. Another way to resolve unanalyzable work conditions would be through the creation of new knowledge from the conversion of tacit knowledge into explicit knowledge due to low level of common situations. On the other hand, when task is analyzable, it signifies the availability of large amounts of information, which need to be reorganized, updated and revised to generate new knowledge. In other words, when there is high task analyzability, people can study to resolve problems. We thus perceive that when there is low task analyzability, socialization and externalization on a rich web 2.0 platforms would have greater effect on knowledge transfer success. While combination and internalization on a lean social web platform would be an appropriate strategy for transforming existing explicit knowledge into new explicit knowledge required for resolving highly analyzable tasks. The various hypotheses as discussed above are illustrated in figure 3.

H9. Task analyzability inversely moderates the relationship between the use of web 2.0 applications for socialization and knowledge transfer and creation.

H10. Task analyzability inversely moderates the relationship between the use of web 2.0 applications for externalization and knowledge transfer and creation.

H11. Task analyzability directly moderates the relationship between the use of web 2.0 applications for internalization and knowledge transfer and creation.

H12. Task analyzability directly moderates the relationship between the use of web 2.0 applications for combination and knowledge transfer and creation.

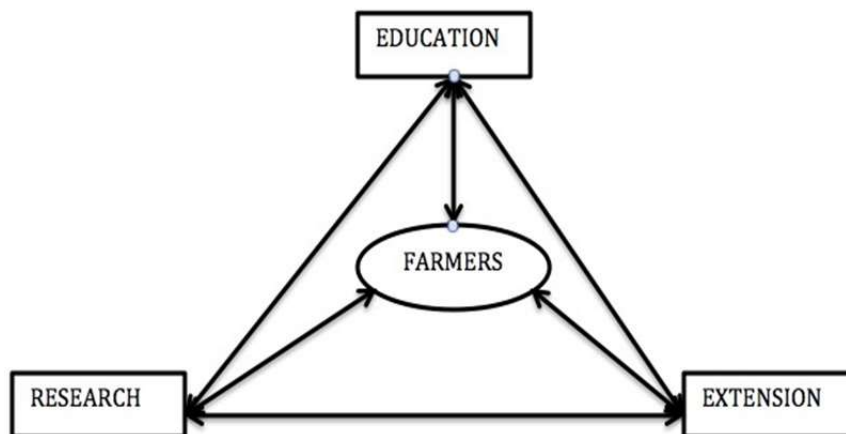
The AKIS Model

Overview of the AKIS Framework

(Nagel, 1979) was the first to introduce and describe the characteristics of the Agricultural Knowledge Systems (AKS). Rölting developed the AKIS framework further and popularized it by including the information component to make it AKIS. In the AKIS for Rural Development (AKIS/RD) framework four main actors are identified and integrated to generate, share, and utilize agriculture-related technology and knowledge. In this model, farmers, researchers, extension agents, and agricultural educators are linked together to form the knowledge triangle to harness knowledge and information from multi-sources for improved farming practices and better livelihood (Gyamfi, 2017). Thus, the primary stakeholders of agricultural-based knowledge and information sharing should be researchers, extension officers and the farmers with the underlying factor being effective communication among these stakeholders. Farmers are at the center of the knowledge triangle with education, research, and education providing services, which are designed to respond to the knowledge needs required by the farmers to improve their productivity, incomes and welfare. However, farmers are not supposed to be passive

receivers of knowledge and technology via extension, but all the actors are supposed to have a stake in the process of knowledge generation, sharing and utilization.

**FIGURE 4
KNOWLEDGE ACTORS WITHIN AKIS FRAMEWORK**



Researchers are not to be seen as the sole supplier of knowledge, but considered as important partners of other social actors who are engaged in the generation and sharing of knowledge. To achieve this goal, various research strategies were designed (especially in the 1980s) to establish closer links among the actors in the knowledge triangle. These numerous approaches include farm system research, on-farm adaptive research, farmer-back-to-farmer, farmer-first-farmer-last, had a common focus on farmers and their involvement at the various stages of the research process. Some authors are of the view that without the full participation of farmers, the technology developed is unlikely to meet their needs.

The study perceives that the use of web 2.0 technologies for knowledge sharing among the primary knowledge actors as proposed in the AKIS framework, could translate into enhanced interactive communication among the knowledge actors towards attainment of knowledge sharing success.

Development of Research Framework (AKIS 2.0)

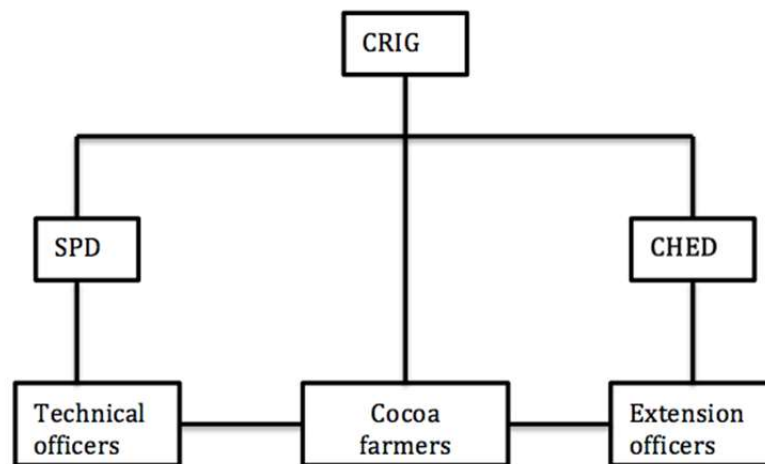
Proposed AKIS 2.0 model for web 2.0 usage for knowledge creation and transfer. The research framework is based on the proposition that knowledge actors' use of web 2.0 applications for knowledge sharing would affect the level of interactions between farmers and extension agents, researchers and farmers, and researchers and extension officer. The high degree of richness of web 2.0 technologies makes it possible for knowledge actors to interact easily while sharing knowledge, without having to be in physical contact with each other. In the words of the MRT, the ability of web 2.0 to allow users to send and receive instant feedback, to tailor interactions to suit personal focus, to provide multiple cues, and language variety could facilitate interaction among knowledge actors. According to the SECI model, interaction plays a key role in the knowledge creation and transfer process. It is through interaction among individuals or between individuals and their environment that knowledge is created and transferred (Nonaka et al., 2000). Knowledge is supposed to flow in three forms through interactions between: farmers and extension agents, researchers and farmers, and researchers and extension officers. Effective interaction among knowledge actors require the choice of appropriate communication media based on the relationship between the richness of the media and the degree of tacitness of knowledge.

The Cocoa-based AKIS Model for Ghana

The cocoa industry in Ghana is viewed by this study as composing of specific groupings of organizations with highly similar activities in relation to cocoa production. Knowledge sharing activities in the industry are therefore not very different from those as pertained in inter-organizational knowledge

transfer but with intra-organizational properties. And so, the ability of the various organizations within the industry to send and receive knowledge is crucial for a successful outcome of the knowledge transfer process (see Fig. 6). At the heart of the cocoa industry is the farmer, while all the other institutions (such as COCOBOD, agricultural educators, Licensed Cocoa Buying Companies, Agricultural Input Dealers and NGO's) provide services designed to satisfy the needs of the farmer for knowledge to improve their yields, income, and welfare, while helping them to manage their farmlands in a sustainable way. This means that the various potential sources of knowledge (such as cocoa research institutions) in the cocoa industry should be clearly identified and made known to cocoa farmers who are the primary recipients of knowledge, as suggested in the knowledge triangle (see figure 4).

FIGURE 5
HIERARCHICAL KNOWLEDGE FLOW MAP FROM COCOBOD TO COCOA FARMERS



In addition to that, there is the need to also establish knowledge networks among researchers, farmers, extension agents and other major sources of cocoa related knowledge, for sustained interactions among them. Primary data was collected from farmers, researchers and extension workers as target respondents. The collected data was then analyzed using statistical tools mainly SPSS and SmartPLS and the outcome of the analysis is presented and discussed in the proceeding sections.

Web 2.0-based AKIS Model

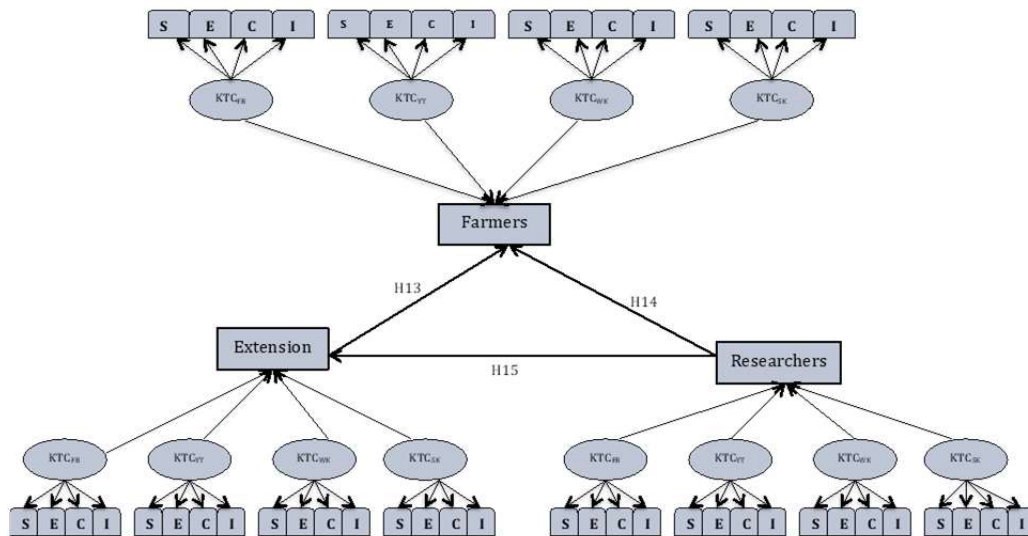
The last objective of the study was to recommend a web 2.0-based AKIS model for web 2.0 usage for knowledge sharing among knowledge actors within the context of agriculture. Based on the theoretical underpinnings involving the combination of three theories of AKIS framework, SECI model and the MRT and the proposed hypothesis in the previous sections, a new conceptual framework, AKIS 2.0 is proposed (see Fig.5). The proposed AKIS 2.0 model indicates that web 2.0 technologies have the abilities to support all the SECI process involved in the knowledge sharing behavior of knowledge actors. According to the AKIS 2.0 model, the media richness of the web 2.0 technologies makes them suitable for supporting all the SECI processes involved in knowledge sharing. Moreover, the use of web 2.0 technologies by knowledge actors not only facilitates knowledge sharing but also enhances interactive communication among knowledge actors. The proposed model would help in gaining further clarity in the subject of web 2.0 usage for knowledge sharing among knowledge actors in agriculture. The model reveals an important connection between media richness and the tacitness of knowledge thereby making it usable for the selection of appropriate social web application for the SECI processes.

Developing Hypotheses for AKIS 2.0

Socialization: The use of web 2.0 applications for socialization, allows knowledge actors to interact freely in small groups at community level, while allowing them to observe, imitate, and practice without having to be present physically at those communities even though being there face-to-face would be the ideal situation sometimes.

H13. *The use of web 2.0 for knowledge sharing would enhance interaction between farmers and extension workers.*

**FIGURE 6
PROPOSED AKIS 2.0 FRAMEWORK**



Externalization: Knowledge actors' use of web 2.0 for externalization, allows them to engage in extensive dialogue thereby helping them to convert their tacit knowledge base into shared experiences. Doing so enhances interaction among knowledge actors across the knowledge triangle.

H14. *The use of web 2.0 for knowledge sharing would enhance interaction between farmers and researchers.*

Similarly, the use of web 2.0 applications for combination and internalization also involves interactions between knowledge actors and in one-way or the other. Thus, the ability of web 2.0 applications supporting all the four types of knowledge creation and sharing. Since all the SECI processes involve interaction among the different groups of knowledge actors it's unsurprising that the use of web 2.0 applications for knowledge sharing through SECI processes could enhance interactions among various groups of knowledge actors.

H15. *The use of web 2.0 knowledge sharing would enhance interaction between researchers and extension.*

RESULTS

Model Specification and Measurement Model

The proposed model is used for testing the hypotheses of the study by way of gaining further clarity on the relationship among media richness, knowledge sharing processes, task characteristics and knowledge transfer success. The section details the validation of the model as well as testing the hypothesis through the use of PLS-SEM (structural equation modeling). The results of both the validation of the measurement model and the structural model for the testing of the hypotheses were obtained from the use of SmartPLS (Ringle et al., 2013) and include the test for construct reliability, convergent validity as well as test for discriminant validity. First of all, the data was modeled to examine the effect of media richness of the individual web 2.0 applications on their usage for the SECI processes and how their usage impact on the knowledge creation and transfer. Moreover, the moderating effect of task analyzability on the use of web 2.0 applications' impact on knowledge transfer success was then examined.

TABLE 1
CONSTRUCT RELIABILITY AND VALIDITY

	Cronbach's Alpha				Composite Reliability				Average Variance Extracted (AVE)			
	FB	WIKI	YT	SKY	FB	WIKI	YT	SKY	FB	WIKI	YT	SKY
COM	0.723	0.820	0.781	0.772	0.827	0.881	0.859	0.854	0.546	0.650	0.605	0.596
EXT	0.833	0.788	0.788	0.723	0.889	0.864	0.863	0.827	0.669	0.615	0.615	0.547
INT	0.833	0.695	0.723	0.787	0.888	0.815	0.827	0.864	0.665	0.526	0.546	0.622
KTC	0.887	0.870	0.853	0.887	0.911	0.898	0.887	0.911	0.563	0.525	0.500	0.563
MR	0.787	0.723	0.820	0.781	0.865	0.827	0.881	0.859	0.623	0.547	0.650	0.606
SOC	0.760	0.805	0.826	0.826	0.839	0.866	0.878	0.878	0.515	0.571	0.590	0.591

TABLE2
FORNELL-LARCKER CRITERION FOR DISCRIMINANT VALIDITY
(ALL WEB 2.0 APPLICATIONS)

		COM	EXT	INT	KTC	MR	SOC
FACEBOOK	COM	0.739					
	EXT	0.633	0.818				
	INT	0.667	0.579	0.815			
	KTC	0.753	0.694	0.718	0.751		
	MR (FB)	0.631	0.580	0.567	0.659	0.789	
	SOC	0.745	0.732	0.624	0.773	0.654	0.718
WIKIPEDIA	COM	0.806					
	EXT	0.783	0.784				
	INT	0.605	0.738	0.726			
	KTC	0.750	0.752	0.718	0.724		
	MR (WIKI)	0.658	0.760	0.714	0.731	0.739	
	SOC	0.668	0.730	0.681	0.725	0.687	0.755
YOUTUBE	COM	0.778					
	EXT	0.765	0.784				
	INT	0.730	0.759	0.739			
	KTC	0.758	0.795	0.758	0.707		
	MR (YT)	0.653	0.786	0.662	0.685	0.806	
	SOC	0.624	0.727	0.720	0.726	0.730	0.768
SKYPE	COM	0.772					
	EXT	0.737	0.739				
	INT	0.645	0.630	0.788			
	KTC	0.758	0.751	0.660	0.751		
	MR (SKYPE)	0.731	0.732	0.640	0.747	0.779	
	SOC	0.689	0.713	0.618	0.769	0.621	0.769

TABLE 3
SUMMARY OF RESULTS OF MODEL 1(T-VALUES) FOR ALL THE APPLICATIONS

	Facebook	Wiki	YouTube	Skype
MR -> COM	16.801***	18.944***	18.150***	25.136***
MR -> EXT	14.675***	31.728***	34.947***	22.844***
MR -> INT	14.451***	23.466***	19.127***	18.878***
MR -> SOC	18.237***	19.651***	26.462***	16.269***
SOC -> KTC	5.342***	5.075***	4.878***	6.773***
COM -> KTC	4.741***	6.399***	5.484***	5.417***
EXT -> KTC	3.011**	2.304**	4.985***	4.188***
INT -> KTC	6.659***	5.652***	3.094**	2.738**

*(Note: t-values are in parentheses; path coefficients are recorded before the parentheses and path coefficients are significance at levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$)*

Afterwards a second-order hierarchical analysis was conducted to access the effect of web 2.0 usage for knowledge creation and transfer through SECI processes on interaction among key knowledge actors in the cocoa sector of Ghana. Overall, the analysis was in three parts: first the estimation of the measurement model, followed by the first-order structural modeling, and then second-order hierarchical multi-group analysis. The proposed model of the study mainly comprised of first-order latent variables namely: Media Richness (MR) of web 2.0 applications (Skype (MR Skype), Facebook (MR FB), YouTube (MR YT), Wikipedia (MR WIKI)), Web 2.0 usage for the modes of knowledge transfer (KT 2.0), (Socialization (SOC), externalization (EXT), internalization (INT) and combination (COM)), Task Analyzability (TA) and Knowledge Transfer and Creation (KTC). KTC serves as endogenous dependent variable to the four exogenous constructs (SOC, EXT, INT, COM), which also serve as endogenous variable to MR. TA is, modeled as moderating variable between web 2.0 usage for knowledge transfer modes and knowledge transfer success.

Structural Model

Results of Hypotheses 1-4

The main objective of these hypotheses was to test whether the media richness of the selected web 2.0 applications could influence their usage for the different modes of knowledge transfer as theorized in the SECI model and MRT. The results of the analysis of model 1 indicate that there is a positive relationship between media richness of Web 2.0 applications and their usage for socialization, externalization, internalization and combination as proposed in the study (see table 8-23). Thus, hypothesis H1, H2 H3 and H4 are all supported by the results of the findings of the study

Results of Hypotheses 5-8

Moreover, from model 1 the results of the analysis indicate that, there exists a positive relationship between the use of Web 2.0 applications for the SECI processes and knowledge transfer and creation in support of hypotheses (H₅-H₈) (see table 4). In other words, the use of web 2.0 applications for SECI processes could lead to knowledge transfer and creation.

**TABLE 4
SUMMARY OF FINDINGS FOR MODEL**

Hypotheses	Relationship	Facebook	Wiki	YouTube	Skype
H₅	SOC -> KTC	5.342***	5.075***	4.878***	6.773***
H₆	COM -> KTC	4.741***	6.399***	5.484***	5.417***
H₇	EXT -> KTC	3.011**	2.304**	4.985***	4.188***
H₈	INT -> KTC	6.659***	5.652***	3.094**	2.738**

TABLE 5
SUMMARY OF RESULTS FROM INTERACTION MODELS

Summary	Skype	FB	Wiki	YouTube
MR (SKYPE) -> COM	0.731(27.339)***	0.631(16.533) ***	0.658(19.058) ***	0.653(17.681) ***
MR (SKYPE) -> EXT	0.732(25.944)***	0.580(15.628) ***	0.760(31.635) ***	0.786(33.935) ***
MR (SKYPE) -> INT	0.640(20.295)***	0.567(14.766) ***	0.714(24.229) ***	0.662(19.923) ***
MR (SKYPE) -> SOC	0.621(17.450)***	0.654(17.504) ***	0.687(21.060) ***	0.730(27.144) ***
SOC -> KTC	0.279(6.002)**	0.185(3.412)**	0.233(4.838)**	0.127(2.569)**
COM -> KTC	0.233(4.225)**	0.131(2.242)**	0.345(5.979) ***	0.279(5.771) ***
EXT -> KTC	0.213(4.082)**	0.177(3.548)**	0.159(2.699)**	0.274(4.696) ***
INT -> KTC	0.117(2.454)**	0.246(5.626) ***	0.273(5.695) ***	0.172(2.988)**
TA -> KTC	0.139(3.178)**	0.278(5.558) ***	-0.050(0.953) NS	0.137(3.045)**
TA*COM -> KTC	0.016(0.328) NS	-0.056(1.165) NS	0.010(0.106) NS	0.027(0.533) NS
TA*EXT -> KTC	0.042(0.592) NS	-0.081(1.763) NS	0.084(0.938) NS	0.080(1.249) NS
TA*INT -> KTC	0.008(0.154) NS	0.043(1.172) NS	-0.048(0.980) NS	-0.102(0.985) NS
TA*SOC -> KTC	0.004(0.068) NS	-0.072(1.562) NS	-0.029(0.608) NS	-0.040(0.615) NS

Results of Hypotheses 9-12

The objective of hypotheses (H₈-H₁₂) was to test whether task analyzability moderates the relationship between the use of web 2.0 applications for socialization, externalization, combination and internalization and knowledge sharing. According to the results of the analysis, the moderation of task analyzability failed to gain support for all the web 2.0 applications leading to the rejection of Hypotheses (H₈-H₁₂) (see table 5).

Results of Hypotheses 13-15

The results of the bootstrapping criterion of the hierarchical web 2.0-based AKIS model (AKIS 2.0) of the study are recorded in table. According to the results, all the hypotheses (H₁₃-H₁₅) gained support. Thus, the results demonstrate strong linkages among all the knowledge actors (extension-farmers, researchers-farmers, and researchers-extension) obtained from their usage of web 2.0 applications for knowledge creation and transfer through SECI processes. The summary of results of the analysis are recorded in table.

TABLE 6
SUMMARY OF FINDING OF SECOND-ORDER ANALYSIS

	Path Coefficients	T Statistics	Significance Level	P Values
EXTENSION -> FARMERS	0.860	44.622	P<0.001	0.000
RESEARCHERS -> EXTENSION	0.439	11.750	P<0.001	0.000
RESEARCHERS -> FARMERS	0.520	18.757	P<0.001	0.000

TABLE 7
SUMMARY OF FINDINGS OF HYPOTHESES(H1-H12)

Hypothesis	Dependent Variable	Independent Variable	Moderating variable	Results
H1-H4	SOC, EXT, COM. INT	MR		Accepted
H5-H8	KTC	SOC, EXT, COM. INT		Accepted
H9-H12	KTC	SOC, EXT, COM. INT	TA	Rejected

TABLE 8
MEDIA RICHNESS AND USAGE OF WEB 2.0 APPLICATIONS FOR SECI PROCESSES

MR/Usage	Socialization	Externalization	Combination	Internalization
Media Richness	Facebook	YouTube	Skype	Wikipedia
Usage	Skype	YouTube	Wikipedia	Facebook

DISCUSSIONS

Discussion of Key Findings

The results of the analysis confirm the proposition that the media richness of web 2.0 applications affect their usage for knowledge sharing (SECI processes) among knowledge actors in the Ghanaian cocoa industry. Consequently, the media richness of the web 2.0 applications makes them suitable for all the SECI processes involved in sharing knowledge among knowledge actors. On the contrary, the original SECI model proposed that, knowledge sharing which has tacit knowledge as input (socialization and externalization) require the use of the highest form of rich media, face-to-face whereas internalization and combination require the use of lean media, referred to as virtual media. The implication is that, web 2.0 applications, which belong to the virtual media class wouldn't be able to support socialization and externalization. However, based on the statistical values (t-statistic) knowledge actors in the cocoa industry in Ghana perceived that the richness of Skype and Facebook, though not to the same degree as face-to-face media, would make them more appropriate for socialization and externalization, whereas Wikipedia and YouTube were deemed more suitable for internalization and combination. Other contrasting results regarding ICT usage for tacit knowledge transfer through socialization, externalization, and internalization also exist in literature (Lee and Choi, 2003). Possible explanation to the discrepancy could be due the fact that originally, SECI was based on web 1.0 technologies and traditional approaches and therefore fails to explain the phenomenon within the context of contemporary media such as web 2.0, which are highly-interactive and multi-user entertainment oriented as used in multi-player online games technologies. Overall, Facebook was found to be most suitable for socialization and internalization, while Skype was preferable for socialization and combination (see table). Although the richness of a given web 2.0 application would make it suitable for a given task (e.g. Facebook for socialization), respondents preferred using it for internalization.

The findings of the study failed to establish the proposition that task analyzability moderates the relationship between web 2.0 usage for SECI processes and knowledge transfer and creation in the cocoa industry in Ghana. The success of using web 2.0 for knowledge sharing doesn't depend on the availability of laid-down procedures. Task analyzability has been shown to moderate SECI processes and knowledge transfer success. However, these studies were based on face-to-face based traditional transfer mechanisms

such as observation and apprenticeship. Moreover, these studies took place within organizational context where there are laid down procedures for almost every task. The current study took place in an environment where tasks are less structured and uncoordinated and within the interactive space of web 2.0 technologies.

It was again theorized in the study that knowledge actors' use of web 2.0 applications for knowledge creation and transfer would enhance the level of interactions between cocoa farmers and extension agents, researchers and cocoa farmers, and researchers and extension officers and the findings of the study confirmed that. The research results show that using web 2.0 applications for knowledge sharing would improve interactions among knowledge actors. The media richness of the web 2.0 applications according to the findings of the study makes it easier for cocoa farmers, extensionists, and researchers to interact easily without having to be in physical contact. The ability of web 2.0 to allow users to send and receive instant feedback, to tailor interactions to suit personal focus, to provide multiple cues, and language variety could facilitate interaction among knowledge actors. On the contrary, findings from previous studies on cocoa-based AKIS indicated poor linkages across the knowledge triangle based on the existing knowledge channels used to interact among knowledge actors (Nana et al., 2013).

Implications of Findings

The findings from the study have implications on research, policy, and practice. Although previous studies have established the potential of web 2.0 in facilitating knowledge sharing, there wasn't a well-defined modality for selecting the appropriate technology for a given type of knowledge sharing. Through the interaction between knowledge tacitness and media richness, the study has brought to light how these two properties could be used as a guide in selecting the appropriate web 2.0 application for a given type of knowledge sharing. The finding thus has implication on management in the sense that prior to the study, many organizations were investing in web 2.0 applications that they didn't need at all, because there wasn't a clear relationship established between social media technologies and the different type of knowledge sharing. Now with the establishment of such as relationship, organizations can invest on only web 2.0 applications that are most needed at a point in time depending on the type of knowledge sharing they want to focus on at given point in time. The fact that the use of web 2.0 applications for the SECI processes could lead to knowledge creation and transfer has implications on the traditional extension methods and approaches. The TOT and T&V paradigms where extension activities could only be managed through face-to-face contact with farmers should give way to a new era of knowledge creation and transfer through enhanced communication via new media such as web 2.0 applications that enable extension agents to build interpersonal relationships with farmers through mutual trust without having to be in physical contact all the time. That is not to say that the existing mechanisms such as FFS approaches used for the creation and transfer of knowledge should all be supplemented with new media such as web 2.0 applications especially on mobile phone platforms.

Research Contribution

The study contributes to the existing body of literature of the fields of information systems, knowledge management, and communications. It has given further clarity regarding the relationship between media choice and knowledge management process among the key knowledge actors in the cocoa industry in Ghana. Perhaps, for the first time the study showcased the possibility of using new media such as web 2.0 application for knowledge creation and transfer among cocoa farmers, extension experts, and researchers in the cocoa industry in Ghana and suggests that the use of these media could enhance interactive communication among the knowledge actors for effective knowledge creation and sharing. The study highlighted on the weaknesses of the existing mechanisms in terms of their richness in supporting all the different stages of knowledge creation and transfer as against how web 2.0 applications could be used to support all the four modes of knowledge creation and transfer by enhancing interaction among the knowledge actors. Based on the above understanding on the relationship between media richness, web 2.0 usage for SECI processes and knowledge creation and transfer among key knowledge actors of the knowledge triangle in the cocoa industry, a novel model for knowledge creation has been

developed for the analysis of the choice and use of the appropriate media for knowledge creation and transfer in the cocoa industry in Ghana. It's composed of two tiers including knowledge management processes and agricultural knowledge and information processes. Emphasis is placed on holistic integration of media usage, knowledge conversion processes, and knowledge creation and transfer among key knowledge actors. According to the model, the choice and use of media for knowledge creation and transfer depends on its media richness and ability to facilitate the different modes of knowledge transfer (socialization, externalization, combination and internalization) among the key knowledge actors in the cocoa industry in Ghana.

Suggestions for Future Research

The study was mainly concerned with transferring knowledge through the use of Information Technology and was not focused on the need to increase the awareness of other social factors that could also affect the use of these technologies. Further research could be appropriate to include these social factors. The study limited task characteristics to task analyzability, meanwhile other task characteristic groups could have been identified and investigated. In the future the various tasks engaged by the cocoa farmers could be identified and categorized to examine which mode of transfer on a given web 2.0 platform would be suitable for accomplishing a given task or task characteristic group. Since the study was conducted in the Cocoa Industry in Ghana, the model could further be validated and applied in neighboring cocoa producing countries like Cote D'Ivoire to assess the impact the use of web 2.0 applications could have on the transfer of knowledge in other industries.

CONCLUSION

By amalgamating the media richness theory, the AKIS model, and the SECI model, the research investigated how the use of web 2.0 applications for knowledge creation and transfer through SECI processes could enhance interaction among key knowledge actors in the cocoa industry in Ghana. Four web 2.0 applications (Skype, Facebook, YouTube, and Wikipedia) were selected to represent web 2.0 usage. Overall, the results and findings of the research indicated that the media richness of web 2.0 applications make them suitable to be used for all the SECI processes to achieve effective knowledge sharing.

Moreover, the use of these applications for knowledge sharing would lead to improved interaction among knowledge actors. The evidence adduced in the study findings suggests that the use of web 2.0 applications for knowledge sharing could present a unique opportunity for a more efficient agricultural knowledge and information system by strengthening linkages through effective interactions among key knowledge actors towards improved agriculture productivity.

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