Research on Web 2.0 Usage for Knowledge Management Processes

the case of the Ghana cocoa industry (COCOBOD)

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RESEARCH ON WEB 2.0 USAGE FOR KNOWLEDGE MANAGEMENT PROCESSES

THE CASE OF GHANA COCOA BOARD (COCOBOD)

BY
ALBERT GYAMFI

DISSERTATION SUBMITTED 2017

AALBORG UNIVERSITY
DENMARK

Response to Comments

1) Regarding the disjuncture between the research question, research design, and the findings, a new set of data from the cocoa famers in Ghana has been collected, analyzed, and added to already existing findings for discussions.
Furthermore, the research model has been enhanced to include all knowledge actors: cocoa farmers, extension experts and researchers. An additional research question and corresponding set of three hypotheses regarding the interactions among all the three actors has been included, tested and findings discussed.

2) Concerning the unusual circumstances of the Ghanaian cocoa industry, chapter 2 has been updated with the inclusion of the marketing system, the production cycle and the farming processes, and the key players in the cocoa value chain, their roles and functions have also been considered.

3) In relation to the disjuncture between the empirical findings, and the theoretical narratives, the discussion chapter has been enhanced to include a bit more elaborative discussions of the findings and their implications on policy, research and extension. An enhanced research model based on the findings and the theoretical framework has also been proposed in the last chapter (chapter 9).

4) Regarding concerns raised about the adoption of the SECI model for the Cocoa sector of Ghana, some discussions have been introduced in chapter 4 in response to justification of the SECI model for the study. A relatively brief discussion of literature on the application of SECI in rural agricultural development in Africa has also been included. The raw data files are available in electronic forms and would be sent electronically to the committee by e-mail since it involves huge excel files that could not be printed out.

5) Chapter 7 has been shifted to chapter 3 and chapter 8 has been dissolved to be included in chapter 4 as part of the theoretical framework. Due to the inclusion of cocoa farmers on the demand side, comment 4 has been discussed as a delimitation in the introductory chapter.

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Dissertation submitted

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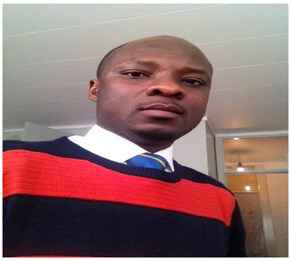
CV



Albert Gyamfi is currently a Ph.D Fellow at Aalborg University Copenhagen. He earned his Masters degree in Management Information System from the University of Ghana. His current research interest focuses on the broad field of knowledge management. He has general interest in the theoretical foundations of organizational behavior and organizational structures with a growing interest in organizational learning, organizational creativity and innovation. His current research is focused on how Information and Communications Technologies (ICTs) such as cognitive technologies and big data influence knowledge management both in organizations and agricultural communities.

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ENGLISH SUMMARY

The study investigates the impact of the use of web 2.0 applications on knowledge transfer in the Cocoa Sector in Ghana. For organizations to survive the turbulence of the emerging business environment, they need to create and transfer new knowledge. When knowledge is transferred successfully, it creates organizational capability and also serves as a driving force for organizational knowledge creation. Most organizations have developed measures to improve their knowledge transfer capabilities. Transferring knowledge via social media websites has received widespread attention by organizations and corporate leaders and also within academic literature. However, in most developing countries like Ghana, knowledge transfer still remains a major challenge, especially in the Cocoa Sector.

According to the Media Richness Theory, the selection of media for a given task depends on the richness of the media and the characteristics of the task. The four modes of knowledge transfer theorized by Nonaka, require the use of media with varying degrees of richness. Firstly, the study proposed that the usage of web 2.0 applications for the different modes of knowledge transfer can be affected by their media richness. Secondary, the relationship between the use of web 2.0 applications for the knowledge conversion modes and knowledge transfer success can be moderated by the characteristics of the task to be accomplished by the transferred knowledge.

The study was conducted using a mixed method approach with a survey questionnaire. The data was collected from a population of 332, which comprised of 62 researchers and 270 extension agents from CRIG, CHED and SPU. The results of the data analysis confirmed that the media richness of the selected web 2.0 applications affect their usage for the different modes of knowledge transfer with the moderation effect of task characteristics gaining partial support. The relationship between the use of web 2.0 for combination and knowledge transfer success was successfully moderated by task analyzability only for YouTube, externalization was found to be moderated by Skype and Wikipedia, internalization by Skype, and socialization by Facebook

DANSK RESUME

Studiet undersøger den indflydelse som brugen af web 2.0 applikationer har på overførsel af viden i kakaosektoren i Ghana. For at kunne overleve turbulensen i de fremvoksende erhvervsvilkår er organisationer nødt til at udvikle og overføre ny viden. Når viden overføres med succes, skabes der organisatoriske kapabiliteter, som udgør en drivkraft for organisatorisk udvikling af viden. De fleste organisationer har udviklet tiltag til at forbedre deres evner til overførsel af viden. Overførsel af viden via sociale medier har været genstand for udbredt opmærksomhed fra organisationer og virksomhedsledere og ligeledes i den akademiske litteratur. Men i de fleste udviklingslande såsom Ghana forbliver overførsel af viden til stadighed en udfordring, og det gælder i særdeleshed i kakaosektoren.

Ifølge teorien om Media Richness afhænger valget af medie til en given opgave af mediets ’rigdom’ (’fedme’) og af opgavens karakter. De fire former for overførsel af viden, som Nonaka har teoretiseret, kræver anvendelse af medier med forskellig grad af ’fedme’. Indeværende studie fremhæver for det første, at anvendelse af web 2.0 applikationer til forskellige former for overførsel af viden er påvirket af deres ’fedme’. For det andet kan forholdet mellem anvendelsen af web 2.0 applikationer og de forskellige former for konvertering af viden med henblik på succesfuld overførsel af viden modereres af karakteren af den opgave, som skal udføres på basis af overførsel af viden.

Studiet er blevet udført ved anvendelse af en ’mixed method’ (’blandet metode’) tilgang inkluderende en spørgeskemaundersøgelse. Data er blevet indhentet fra en population på 332 individer, omfattende 62 forskere og 270 ’extension agents’ fra CRIG, CHED og SPU. Resultaterne af analysen har bekræftet, at de udvalgte web 2.0 applikationers ’fedme’ påvirker deres anvendelse til de forskellige former for overførsel af viden, modereret af karakteren af den opgave, som understøttes. Forholdet mellem anvendelse af web 2.0 til kombination og succesfuld overførsel af viden blev med succes modereret af opgavens grad af analyserbarhed kun hvad angår YouTube; eksternalisering var modereret af Skype of Wikipedia; internalisering af Skype; og socialisering af Facebook.

DEDICATION

This thesis is dedicated to my lovely wife Patricia Agyeman Duah, and my wonderful kids Jair, Ursula, Afriyie and Godslove. I love you all.

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My Father in Heaven, I thank you for making this dream a reality. I would like to make a special mention of Anders Henten for his encouraging supervision of this thesis. Prof. Anders Henten, I really thank you for the patience, pieces of advice, encouragement and comments that guided and shaped up this research. Sir, I'm very grateful and appreciative of your support. Special thanks also go to Professor Knud Erik Skouby, Reza Tadayoni, Annete Bysøe and the entire staff of CMI, Aalborg University, Copenhagen-Denmark. I would like to say that you are such a wonderful family to work with.

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TABLE OF CONTENTS

TABLE OF FIGURES

CHAPTER 1. INTRODUCTION OF THE STUDY

1.1. INTRODUCTION

Ghana, like most cocoa producing countries, depends on cocoa as her major contributor of Gross Domestic Product (GDP) and foreign exchange earner (Chuhan-Pole & Angwafo, 2011; Williams, 2009). Cocoa provides employment for hundreds of thousands of people throughout the country with approximately one million cocoa producers, who are predominantly smallholder farmers, throughout the supply chain. Ghana is currently the world's second largest producer of cocoa, representing 21% of global production after Cote d'Ivoire. Cocoa production has gradually rebounded since the 1980s with 2011 hitting a record high of more than 1,004,194 tons for the 2010/2011 cocoa season, which is the highest in the country's history. In spite of the recent high level of production, Ghana's cocoa yield is still 25% below the average yield of the ten largest cocoa producing countries, and 40% below the average yield level of Cote d'Ivoire (Mohammed et al., 2012). The quality of the cocoa beans from Ghana has been known to be among the best in the world, which causes the country to earn premiums in the global market (Kollavalli & Vigneri, 2008), and the general performance of Ghana's cocoa industry has been described as an African success story (Williams, 2009). However, the productivity level has still remained low, with 50% to 65% of cocoa farmers producing 400Kg/ha with low technology (Laven & Boomsma, 2012). The cocoa sector in Ghana has not been fully liberalized, and is more or less controlled by the government through the Ghana Cocoa Board (COCOBOD, for short), which was established in 1947. In responding to the low productivity level in the sector, the COCOBOD has set aside over $100 million from the gross Free on Board (FoB) price, as a way to stimulate growth in the productivity levels among farmers, through Hi-tech programs, research and investments in Disease and Pest Control (Laven and Boomsma, 2012). The government's concern on the low productivity levels is again reflected in the launch of the National Cocoa Rehabilitation Program held on the 27th April, 2012, where the COCOBOD had made provision for 20 million seedlings, that are more disease and drought resistant, to farmers in order to increase yields.

The move to boost the productivity levels among cocoa farmers has of necessity, heightened up research activities, and the generation of new knowledge and technology in the sector, thereby requiring the need for effective knowledge transfer among the various knowledge producers and the farmers who are the ultimate end users of knowledge. In fact, a more efficient means of knowledge transfer from the research institutes and all other players to the cocoa farmers and communication platforms that would also enable the farmers to communicate their needs to the various knowledge producers is crucial if not critical, not only towards the upward adjustment of the productivity levels, but for the advancement and development of the sector as a whole. The functions of COCOBOD include production, research, extension, internal marketing, external marketing, and quality control. The operations of the board are classified into pre-harvest sector and post-harvest sector and effectively handled by its subsidiaries, namely: Quality Control Division (QCD), Cocoa Marketing Company (CMC), Cocoa Research Institute of Ghana (CRIG), Cocoa Health and Extension Division (CHED), and the Seed Production Unit (SPU). The QCD and CMC divisions are responsible for the post-harvest activities. The post-harvest activities include the quality control measures undertaken by QCD and the internal and external marketing of cocoa by the CMC. The context of this study is more related to the pre-harvest sector which is more concerned with the fundamental issues related to the actual cocoa production at the farm level and handled by CRIG, CHED and SPU.

CRIG is the central cocoa research base, where all major research activities into problems relating to the production of cocoa and other cash crops such as coffee, and sheanut take place. The CHED is responsible for the control; removal and destruction of the cocoa swollen shoot virus disease. This involves the cutting down of the virus-infested trees and replacing them with the swollen shoot resistant hybrid seedlings. They are also responsible for the training of extension staffs that are supposed to be the linking agents between the researchers and the cocoa farmers. The Seed Production Unit (SPU) is mandated for the production of and improvement of the high-yielding early bearing hybrid seedlings developed by CRIG. This thesis covers the key actors involved in the generation and transfer of knowledge, which include researchers from CRIG, and Community extension Agents (CEA) from CHED and SPU. The chapter focuses on the discussion of the core concepts of the study beginning with the outline of the background to the study. The chapter continues to give an overview of the entire study with discussions on the research questions, objectives of the research, research problem of the study, research strategy and methodology. It then closes with the scope of the study as well as the organization of the chapters.

1.2. BACKGROUND OF THE STUDY

Among the key factors that enable organizations to compete effectively is their capacity to leverage their existing knowledge and to create new knowledge that can position them advantageously in their chosen markets (Gold, et al., 2001). The ability of organizations to consolidate and reconcile their knowledge assets is crucial to their survival within the exponentially growing knowledge-based economy (Sun & Scott, 2005; Van Wijk, Jansen, & Lyles, 2008). In order to do this, enterprises should have a way of collecting, organizing, clarifying, disseminating, and most importantly, transferring knowledge. In recent years not only has Transferring knowledge been considered important but has also received widespread attention by organizations and corporate leaders as well as within academic literature (Sun & Scott, 2005; Van Wijk et al., 2008). When knowledge is transferred successfully it creates organizational capability (Kogut & Zander, 1992). Achieving success in knowledge transfer can be a driving force for knowledge creation endeavor (Kang et al., 2010). A number of studies in the field of knowledge management and knowledge transfer are related to cases of organizations in the developed economies with very little in the region of the Sub-Saharan Africa. Much of the studies done in the arena of knowledge management are conducted in knowledge-intensive organization, which are resource-endowed with highly educated populace. Little attention is paid to agricultural institutions in Africa such as the cocoa industry in Ghana, which is characterized by ageing smallholder cocoa farmers with very high rate of illiteracy (Mohammed et al., 2012). Meanwhile, access to knowledge and information is regarded as crucial and lack of it is more critical in agriculture than any other area of human endeavor (Baah & Anchirinah, 2011; Baah, Anchirinah, & Badu-Yeboah, 2009). Not only do cocoa farmers need interventions such as access to credits, they are also after information and knowledge that are timely and cost effective so that they can capture the moment and benefit.

Considering the critical need of knowledge to cocoa farmers, the Cocoa Research Institute of Ghana (CRIG) is dedicated mainly to conduct cocoa research. For almost 70 years CRIG which started as West Africa Cocoa Research Institute (WACRI) has remained focused as a reputable research institute and has accumulated enormous amount of knowledge on almost all aspects of cocoa cultivation (Baah, 2006). However, according to World Bank's report (2011) on supply chain risk assessment in the Ghanaian cocoa industry, crop diseases and insect pests such as black pod, cocoa mirids/capsids, swollen shoot, mistletoe and so on, pose the greatest risk to the cocoa supply chain in Ghana. Interaction with some of the cocoa farmers indicates clearly that very little of the knowledge generated is able to reach to them. The interest has to be shifted to how much of this knowledge generated through research is effectively transferred to the poor cocoa farmers in whose interest the knowledge is generated, and has also paid for their services through indirect taxation (Baah, 2006).

Up until now, The traditional 'training and visit' extension system which is widely propagated by the World Bank where extension agents visit farmers individually or in groups to demonstrate agricultural best practices is what is being relied on in most institutions in developing countries (Birner & Anderson, 2007). Transfer of knowledge by COCOBOD is largely established on this form of agricultural extension system with 192 Community Extension Agents (CEA) providing knowledge support for 800,000 cocoa families.

A major challenge with the extension system is that most cocoa farmers live in remote villages where access to good road infrastructure is non-existent making the cost of transferring knowledge through face-to-face interaction very high. The high cost of reaching farmers may result in limiting the reach of extension agents to farmers leading to inability to provide knowledge that is timely or some farmers not receiving any new knowledge at all. Moreover, researchers and extension agents depend on broadcasting technologies, news papers, leaflets and other face-to-face engagements to communicate their research findings to the cocoa farmers most of who are aged and illiterate (Baah and Anchirinah, 2011). The cumulative effect of these challenges limits the effective flow of knowledge from researchers to cocoa farmers. This can also affect farmers' readiness to adopt new technologies to improve productivity.

The emergence of web 2.0 applications and rapid growth of mobile phones creates an opportunity to support if not replace some of these mechanisms with more interactive medium for the transfer of knowledge to cocoa farmers at anytime anywhere. Interacting with some stakeholders in the cocoa industry prior to this study suggested a mixed perception. To one group, the use of social media for knowledge transfer to cocoa farmers is far-fetched since most of the farmers are aged and illiterate. Others are of the view that with some education on how to use social media and Smartphone it would be very effective means of transfer. This gives some indication of the need for clarity regarding the potential of web 2.0 usage for knowledge transfer to the cocoa farmers in Ghana. A probe into how these social web applications can influence knowledge transfer in the Ghanaian cocoa industry can be a strategic area of interest.

1.3. CONCEPTS AND PRINCIPLES OF WEB 2.0 TECHNOLOGIES

The term web 2.0 is defined as "the business revolution in the computer industry caused by the move to the Internet as a platform, and an attempt to understand the rules for success on that new platform. Chief among those rules is this: Build applications that harness network effects to get better the more people use them" (Musser & O'Reilly, 2007). Web 2.0, which was originally coined in 2004 by O'Reilly Media, is used to refer to a second-generation approach to the World Wide Web (WWW) with community-driven services such as social networking sites, blogs, wikis, etc. (O'Reilly, 2006; Paroutis & Saleh, 2009). The capabilities of web 2.0 has shifted the focus of end users from being passive content consumers to active user participation where they are allowed to collaborate, communicate, create, control, and share contents using the web as a medium for communication. Web 2.0 tools come in different forms and classes including blogs, collective intelligence (wikis), digital content management (media sharing), social networks, mash-ups, virtual worlds, RSS (Really Simple Syndication), tagging, peer-to-peer programs and so on.

Blogs are personal Web diaries that allow individuals to bring up their ideas, experience and opinions on a subject to bear. Blogs can combine texts, images, sound, video, links to other blogs and websites. Technorati, blogger.com and engadget.com are few web applications of blogs. *Collective intelligence (Wiki)* is a co-authorship tool used for building up shared knowledge within the web 2.0 environment. Web application of wikis includes websites that allow users to freely add, delete and upgrade content using web browser. The most popular example of a wiki web application (website) is Wikipedia, which is an Internet encyclopedia that is co-authored by users. *Digital content management* refers to the group of websites that allow users to share videos, sounds and images being it personal or professional with other end-users. Podcast is an example of a content management tool that allows the sharing of sound files uploaded on the Internet. Popular websites that use these media sharing tools include YouTube and Podcast Alley. *Social networking* tools allow users to connect on shared interest, hobbies, values or friends via online. Social networking websites like Facebook incorporate some of the applications already mentioned above to allow members to connect with those they choose to interact.

Mash-up is a website tool that combines content from more than a single source to form an integrated experience. Mash-ups are used to combine data from different sources to form a unique and distinct web service, which was not originally present at those sources used. Facebook is an example of social network website that applies mash-ups to merge, join, filter, annotate, web accessible data to form micro-integrated service in a single web interface. *Virtual world* represents a simulated form of interactive environment, which can be accessed through an online interface. Virtual worlds allow users to meet and interact online with a real world experience. Each end-user is represented in three-dimensional domain within the virtual world through 'avatars'. Six features are common with all virtual worlds: shared space, graphical user interface, immediacy, interactivity, persistence, and community.

Really Simple Syndication (RSS) is an alert technology used to update end-users about blogs or articles that were previously defined by the user. These usually come in the form of short messages to notify users about articles that are newly published on their own selected topics of interest or news update. RSS-enabled websites allow users to subscribe to websites so that they can receive new contents automatically instead of checking the website manually for updates. *Tagging* is online form categorization tool that allows users to assign one-word descriptors to bookmarks so that they can remember and organize them easily. Tagging makes information easy to search, discover and navigate over time. Folksonomies are user-generated taxonomies that help people to connect with contents in social software and also aggregate contents from different sources into a common subject-related location. Examples of web 2.0 application that make use of tags include Flickr, which allows users to tag photos for categorization, del.icio.us for website bookmarks, and Technorati for blogs. *Peer-to-peer* technologies involve computers on the same network sharing parts of their transmission capacities or contents with other users.

Skype technologies is an example of peer-to-peer application that use part of the connection capacity of all the users that are signed-in, to keep the system running.

Web 2.0 tools have also been adopted in organizations as social software, to support human communication, interaction, and collaboration within organizations. Just as the term intranet was coined out of Internet to represent the implementation of Internet technologies within organizations, the term Enterprise 2.0 was phrased by McAfee (2006) to symbolize the application of web 2.0 technologies inside the organization. According to McAfee (2006), "Enterprise 2.0 is the use of emergent social software platforms within companies, or between companies and their partners or customers"(McAfee, 2006). Different classification models have been created in attempt to clarify the functions, tools and web application of web 2.0 in organizations. These classification models include SLATE, FLATNESSES and 4C models designed by McAfee's (2006), Hinchcliffe (2007), and Cook (2008), respectively (Cook, 2008; Hinchcliffe, 2007; McAfee, 2006).

According to the SLATES model, the web 2.0 tools that can be employed by organizations fall into six classes namely: search, links, authoring, tags, extensions and signals. Search technologies involve the tools that enable intranet users to find what they are looking for. Links provide guide to users on what they are searching for and provide structure to the online content. They represent the foundational basic unit of connecting the entire web together (Hinchcliffe, 2007). Authoring technologies allow people to create contents for a broad audience either individually or collaboratively. Tags are tools that are used mainly for content categorization. Extensions take tagging a step further to introduce automation into the categorization process and pattern matching.

Extension results from a combined use of tags, authoring and linking tools, which enables knowledge systems to identify patterns, which is used as extension to information and relationships. Signals represent tools used to draw users' attention when updates of their contents of interest appear. Tools like RSS (Really Simple Syndication) feed are used by bloggers to provide notifications to users each time they update their contents. Aggregators are used to query sites for updates, download them, put them in order and provide notice in the form of headlines to interested users (McAfee, 2006). Dion Hichcliffe (2007) presented another classification model called FLATNESSES (Freeform, Links, Authorship, Tagging, Network-oriented, Extensions, Search, Social, Emergence, and Signals) to augment the SLATES model, to capture the social, emergent, network-oriented and freeform aspects of Enterprise 2.0.

Cook (2008) introduced a pragmatic model he referred to as the 4Cs model. According to the 4Cs approach, social software could be categorized into communication, cooperation, collaboration, and connection tools. Communication tools are platforms that allow users to converse among themselves via text, image, voice, video, or a combination of these. Communication social software enables people to engage in informal communication, which is necessary for building up effective and ongoing relationship. Social software that supports informal organizational communication includes blogs (audio, video), IM tools, Podcasts, Virtual world and web-conferencing (a combination of face-to-face and telephone communication).

Cooperation with regards to social software involves division of tasks into subtasks with no pre-defined goals where individuals assigned to the various subtasks retain authority of their contributions and share information as and when needed (Cook, 2008). The job of the cooperative social software then is to assemble data to show the combined picture of the overall task. They rely mostly on network effect to deliver maximum value to both the individual and the organization at large (Cook, 2008). Sharing is among the main functions of cooperative social software since its real value depends on individual's own usage as well as other people's usage of the software. Examples include media sharing, social bookmarking, and social cataloguing.

Collaborative social software refers to the group of software that enables group of individuals to solve specific problems through coordination of efforts with a shared commitment and common goals. The main focus of collaboration is on the knowledge generated from the process of developing a product. Examples of collaborative social software include wikis, blogs and virtual communities of practice.

Connection social software relies on networking technologies to allow people to connect to others as well as content. Such tools include social networking, tagging, search, syndication (RSS), and Mashups. Collaboration and connection tools require people to work in a more structured manner as compared with cooperation and communication tools. Similarly, collaboration and cooperation social software require relatively more interaction than connection and communication tools due to their potential in supporting group activities rather than individuals (Cook, 2008). Organizational structures and culture can also influence the choice of the appropriate web 2.0 tools in organizations. Organizations with formal structures and a culture of group interactions are better served with collaboration tools, whereas those with informal structures and a culture for rewarding individual innovative efforts would like to invest in web 2.0 tools that support communication (Cook, 2008).

Web 2.0 usage at the organizational level could be analyzed in two dimensions: technology adoption and user orientation. The technology adoption dimension involves either adoption of web 2.0-system infrastructure (such as SOA and AJAX) or web 2.0 software applications.

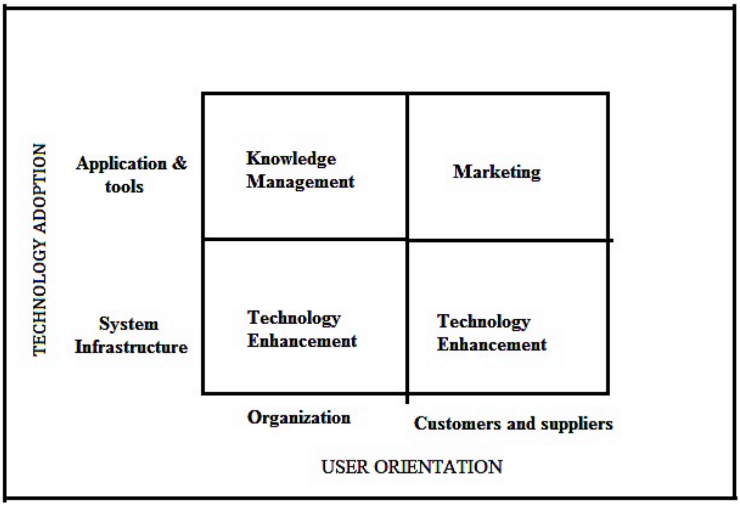

Figure 1-1: Adopted from Levi (2009) 1

User orientation adoption type involves employing web 2.0 technologies for use by members in organization or for use by customers, partners and suppliers of the organization (Levy, 2009). The adoption of web 2.0 in knowledge management initiatives in organizations involves the use of web 2.0 applications such as wikis and blogs for the transfer and sharing of knowledge. The use of these applications on the public Internet platforms (Social websites) such as Skype, Facebook, YouTube, and Wikipedia have become a strategic communication channel used by organizations to reach out to both external and internal audiences and that is the focus of the current study. The study focuses on these four social webs due to the popularity of their usage in the cocoa industry in Ghana, especially among extension agents and researchers.

1.4. PROBLEM STATEMENT OF THE RESEARCH

According to the knowledge spiral model, knowledge moves from the individual level and becomes embedded within the organization through four modes of conversion: socialization, externalization, internalization, and combination (Cummings & Teng, 2003; Dinur, 2009; Nonaka, 1994). These modes of knowledge conversion result from the continuous and dynamic interplay between the tacit and explicit forms of knowledge. As a result of the interaction between the two forms of knowledge, organizations are able to create new knowledge from existing knowledge by continuously managing the four knowledge conversion modes in a cycle (Alavi & Leidner, 2001; Dinur, 2009; Nonaka, 1994). A major underlying feature of these conversion processes is interaction (Nonaka, Toyama, & Konno, 2005).

According to the Media Richness Theory (MRT) different media have different degrees of richness. Some media are richer than others and so before choosing to use a medium for a communication task such as knowledge transfer, there is the need to factor into it the richness of the media being used to accomplish the task. When managers choose media with the characteristics that fit the characteristics of the task they perform, their performance would improve (Daft & Lengel, 1986). The different modes of knowledge transfer require media with varying degrees of richness (Nonaka et al. 2000). While some of the knowledge transfer modes require highly rich media, others require media of low richness. When the media with the appropriate richness is not used for the required mode of transfer, it can affect knowledge transference and performance. This makes the selection of appropriate media an important aspect of the knowledge transfer process (Murray & Peyrefitte, 2007; Panahi, Watson, & Partridge, 2013). The usage of a media for the accomplishment of a given task depends not only on the richness of the media but also on the characteristics of the task the media is used to perform (Daft & Lengel, 1986). The relationships among knowledge conversion processes, task characteristics and media richness have been established in literature but in compartments (Murray, 2003; Anothayanon, 2006). While some of the studies focused on the relationships among knowledge conversion, task characteristics and knowledge transfer others focused on media richness and knowledge transfer with none of them examining the holistic relationship among the four constructs. Meanwhile, the fact that the richness of a medium qualifies it to be used for a given mode of knowledge transfer does not guarantee the accomplishment of knowledge transfer success. It should therefore be necessary to take into consideration, the nature of the task the knowledge being transferred is to accomplish. The key argument here is that the success of the knowledge transfer process can be affected by the richness of the media used for the transfer as well as the characteristics of the task the transferred knowledge is to accomplish (Anothayanon, 2006; Murray & Peyrefitte, 2007). The study is, thus, designed to investigate the relationships among media richness, task characteristics, and the knowledge conversion modes and how these factors can affect knowledge transfer success in the web 2.0 environment.

1.5. OBJECTIVES OF THE STUDY

The overall objective of this research is to gain clarity in the understanding of the relationship between media usage and knowledge creation and transfer through socialization, externalization, combination and internalization (SECI). Media usage is dependent on the richness of the media and the characteristics of the knowledge transfer task (Daft and Lengel, 1986). Before knowledge can be transferred it has to be converted from one form (tacit or explicit) to the other (Nonaka et al., 2000). A better understanding of the relationship among the knowledge conversion activities, richness of the media employed, and the characteristics of the task associated with the transfer of knowledge will help in assessing the overall impact of media usage on knowledge transfer and creation.

The specific objectives of the study are thus:

- To examine the effect of media richness of web 2.0 applications on their usage for knowledge creation and transfer activities in the cocoa industry in Ghana.
- To provide a theoretical understanding of how the choice of media for the SECI processes could affect the transfer and creation of knowledge in the cocoa industry in Ghana.
- To assess the effect of web 2.0 usage for knowledge transfer and creation on interactions among researchers, extension agents and cocoa farmers the cocoa industry in Ghana.
- To propose a model that will aid in the selection of the appropriate media for knowledge creation and transfer through the SECI processes in the cocoa industry in Ghana.

1.6. RESEARCH QUESTIONS AND HYPOTHESES

The main research question that will guide the study is 'what influence can web 2.0 applications usage have on the knowledge transfer activities in the cocoa industry in Ghana? In order to have a broader scope of the above curiosity, four sub-questions are formulated to guide the study. Each research question is to be answered by set hypotheses. Hypotheses 1-12 depicted in figure 5, while hypotheses 13-15 are illustrated by figure 6.

1. What is the effect of the media richness of web 2.0 applications on their usage for knowledge transfer and creation in the cocoa industry in Ghana?

    a) H1: Media richness of Web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) is positively related to their usage for the socialization mode of knowledge creation and transfer.

    b) H2: Media richness of Web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) is positively related to their usage for the externalization mode of knowledge creation and transfer.

    c) H3: Media richness of Web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) is positively related to their usage for the combination mode of knowledge creation and transfer.

d) H4: Media richness of Web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) is positively related to their usage for the internalization mode of knowledge creation and transfer.

2. What is the effect of the use of web 2.0 applications for the SECI processes on knowledge transfer and creation in the cocoa industry in Ghana?

    a) H5: The use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for socialization is positively related knowledge transfer and creation.

    b) H6: The use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for externalization is positively related knowledge transfer and creation.

    c) H7: The use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for internalization is positively related knowledge transfer and creation

    d) H8: The use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for combination is positively related to knowledge transfer and creation

3. What is the moderation effect of task analyzability on the relationship between web 2.0 usage for SECI processes and knowledge transfer and creation in the cocoa industry in Ghana?

    a) H9: Task analyzability moderates the relationship between the use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for socialization and knowledge transfer and creation

    b) H10: Task analyzability moderates the relationship between the use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for externalization and knowledge transfer and creation

    c) H11: Task analyzability moderates the relationship between the use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for internalization and knowledge transfer and creation

    d) H12: Task analyzability moderates the relationship between the use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for combination and knowledge transfer and creation

4. What is the effect of web 2.0 usage for knowledge creation and transfer on the nature and level of interaction between knowledge actors in the cocoa industry in Ghana. The following

    a) H13: The use of web 2.0 applications for knowledge creation and transfer affects the nature and level of interaction between cocoa farmers and extension officers in the cocoa industry in Ghana
    b) H14: The use of web 2.0 applications for knowledge creation and transfer affects the nature and level of interaction between farmers and researchers in the cocoa industry in Ghana
    c) H15: The use of web 2.0 applications for knowledge creation and transfer affects the nature and level of interaction between extension officers and researchers in the cocoa industry in Ghana

1.7. THE THEORETICAL FRAMEWORK

The overall research model of the study is based on the Agricultural Knowledge and Information Systems (AKIS) model, Nonaka's SECI model, and the media richness theory (MRT). The AKIS model was applied to discover how the linkages among the primary knowledge actors (cocoa farmers, extensionists, and cocoa researchers) in the cocoa industry could be enhanced through the use of web 2.0 applications for the creation and transfer of knowledge. The SECI model is used to identify the different modes/stages involved in the creation and transfer of knowledge and the MRT was employed to assess how the richness of the media used for the different knowledge creation/transfer modes affect these processes.

1.7.1. THE OVERALL RESEARCH MODEL

According to the theory of organizational knowledge creation, new knowledge is created through the interaction between tacit and explicit knowledge, which results in four knowledge conversion modes (SECI): Socialization, Externalization, Combination and Internalization. Each mode of knowledge conversion requires the use of media with varying degrees of richness. For example, socialization and externalization, which involve the conversion of tacit knowledge, require the use of rich media while media of low richness is appropriate for internalization and combination (Nonaka et al., 2000). According to the Media Richness Theory (MRT), the selection of media for a communication task depends on the richness of the media and the characteristics of the communication task. We, thus, propose that there exists a relationship among web 2.0 usage for SECI, task characteristics, media richness and knowledge transfer and creation in the web 2.0 space. A task is considered as analyzable (high analyzability) when there exists predetermined procedures for responding to potential problems related to the task.

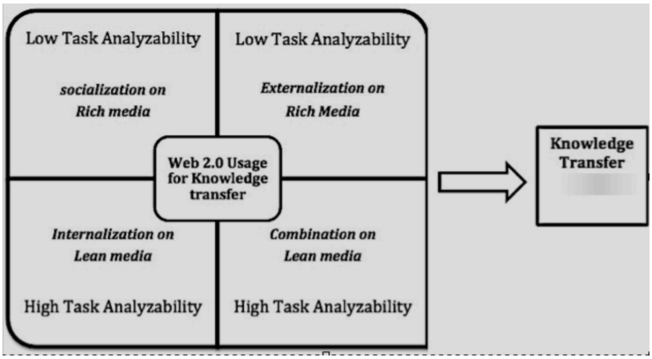

Figure 1-2: Overall Research Model

When a task has a high degree of analyzability, it signifies that there is availability of large amount of information, which people can study to resolve problems.

The availability of such large quantity of information also calls for the need to reorganize, update and generate new knowledge. Socialization and combination modes of knowledge conversion, which require media of low richness, are associated with high task analyzability (Anothayanon, 2006).

On the other hand, when task is unanalyzable, then there are no laid down procedures for resolving challenges associated with the performance of such tasks and as a result people have to rely on their own subjective judgments and experience. Task of low degree of analyzability could be resolved through the transfer of tacit knowledge as involved in socialization and externalization on a rich media platform (see figure 2). We argue herewith that the use of appropriate media for a given mode of knowledge conversion can affect task accomplishment and consequently, the attainment of knowledge transfer and creation within the web 2.0 environment.

The SECI modes of knowledge transfer serves as the dependent variable for media richness of the web 2.0 applications. Knowledge transfer and creation (KTC) is treated as the dependent variable for task analyzability (TA), and the SECI modes of knowledge transfer, while TA moderates the relationship between SECI modes of transfer and KTC (see figure 1-3). The study consists of three types of variables: independent variables, moderating variables and dependent variable.

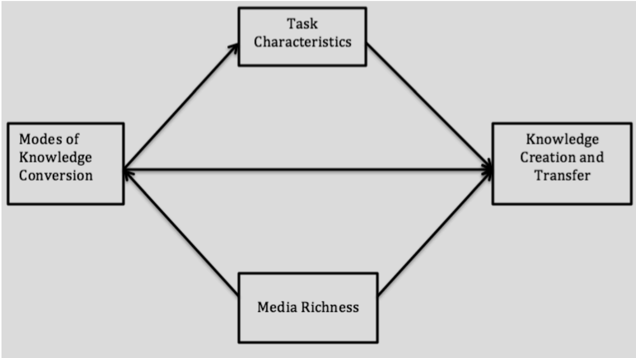

Figure 1-3: Basic Research Model

In the cocoa industry in Ghana there are three main knowledge actors namely cocoa farmers, extension officers and cocoa researchers. According to the AKIS framework, these knowledge actors form the knowledge triangle. The main generators of agricultural-based knowledge are the cocoa researchers (CRIG). The knowledge generated by researchers at CRIG is passed down to the extension officers (CHED) to be distributed to the cocoa farmers (Farmer Associations). The researchers are then supposed to interact with the farmers directly to assess the applicability of the knowledge transferred to the farmers and receive feedback directly from the farmers to be incorporated in future research solutions.

To operationalize the overall and basic models, two hypothesized models are developed and tested sequentially. In the first set of hypotheses, the objective was to test the relationships between the interactions among media richness of web 2.0 applications, SECI processes and task analyzability and knowledge creation and transfer. The second figure represents a second-order multi-group analysis to discover how the use of web 2.0 applications for knowledge creation and transfer could affect the nature and level of interaction between each of the knowledge actors through interactive communications.

1.7.2. HYPOTHESIZED MODELS

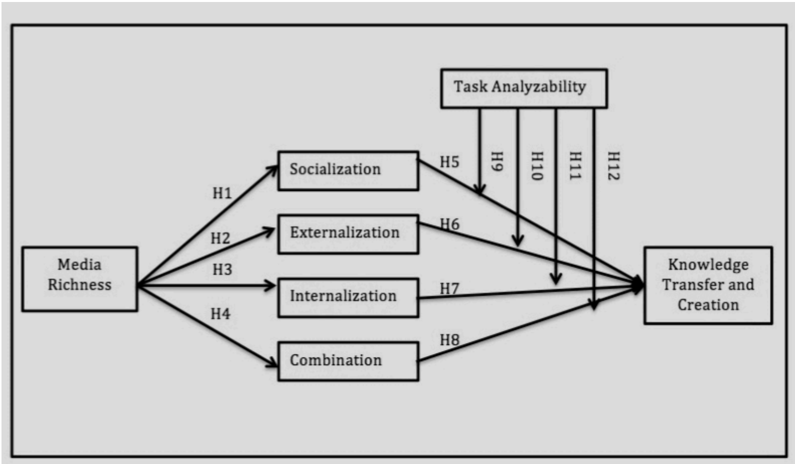

Figure 1-5: Hypothesized model for hypotheses 1-12

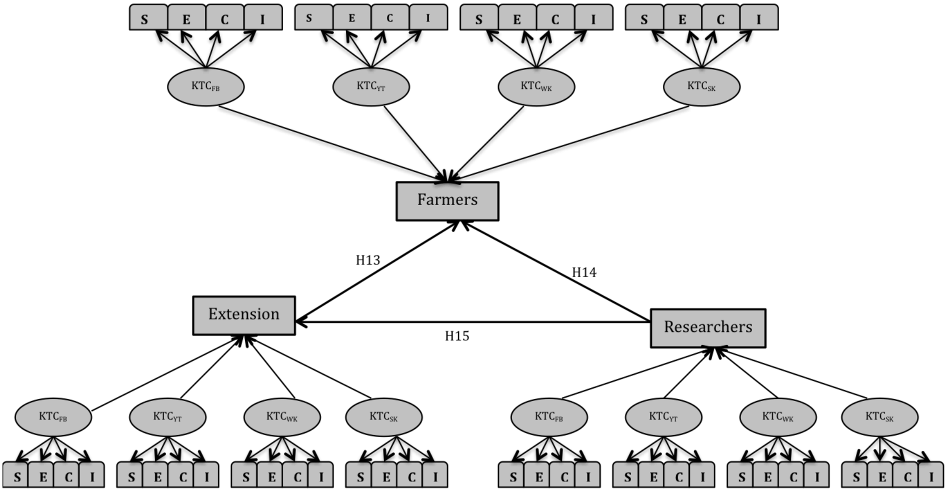

Figure 1-6: Hypothesized Model for hypotheses 13-15

1.8. RESEARCH DESIGN

The overall design of the study can be described as an embedded single-case (Yin, 2009) involving cocoa researchers and the community extension agents who are spread among three divisions of the COCOBOD as the units of analysis. The data collection strategy used in this study is the concurrent mixed method approach also known as concurrent triangulation design. This strategy allows the researchers to use a single instrument to collect both quantitative and qualitative data in a single phase of the research process (Creswell, 2009; Saunders, Lewis, & Thornhill, 2012).

Survey research was used to collect data on the perceptions of the respondents on the effect of media richness of web 2.0 applications on their usage for the SECI modes of knowledge transfer and how the use of web 2.0 applications for the SECI processes could lead to knowledge creation and transfer while measuring the moderating effect of task characteristics on that relationship. Semi-structured interviews were used to collect qualitative data for triangulation purposes. Purposive sampling was used to select the divisions of COCOBOD needful for the study in order to reflect on the subject and purpose of the study. A simple random sampling was then used to choose the number of respondents required for the study.

1.9. SIGNIFICANCE OF THE RESEARCH

The ability of organizations to manage their knowledge effectively is crucial for their survival in today's growing knowledge-based economy. Knowledge management involves series of inter related activities which include the ability of organizations to transfer knowledge. The capacity of organizations to effectively transfer knowledge both internally and externally enables them to compete effectively in their chosen markets (Gold et al., 2001). Achieving success in knowledge transfer is a driving force for knowledge creation endeavor (Kang et al., 2010). In order for organizations to create new applications they need to create and transfer new knowledge (Henderson & Cockburn, 1994). New knowledge is created from existing knowledge when the knowledge of individual members in the organization is allowed to go through the four SECI modes of conversion (Nonaka and Takeuchi, 1995). Through the SECI modes of knowledge transfer, knowledge transcends from individuals to group, from groups to the organization and from organization to inter-organization. Knowledge creation and transfer are achievable, when the SECI modes are well managed. Knowledge transfer and creattion impacts positively on the performance of all types of organizations, at all levels. The findings of this research will thus benefit not only agricultural institutions such as the cocoa industry in Ghana but all forms of organizations including public and private sectors.

The study provides a framework for assessing how media richness, task analyzability and web 2.0 usage for SECI modes of knowledge transfer interact towards organizational knowledge transfer and creation and in turn organizational learning. The model would inform the strategy regarding the choice and use of the appropriate Web 2.0 applications for the different SECI modes of knowledge transfer for organizational knowledge transfer and creation. In order to achieve the desired results in knowledge transfer endeavor, the choice of media with the appropriate degree of richness is an important factor. The cocoa industry like most organizations in Ghana have not introduced web 2.0 technologies into their knowledge transfer activities because they haven't yet ascertained the impact it would have on knowledge transfer and creation.

The results of this study will, thus, guide organizations like the cocoa industry in Ghana which is yet to introduce social media applications to compliment or substitute for some of their existing communication mechanisms to place their focus on which social web applications is most appropriate for a given mode of knowledge conversion for successful knowledge transfer. This is so important because a wrong match between the media richness and knowledge conversion type may not result in attaining the optimum level of knowledge transfer success. A major determinant of media usage is the richness of the media. One factor people consider in choosing media is the characteristics of the media such as the ability to provide instant feedback, and multiple cues. Before choosing a new media to supplement or replace existing ones it is important to know some features of the new media, and key among such considerations is the richness of the new media if it is more suitable than or similar to the previous ones. The findings of the study will provide users with media richness information about the selected social web applications to inform their usage for knowledge conversion and transfer success.

The results of this study will help organizations to determine which mode of knowledge transfer on a given web 2.0 platforms would be appropriate for a given task depending on the analyzability of the task. Such information will help in the adoption of the appropriate web 2.0 applications for knowledge transfer projects. Inappropriate use of media for the right task and knowledge transfer may result in unnecessary losses in resources such as budgets and time. To avoid such losses, there is the need for sectors like the cocoa industry to be able to select and use the appropriate media for the required task associated with a given mode of knowledge transfer. The findings from this research will help the industry to be well equipped with the information needed to make an informed decision regarding the possibility of introducing Internet applications and ICTs to support their knowledge transfer activities.

The findings of the study will assists the various cocoa research institutions to better understand the applicability of web 2.0 technologies and the potential of such technologies in bridging the gap between them and the cocoa farmers who are supposed to use research findings of the researchers, among other things, to boost their levels of productivity. When these concepts of web 2.0 applications and knowledge transfer are well understood, it will enable these institutions to know how best they can incorporate such technologies into the broader cocoa knowledge and information systems to ensure efficiency in the overall knowledge transfer process between researchers and cocoa farmers.

The study will contribute to the existing literature in knowledge management for the reason that, there is a dearth of research that has demonstrated the relationship among the media richness of Web 2.0 applications, task analyzability and the SECI processes of knowledge conversion for the attainment of knowledge transfer and creation. The existing studies have demonstrated the relationship between Perrow's four categories of task characteristics and Nonaka's knowledge conversion modes towards knowledge transfer and creation without considering the impact of media richness on these factors (Deutch, 2014). Other studies have also been concerned with the relationship between media richness and knowledge tacitness in the knowledge sharing process (Murray and Peyrefitte, 2007). The results of the current study will provide further clarity regarding how the richness of web 2.0 applications such as Skype, Facebook, YouTube, and Wikipedia can impact on their usage and how the usage of these applications would influence knowledge conversion processes, and task characteristic groups towards successful knowledge transfer.

1.10. SCOPE OF THE RESEARCH AND DELIMITATION

The research covers the factors that influence web 2.0 usage for knowledge transfer within the Ghanaian cocoa sector. The research in the area of knowledge transfer is concentrated at three levels: intra-firm, inter-firm, and trans-national (Duan, Nie, & Coakes, 2010). These levels can further be sub-divided into governance modes, which include strategic alliances, joint ventures, acquisitions, and MNCs (multinational corporations) (Bresman, Birkinshaw, & Nobel, 2010; Cummings & Teng, 2003). However, the transfer of knowledge in the Cocoa Industry in Ghana has a distinct connotation. The cocoa sector in Ghana has not been fully liberalized, and is more or less controlled by the government through the COCOBOD, which has the key mandate to ensure that cocoa farmers have access to the required knowledge and technology to boost productivity. So by default the cocoa farmers have the right to use and consume the resource attributes of the knowledge generated by COCOBOD.

When knowledge is transferred to an actor that originally possesses the rights to use and consume the knowledge, then such a transfer is considered as intra-firm transfer (Foss, Knudsen, & Montgomery, 1995). However, in order for the transfer to be purely intra-firm, it is expected that the cocoa farmers should have been within the hierarchy of COCOBOD (Cummings, 2001), but that is not the case of the cocoa industry in Ghana and so we cannot conclude that this is a pure case of intra-firm knowledge transfer. On the other hand, every cocoa farmer in Ghana pays an *indirect tax* for the research to be conducted (Baah, 2007). That means there is an aspect of *indirect* knowledge commercialization involved in the transfer (Foss et al., 2005). According to Foss et al. (2005), when there is an aspect of the knowledge transfer taking place within a market, such a transfer should be regarded as an inter-firm knowledge transfer (Foss et al., 2005). Thus, the transfer of knowledge from the COCOBOD to cocoa farmers can neither be considered as wholly intra-firm transfer nor as fully inter-firm transfer but a mixture of the two. A study of this nature regarding knowledge transfer, especially with the use of social media applications, is not common in literature. The study concentrates in the transfer of knowledge between cocoa researchers and farmers through community extension agents for the reason that they are the key actors involved in knowledge transfer. The factors identified in the study would aid in assessing the readiness of the industry to introduce the use of the social media as an integral part of its knowledge transfer mechanisms.

The scope of the study was restricted to the three divisions of the Ghana Cocoa Board (COCOBOD for short), which are CRIG, SPU and CHED and the main farmer groups and associations: Ghanaian Cocoa Coffee Sheanut Farmers Associations (GCCSFA) and Kuapa Kokoo Farmer Union (KKFU). The data collected was taken from researchers, cocoa farmers and cocoa extension officers who have access to the Internet and are familiar with the use of web 2.0 applications. These criteria was used in selecting respondents for the study due to the study focus of seeking to establish the role of web 2.0 applications in knowledge creation and transfer in the Cocoa industry in Ghana. The other divisions of COCOBOD were not considered because they did not form part of the primary actors involved in transferring knowledge directly to the cocoa farmers. Therefore the accuracy of the usage of the selected web 2.0 application for the different modes of knowledge conversion is dependent on the participants' own judgments.

A web 2.0-based knowledge creation and transfer model that could be used for the selection and use of web 2.0 application for the creation and transfer of knowledge in the Ghanaian cocoa industry was proposed based on the results of a limited size of the survey sample. Meanwhile, varying degrees of external factors from different industries, the nature and structure of the administrative control of the board, the socio-political environment, the marketing arrangements of the industry etc. could affect the results of the study and thus affect the generalizability of the proposed model of the study. Moreover, the testing of the model was also beyond the scope of the current study.

1.11. ORGANIZATION OF THE REMAINDER OF THE STUDY

Chapter two gives a descriptive account on the overview, structure and operational activities that take place in the industry, including some historical accounts of how cocoa was introduced into the economic landscape of Ghana.

Chapter three gives a descriptive account on the various ICT innovations implemented for agricultural and rural development in Ghana

Chapter four reviews the relevant literature on SECI model, Media Richness Theory and the influence of ICT on the knowledge transfer process in the context of web 2.0 applications.

Chapter five presents a discussion on how the principles of web 2.0 facilitate the management and transfer of knowledge within the space of web 2.0 applications.

Chapter six provides a discussion on the theoretical foundation of the study. This includes the conceptual model and the research hypotheses.

Chapter seven specifies the design and implementation of the research methodology employed in transfer in agriculture in the study. It covers the design of the questionnaire, the selection of the units of analysis, as well as the procedure and protocols of the case study.

Chapter eight is used to present the analysis and research findings from the quantitative survey used in the research.

Chapter nine discusses findings, implications, and conclusions.

CHAPTER 2. OVERVIEW OF THE ACTIVITIES IN THE COCOA INDUSTRY

2.1. INTRODUCTION

The cocoa tree originated from the rainforest of Central and South America close to the Amazon River. The Mesoamericans then domesticated it with the Mayans being the first to establish a cocoa plantation in the lowlands of South Yucatan (COCOBOD handbook, 2000). The spread of cocoa to other parts of the world took place during the expansion of the European empires, which rose from the fifteen century to about 1914. The Spanish were the first to introduce cocoa to the African continent when they established their plantations on an island called Fernando Po (currently Bioko Island in Equatorial Guinea). From there it spread to the other parts of West Africa including Gold Coast (Ghana), Nigeria and Ivory Coast (Cote d'Ivoire). In Ghana it is noted that Dutch Missionaries were the first to plant cocoa around 1815 in the coastal areas and the Basel Missionaries also cultivate cocoa at Aburi in 1857. Meanwhile it was until Tetteh Quarshie brought the *Amelonado* cocoa pod from Fernando Po in 1879 and established a cocoa plantation at Mampong (Akwapim) in the eastern region of Ghana, that the spread of cocoa cultivation took place in Ghana (COCOBOD handbook, 2000). Farmers then began to buy the cocoa pods from the farms of Tetteh Quarshie to establish their own cocoa farms and that's when cocoa cultivation began to spread to other parts of the Eastern region of Ghana. Later on in 1886, Sir William Brandford Griffith who was the then Governor arranged for cocoa pods to be brought to Ghana from São Tomé. The Cocoa seedlings were then raised from the pods at the Aburi Botanical Gardens (COCOBOD handbook, 2000).

The introduction of cocoa into the agricultural landscape of Ghana marked the beginning of an economic turn-around for most farmers. Since most farmers realized the potential earnings from the economic crop and started moving away from the point of introduction of the crop to the hinterlands to acquire forest lands for the cultivation of cocoa. This was recorded as an indication of the responsiveness of the cocoa farmers towards economic incentives (Hill, 1997). The first cocoa shipment at the international level took place in 1885 from the Gold Coast and by 1908 the volume of shipment had grown to 20,000 metric tons. With 41000 tons, Ghana became the World's leading producer of cocoa in 1911 and eventually contributed about 40% of the total outputs of the World in the early 1920s. A decade later, the cocoa production in the Eastern region reached its peak level and started declining due to decrease in soil fertility and the outbreak of disease and pests affecting the cocoa plantation.

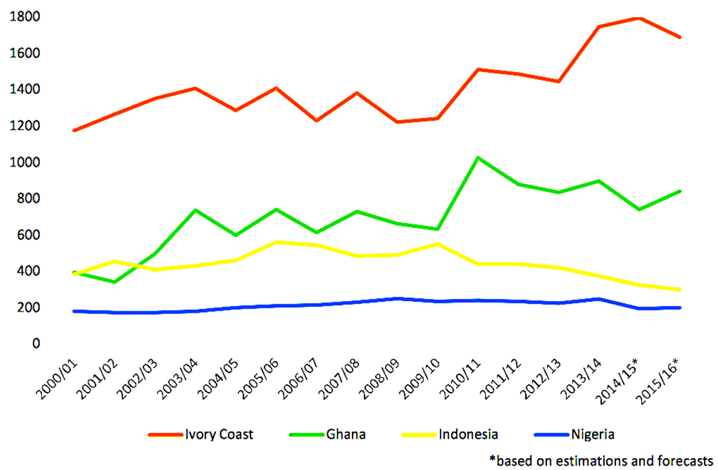

Figure 2-1: Top Four Cocoa Producing Countries 1

The production center then shifted from the Eastern region to the Ashanti and the Brong-Ahafo regions in the 1940s due to the availability of fresh forestlands. The levels of production then reached 400,000 metric tons in 1960, 580,000 metric tons in 1964/65 and declined sharply to 324,000 metric tons 1976/77 and 158 metric tons in 1983/84. Presently, Ghana is the 2nd largest cocoa producing country recording its highest production of over one million metric tons in the year 2011 with its percentage share of annual foreign exchange dropping from 45% in the 1960s to 25% (Essegbey & Ofori-Gyamfi, 2012; Laven and Boomsma, 2012). However, it still remains the most significant economic crop for the nation providing employment and income for approximately one-third (30% of export earnings and about six million) of the Ghanaian population (Laven and Boomsma, 2012; Gockowski & Sonwa, 2011; Monastyrnaya et al., 2016). The cocoa beans from Ghana are rewarded with a premium price of between 4-6% on the World market for its quality due to its higher than average fat content and mild and rounded flavor cocoa beans (Williams, 2009; Kolavalli & Vigneri, 2011; Mulangu et al., 2015)

Cocoa is considered as a specialized product in Ghana not only for its economic importance, but also due to some unusual characteristics exhibited through the farming processes, the processing of the cocoa beans and the marketing structure of the crop that makes it different from the other export crops in the Ghanaian economy. Due to these strategic advantages of cocoa in Ghana’s economy, the Ghana Cocoa Board (COCOBOD) was established in 1947 as the main governing body of the industry, to oversee not only the marketing but also to facilitate the production and processing of cocoa beans of premium quality. The industry is regulated by the PNDC law 81, which gives COCOBOD the legal powers to promote and regulate the production, processing and marketing of cocoa in Ghana. However, in 1993, the internal marketing of cocoa was liberalized with the introduction of private sector participation making Ghana the only major cocoa producing country without a completely liberalized marketing system. The partially liberalized marketing structure is adopted with Licensed Buying Companies (LBCs) competing for market share. The focus of this chapter is to highlight on the various stages involved in cocoa production from the farm-level to the processing and marketing stages and the roles and functions of the key actors in the industry at the stages of the cocoa production cycle. The chapter begins with the structure and operations of the various actors in the industry including the operations and functions of the divisions and departments of COCOBOD. The farming processes, from the growing stages to the harvest and post harvest, as well as, the internal and external marketing of cocoa are also highlighted. The chapter concludes with how cocoa is processed into semi products in Ghana.

2.2. STRUCTURE, FUNCTIONS AND OPERATIONS OF THE COCOA INDUSTRY

The main actors involved in the domestic operations and activities of the Cocoa industry are the smallholder cocoa farmers, the LBCs, and the COCOBOD, as well as hosts of other supporting actors such as private haulers, financial institutions, civil society organizations, farmer associations, and processing industries (Essegbey and Ofori-Gyamfi 2012; Laven and Boomsma, 2012;Monastyrnaya et al., 2016). The overall structure of the industry is divided into two sectors: Pre-Harvest sector and Post-harvest sector. The pre-harvest sector comprises of the smallholder cocoa farmers and three divisions of the board (CRIG, SPU, and CSSVDCU (now CHED). whose activities are directly related to the farming processes and the production of the cocoa beans. The post-harvest operations involve the LBCs, private haulers, QCC and CMC. Farmers produce the cocoa, CRIG conduct research and advices farmers on new technologies, SPU multiplies and distributes the new improved hybrid cocoa seedlings to farmers and CHED controls the CSSV disease.

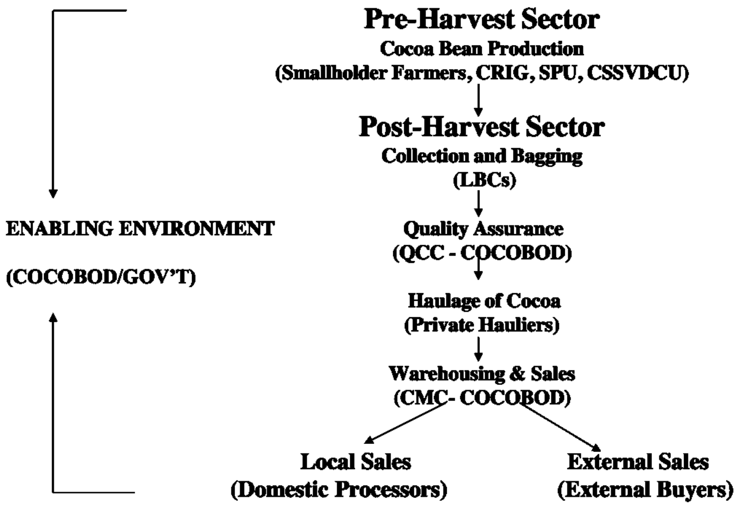

Figure 2-2: Simplified Structure of the Cocoa Industry 1

LBCs then purchase the cocoa beans directly from farmers after fermentation and drying of the beans, and bag them to make them ready for delivery to CMC. QCC conduct quality checks on the cocoa beans and registered private haulers transport them from the district level to the three takeover points for final checks by QCC. The beans are finally handed over to CMC for export.

2.3. SMALLHOLDER COCOA FARMERS

Approximately 800,000 households of smallholder cocoa farmers are into cocoa production in Ghana (Laven and Boomsma, 2012, Monastyrnaya et al., 2016). The farmers are responsible for all the processes involved in cocoa production, from the growing, management, harvesting, fermenting, and drying of the cocoa beans. Some studies have recorded that most cocoa farmers (above 50%) are aged 50 years and over and have concluded that the population of cocoa farmer is aged (Baah, 2007; Baah and Asamoah, 2001; COCOBOD, 1995; Asante, 1998). Other studies Baah (2007), Asante (1998), Donkor et al., (1991) and Arhin (1985) have recorded high levels of illiteracy rate 33%, 47%, 55%, and 71% respectively among cocoa farmers. With the exception of cocoa farm owners who are automatically registered members of the Ghanaian Cocoa Coffee Sheanut Farmers Association (GCCSFA), the overall majority of cocoa farmers are not in any formal organization. However, GCCSFA is known not to be representing the interest of the farmers. Other farmer associations that function as farmer organizations are the Kuapa Kokoo Farmer Union (KKFU) and Cocoa Abrabopa Association (CAA).

Beside these formal farmer groups, there are also informal groups that farmers create among themselves in order to help each other, especially during harvesting periods due to the intensive nature of labor required. These informal groupings are usually organized within the immediate local farming communities and are locally referred to as nnoboa (Laven and Boomsma, 2012, Monastyrnaya et al., 2016). Nnoboa is a system whereby a group of farmers join together and decide to visit each others farm to help complete a task that usually require immediate action. The formation of these informal groups also help farmers to gain access to credits from the banks since banks find it easier to deal with organized groups than individuals. Cocoa farmers in Ghana are categorized based on their levels of ownership of the cocoa farmland. Based on this categorization, farmers could be classified as owner-operators and sharecroppers. Owner operators are farmers who own the farmland and manage the farms themselves. There are two types of sharecroppers: *abunu* farmers and *abusa* farmers (Baah, 2007). The abunu farmers are those who are contracted to manage the farm of another farmer so that when it matures s/he receives one-half of the entire farm. The abusa sharecroppers have a similar contractual agreement except that they receive one-third of only the harvest. Almost 80% of cocoa farmers in Ghana are owner operators while the remaining are sharecroppers.

On another scale, farmers are categorized according to how they are able to make effective use of research recommendation to improve their yield (FAO/World Bank, 1986). Based on this classification, cocoa farmers could be placed in five levels of technologies (Baah, 2007). Farmers belonging to the first technology (Level 1) obtain the least mean yield between 200-225kg/ha as a result of almost non-application of CRIG recommendations. The level 2 technology farmers undergo almost the same farming process as level one except that they use the new hybrid technology by CRIG and so obtain a little higher mean yield of 300-325kg/ha. Farmers that belong to the fifth technology level adopt almost all the research recommendations of CRIG and obtain the highest mean yield in the region of 700kg/ha (see Table). Majority of cocoa farmers in Ghana (between 50-65%) falls within the low (Levels 1 and 2) technology group, between 20-40% in the medium technology (Levels 3 and 4) and the remaining part belonging to the high technology (Level 5) (CRIG, 2010; Baah, 2007; Laven and Boomsma, 2012). These categorizations show a direct relationship between access and usage of research-based knowledge and levels of productivity. Baah (2007) argued that the class farmers belong influences their access and use of knowledge generated through research and calls for a reassessment of the impact of research and for that matter CRIG on the cocoa industry at large. Baah (2007) argued further on that the task of making farmers informed of research recommendations should not be the preserve of extension organizations but research institutions like CRIG should take an equal responsibility not only to inform farmers who have paid for their services, but to share knowledge with them in a more interactive manner. This then calls for a strong and interactive relationship among researchers, extentionists and cocoa farmers to ensure effective creation and transfer of knowledge to cocoa farmers to enhance their productivity

Technology Level	**Farming Process**	**Average Yield (Kg/Ha)**
1	• Begins with cutting down trees and burning • Planting food crops like cocoyam and plantain • Use unselected seed from own farms/neighbor's • Interplant cocoa at stake at irregular spacing • Do little or no brushing, no pruning, no mistletoe control, no control of capsids or black pod or shade	200-225
2	• Same as level 1 except using hybrid seeds	300-325
3	• Unselected seed • Random stake planting • Do regular brushing, pruning, control mistletoe and shade • Control capsids and black pod diseases	400
4	• Do same as level 3 **except** • Using hybrid seedlings raised in polybags as recommended • Use recommended planting spacing of 2.5x2.5m	550
5	Apply the full complement of CRIG recommendations (same as level 4) **plus** Manage shade regime by planting trees like *Glyricidia spp.*	700

Table 2-1: Categories of Cocoa farmers 1

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2.4. OPERATIONS OF THE LICENSED BUYING COMPANIES (LBCS)

Partial Liberalization: The marketing system of Ghana's Cocoa industry is characterized by certain unique marketing arrangement that combines elements of privatization and a strong government presence (Vigneri & Santos, 2008). It is recorded in literature that Ghana is the only major cocoa producing country with a partially liberalized marketing system (Williams, 2009; Laven and Boomsma, 2012), with COCOBOD retaining monopoly through its marketing arm CMC. The internal marketing of cocoa began with Multi Buying Agencies, which included United Africa Company (UAC), Cadbury and Fry, Ghana Cooperative Marketing Association and United Ghana Farmers Council, after the attainment of the independence of Ghana. Later on after the 1966 coup, other indigenous Ghanaian companies like Asempaneye Group Farmers Limited, Aboafo, and Cocoa Farmers Company also registered to join the marketing of cocoa within Ghana. However, these local Ghanaian companies became indebted to the Ghana Cocoa Marketing Board due to poor operational and financial performances. After some time, the Board integrated all the indigenous companies except Ghana Cooperative Marketing Association into a department called Produce Buying Agency. In 1977, the Produce Buying Agency became Produce Buying Division. In November 1981 it was incorporated as a 100% state-owned enterprise and a subsidiary of COCOBOD, and granted certificate to commence business in the same year. The name Produce Buying Division was changed to Produce Buying Company (PBC) in October 1983 upon special resolutions of its board of directors.

PBC then continued to enjoy full control over the domestic purchases of cocoa beans until the early 1990s due to a number of structural reforms that took place in the cocoa industry (Vigneri and Santos, 2008; Asante-Poku & Angelucci, 2013). The first reform, which began in 1984/85, resulted, among other things, in the change of name from Cocoa Marketing Board (CMB) to Ghana Cocoa Board (COCOBOD). The second reform, which was implemented in 1992, also led to the re-introduction of multiple buying systems resulting in partial liberalization of the sector. Following that decision of government to promote competition into the internal marketing of cocoa, COCOBOD has been issuing licenses to a number of private companies, called Licensed Cocoa Buying Companies (LBCs), to purchase cocoa beans from cocoa farmers alongside PBC. The operations of the LBCs are governed by COCOBOD through the legal framework embodied in the "Regulations and Guidelines for the Privatization of Internal Marketing of Cocoa". To become a LBC, the prospective buyer must apply to COCOBOD to be considered as a buyer of cocoa. The application then goes through a vetting process undertaken by an independent committee, which is set up for that purpose. Successful applicants are initially issued a provisional license, which can be converted to a full license upon the Board's satisfaction that the provisional Licensee has the needed logistics for effective operation. At the inception of the multiple buying system in 1993, light crop season, six LBCs had been in operation in addition to the Produce Buying Company (PBC) which is still a subsidiary of COCOBOD. The number of LBCs increased to thirteen in the 1996/97-crop season alongside PBC. The thirteen LBCs together controlled 32% of the cocoa beans purchase as against 68% of PBC. Currently, PBC controls only 33% of the cocoa beans purchase competing with 36 other LBCs (Asante, 2014).

Financing of LBCs: COCOBOD determines the floor price that is paid to all cocoa farmers in the country. The producer price review committee (PPRC) by reference to the average free-on-board (FOB) price determines the producer price that farmers should receive at the cocoa season. The producer price, which is normally above 70% of the FoB price, is fixed annually to enable famers to know in advance what they can expect at the harvest season irrespective of the price at the international market (Laven and Boomsma, 2012; World Bank, 2011). For example the producer price for the 2016-17 season was fixed at 77.45% of the FOB price, representing 11% increment of the previous season. In doing so, COCOBOD completely absorbs the price risk that the farmers could have incurred from the freely floating cocoa prices at the international market. To mitigate the risk involved in this practice, COCOBOD through CMC conducts pre-harvest sales of between 60-80% of projected yield at a fixed price to international merchants, cocoa processor and chocolate manufacturers and use the forward contracts as a collateral for procuring international loan in advance for the harvest season. The funds are then passed down to the LBCs as a 'seed fund' to finance the purchase and evacuation of cocoa beans from the districts to the takeover points.

Part of the idea of introducing the LBCs into the domestic market was to introduce competition into the marketing structure in the sense that they were expected to compete with each other by purchasing the beans above the floor price so as to solicit for more business, yet that is rarely the case. According to them, the margins are so low to make any sense of competing among themselves. Instead they resort to devising various non-price mechanisms and strategies such as offering token gifts like bar of soaps, sugar, salt, providing prompt cash payment, input subsidies, access to credits and so on. The profitability of the LBCs is, thus largely based on the commission they receive from the board per the quantity of beans they are able to purchase.

Risk Assessment: there are a number of risks associated with this form of pricing policy in the sense that when the price at the international market increases above the fixed price used for the pre-harvest sales, then COCOBOD could consider that as a loss. On the other hand when there is a drop in price at the World market, then COCOBOD could have gained over their purchasers. When there is a surplus, which means the actual price of cocoa at the international market is greater than the predicted price used for the estimation of the producer price, the margin is shared between government and the farmers with farmers receiving their share as yearly bonuses. On the other hand when there is a deficit, it is borne only by the government. Moreover, it also encourages smuggling of cocoa beans into the neighboring borders like Cote D'Ivoire. Unlike Ghana, price of cocoa in Cote D'Ivoire is based on the spot bases from the prices at the international market throughout the cocoa season. As a result when the Ghanaian farmers compare the guarantee price with the on the spot price of Cocoa in the Cote D'Ivoire market, they smuggle their beans there and the impact has been recorded as significant. It has contributes immensely towards COCOBOD's inability to hedge the entire crop in advance as it renders the determination of the actual size of production uncertain. All these call the need to look into the possibility of introducing ICTs that could help in tracking the inflows and outflows of cocoa beans in the country.

2.5. DIVISIONS AND FUNCTIONS OF THE GHANA COCOA BOARD (COCOBOD)

The Cocoa Marketing Board referred to as the Gold Coast Cocoa Marketing Board (GCCMB) was established by ordinance in 1947 as the central administrative body of the institutions and organizations concerned with the various aspects related to operations and services in the entire cocoa industry (COCOBOD handbook, 2000). The GCCMB later became Ghana Cocoa Marketing Board (GCMB) after independence when Gold Coast became Ghana. In 1984, GCMB was dissolved and reconstitute as part of the 1983 reforms to become Ghana Cocoa Board (COCOBOD) to perform additional roles including research and quality control. Cocoa House is the name of the building that provides offices for the board, which started work in a rented apartment. The foundation stone of Cocoa House was laid in 1957, the same year Ghana obtained independence from the colonial masters, by the then president Dr. Kwame Nkrumah. The building of the cocoa house was not to just avoid the payment of rental apartments but to also serve as living monument for the hard work of the Ghanaian cocoa farmers and to express the faith the board had in the future of the cocoa industry.

Since 1996 the Minister of Finance has been exercising the ministerial responsibility of the Cocoa Industry. The board of directors appointed by the Government of Ghana governs the board. The Government nominates the board from various professions including each of the workers of COCOBOD, as well as, the farmers' Associations of Cocoa, Coffee and Sheanut. The overall administrative head of COCOBOD is the Chief Executive Officer who is assisted by three Deputy Chief Executives serving the administrative responsibilities for Finance and Administration, Agronomy and Quality Control and Operations. The head office of the board is composed of eight directorates and seven Departments/Units. The eight Directors are responsible for Human Resource, Research, Audit, Finance, Medical, Legal, Special services (Security and Intelligence), and General Services (Estates, Civil works and Transport). And the Departmental Heads are in charge of Public Affairs Unit, Security and Scholarships Unit, Information Systems Unit, and Estates and Transport Unit. The legal services department of the board report directly to the Chief executive as well as the security and scholarships and Public Affairs, whereas the remaining units also report to the CEO through their Directorates.

2.6. FUNCTIONS AND OBJECTIVES OF THE BOARD

The main objectives of the Board are as follows:

i. To promote the production of cocoa, coffee and sheanut.

ii. To introduce programs aimed at controlling pests and diseases of cocoa, coffee and sheanut.

iii. To encourage and undertake the processing of cocoa, coffee, sheanut and cocoa waste with the aim of adding value for both export and local consumption.

iv. Promote, undertake, and encourage scientific research aimed at improving the quality of cocoa, coffee, sheanut and other tropical foods.

v. Regulate the internal marketing of cocoa coffee and sheanut.

vi. To secure favorable arrangements for the purchase, grading and sealing, certification, sale, and export of cocoa, coffee and sheanut.

vii. To purchase, market, and export cocoa and cocoa products produced in Ghana, which is graded under the Cocoa Industry (Regulations)(Consolidation) Decree, 1968 NLCD 27, or any other enactment as suitable for export

viii. Assist in the development of the cocoa, coffee, and sheanut industries of Ghana.

The functions of the Board, which is focused on production, research, extension, internal and external marketing and quality control include:

i. To determine the producer price of cocoa and other related fees and rate, with the prior approval of Government

ii. To ensure prompt payment for all cocoa beans bought from producers. Formerly, these payments were to be made through a check system called the Akuafo Cheque and so the board was to ensure that payments were made accordingly.

iii. To encourage the establishment of Licensed Buying Companies (LBCs) and to regulate their mode of operations.

iv. To acquire and hold interest in the business of any person or company carrying on functions (internal or external to Ghana), similar or related to the objects of the Board and may dispose of their interest.

v. To provide seedlings, credit, and other facilities to the farmers to plant new farms as and when it may be required.

vi. To ensure quality production and marketing of cocoa.

vii. To carry out other activities as may appear to the Board to be favorable to the achievements of the objectives and functions of COCOBOD with the approval of Government.

Currently, these functions have been categorized into Pre-harvest and post-harvest which are undertaken by specialized divisions of the board. The pre-harvest functions is concerned with the fundamental issues relating to the actual production at the farming level. The divisions responsible for such functions are the Cocoa Research Institute of Ghana (CRIG), the Seed Production Unit (SPU), and the Cocoa Swollen Shoot Virus Control Unit (CHED) now known as the Cocoa Health and Extension Division (CHED). The Quality Control Division (QCD) and the Cocoa Marketing Company (CMC) perform the Post-harvest functions.

2.7. SUBSIDIARIES AND DIVISIONS OF COCOBOD

Originally six sub-divisions were created by COCOBOD to enable it carry on its functions. These were:

- Cocoa Marketing Company (Ghana) Limited
- Produce Buying Company Limited
- Cocoa Processing Company Limited
- Cocoa Services Division
- Cocoa research Institute of Ghana
- Quality Control Division

During the coca sector reforms in 1983, two of the sub-divisions Produce Buying Company and Cocoa Processing Company were privatized. Cocoa Services Division was also split into Seed Production Unit (SPU) and CHED (now CHED). So currently, the divisions have been revised into five subsidiaries namely:

- Cocoa Research Institute of Ghana
- Seed production Unit
- Cocoa health and Extension Division
- Quality Control Company
- Cocoa Marketing Company

2.7.1. COCOA RESEARCH INSTITUTE OF GHANA (CRIG)

CRIG was established in June 1938 at Tafo (Akim-Abuakwa) in the Eastern region of Ghana as the Central Cocoa Research Station of the Gold Coast to undertake research on diseases and pests, which had adversary, affected cocoa production in the Eastern Region, which was the underpinning of the industry. The institute was formed to investigate the problems and design solutions to control the outbreak of the disease and pest, according to the recommendation of the Agricultural Advisor of the then British Minister of State for the Colonies, Sir Frank Stockdale. In 1944, the research institute became the West African Cocoa Research Institute (WACRI) to cater for the research needs of both Ghana and Nigeria, with Mr. O.J Voelcker as the first Director. When Ghana and Nigeria attained their independence in 1957 and 1960 respectively, WACRI was then dissolved into CRIG and CRIN for Ghana and Nigeria respectively in 1962. CRIG then came under the management of the National Research Council, which later became Ghana Academy of Science. In 1968 CRIG came under the management of the Council for Scientific and Industrial Research (CSIR) after the dissolution of the Ghana Academy of Science. Between 1973-1976 CRIG was managed as a subsidiary of the Ghana Cocoa Marketing Board (GCMB), then came under the Ministry of Cocoa Affairs until 1979 when the Ministry was dissolved and subsequently CRIG came under the Ghana Cocoa Board (now COCOBOD) in 1984 (CRIG Handbook, 2011).

2.7.1.1 Research divisions and activities at CRIG

CRIG conducts its research in seven scientific divisions: Agronomy/Soil science, plant Breeding, Entomology, Plant Pathology, Physiology/Biochemistry, Social Science and Statistics and New Products development. The Agronomy/Soil science focuses on the development of appropriate techniques for addressing the problems of farmers relating to establishment and management of cocoa, coffee, kola, shea nut and cashew. The focus of investigation broadly includes plant propagation, determination of optimum plant density and spatial arrangement, suitable shade tree selection and density. Other areas include weed management, agro forestry including intercropping with food and other cops. The Entomology division is concerned with the investigation of pest problems related to cocoa, coffee, kola, and shea nut and the possible control measures, which include the application of Integrated Pest and management (IPM) methods involving the use of sex pheromones, parasites and natural enemies for the control mirids and mealybugs. The studies are carried on the biology, ecology, and population dynamics of mirids, which attack cocoa, as well as mealybug vectors of cocoa swollen shoot virus. The unit also undertakes screening of insecticides for mirids control and their effect on non-target organisms. Plant Breeding Division is concerned with the study and introduction of new germplasm, selection and breeding of new varieties of cocoa coffee, kola and shea nut in other to improve yield and maintain quality coca beans and to also test for promising varieties for disease and drought resistant varieties for establishment in degraded areas.

The research focus of the Plant Pathology Division is on fungal and viral diseases that affect cocoa, coffee, kola and Shea nut. Two important diseases under their watch are the black pod, which is caused by *phytophthora* species and the swollen shoot caused by the cocoa swollen shoot virus (CSSV). The division is thus sub-divided into the Mycology and Virology sections. While the mycology section concentrates on the black pod, the virology side also focuses on the CSSV. The Physiology/Biochemistry Division conducts research relating to the physiological basis for yield, which include plant nutrition and drought resistance/tolerance for the establishment of cocoa in degraded areas. The biochemistry section of the division also undertakes studies into the molecular basis of the CSSV and *phytophthora* species in collaboration with the Plant and Pathology division.

The New Products and Development unit was established in 1993 with the aim of finding means of generating additional income to farmers. The research that the unit undertakes is related to how new products such as industrial alcohol, soft drinks, pectin and acetic acid (vinegar) can be developed from the 'sweatings' of cocoa. Other new products obtained from their research findings include toilet soaps and cosmetics from cocoa butter and animal feeds from cocoa pod husks. The main function of the Social Science and Statistics Unit is to provide social science perspective to research by liaising between the research divisions and farmers in other to promote the relevance of research findings to the smallholder farmers. The unit also coordinate outstation and on-farm trials of component and packaged technologies while identifying social and economic constraints to the technological packages developed by CRIG.

Some of the research achievements of CRIG since its inception include the following:

- Control of mirids by mass spraying with insecticides
- Characterization of CSSV disease as caused by a virus, discovery of mealy bugs as vectors of the virus and control of the disease by eradication

- Isolation and characterization of CSSV and development of diagnostic methods
- Introduction and testing of Amazon cocoa
- Development of early bearing and high yielding WACRI series II hybrids by crosses between Amelonado and Amazon cocoa.
- Development of inter Amazon hybrids
- Understanding the relationship between cocoa shade, nutrition and yield
- Identification of fast growing, exotic and indigenous shade trees for cocoa
- Development of numerous agronomic packages guaranteeing yield of over three tons/ha
- Mass hand pollination of clonal seed gardens for large scale production of seed pods
- Understanding coca fermentation and flavor chemistry.
- Short term control of a severe type of Black pod disease (*phytophtora megakarya*)
- Production of pectin, alcohol and alcoholic beverages, animal feed, jelly, soap, and cosmetics as by products from cocoa waste.
- Overcoming the problem of self-incompatibility in kola (*Cola nitida*), selection and multiplication of types, which are cross and or self-compatible, thus guaranteeing high yielding planting material.
- Development and release of elite Robusta coffee planting material for establishment of national Coffee Wood Garden
- Development of agronomic packages that guarantee high yields and good quality cashew nuts

2.7.2. COCOA HEALTH AND EXTENSION DIVISION (CHED)

The CHED now CHED was also formed from the former CSD, which was established in 1945. The key objective of the Unit is to identify and treat the CSSVD throughout the cocoa growing areas, so as to stop its spread in the country. The first CSSVD case was reported in the 1930s in the Eastern region of the country. Since then it has spread throughout the cocoa regions in the country. In 1936 it was discovered that the disease is caused by a virus infection, which require that the visibly and latently infected trees should be cut and replanted. This approach has remained as the only recommended control measure.

In 1945/46, the threat of CSSVD on the cocoa industry was so devastating and that led to the establishment of the Cocoa Division as a subsidiary of the then Department of Agriculture to find solutions to the control of CSSVD. Ordinances regarding Swollen Shoot Disease Control Schemes were passed, which resulted in the cutting down of almost 135.7 million trees. In 1962 when it was realized that the disease had been fairly brought under control, the Cocoa Division was dissolved with farmers given the sole responsibility to manage the disease under the United Ghana Farmers' Cooperatives (UGFC).

In 1964/65 when it became apparent that the farmers couldn't handle the control of the disease, the Cocoa Division was reconstituted and tasked again to map out the extent of the disease incidence. Hence another nationwide survey was commenced in 1970 and ended in 1980. In 1972, all the institutions that deal in Cocoa were brought under the outfit of Ministry of Cocoa Affairs by the new government and the Cocoa Division was renamed Cocoa Production Division. When the Ministry of Cocoa Affairs was dissolved in 1979, the Cocoa Production Division was brought under the management of the Ghana Cocoa Board (COCOBOD).

In 1983, the Government realized the huge workforce of the Board which stood around 103, 000 with the Cocoa Production Division alone having 45,000 share of the total workforce. A major restructuring exercise of the Board then took place in 1985 after a series of consultations and seminars and the Cocoa Production Division then became Cocoa Services Division with three key functions:

- To control the spread of the CSSVD
- To produce and supply hybrid seedpods to farmers (cocoa agronomy)
- To educate farmers on approved agronomic and cultural practices in cocoa cultivation (cocoa extension)

At this time, the Seed Garden Unit was fully integrated into cocoa stations and brought under the management of CSD to accomplish the second function. In 1998, as part of the reorganization of the Agricultural Sector, the extension wing of the former Cocoa Services Division (CSD) was merged with the mainstream Department of Agricultural Extension Services (DAES) of the Ministry of Food and

Agriculture (MOFA). This led to the dissolution of CSD and the formation of CHED and SPU in January 2001 to produce and supply cocoa seedpods to the farmers.

2.7.2.1 The Mission, Structure, and Functions

The mission of the Cocoa Health and Extension Division is "To control the spread of cocoa swollen shoot virus and black pod diseases, assist farmers to re-plant their treated and died out farms with improved cocoa varieties in all cocoa growing areas of the country; pursue effective pests control and cocoa rehabilitation programs as well as provide back-up extension services to meet the technical needs of cocoa farmers". The structure of CHED is composed of a ten-member management committee that ensures the effective implementation of policies. The Unit is headed by an Executive Director who is assisted by two deputies one in charge of Operations and the other in charge of Finance and Administration. The head office is composed of six departments, which are Technical, Extension, Cartography, Human Resource, Accounts and Audit. The Unit also operates in all the seven cocoa growing regions: Eastern, Ashanti, Central, Western North, Western South, Bron-Ahafo, and Volta. These regions are sub-divided into forty-one (41) districts. Moreover, CHED has an oversight responsibility of managing the Bunso Cocoa College, which is responsible for manpower training and development of CHED staff. A Principal whose position is equivalent to a Technical Manager heads the college. The functions of CHED include the following:

- Surveys all cocoa growing areas to identify CSSVD outbreaks and treat all infected farms within all discovered outbreak areas.
- Assist farmers to replant treated farms with improved varieties, which are early bearing, high yielding, and disease tolerant.
- Generate data on the distribution of cocoa varieties and their conditions.
- Pay compensation to farmers whose farmers have been treated, replanted, and maintained due to CSSVD infection.
- Provide assistance to farmers establishing new cocoa farms.
- Assist farmers to rehabilitate old and moribund cocoa farms.

Other functions of the Unit can be associated with the Cartography Department, which is responsible for collating data on field operations and developing appropriate management information systems to support the control of CSSVD, as well as, rehabilitation and extension activities. The data capturing exercise involve the use of hand-held GPS equipment for capturing data on farms, Arc pad application software for processing the data captured into a Standard Storage Format (SSF), which is then converted into a geo-database format for storage in an ArcGIS Environment for manipulation, analysis, and management.

Other activities engaged in by the Cartography Department include:

- Prepare suitable plan/maps and charts using GIS (Geographic Information systems) and other decision-making systems.

- Design and manage database system on the ex-gratia compensations of farmers and farm rehabilitation costs.

- Field data processing, training, monitoring, and maintenance of GPS equipment used for data capturing.

2.7.3. THE SEED PRODUCTION UNIT OF COCOBOD (SPU)

The role of SPU can strategically be defined by four key parameters in relation to the low productivity of cocoa in the industry. These are:

i. Aged farms (senescence): 23% of the cocoa tree stock belong to the D-class which means they are more than 30years old and have therefore passed their economic yield potential.

ii. Disease infection: 10% of cocoa production area is infected with CSSVD

iii. Predominance of the low yielding cocoa varieties: 70% of the total cocoa tree stock is composed of the Amelonado and Amazon low yielding cocoa varieties as compared with the hybrid variety.

iv. Poor extension service delivery: lack of effective extension service delivery for the cocoa sector resulting in low level of farm maintenance and other cultural practices.

These factors have contributed to the low productivity levels in the cocoa industry. The SPU's contribution towards increased productivity includes products, services and strategies directed at mitigating the above-mentioned factors.

The SPU is responsible for multiplying and making available to farmers the improved hybrid seedpods developed from the research breeding programs and the resultant hybrid seedlings. The hybrid seedpods have these characteristics desirable by the farmers:

- High yielding: they are 3-4 times higher than the traditional Amelonado and Amazon varieties.
- Early bearing: they start bearing fruits at 2 and half years after planting giving farmers early return on investment (ROI).
- Disease tolerant: they have a high level of tolerance to CSSVD.
- Sturdiness
- All year production

The planting of the hybrid cocoa seedpods is of utmost importance towards the attainment of the following national goals:

- Replace old cocoa tree stock
- Rehabilitate old cocoa areas
- Increase the productivity of cocoa farmers
- Contain the spread of CSSVD
- Allow a more rapid ROI in cocoa cultivation and assured income all year round

2.7.3.1 Services: Extension Message Delivery

The frontline staff of SPU educates cocoa farmers on cocoa and coffee agronomic practices recommended by researchers to enhance their productivity. They maintain demonstration farms for farmers to observe the potential benefits of the improved technologies during their residential training and extension education organized by the division at the farmers' hostels. SPU also undertakes awareness and sensitization programs on Worst Form of Child Labor (WFCL), negative effects of cocoa smuggling, and diversion of cocoa inputs on the performance of the industry. Mechanisms employed include rallies, farmers' group discussions, and radio programs. They also collaborate with other stakeholders in the industry to offer extension delivery services on production and processing of cocoa beans so as to ensure high quality beans and flavor.

Strategically Cocoa Seed Gardens have been created as the only source of the improved hybrid cocoa seedpods where farmers can purchase for their farms. These are cultivated at twenty-three of the twenty-seven (27) cocoa stations distributed at all the cocoa growing regions. The hybrid cocoa seedpods are obtained through hand pollination of flowers of selected female parents by pollen from selected clones developed through research by CRIG. The twenty-seven (27) cocoa stations are spread throughout the cocoa growing regions as follows:

Eastern Region (8): Akwadum, Akoasi, Apedwa, Asamankese, Bieni, Bunso, Oyoko and Pankese.

Ashanti Region (6): Akumadan, Fumso, Kwadaso, Jamasi, Juaso and Poano.

Brong Ahafo Region (4): Bechem, Goaso, Sankore and Wamfie.

Western Region (3): Achichire, Buako and Wassa Saamang.

Volta Region (3): Akaa, Ampeyo and Saviefeh.

Central Region (3): Assin Foso, Breman Asikuma and Breman Baako.

2.7.4. QUALITY CONTROL COMPANY

The QCC is responsible for maintaining the quality of the cocoa beans and other crops like coffee and sheanut, which are exported to other countries. The QCC was established in 1991 as a result of the revitalization exercise in the Cocoa Industry. This brought about the merger of the Produce Inspection Division (PID) and Infestation Control Department (ICD) both of which were under the management of COCOBOD.

2.7.4.1 Produce Inspection Division (PID)

The history of PID can be traced back to the 1920s as a unit of the Department of Agriculture to initiate research into the possibility of introducing quality standards for agricultural produce in the country. In 1926 the United States of America rejected the country's cocoa. This prompted the then colonial government to encourage voluntary inspection of all agricultural produce, especially cocoa, in 1927. Meanwhile, no regulatory body or set standards was available to guide this very important aspect of cocoa preparation for export. Hence in 1934, the British government enacted the Cocoa Industry Regulations Ordinance, which empowered specially trained staff of the Department of Agriculture to conduct compulsory examination of cocoa beans before export. In 1942, the Department was re-organized under the leadership of Sir Frank A. Stockdale with PID assigned to take responsibility for the inspection of cocoa produce in the country.

By 1953, the official inspection, grading and sealing of cocoa for export had come under the full control of PID. The Decree on the Cocoa industry (regulation) (Consolidation) that was passed by the Government of the National Liberation

Council (NLC) as the N.L.C.D. 278 in 1968 empowered PID as the sole regulatory body responsible for ensuring quality of cocoa beans in the Cocoa Industry. The Legislative Instrument (L.I 598) in accordance with the Decree detailed the inspection procedures as well as the punitive measures were also enforced (Quality Control Division Handbook, 2000). The PID remained as a Unit under the Department of Agriculture until m1973 when it was taken over by the Ghana Cocoa Marketing Board (GCMB).

2.7.4.2 Infestation Control Department (ICD)

When the Cocoa Marketing Board was established in 1947, the primary responsibilities of all the functional areas of the cocoa business were brought under its administration. As the volume of cocoa produced in the country increased, the storage period prior to export of the beans was prolonged over time. The prolonged storage period exposed the beans to increased pest attack and infestation. It happened so that in the mid-fifties, the shipment to the U.S.A was again rejected leading to a colossal financial loss to the Board. It became necessary, therefore, for the Board to contract a private company by name Messrs.' Pest Destruction West Africa to undertake a disinfestation services. In 1959, the Board established its Insect Control Unit (ICU) based on the recommendations of the Ministry of Agriculture, Fisheries and Food and the Tropical Products Institute both from the UK. Subsequently, a Stored Products Entomology Unit was set up within the ICU in 1965 by the Board to undertake research into the operations of the ICU. The ICU together with the Stored Entomology Unit later on became a department of the Board named as the Infestation Control Department (ICD).

2.7.4.3 The Merger between PID and ICD

In 1975, when it was realized that the two departments PID and ICD had a complimentary functions and objectives to ensure the export of high quality cocoa beans, the Board decided to merge them, however the name PID was retained for the new Division. However, the merger lasted for only four years due to managerial incompatibility among the staff of the two departments. This resulted in the dissolution of the merger in December 1979 and the two units reverted to their respective former positions. As a result of the restructuring of COCOBOD, a second merger of the two units was effected in 1991 under the common name Quality Control Division.

2.7.4.4 Mission Objectives and Functions of QCD

The mission of the QCD is to develop and provide systematic strategies that will ensure the supply of best grade cocoa, coffee and sheanut both at the local and international levels.

The objectives of the division include:

- Prevent the exportation of inferior or infested cocoa, coffee, sheanuts, to overseas buyers and local mills.
- Inspect, sample, grade, seal, and disinfest cocoa and other produce for Licensed Buying Companies (LBCs)
- Ensure that facilities of LBCs (storage premises, gratings, tarpaulins, etc.) conform to laid-down regulations in order to maintain quality of produce in their custody.
- Monitor the operations of LBCs with regards to produce at all times.
- Organize periodic courses to educate farmers and personnel of LBCs on the preparation and storage of good quality cocoa, coffee and sheanuts.
- Undertake commercial disinfestation services

The functions of the division are in two forms:

1. Inspection, Grading, and Sealing of cocoa, coffee, and sheanuts
2. Disinfestation services

These functions are undertaken at up-country centers and the ports for prescribed fees. Up-country operations involve the dealings with the LBCs and the cocoa, coffee and sheanut farmers.

2.7.5. THE COCOA MARKETING COMPANY (CMC) (GH) LTD

The CMC is a subsidiary of the COCOBOD with the sole responsible for the sale and export of cocoa beans and the partially processed cocoa produce from the cocoa processing factories of COCOBOD to the overseas destinations. The company was also responsible for the export of coffee and sheanut, however, those two crops were privatized in 1991. The company has offices both in Ghana and London. The office in London receives bids from prospective buyers and sends them to Accra for decision to be taken on them.

2.7.5.1 Sales Objectives of the Company

The main objective of the company regarding sales is to sell to the external market at the best obtainable prices and to undertake its external marketing function in a way and manner that maximizes the foreign exchange revenue accrued to the country (COCOBOD handbook, 2000). According to the company's sale policy, Sales of cocoa beans are made only to companies, which are registered as buyers except sales made under bilateral arrangements to other countries. Before a firm can be registered as a buyer, it has to apply by writing directly to the managing director of the company. Prospective buying companies need to show that they have been involved in the trading of cocoa in some capacity in a cocoa consuming country and have the capacity to handle the commodity on the international market. In other for CMC to ascertain the financial capacity of the prospective firm, it has to provide the name and address of their bankers. They should be able to prove financially that they can purchase not less than 2500 tonnes of the beans per crop year, which begins from The 1st October, and ends at the 30th September. They must also show evidence of membership of the Cocoa Association of London and/or the New York Cocoa Merchants Association. When all the requirements are met, the prospective buying company is issued a buying license renewable per each crop year.

2.8. THE PRODUCTION PROCESS OF COCOA IN GHANA

The cocoa production process entails the growing, maintenance, pest and disease management, harvesting and post-harvesting stages.

2.8.1. GROWING STAGE

In Ghana, cocoa is only grown in six out of the ten regions due to the agro climatic requirements of the crop. The cocoa tree grows best in the tropical evergreen forest belt within 18 degrees north and 15 degree south of the equator. Mostly, cocoa is grown in an area with an altitude of not less than 400 meters above sea level with average annual temperature between 18^o and 32^o and rainfall between 1000mm-3000mm per annum and the dry season in such an environment should not exceed three month (International Trade Center, UNCTAD/WTO, 2001). In Ghana the climatic conditions for optimum cocoa production fall within areas with temperature between 25^o-26^o and average annual rainfall of 1200mm-1600mm (COCOBOD Cocoa manual, 2010) (see Figure 2-3). Before one starts growing cocoa, there is the need to understand the varieties of cocoa that are cultivatable: Criollo, Forastero, and trinitario. From these many hybrids have been developed and used as current cultivars for planting. The criollo is characterized with a mild-flavor and pleasant aroma and is mostly grown in countries such as Mexico, Guatemala, and Venezuela. However they are less grown due to their high risk of disease infestation. The most grown variety is Forastero forming the bulk of what is referred to as the 'basic' cocoa beans (International Trade Center, UNCTAD/WTO, 2001). They originated from indigenous states of the Amazon regions including Peru, Ecuador, and Colombia). The trinitario variety is found mainly in the West Indies and known to a cross between Criollo and Forastero.

Figure 2-3: Map of Ghana Showing Cocoa growing Regions 1

Acquiring seeds: One of the main reasons why growing cocoa is different from other cash crops is associated with the seedlings used for cocoa production. In Ghana cocoa farmers are supposed to obtain cocoa seedlings from seed gardens managed by a division of COCOBOD called the Seed Production Unit (SPU), which serve as commercial producers and distributors of special hybrid varieties of cocoa generated by the Cocoa Research Institute of Ghana (CRIG). The hybrid varieties are obtained by crossing parent clones from the upper Amazon to obtain certain desirable qualities. For example, unlike the Amelonado, traditionally known as Tetteh Quarshie, which begins fruit bearing after five years, the hybrid seedlings start bearing fruits earlier (2 years after transplanting). They are also high yielding, have better resistance to black pod and swollen shoot virus diseases as well as capsids. The reasons why farmers cannot reproduce their own hybrid seeds is because those seeds lose their desirable qualities after the their generation. And the first generation is produced by CRIG, they are then multiplied through manual pollination for commercialization by SPU and so it reaches the farmer as third generation seedlings and cannot be reproduced further. Every cocoa-growing region has at least a seed garden where farmers could go and obtain their seeds at given period on the cocoa calendar where the seeds would be matured and available.

Nursery: After farmers have obtained their recommended seedlings from the seed gardens manned by COCOBOD, then they can move ahead to the nursery stage, where the seedlings are raised for transplanting. Here, the site must be carefully selected to avoid losses. It is recommended by experts that the selected site should be flat, close to a permanent water source, with a permeable soil for avoiding water logging. When it gets too close to a nearby cocoa farm, the seedlings could be infested with the cocoa swollen shoot virus disease. Shades are required to avoid contact with direct sunlight. The cocoa seedlings could either be nursed in black polythene bags or directly on seedbeds. When the seeds germinate, the seedlings should be watered once in a day but should be either in the morning or in the evening to avoid over-watering. The shades should gradually be reduced from a month to transplanting, which usually takes between 5-8 months, to get the seedlings hardened for transplanting.

Field planting begins with pre-planting exercises such as selection of appropriate site, preparation of the land, lining and pegging, and shades establishment. Apart from the climatic requirements, the selected site should also meet certain required soil conditions. The soil must be at least 1.5m deep, homogenous as possible, good water retaining, drainage and aeration properties. Based on these soil properties, the recommended soil type is the loamy or clayey loamy soils, with a pH of between 5 and 8 with a high level of organic matter content at the topmost 15cm. The land clearing exercise, which usually involves the felling down of large trees should take place between December and February. Even though trees are required to provide shades for the cocoa plants, not all large trees are suitable since some of them could already be infested with the swollen shoot virus and so are undesirable to keep in the plantation. However, others, which are desirable, could be retained with 15-18 trees per hectare. Moreover, food crops such as cassava, plantain and cocoyam trees could also be used to provide temporal shades for the young cocoa plants. The spacing used for planting is another important issue to be taking into consideration at the planting phase. Planting without enough spacing could result in unhealthy plantation as a result of many plants competing for the same amount of water and other nutrients and so the recommended spacing is 10ft x10ft.

2.8.2. MAINTENANCE OF COCOA PLANTATION

The maintenance stage involves weeding, pruning, shade management, and fertilization to ensure proper health of the plantation. *Pruning*: basically is the removal of unwanted parts of the cocoa plant to ensure maximum productivity. Many types of pruning are applied in the cultivation of cocoa but the most common types are the formation pruning, the sanitation and the structural pruning. The formation pruning is carried out during the formative years of the young cocoa plantation, which falls within the 3rd, and 4^{th} year of establishment. It's mainly carried out to adjust the first '*jorquette*' to create the desirable shape during establishment. This type of pruning involves the cutting off of excess shoots and removing low lying branches to retain the first point of branching at a height of at least 1.5m. The sanitation and structural pruning are carried out in a matured cocoa plantation. Sanitation pruning is used to remove diseased and infested branches while structural pruning is done to shape the canopy to desired shape and architecture. *Weeding:* Weeding is required to prevent 1) weeds from competing with cocoa plants for nutrients, water and light, 2) incidents of insect pests and rodent attacks 3) farm from becoming too humid for increased incidence of black pod infestations and many other adverse incidence that impede productivity. Weeds could be controlled either by manual weeding or by chemical weed control, however combination of weeding by hand and chemical weed killers is recommended thrice a year for ensuring proper flowering and good harvest. *Shade management*: in order to achieve optimum level of cocoa production, there is the need to regulate the amount of sunlight passing through the plantation by managing the shades provided by the surrounding trees. A matured cocoa farm requires only 60% of sunlight to penetrate the ground, which means 40% shading is required. Gradually removing temporary shades and reducing the number of matured forest trees to about 15 to 18 trees per hectare could achieve this. *Fertilization* is a very important process in cocoa cultivation in helping the soil to regain its fertility from continuous cropping on farmlands, especially in Ghana. Studies have shown that three to four years of continuous fertilizer application has the potential of doubling the yield of cocoa (COCOBOD Cocoa manual, 2010). However, special care has to be taken and cocoa farmers are advised to apply COCOBOD recommended fertilizers depending on the stage of plant growth, soil type and the fertility of the soil. The government of Ghana, as part of her role to ensuring increased cocoa productivity usually provide these types of fertilizers at a highly subsidized price.

2.8.3. MANAGEMENT OF COCOA PEST, DISEASES AND PARASITES

There are a whole lot of pests and diseases that could affect the cocoa plant right from the nursery, through the establishment to the maturity stage. However only the most dangerous and damaging ones is the focus of this section and a more detailed discussion could be read from the COCOBOD Cocoa manual (2010). *Cocoa pests:* the most common and damaging pests include mirids (capsids) and borers (International Trade Center, UNCTAD/WTO, 2001; COCOBOD Cocoa manual, 2010). Mirids feed on the tender and succulent portions of the shoot by piercing and sucking the sap. The infested area then dries up, as sap no longer circulates which results in killing the young trees. Currently in Ghana, chemical control is the only reliable measure for the management mirids. The cocoa stem borer is a moth with developmental stages similar to butterflies. The first stage larva bores holes into the cocoa stem, branches or sometimes exposed roots for its development. The five stages of their development, which usually lasts for three months, can cause serious economic losses since they weaken the cocoa tree leading to loss of yield and eventually death if not controlled. Chemical control also exists for their management. *Cocoa diseases:* the most destructive diseases are the cocoa swollen shoot virus disease (CSSVD) and the *phytophthora* commonly known as black pod disease. The CSSVD has really caused serious damages to the cocoa industry in Ghana and so a whole division was created by COCOBOD to deal with it. The CSSVD is a viral infection caused by the cocoa swollen shoot virus and their infestation affects the leaves, stem, roots and pods. They are mainly managed by cutting down the affected tree and its contacts, if detected earlier enough, so that both the tree and the virus wither and die together before spreading out. The black pod disease is caused by fungus and mainly attacks the pods. The infested pods turn brown or black causing it to rot together with the beans. If not well managed, the aggressive type of the disease can cause an entire loss of the yield for the season. It could be managed in different ways including removing diseased pods and burning them and spraying the unaffected pods with fungicides to avoid spread. *Parasites:* mistletoes are the main parasitic plant that affects cocoa and in Ghana, they cause considerable damage. Under heavy infestation, they can cause the loss of an entire plantation. Several types of control strategies are being tried but preventive measures, such as well-maintained farms, are mostly recommended.

2.8.4. HARVESTING AND POST HARVEST MANAGEMENT

Harvesting: the first harvest of cocoa beans takes place between 3-5 years after planting depending on the cocoa variety. Usually the hybrid or improved variety takes shorter time to mature (i.e. 3 years) while the traditional variety takes a bit longer (i.e. 4-5 years). In Ghana, harvesting of cocoa takes place in two crop seasons. According to the cocoa calendar, the main crop season takes place between October and March, while the mid-crop season takes place in May-August. Harvesting is done at regular intervals of 3-4 weeks when the pods are ripe. The pod of the variety of cocoa grown in Ghana turns from green to yellow color when they are ripe and are harvested by cutting the stalk at close to the pod as possible with cutlasses or sickle on long pole, to avoid the possibility of damaging flower cushions required to produce the flowers for the fruit of the subsequent harvest. The pods are then collected and carried to a common pod-breaking site normally within the farm. The pod-breaking exercise then begins (see Fig. 2-4). Pods are broken not more than five days with either a breaking knife or a wooden club. However, wooden clubs, which are basically, wooden sticks with smooth edges, are preferable to avoid damaging the beans. The beans are then scooped out of the broken pod and the husks with the placenta are then discarded. The freshly extracted beans are then poured out on well-arranged plantain/banana leaves, or into baskets, or wooden boxes and covered for fermentation to take place.

Fermentation: the fermentation process then begins on the same day the pods are broken. Fermentation has three key importance: 1) to prevent the seeds from germinating 2) to process the astringent and unpleasant flavor of raw cocoa into pleasant flavor and aroma of good tasting chocolate and 3) to develop chocolate precursors in the beans.

Figure 2-4: Cocoa farmer breaking his pods after harvesting

Two stages are involved in the fermentation process, which usually takes six days to complete. The anaerobic fermentation, which represents first stage of the fermentation process, takes place in the first two days. It involves the fermentation of yeast and lactic acid bacteria, which results in the breaking down of the pulp to allow air penetration in the beans. The aerobic fermentation then takes over from day three through to day six. This involves the transformation of alcohol to acetic acid by acetobacter.

Drying and storage: drying of cocoa beans begins at the end of the fermentation process and it's required to reduce the moisture content from 55% to about 7.5%. This is a very important phase of the cocoa production cycle that needs careful attention. When it is poorly done, it could seriously affect the quality of the beans, which could lead to the rejection of the entire produce of the farmer. The drying process shouldn't be too slow to prevent moulds and off-flavors developing in the beans. Neither should the process be too quick, since that could also develop acidic and bitter flavors in the beans due to incomplete chemical reactions resulting from the fermentation stage. There are two methods that could be employed in the drying process: sun drying and artificial drying. Traditionally, sun drying is the most common and simplest method used in drying cocoa in Ghana. It involves spreading out the cocoa beans on raised mats made of bamboo or straw and placed under the sun. This method usually takes 7-15 days during which the beans must be frequently stirred, to pick out foreign materials such as the remains of placenta, germinated, flat, and black beans are all removed. There are improved natural drying methods that could also be used to achieve better results. These are specially designed to protect the beans from rain, showers and dew, especially during the night. Among these improved designs are: the autobus drier, the mobile roof drier, the tent drier and the greenhouse drier.

Figure 2-5: Cocoa Farmer Spreading Cocoa Beans on raised mat to dry 1

The autobus drier has a fixed frame with a movable drying screen that could slide in and out of the frame via rails and the mobile roof has a fixed drying frame with a movable roof. The tent drier is not too different from the traditional set-up, only that it has a transparent plastic covering to allow sunlight to penetrate and a black covered drying area to conserve heat energy that could be expended during the night. The last among this class of specialized sun driers and the most expensive is the greenhouse drier. It is specially designed for drying large quantities of cocoa beans and requires a special ventilation system that is based on the principle of heat convection and a system for controlling the drying parameters.

Artificial driers are also available especially in countries where there are no prolonged dry periods after harvesting and fermentation. However, this method is not the best since it can result in poor quality beans due to contamination by smoke or fires or suffer from quick drying.

Figure 2-6. Source: Adopted from CTA and ISF (2014): Improved Cocoa Beans Drying Mechanisms 1

Simplest and preferable forms are the convection driers, which consist of a simple flue in a plenum chamber with a permeable drying platform situated above (see Fig). When the beans are well dried, it turns brown in color and produces a ‘cracking’ sound when they are pressed lightly in a fist. After drying, the cocoa beans should then be packed into clean and strong jute bags and kept completely dry in such a way to stay free from moulds, damage by insects, and fatty acids. It is then ready to be purchased.

2.8.5. THE COCOA CALENDAR

Each of these stages is supposed to take place at specific period on the year’s calendar. The cocoa calendar is a special calendar designed to guide cocoa farmers on agronomic practices they need to undertake all year round to enhance productivity. Farmers are required to keep notice of the various dates associated with the various farming activities on the calendar. Among the reasons why cocoa is considered, a specialized crop could be that cocoa cultivation is capital intensive and failure to follow the cocoa calendar and their related activities from nursery to post-harvesting could cost the farmers the entire the cocoa plantation.

Activity	Month (s)
Nursery	January, February, October, November, December
Sanitary Pruning	April and May
Control of black pod disease	Between May and December
Control of mirids	Between August and December
Mulching and Shade Management	Between March and May

Table 2-1: 2017 version of the Cocoa Calendar 1

2.9. THE COCOA MARKETING PROCESS IN GHANA

The marketing process begins with the cocoa farmers and ends with the Government of Ghana (GoG) as the exporter with COCOBOD overseeing each stage of the marketing process including internal marketing and export (World Bank, 2011). *Internal marketing:* When the harvesting process is over, cocoa farmers are supposed to sell their beans to LBCs at the guaranteed nationwide fixed producer price. There are approximately 2700 buying centers where farmers can sell their beans to the LBCs. These locations are strategically and geographically positioned based on the proportion of cocoa beans produced within the six cocoa producing regions. These buying centers are operated by the LBCs through purchasing clerks hired from the local communities. After making their purchases, the QCD are requested to grade and seal the cocoa beans at a fee determined by the PPRC. The beans are then transported and evacuated through private haulers at the district collection points (depots) and then to one of the three takeover points namely: Kaase inland depot, Tema and Takoradi port facilities. Upon passing the final quality control they are then bought by the CMC at a fixed price. From then onwards, the CMC take over the beans at the various take-over points and management of the beans becomes the sole responsibility of the CMC until shipment to overseas. The Board according to the margins determined by the PPRC pays the LBCs. The purchase price, which the Board pays to the LBCs for selling the beans to them is also determined and set yearly by the PPRC. It covers the average transportation cost, commission to purchasing clerks employed by the LBCs, and other costs incurred by the LBCs (Lundstedt and Parssinen, 2009).

External Marketing: CMC, which is the marketing arm of COCOBOD/GoG, has the exclusive right to market and export cocoa to the external market. As part of the reform, it was expected that the LBCs would be permitted to export 30% of their purchases after meeting the conditions set by COCOBOD. The 30:70 percent split between LBCs and CMC was expected to take place in the 2002/2003 cocoa year-ends (Laven 2005; Lundstedt and Parssinen, 2009). However, as it seems now, no LBC has been granted an export license and so the government remains the sole exporter through CMC. Among reasons given by government for maintaining the monopsony market structure by failing to grant export licenses to the LBCs is to ensure and maintain high quality and price premium. Government fear is that opening up the export market for competition would lead to deteriorating of quality since monitoring purchases would be very difficult. It is also argued that it is due to weaknesses in Ghana's tax system, as a result a deregulated system would cause the government to lose a greater percentage of cocoa generated revenue (Lundstedt and Parssinen, 2009). According to COCOBOD, the LBCs are not interested or even ready to engage in exporting cocoa to the international market. On the contrary some LBCs have stated that their main objective of becoming licensed buyers was to enter the export market and so they see COCOBOD's failure to issue export licenses as deliberate attempt to hinder them from achieving their goal. Two of such companies are Olam and Armajaro who have their bases in Singapore and UK respectively and are well known as leading suppliers of cocoa and other commodities in the world market (Asante, 2014).

2.10. PROCESSING OF COCOA BEANS FOR EXPORT

The cocoa beans from Ghana are noted as of premium quality in the international market. This achievement, to a larger extent, could be attributed to the quality control checks they undergo before they are accepted for export. Before cocoa beans are ready for the market (internal and external) they have to undergo a rigorous quality checks to ensure that they satisfy the criteria for assessment of cocoa beans quality that defines cocoa to be of merchantable quality in the World market. For cocoa beans to meet the assessment criteria, they have to be thoroughly fermented and dry, free from smoke and any other foreign odor, and without any evidence of adulteration. Moreover, beans have to be reasonably uniform in size, reasonably free from broken beans and virtually without any foreign matter. In order to meet the assessment criteria, the Quality Control Division (QCD) of COCOBOD, responsible for establishing cocoa bean quality in Ghana conducts inspection, grading, sealing and disinfestation services of cocoa beans produced in Ghana.

2.10.1. INSPECTION, GRADING, AND SEALING ACTIVITIES

Inspection, grading, and sealing of cocoa beans can only take place in storage facilities that have been certified as Scheduled Grading Centers. The LBCs have the responsibility of erecting their own sheds for the storage of their purchases of cocoa and other exportable produce. When these storage sheds are erected by the LBCs, the QCD then have to inspect the sheds and issue certificate of approval to indicate that the sheds qualify for the purpose for which they are built. Upon the approval of the premises, the LBCs are issued Certificate of Registration, which designate the premises as a Scheduled Grading Center. Until a shed has been certified accordingly, no grading and sealing activities can take place in that premises. The grading of cocoa is done through a process called “cut-test”. After grading and sealing, “Certificate of Inspection of Produce” is issued to certify the produce. Afterwards, a supervising officer can conduct “check-testing”, which involves a re-examination of the graded produce, for confirmation. Depending on the percentage of defect, the cocoa beans can be graded as grade I, grade II and grade III. The cocoa beans can further be graded according to the sizes of the beans: main crop (up to 100), light crop (101-120), Small beans (121-130), type 4 (131-150), and remnant beans (151 and above).

2.10.2. INFESTATION CONTROL ACTIVITIES

There are eighteen (18) “Disinfestation zones” within which trained pest control staff of the unit operates. These zones are strategically located to provide services the ports, regional capitals, and district offices. Infestation control involves:

- Spraying of empty sheds with approved insecticide to eliminate residual infestation.
- Regular insecticidal fogging of sheds stocked with produce to reduce insect population
- Fumigation of produce to control all stages of pest infestation.
- Use of poison baits to control rodents in storage premises.

2.10.3. PORT OPERATIONS

The produce purchased by the LBCs are graded by QCD and taken over by the Cocoa Marketing Company Limited (CMC), on behalf of COCOBOD, at the “take-over centers”. The take over centers represent the ports: Tema, Takoradi, and Kaase near Kumasi. The port activities involve two parts:

- Treatment on arrival and
- Treatment prior to shipment

When the consignment of cocoa arrives, the staff of QCD conducts a “check-sampling” exercise. This exercise is conducted to check whether the original quality as graded up-country has been maintained through proper storage and during transit. When it is established that both the quality and quantity is within the required standards, a “Purity Certificate” is issued for take-over to be effected. When the test shows that the cocoa beans don't meet the required standard, it is rejected and returned to the LBC concerned to be reconditioned (QCD Handbook, 2001). On the other hand when the beans are found to be below Grade II, it is considered as sub-standard and may be traded at a discount price without the option of reconditioning. When the test proves that the beans are mixed with black beans or foreign matter it is regarded as adulterated cocoa and confiscated. After the check sampling exercise is completed, the entire consignment that passed the test is fumigated with phosphine as a precautionary measure against inherent insect infestation. The fumigation exercise is conducted on the entire consignment prior to shipment and covered by "Fumigation Certificate". The quality of the beans is re-checked and certified with "Purity Certificate". The entire empty vessel or ship is also disinfested and "Treatment Certificate" issued before loading of the cocoa begins. The Captain of the ship is interviewed to find out the subsequent ports of call and other relevant information that would help QCD to ascertain possible causes of infestation when such cases are reported.

Right from the beginning of the farming process to the marketing and processing stages, an enormous volume of knowledge is created which needs to be transferred from various divisions of COCOBOD and other stakeholders across the entire cocoa value chain, to the cocoa farmers.

2.11. PROCESSING COCOA IN GHANA

Historical Background: In 1949 Gill and Duffus Group Ltd. of London established the West Africa Mill (WAM) that was when the cocoa processing industry started. In 1963, the Government acquired 51% of WAM and commenced the building of two processing factories at Tema and Takoradi through the Cocoa Products Corporation. The Takoradi factory was commissioned in 1964 and was constructed by Thyssen Stahlunion. Paterson Simons and Edward of Britain managed the factory under a five-year agreement with the government, to process raw cocoa beans into butter, cake, and liquor. In 1969 the factory was brought under the management of COCOBOD. The factory at Tema, which was under construction by Drevici Group of Companies also began in 1963 but came to completion in 1972 and was handed over to the Board at the same year. In 1973 COCOBOD established Cocoa Products Company to control and coordinate the operations of the two factories and also acquired the Golden Tree Chocolate factory, which had been under construction as an attachment to the Tema factory, all at the same year. The two factories were then incorporated (as a Limited Liability Company) to become the Cocoa Processing Company (CPC) in 1981, as a subsidiary of the COCOBOD. In the following year the COCOBOD translated its 51% shares in WAM into a fully owned subsidiary after Gill and Duffus traded-off its shares. The constituent units of CPC were then became the Cocoa Processing Company Limited (CPC), Tema, which was used for the production of cocoa products under the brand-named "Portem" and "Golden Tree" chocolate and Confectionery. The Takoradi branch of the CPC Ltd. was used for the production with the brand-named of “Taksi”, while the WAM division of CPC Ltd. was used to produce cocoa products with the brand-named “WAM”.

In 1990, the Tema factory (Portem) was split into two units as: Portem (Cocoa) factory for the conversion of cocoa beans into cocoa butter, liquor, cake, and powder and Portem (Confectionery) factory for the manufacturing of chocolate, coverture, “pebbles” and instant coca powder. Overall, CPC Ltd. had four factories before some were put under divestiture in 1992: CPC Ltd. Portem (Cocoa) factory, CPC Ltd. Portem (Confectionery), CPC Ltd. Taksi, and CPC Ltd. WAM. In September 1992, CPC Ltd. WAM at Takoradi was divested under the government’s divestiture policy to become WAMCO Ltd. with the COCOBOD holding 40% share in the new company while the Schroeder, of the Hosta Group of Companies, Germany held 60% as the majority share. In December 1993, the second factory in Takoradi, CPC Ltd. (Taksi) was also divested with WAMCO Ltd. acquiring that fully. The other two factories of CPC Ltd. at Tema remained subsidiaries of COCOBOD. However, in 2003, the government offloaded 25% of its share and listed it on the Ghana Stock Exchange (the GSE All-share Index). As at now, the government owns about 48% of the shares of CPC while COCOBOD also controls 22%. Currently the company has two cocoa factories and a confectionery factory. The cocoa factories processes cocoa beans into cocoa liquor, cocoa butter, cocoa cake and cocoa powder, which are marketed under the brand-named “Portem” mostly in the international market. In 2004, MAN Ferrostaal, a German company was contracted to update and expand the capacity of the factories, which also selected Buhler (Chocolate and Cocoa) as a technical partner. The project was commissioned in 2005 and now the cocoa factories have an annual throughput of 64,500, a capacity of 4 metric tons per hour, up from the initial installed capacity of 25,000 tons.

The confectionery factory processes part of the semi-finished products into chocolate confectioneries such as chocolate bars, Chocolate spread, Drinking chocolate, and Chocolate “dragees”, which are sold under the brand-named Golden Tree. At the 2002 Monde Selection Competition, held in Paris, France, CPC was re-confirmed as one of the World best chocolate producers with seven of its chocolate products wining gold medals. Currently, there are five cocoa processing companies operating at various levels of processing including Barry Callebaut, Afrotropics, Cargill, and Archer Daniels Midland (ADM).

Presently, about 80% of cocoa in Ghana is directly exported in raw form while the remaining is processed domestically into semi-finished or consumer products (Monastyrnaya, 2016). 95% of domestically processed beans are in the form of semi-finished products like liquor, butter, powder and cake, most of which is again exported out of the country, leaving only 5% processed cocoa beans for domestic consumption in the form of confectioneries and other cocoa-based products. Meanwhile the government aims at processing at least 60% of total cocoa output domestically before exporting. This has necessitated the need for the government to offer competitive packages with the aim of attracting foreign direct investments into the domestic cocoa processing sector. Packages such as discounts, tax free zones, and extended payment credits are thus offered as economic incentives (World Bank, 2013). Moreover, domestic processors are offered a discount of 20% on beans that are produced in the light cocoa season (Monastyrnaya, 2016). Such efforts by the government resulted in an increase in the domestic grinding capacity from 110,000MT in the early 2000s to about 431,000MT in 2013 (World bank, 2013). The growth in the domestic processing capacity has increased the competition for discounted cocoa beans thereby depleting its availability. To purchase beans produced in the main cocoa season by domestic processors do not attract any discount while importing beans into the country also attracts 20% duty, coupled with high operational costs makes such decisions economically inefficient. Consequently, domestic processors are unable to procure the quantities of cocoa beans they require to operate in their full capacities.

CHAPTER 3. IMPLEMENTATION OF ICTS FOR AGRICUTURE AND RURAL DEVELOPMENT

3.1. INTRODUCTION

The adoption of ICT in agriculture in Africa is of strategic importance to multi-stakeholder knowledge transfer and sharing (Yonanzi et al., 2012). The use of ICTs in agriculture creates a common platform for multi-stakeholder collaborative research that includes farmers, researchers, extension agents businesses, governments and other citizens. Doing so improves the efficiency and effectiveness of research by reducing the time needed to conduct research and also allowing the research to be tailored along the most relevant topics to solve the exact needs of farmers (Yonanzi et al., 2012). Ghana is among the first, if not the first country to get connected to the Internet in 1995 and has an ICT policy that stands out in history due to its pursuit to use ICT as a tool for poverty alleviation and to achieve civil society objectives. With the objectives laid out in the ICT for Accelerated Development (ICT4AD) plan, ICT was at the center of the country's quest to achieve the middle-income status by 2015. Like many other developing countries Ghana is faced with the choice of the growing capabilities of ICT in its agricultural sector to facilitate knowledge transfer and creation. The chapter discusses the problems and prospects associated with the infusion of ICT applications into agriculture for capacity-building and rural development in Africa inclusive of Ghana.

3.2. ICT4D AND WEB 2.0 APPLICATIONS

According to Sutinen & Tedre, (2010) social science perspective on ICT4D research can be categorized into four depending on whether 1) development challenge at hand is well-defined or well known and 2) technical solution for the problem exists or not. The first category, which is a matching type of research, involves pinpointing and understanding a social or economic needs or issues and matching it with an existing technical solution, preferably more affordable so as to improve the social/cultural or economic situation (Nyakaisiki, 2016). The second category referred to as evaluation research, involves evaluating how well an existing technical solution could solve some specific socio-economic challenge. The third category is an exploratory research, which is done as groundwork for further research of categories 1 and 2. With the exploratory research, the problem area is not well known and the goal is to delimit the boundaries of the problems and open up new areas for investigations. The fourth category is termed as constructive research since it involves the researcher having to construct (define, design, implement, and test) an artifact for tackling an issue at hand.

The goal of the current study is not to construct a new tool in order to solve an existing problem since according to Sutinen and Tendre (2010), that situation is required when there are no available tools that could be used to solve the known existing challenges. Before we can arrive at that conclusion, we need to first exhaust all possibilities of using the existing tools. Moreover, there is also an issue of affordability, which is among the key challenges confronting ICT usage in developing countries, especially in Africa. There are some noted evidences of unsustainability due to non-affordability of the users of such initiatives (Nyirenda-Jere & Kazembe, 2014). The study does not fall within evaluation research, as most ICT initiatives within the agricultural sector haven't attained the maturity stage where meaningful evaluation could be ascertained. Even though there has been some measured success we are of the view that it is still quite early for a meaningful evaluation to be done regarding ICTs usage in agriculture in developing countries. The focus of this study could thus be classified under the first category since it involves the matching of existing tools, web 2.0 applications to an existing socioeconomic issue (knowledge transfer) in a developing country, Ghana. To further clarify the focus of the research, there is the need to examine the role of web 2.0 applications in the shift from ICT4D1.0 to ICT4D 2.0.

The dawn of the Internet and web 2.0 applications marked the second phase of ICT4D termed as ICT4D 2.0 with emphasis on longevity, scalability, and objective impact evaluation (Heeks, 2008). The first phase of ICT4D was birthed out into the Millennium Development Goals with the Internet in the 1990s (Heeks, 2008). However, its implementation couldn't stand the test of time but resulted in failure due to three main factors: sustainability, scalability and evaluation. The projects were dominated by individual telecentres-basically a room or a building with one or more internet-connected PCs, which were very limited, and so scalability and evaluations became issues. Moving forward, there is an aroused interest that ICT4D2.0 should begin with the technologies that are already penetrating such as mobiles; radios and televisions; however, developers and researchers should continue to seek ways of incorporating computing and Internet functionalities. In doing so, researchers and developers are to take into consideration the low literacy rates of the poor in the developing countries and so applications with audiovisual interfaces capable of creating interfaces for all possible local languages are recommended (Heeks, 2010). Meanwhile, there seem to be some commonalities between the proposed requirements of ICT4D2.0 and the principal features of web 2.0 technologies. Consequently, most of the key principles of Web 2.0 are, highlighted in the ICT4D2.0 manifesto (Heeks, 2010). For instance, the 'long tail' principle of Web 2.0 is also featured in the ICT4D2.0 agenda, in the sense that it involves using "digital technologies to draw on the capacities of the 80% who hold only 20% of the world's resources". Moreover, cost effective scalability is among the major factors that led to the failure of the previous phase of the ICT4D agenda and has motivated the search of sustainable and scalable solutions. In the subsequent sections, we seek to discuss current developments of ICT4D in farm developments and implications on extension activities in Africa.

3.3. ICT4D IN FARM IMPROVEMENTS AND AGRICULTURAL EXTENSION

ICT is any device, tool, or application, ranging from radio to satellite imagery, to mobile phone and electronic money transfer, that permits the collection, processing, storage, or exchange of data through interaction or transmission (Bagazonzya et al., 2011; Deloitte, 2012). It encompasses both old media and new technologies that allow communication and sharing of information facilitated by telecommunication networks (R. Chapman & Slaymaker, 2002). The application of ICTs to development-oriented projects is referred to as ICT4D (Heeks, 2008). The potential impact of ICTs for boosting the agricultural sector and the lives of farmers in Africa has been touted to great lengths but there still remain many challenges regarding sustainability and affordability (Deloitte, 2012; Bagazonzya et al., 2011; Nyirenda-Jere & Kazembe, 2014). The use of ICTs such as mobile telephony, radios, geographic information systems (GIS) and satellite imagery technologies in agriculture has been rapid in Africa including areas which would have been very difficult, if not impossible, to reach (Moyo, BAH, & Verdier-Chouchane, 2015; Bagazonzya et al., 2011). Many factors have contributed to the widespread use of ICTs in agriculture including: low-cost and pervasive connectivity; adaptable and more affordable tools; advances in data storage and exchange; innovative business models and partnerships; and the democratization of information (Bagazonzya et al., 2011; Deloitte, 2012). It’s believed by many that if ICTs are effectively put to use, it would help in alleviating much of the information needs required to improve the livelihoods of smallholder farmers by bridging the critical knowledge gap between stakeholders, which is key for economic development and growth (Deloitte, 2012).

3.3.1. MANAGING AGRICULTURAL KNOWLEDGE THROUGH ICTS IN RURAL AFRICA

Knowledge creation and transfer are identified as being among the main issues confronting the developing world, in general and Africa in particular where a greater need of ICTs are required (Deloitte, 2012). Most of the innovative technologies and best farming practices generated through research by civil society, government and the private sector that could aid in modernizing small-scale agriculture are unable to reach their intended beneficiaries. Most institutions involved in creating new knowledge and developing new agricultural technologies have very inadequate processes and dissemination capacities to transfer outputs widely enough to reach potential recipients who are mostly smallholder farmers. These bottlenecks associated with the flow of knowledge from knowledge senders to knowledge receivers are mainly attributed to inefficiencies of the traditional systems used for their transfer (Deloitte, 2012). ICTs could enhance the creation and transfer of knowledge in many ways including:

- Identifying the knowledge needs of the farmers
- Connecting the relevant stakeholders
- Managing the flow of knowledge and information, across agricultural value chains

3.3.2. IDENTIFYING THE KNOWLEDGE NEEDS OF FARMERS IN DEVELOPING COUNTRIES

For ICT usage in agriculture to be beneficial to farmers in Africa, identifying the knowledge needs of the farmers in the farming lifecycle is crucial since knowledge needs differs from stage to stage. Studies in developing countries have adopted various frameworks for understanding the knowledge needs of farmers from one stage to another on the agricultural production cycle (Robert Chapman & Slaymaker, 2002). Chapman and Slaymaker, (2002) categorized farmers' knowledge needs into Type A and Type B. Type A knowledge refers to the need for farmers to receive training and education for long term capacity building. Type B refers to the information needed by farmers to make short-term decisions and thus require frequent update. Both forms of knowledge are essential for making informed decision towards increased productivity (Chapman and Slaymaker, 2002).

Lwoga et al. (2010) identify two forms of agricultural knowledge as being predominant in rural farming communities of developing countries: indigenous knowledge and exogenous knowledge. Indigenous knowledge is tacit in nature and embedded in the experiences and practices of local people within a unique culture (Lwoga et al., 2010). Most farmers in sub-saharan Africa relate very well to this form of knowledge as the basis not only for agriculture, but health care and education etc. because they are mostly smallholders (Lwoga et al., 2010). Exogenous knowledge is a non-traditional knowledge base that local farmers obtain from their interactions with research institutions, western scientific thinking, values and philosophies, as well as ICTs (Lwoga et al., 2010). ICTs play important role both in the management and integration of indigenous and exogenous knowledge, which is necessary for improved agricultural activities in rural Africa (Lwoga et al., 2010). When indigenous knowledge is not well documented and transferred, it may lead to loss of intellectual property rights of indigenous people, and ICTs makes it possible for this form of knowledge to be captured, documented and transferred (Lwoga et al., 2010). Despite the availability of ICTs in the surveyed communities, Lwoga et al. (2010) found that ICT usage of farmers in Tanzania was more towards access to exogenous agricultural knowledge than indigenous agricultural knowledge.

Overall the use of Internet applications for the acquisition and sharing of both indigenous and exogenous knowledge were on the lowest side while mobiles usage was on the high side.

In a national survey conducted in India, (Mittal et al., 2010) identified six stages of agricultural lifecycle as crop planning, buying seeds and other inputs, planting, growing, harvesting and selling. The knowledge needs of farmers for all the six stages were categorized into three as *fundamental* information on farming techniques (know-how), *contextual* information (e.g. weather), and *market* information (e.g. prices of inputs and commodities). Emphasizing the importance of identifying the knowledge needs of farmers regarding ICT usage for agricultural knowledge transfer in Africa, Hellström, (2010) distinguished four specific areas of needs by smallholder farmers as: (1) Education and awareness which links farmers to extension agents (2) commodity prices and market information service is used to provide an up-to-date pricing of commodities (3) data collection is a service used to collect and aggregate geographical data and (4) pest and disease outbreak warnings and tracking-used to send and receive knowledge regarding outbreaks of diseases and pest via mobile (Steinfield & Wyche, 2013). The World Bank (2011) report identified three stages in the agricultural production cycle: pre-cultivation, crop cultivation and harvesting and post-harvest (Deloitte, 2012). Knowledge needs of farmers at the pre-cultivation stage include land selection, crop selection, calendar definition, and access to credit. At the crop cultivation and harvesting stage, farmers need knowledge regarding land preparation and sowing, input management, water management and fertilization, and disease and pest management. Knowledge about marketing, transportation, packaging, and food processing are needed at the post-harvest stage of the farming lifecycle (Yohanzi et al., 2012).

ICTs have been successfully put to use in all the stages of the agricultural life cycle. At the pre-cultivation stage, ICTs are used to facilitate land registration process, land allocation and use, crop selection, obtain weather information for the planting calendar, take inventory, and facilitate access to credit. ICT-solutions that could support knowledge transfer at this stage include: information systems (Decision Support Systems (DSS), Geographical Information Systems (GIS), and ICTs that enable learning, knowledge exchange, and networking solutions. The use of GIS and remote sensing technologies (RS) are increasing being used to ensure more efficient land use and water management. In Ethiopia and Mozambique, satellite imagery data and GIS are used for land registration and inventories. Kilimo Salama is a mobile-based technology, used to deliver mobile-based crop insurance on purchased inputs such as certified seed, fertilizers, and crop protection products to protect farmers against adverse weather shocks and crop failures. The M-PESA mobile platform belongs to this stage of the production cycle for its usefulness in facilitating farmers' access to credit in Kenya. Other Modeling-based ICT solutions are also considered helpful for crop selection at the pre-cultivation stage.

At the cultivation and harvesting stages, ICTs are used to generate and transfer valuable data and information to smallholder farmers who were previously out of reach. Through the use of ICTs information on land preparation, crop health, input management, and pest and water management are able to get to farmers who could otherwise be out of reach. The Bill and Melinda Gates Foundation in conjunction with the GSMA mAgri Program through the mFarmer initiatives have developed the mobile agricultural value-added services (Agri VAS), which were launched in India, Kenya, Mali and Tanzania to transfer information and knowledge on crop cultivation and market prices to farmers. ICT solutions that support online commerce and networking such, as e-commerce and m-commerce can be useful at the post harvest stage for marketing purposes. The use of ICTs at the post-harvest stage includes providing market information that is crucial to improving market efficiency (Moyo, Bah and Verdier-Chouchane, 2015). Unavailability of sufficient and reliable information on prices and market conditions makes it nearly impossible for farmers to receive fair prices for their crops, which in turn discourages them from investing more in inputs and technologies for increased production. So far, ICTs have been successfully put to use in providing access to market information to inform farmers about market prices. Such information has helped empowering farmers in making negotiations with intermediaries regarding the sales of their farm produce. ICT initiatives, which have been successful in the agricultural marketing arena, include Esoko (sub-Saharan Africa), e-Choupal and Reuters Market Light (India), Manobi (Senegal), Infotrade (Uganda), Ethiopian Commodity Exchange (ECX), and Zambian National Farmers Union MIS (Zambia).

3.3.3. ENHANCING INTEGRATION AMONG STAKEHOLDERS OF AGRICULTURAL KNOWLEDGE

Bridging the knowledge gap between the various stakeholders is critical in addressing key issues such as economic development and growth within the sector. In order to enhance collaborative and participatory research to generate new knowledge and information for farmers, there is the need to build-up strong linkages among the multi-stakeholder research partnership referred to as the knowledge quadrangle (farmers, extension professionals, researchers, and educators), to promote mutual learning, generate, share and utilize technology, knowledge and information (Spielman & Grebmer, 2004). Meanwhile, much of Africa's agricultural knowledge is in indigenous form passed down and continues to be handed down through spoken word as a result of strong history of oral tradition. Due to the low levels of literacy, most rural farmers are more comfortable with spoken words and peer-exchanges making written information of no use to most of them. Consequently, the main source of knowledge and information for most smallholder farmers is through media such as radio and television (Nyirenda-Jere and Kazembi, 2014). In fact, radio and TV still remain the most pervasive form of communication and medium for knowledge transfer to most rural communities in Africa. Meanwhile, farming in recent times, has become much more diverse since it is combined with other activities with different partners playing different roles at different times in both the agricultural value chain and crop life cycle. The linear model of technology transfer from researchers to farmers involving the use of only broadcasting technologies such as radio and TV is, thus, outmoded and needs to be replaced or supplemented with interactive model of networking systems (Poppe, 2012). The use of broadcasting technologies like radio and TV gives farmers very little or no opportunity to provide feedbacks, making the communication non-interactive, which in effect doesn't enhance participatory research.

The use of ICTs that can facilitate collaborative research by enabling access to the Internet, libraries, databases and other information resources thereby enhancing data collection, access to and application of the results of research should be encouraged. To this effect, information system platforms that could integrate the various stakeholders, especially those among the actors of the knowledge quadrangle could be highly advantageous for agricultural sector in Africa in the sense that, it could minimize the duplication of data to ensure consistency, and also improve data integrity. Using Web 2.0 applications including social media could enhance collaborative research and knowledge creation by making data and information available to all interested parties particularly among the actors of the knowledge quadrangle thereby ensuring communication and collaboration among them.

Decision making in farming could be very challenging since they are mostly multi-dimensional in nature. Such decisions may require the integration of water management, nutrients, pest and diseases, and weather forecasting, and even more, all at the same time. Decision-support systems and geographical information systems (GIS), which are capable of amplifying, accelerating, and improving precision of results, could aid researchers and extension officers in supporting farmers in such decision-making. Frameworks, which could help in the analysis and gaining further understanding of the key issues associated with how ICTs could be used to consolidate existing mechanisms for knowledge creation and transfer in the agricultural sector, particularly in Africa, could be advantageous as well.

3.3.4. MANAGING THE FLOW OF KNOWLEDGE AND INFORMATION, ACROSS AGRICULTURAL VALUE CHAINS (AVCS)

Up to 80% of the food in sub-Saharan Africa is produced by smallholder. In order to integrate international distribution channels and take advantage offered through increased globalization, there is the need for African farmers to deliver high quality products at competitive prices and enhance their capacities to meet the norms and standards laid down by their international trading partners (AfDB, 2016). It is expected that greater integration into AVCs would enable farmers to harness interdependence among various actors across the value chains, which could facilitate their access to inputs, financing, and end-markets at the local, regional and international levels. Participation in AVCs could also enable farmers to have a greater voice in the value chain and enhance their economic returns, as well as, enable them to rise up into higher-value activities, capture a greater share of value in global markets and consequently, enhance the sector's competitiveness (AfDB, 2016).

However, in order to realize the full benefits of integration into AVCs, there is the need to recognize that value chain relationships require a multi-faceted process of interaction involving different modes of knowledge transmission between various actors across the value chain (Saliola & Zanfei, 2009). Participation in AVCs trigger knowledge and technology transfer and so the need to effectively and efficiently manage the flow of knowledge among value-chain participants cannot be overemphasized. The rapid uptake of ICTs including the use of Internet is providing an important opportunity for improving the performance of AVCs by strengthening the interactions among the various stakeholders across the value chain. The use of traceability technologies could also enhance integration into the global value chains. Across the value chains, traceability technologies are used to record information on items moving through the supply chain so that they could be tracked from its origin to the destination across the global value chain. Traceability is also used for food and animal tracking. In Kenya iCow is used to provide valuable information on cattle to monitor the back and forth movements of the animals. The Namibian Livestock Identification and Traceability System (NamLITS) is used to support the eradication, control and risk management of contagious diseases the affect livestock. Among the major challenges confronting the cocoa industry in Ghana, is the smuggling of cocoa beans into neighboring countries like Cote d'Ivoire. Traceability technologies could, thus, be used to curb the smuggling activities going on in the industry. However, the use of traceability technologies also requires the use of applications that could be used to record and transmit data from one point to the other. Different web applications could therefore be used to facilitate the transmission of data from the source to the destination across the global value chain (Bagazonzya et al., 2011; AfDB, 2016). Nevertheless, not much has been done regarding investigations into how the various web applications could be used to record and transfer data, information and knowledge across the regional AVCs in Africa.

3.3.5. MOBILE USAGE AND AGRICULTURAL KNOWLEDGE TRANSFER

Mobile technology has emerged as the "access technology of choice" for both voice and data. Mobile technologies including mobile phones, GPS systems, barcode scanners, RFID readers, and smart card readers are currently being used to capture and store data. The use of mobile devices and services, involving text, voice and multi-media messaging for knowledge transfer has also gained popularity in recent times. Initiatives such as Agricultural information systems and market information systems are developed are being used to provide farmers with information on farm inputs, markets, weather and other ancillary services. However, most of these initiatives are pilot projects, which are either fully subsidized service provided by governments, or fully commercialized services provided by 'infopreneurs'. In either way, sustainability remains a key issue. In some cases the projects begins as a funded project with the expectation that when farmers realize the usefulness they would be willing pay for the services, without bearing in mind that most of these rural smallholder farmers live on less than $1.0 per day and so even though they realize the value of these services they are simply unable to pay and so the project got folded-up. That not withstanding, these initiatives have recorded some successes. Muto & Yamano (2009) recorded a reduction in marketing cost and increased farm-gate prices due to improved access to price information. (Pye-Smith, 2014) recorded how ICTs are transforming the lives of rural people in Rwanda through community telecentres. However, it appears most of these successes happened at the micro-level with the impact at the regional and national level remaining unclear.

The livelihood of agricultural dependent rural communities in Africa can be improved in various ways through the use of mobile devices and services (Hellström, 2010). According to the editors of e-Transform Africa such initiatives, which have taken-off in Africa include DrumNet system, which transfers knowledge about finance and marketing to a network of farmers in Kenya. In other developments, some local farmers in Tanzania are trained to use smartphones and web portals to document their farming environments and share the information thereby promoting participatory knowledge creation among researchers, extension agents and farmers. Two smartphones are used to run a shift system where a group of five men and five women in a community take turns to document their farming information using pictures and voice recordings to capture a variety of useful information and sharing them on the web portal for others to have access. According to the researchers who were involved in the project called "the voice of the farmers", using ICTs can enable farmers not to remain as consumers of knowledge but rather equally engaged in defining their goals and sharing their outcomes with researchers and extension agents (Muilerman, 2013).

Steinfield and Wyche, (2013) distinguished mobile phone-based agricultural services into four main blocks namely:

- Farmer advisory and information services,
- Market information services
- Financial services
- Decision support services

The focus of the farmer advisory and information services is towards providing agricultural knowledge to farmers usually via two-way interactions with extension agents and other experts such as researchers. The services obtained by farmers may include knowledge about basic information on crops and techniques, diseases and pest control as well as receiving responses to their questions. Examples of mobile platforms that provide these services include M-Kilimo in Kenya and Cocoalink in Ghana. Marketing information service platforms empowers smallholder farmers in their bargaining at the farm gate by providing them with information regarding prices of their crops, usually via text messages. Reuters Market Lite (RML), Esoko, Kenya Agricultural Commodities Exchange (KACE), and M-Farm belong to the marketing information service platform. M-PESA and M-Shawri are among the common mobile money platforms that provide financial services to farmers in areas where access to traditional banking organizations does not exist. iCow and Nutrient Manager for Rice (NMRice) are examples of platforms that offer decision support services to farmers. When the farmers provide information such as height of crop, weight of livestock etc. of their farms, it can then be combined with other data such weather patterns, date, and location of farmers to provide recommendations on fertilization, feeding, watering etc.

In spite of the amount of work that has been done regarding the potential of ICTs, including internet and mobile phones, for the transfer and sharing of knowledge and information in farming communities especially in rural area of Africa. There still remains much to be learned about how we can best leverage the use of ICTs to enhance the transfer of knowledge to farmers who are mostly located in rural parts of Africa. Particularly, research that focuses on creating a better understanding of factors that influence the adoption of ICT-based services by smallholder farmers in Africa and the impact of these services on their knowledge needs may be of strategic importance (Steinfield and Wyche, 2013). Ghana is among the first countries in West Africa to connect to the Internet in 1995 and has an ICT policy that stands out in history. In the subsequent sections of the chapter we seek to have an overview of the ICT landscape and how ICTs have evolved over time.

3.4. THE ICT LANDSCAPE IN GHANA

Most countries in the World (both developed and developing) are benefiting from the use of ICTs in every sphere of their lives. Ghana was among the first African countries to undergo ICT reforms and establish legal and regulatory framework in response to the global policy changes in the ICT industry. In August 1994, Ghana took an important step to become one of the first countries to introduce widespread liberalization in telecommunication services by embracing the potential of competitive markets to stimulate growth and innovation in the sector (National Telecommunications Policy, 2005). The policy was based on a 5-year Accelerated Development Program (ADP) with the aim to increase teledensity from 0.31% to between 1.5 to 2.5%. This goal was to be attained through the provision of public and private payphones; improved public access in rural and urban areas; expand coverage of mobile services; promote Ghanaian ownership of telecommunication companies; and retain overall public regulatory control of the sector through the creation of a single agency (Alemna & Sam, 2006). Through the ADP, the country was able to achieve an increase in teledensity from 0.34 lines to 1.16 lines per 1000 inhabitants and public phones also increased from 0.001 to 0.016 per 1000 inhabitants by the year 2000 (Alemna and Sam, 2006). In the later part of 2003, the government of Ghana introduced the ICT4AD policy with an overarching objective being to engineer an ICT-led socio-economic development process with the potential to transform Ghana into a middle-income, information-rich, knowledge based and technology-driven economy and society (Ghana government, 2003). The strategic focus of the policy was to use ICT as a broad-based driver of developmental goals through the development, deployment, and utilization of ICTs as engine for all sectors of the economy and the society and thus making ICT a key driver for economic growth.

Regulatory and Institutional Frameworks: With these changes taking place, it became necessary to establish new and appropriate institutional and regulatory structures. The Ministry of Communication (MoC) was created with vision to manage the conversion of ICTs to ensure free flow of information and to gather feedback for the promotion of viable integrated national development process within a global setting (MoC, 2016). In line with the policy guidelines of the Medium Term National Development Policy Framework (MTNDPF), MoC has a core responsibility to initiate and develop national policies that would help to achieve cost effective information and communications infrastructure and services for the enhancement and promotion of economic competitiveness. In other to perform the core functions, which include building capacity for the ICT sector, the Ministry is composed of agencies and statutory bodies that help in the implementation of policies related to operational and regulatory framework. These include the National Communications Authority (NCA), Ghana Investment Fund for Electronic Communications, National Information technology Agency (NITA), Ghana-India Kofi Annan Centre of Excellence in ICT (AITI-KACE).

The National Communication Authority (NCA) was established in 1996 as the central body responsible for regulating communication by wireless, cable, radio, television, satellite, and similar technologies to ensure an orderly development and operations of efficient and communication services in Ghana. Prior to the establishment of NCA, regulatory function of the sector was undertaking by the then Post and Telecommunication Corporation (P&T), which acted as both a player and a referee by providing licenses to private users. The National Media Commission (NMC) was also established to oversee the regulation of the electronic and the print media while NCA focused on the regulation of communication in the country.

In July 2004, the Government of Ghana established the Ghana Investment Fund for Telecommunications (GIFTEL) under the ICT4AD policy as an agency of MoC to facilitate the provision of universal access to basic telephony to the underserved communities in the country. Although GIFTEL started operations in January 2005, the Electronic Communication Act 775, which provided the legal framework for its operations, was not ready until 2008. The name was then changed to Ghana Investment Fund for Electronic Communications GIFEC, with a broader scope of operations, which included provision of access to electronic services such as ICTs, broadcasting, internet, multimedia services and basic telephony to the underserved communities in the country (GIFEC, 2015). The National Information Technology Agency (NITA) was established in 2008 in accordance with the Ghana National Information Technology Agency Act 771, with the task of providing leadership in the diffusion and adoption of information and communication technologies in the public sector. NITA is the agency responsible for the implementation of Ghana's ICT policies such as espoused in the e-Ghana project, which seeks to assist Government to generate growth and employment via leveraging ICT and Public Private Partnership. The Ghana Multimedia Incubator Center (GMIC) was also established in 2005 under the ICT4AD initiative to promote ICT Entrepreneurship Development. With support from UNDP and the government of Ghana through MoC, the center incubates start-ups and young businesses with innovative ICT ideas to mature into viable business ventures. The Ghana-India Kofi Annan Center of Excellence in ICT was established in 2003 through the partnership between the Government of Ghana and the Indian Government as the first Advanced Information Technology Institute (AITI) in Ghana. The state-of-the-art facility is to stimulate growth of the ICT sector not only in Ghana but the whole ECOWAS region to create an enabling environment for innovation, teaching and learning, while providing practical research on the application of ICT4D in Africa. As a result of these developments, the ICT landscape in Ghana is characterized by the proliferation of services such as mobile and fixed line telephony, cable TV, and wireless broadband.

3.4.1. ACCESS TO TELECOMMUNICATIONS SERVICES IN THE COUNTRY

Access to telecommunication services in the country can be categorized into three: Fixed line, Mobile voice, and mobile data and broadband wireless access. *Fixed Line Telephony:* The use of fixed line telephones has been dwindled by the proliferation of mobile telephony. At the end of February, 2016 only two operators, Vodafone Ghana and Airtel Ghana were found to be providing fixed telephone lines with a total subscription of 270,730. Out of this number of subscriptions, Vodafone Ghana recorded a total subscriber base of 262,680 while Airtel ended the month of February with 8,050 subscribers. *Mobile Voice:* mobile voice telephony has outstripped landlines since its inception decades ago. The proliferation of the mobile telephony in the country and other countries in the Sub-Saharan region is pushing the drive towards achievement of universal access to telecommunication. For instance, currently most communities in the rural areas in the country are able to pick up signals of mobile telephone operators.

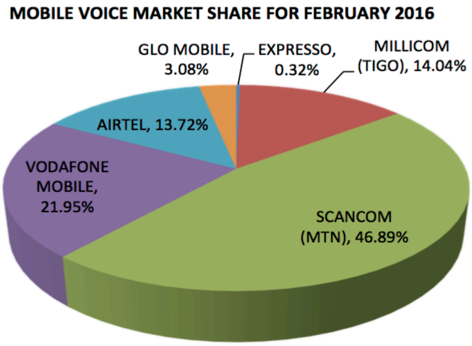

Figure 3-1: Source Ghana National Communications Authority (2016)

As the figures indicate, the total subscription of mobile voice telephony stood at 35,802,135 at the end of February 2016 representing a penetration rate of 130%. The subscription figures for the various mobile network operators and the corresponding market share are illustrated in table 3-1**.** *Mobile data and Broadband Wireless Access:* Access to Internet in the country is mainly through mobile Internet connectivity. Access to mobile Internet could either be through mobile data or broadband wireless access (BWA). Overall 18,550,103 have subscribed to mobile Internet with the broadband wireless access having a subscription of only 100,980. Currently, the total penetration rate of Internet in the country is 67.36% (see Table).

3.4.2. RADIO AND TELEVISION COVERAGE

Radio is found to be the most prevalent broadcasting device in many developing countries. According to the ITU ICT indicator database, as at 2007/2008 the radio penetration in Ghana was above 70% while television household percentage was 51%. In rural areas where farming is the main economic activity, radio is found to be in greater use far more than television. The reason could be that a transistor radio does not require electricity, which some rural areas do not have access to and also radio devices are cheaper than television. The list of radio and television stations currently in operation in the country is provided in table 3-1. Overall, 26 TV stations and 412 radio stations are licensed to operate in the country. However, 313 radio stations are currently in operation with the remaining guaranteed to start operation soon.

	Mobile Data		Mobile Voice	
	Subscription	Market-share	Subscription	Market-share
CELLULAR MOBILE OPERATORS				
EXPRESSO	45,037	0.24%	115,058	0.32%
GLO Mobile	358,996	1.94%	1,103,301	3.08%
AIRTEL	2,978,334	16.60%	4,910,607	13.72%
MILLICOM (TIGO)	2,722,504	14.68%	5,026,237	14.04%
VODAFONE MOBILE	3,403,780	18.35%	7,859,486	21.95%
SCANCOM (MTN)	8,940,472	48.20%	16,787,446	46.89%
BROADBAND WIRELESS ACCESS (BWA) OPERATORS				
SURFLINE	72881			
BLU	1433			
BROADBAND HOME	26,666			
TOTAL	18,550,103	100.00%	35,802,135	100.00%
PENETRATION RATE	67.36%		130.00%	

Table 3-1: Source Ghana National Communications Authority (2016)

3.4.3. OVERVIEW OF ICT APPLICATIONS IN THE AGRICULTURAL SECTOR OF GHANA

Agriculture plays a dominant role in the economy of most developing countries including Ghana. As a result, many ICT4D projects have focused on the agricultural sector. The World Bank and other development-oriented organizations have also provided several documentations on how ICTs could be harnessed to support various activities along the entire agricultural value chain. All these scholarly work indicate that ICTs have a great potential for overcoming key constraints, in the agricultural value chain. The use of ICT applications in the agricultural sector are offering opportunities to reduce transaction cost, increase access to markets, improve productivity by providing real time information on better farming practices, provide better and more frequent access to critical market information, and improve communication throughout the entire value chain (Debrah and Asare, 2013). In the subsequent sections we will provide a broad overview on how ICTs are being harnessed to support the activities of smallholders towards increased agriculture productivity in the country.

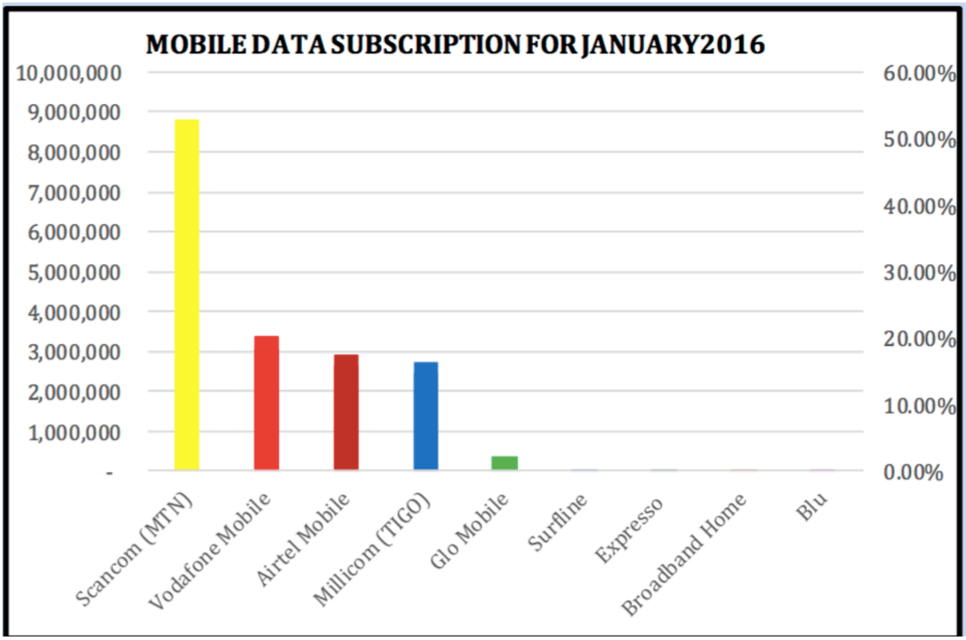

Figure 3-2. Source: Ghana National Communications Authority (2016)

Summary Of Television Broadcasting Stations In Ghana

Company Name	Trade Name	Frequency Band of operation	Area (s) of operation
Ghana Broadcasting Corporation	GTV	Vhf	Nationwide
TV3 Network Limited	TV3	Vhf	10 Regional Capitals
Metropolitan Entertainment Television	Metro TV	Vhf	10 Regional Capitals
Television Africa Ltd.	TV Africa	Vhf	Greater Accra Region Eastern Region Central Region Western Region Ashanti Region
Crystal Radio vision Network Ltd.	Crystal TV	Uhf	Greater Accra Region Eastern Region Ashanti Region
Net 2 TV Limited	Net 2 TV	Uhf	Greater Accra Region Eastern Region
Independent TV Limited	Top TV	Uhf	Greater Accra Region
K & N Investment	E-TV Ghana	Uhf	Greater Accra Region Eastern Region
Viasat Broadcasting Ltd.	Viasat 1	Uhf	Greater Accra Region Eastern Region Central Region Western

			Region Ashanti Region
Three Angles Broadcasting Network Ghana	3abn	Uhf	Not On Air
Multiple Concepts	GH One	Uhf	Greater Accra Region
Smart Multimedia	Light TV	Uhf	Greater Accra Region Ashanti Region
U2 Company Ltd.	UTV	Uhf	Greater Accra Region Ashanti Region
Integrated Media X-change (Imx)	-	Uhf	Not On Air
The Cardinal Foundation For Distance Learning (Cafdil)	Cafdil	Uhf	Central Region
Centre For Intercultural Learning Talent & Development, Agoro	Coastal TV	Uhf	Central Region
Great Kosa Company Ltd.	Kantanka TV	Uhf	Greater Accra Region
Empire Broadcasting Network	-	Uhf	Not On Air
HbaTV& Communications Network	-	Uhf	Not On Air
C Television Limited	CTV	Uhf	Not On Air

Orakle Advertising Limited	-	Uhf	Not On Air
CaTV Limited	Cable Gold	Uhf (2 Multiplexes)	Greater Accra Region
Crystal Radio vision Network Limited	Crystal TV	Uhf (2 Multiplexes)	Greater Accra Region
Wilsad Support Limited	First Digital	Uhf (2 Multiplexes)	Greater Accra Region Eastern Region Western Region
Go TV Ghana Limited	Go TV	Uhf (2 Multiplexes)	Greater Accra Region Eastern Region Western Region Central Region Ashanti Region Northern Region Brong Ahafo Region
Next Generation Broadcasting Limited	Smart TV	Ghana Broadcasting Corporation	Greater Accra Region Ashanti Region

Table 3-3: Source Ghana National Communications Authority (2016)

Summary Statistics of FM Stations in Ghana as at Fourth Quarter, 2015

Regions	No. Authorized	Public	Public (Foreign)	Community	Campus	Commercial	No. In Operation
Ashanti	53	2	1	4	2	44	43
Brong Ahafo	57	3	-	5	2	47	50
Central	29	2	-	8	3	16	25
Eastern	35	2	-	6	1	26	32
Greater Accra	48	2	3	6	3	34	45
Northern	40	7	-	12	1	20	24
Upper East	16	2	-	4	1	9	12
Upper West	17	2	-	8	1	6	9
Volta	45	3	-	10	1	31	27
Western	72	5	1	5	2	59	46
Total	412	30	5	68	17	292	313

Table 3-4: Source Ghana National Communications Authority (2016)

3.5. ICT INITIATIVES THAT ADDRESS THE INFORMATION NEEDS IN THE AGRICULTURAL SECTOR

Over the past ten years or so, there has been a remarkable progress in the use of ICT in agriculture, especially in the area of providing farmers access to advisory service such as market and crop information. The use of ICT applications towards agricultural development in the country began in the mid- 2000s through the joint efforts of department partner support and private sector initiatives. In 2004, the United States Agency for International Development (USAID) introduced its flagship project called Market Information Systems for Trader Organizations in West Africa (MISTOWA) and was implemented by the international Fertilizer Development Center (IFDC). In 2005, an American consulting firm called Chemonics implemented another project dubbed Trade and Investment Program for a Competitive Export Economy (TIPCEE) also funded by USAID. Since that time many ICT-based initiatives have been introduced in the agricultural sector of the country. This section of the study discusses the various innovative ICT-based projects used to provide agricultural information to farmers within the agricultural sector in Ghana. The various innovative ICT-based initiatives fall under four main categories: Public sector, For-Profit Organizations, Donor Funding Projects, and Non-Governmental Organizations.

3.5.1. PUBLIC SECTOR ICT INITIATIVES FOR AGRICULTURAL INFORMATION DISSEMINATION

3.5.1.1 The e-Agriculture Program

With the establishment of the E-agricultural project funded by the World Bank, Ghana is seen to be among countries, in the Sub-Saharan Africa, which are at the forefront of integrating ICT solutions into agriculture for sustainable agriculture and rural development. The establishment of the E-Agriculture program is in line with the country's commitment to achieve its targets in the Millennium Development Goals (MDGs). The implementation of the E-Agriculture program also brings Ghana closer towards the achievements of its targets set in the ICT4D framework intended to significantly enrich the socio-economic and cultural well-being of its citizenly through the modernization of agriculture. Given the transformation potential of ICTs for agriculture and rural development, the E-agriculture platform promises to tackle poverty alleviation through adequate dissemination and adoption of successful technologies, good practices and innovations especially, those generated from the West Africa Agricultural Productivity Program (WAAPP) to farmers most of who live in the rural areas. The platform is supposed to provide farmers with direct access to affordable content through the use of innovative ICT applications. This would help to increase knowledge sharing among key stakeholders and reduce the existing knowledge gap between the various knowledge producers and farmers. In doing so, it is expected that the current extension to farmer ratio in the country could be reduced from 1:3000 to 1:1 since farmers could now receive direct extension support service through a well established inter directorate call center, a toll-free interactive voice response (IVR) system, and an e-agriculture portal available through the e-extension platform.

The e-Extension Platform: As part of the E-agriculture project Ghana has also established an E-extension system, which is intended to remove various bottlenecks experienced through the existing extension programs by giving farmers direct access to affordable contents through the use of range of ICT applications. Prep Eez have been contracted in partnership with the West Africa Agriculture Productivity Program (WAAPP) under the Ministry of Food and Agriculture (MoFA) and the World Bank for the implementation of the E-agriculture and E-extension projects. The various components of the e-extension platform include the e-Agriculture portal, toll-free Interactive Voice Response (IVR), and Multidirectional Call Center. The e-Agriculture portal serves as knowledge management platform as well as operational process management platform that integrate research/content from the various stakeholders including MOFA, CSIR, and WAAP for end-user support. The main objective of the portal is to serve as a common platform where key stakeholders such as farmers, and the management and staff of MOFA could interact to share knowledge, skills, and experiences in agribusiness. The main features of the portal include the profiles of the various actors in the agriculture value chain, online discussion forum, general and specialized databases and information on agriculture, and statistical data. There is also a section where various corporate value chain actors could upload their profiles, as well as many different types of contact information. As part of these initiatives, Pre-Eez have developed a toll-free mobile phone Interactive Voice Response (IVR) technology to link MOFA, CSIR, and WAAP content and translate them into local languages. Farmers are allowed to call on the system with standard mobile phones and access the approved content toll-free. They could do so individually or as groups. The various content providers are also able to transfer knowledge and information to a wider recipient without having to leave their desk. There is also the possibility of recording all sessions for future playback from anywhere both on the phone and over the Internet. Officers can also make presentations on the platform from any location through an interactive web video, whiteboard and voice resources. With the GSM conferencing and messaging features, farmers are able to gain access to information on best practices from qualified content providers. Currently, the IVR platform provides information on best farm practices for cassava, yam, cocoyam, rice and maize in twelve local languages. In 2014 alone, the system had 86,000 farmers who were known to be active on the platform with approximately 1.6 million unique calls being made unto the service. The call center is a voice contact center where queries raised by farmers are resolved instantly and responded to in the appropriate local language. The facility is composed mainly of telecommunication and computer systems, which can provide a range of call handling services including customer support, direct assistance, language support and more. The facility is an innovative agricultural extension management system, which employs diverse ICT applications including both traditional ICTs and emerging technologies. It is the first time the sector has acquired an infrastructure of this kind and it’s expected to extend the reach of the public extension system to the entire farming community, especially the remote areas. It is estimated that the center would facilitate in building close linkages and enhance interactive communication among various stakeholders.

Cocoalink: The use of mobile phones has enhanced communication of cocoa farmers in the rural communities with farmers using mobile phones not only for meeting their social needs but also their economic needs as well. The Government of Ghana through the Ghana Cocoa Board (COCOBOD) has teamed up with Hershey’s Company and the World Cocoa Foundation (WCF) through Public Private Partnership (PPP) initiative to develop a mobile phone technology called Cocoalink.

CocoaLink is designed to deliver timely farming, social and marketing related information through the use of voice and text messaging for a two-way communication. Both farmers and extension agents utilize the platform. Farmers enrolled on the platform receive weekly information via SMS text and voice messages in English language and other local languages, while extension agents also use the service to collect data on the farmers. CocoaLink was first introduced in 2011 as a build-up on the success of the education and literacy programs being undertaken by the World Cocoa Foundation to reach out to 8000 cocoa farmers within 15 pilot communities in the Western region at pilot stage. The core content of the messaging relates to improved farming practices, farm safety, child labor, crop disease prevention, post-harvest production and marketing and COCOBOD delivers that. CRIG also provides agricultural and social messages that are pertinent to the industry to the farmers through CocoaLink. The information sent to the farmers on the platform is based on the cocoa-growing calendar. The cocoa-growing calendar refers to the activities and task that the farmers are supposed to undertake on their farms at specific times of the year. Farmers are required to observe these activities within specified time periods, and failure to observe them accordingly can affect their productivity. This is where CocoaLink comes in to provide timely messages related to planting, pruning, fertilizer application, labor, and improved famer and family safety. Farmers are also able to give feedback by speaking directly to local cocoa extension agents serving as representatives of the program. Once a month, farmers within the CocoaLink community meet their representative who takes the opportunity to explain further the core content of the messages that were sent to the farmers and farmers are also able to ask questions during such interactions. By 2013 about 18000 cocoa farmers had been registered to receive practical information with experts in the industry and other experienced cocoa farmers. To subscribe to the program farmers have to CocoaLink, farmers have to provide their names, villages and mobile phone numbers. It was expected that over 100,000 out of over 700,000 cocoa farmers who reside across mobile phone coverage would be enrolled onto the platform within the three years of the pilot. At the end of the three-year pilot program of CocoaLink, 50, 000 cocoa farmers had been subscribed to the platform and farmers within the 15 CocoaLink farming communities had their yields increased by 45.6% compared with unsubscribed cocoa farmers (Hershey company, 2014).

3.5.2. FOR-PROFIT ORGANIZATIONS' ICT INITIATIVES FOR AGRICULTURAL INFORMATION DISSEMINATION

Many Profit oriented ICT initiatives are in existence in the agricultural sector serving as advisory channel for farmers in the country. These include Esoko, Farmerline, Farmforce, GeoTraceability, and MojaCast. *Esoko* is a Ghanaian-based ICT software development company currently operating in 10 African countries with Ghana as the headquarters. Basically, the name Esoko means e-market, because it originated from the word *Soko,* which in Swahili means market with the 'e' term referring to electronic. It originated as TradeNet in 2004 was rebranded as Esoko in 2009. The original focus was on agricultural marketing and so it was providing market data to various stakeholders within the agriculture and trade sectors via SMS and the Internet platform. The platform, which is a form of a communication tool, was developed to enable traders, researchers, businesses, exporters, farmer groups, NGOs and governments to connect and reach out to farmers. Currently the platform provides various solutions via alerts, surveys, push, SMS polls, Knowledge plus, Inbox, Agents, Marketplace, Data Collection, Support and Training, Call centers, and monitoring and evaluation. The main information delivered to farmers from the Esoko platform include information on the weather, market pricing, and other advisory services. With the information on market price, which is delivered daily via SMS, farmers are able to make informed decision regarding how much they can sell their produce. The information on the weather also helps the farmers to know when it is appropriate to plant their crops to avoid losses. According to report from the French National Institute for National Research, smallholder farmers in Northern Ghana who received and applied Esoko SMS market prices increased had a 10% increased in revenue. Prestat, a chocolate company based in the UK, is also in partnership with Esoko and Cocoa Abrabopa in delivering SMS messages on market prices, weather forecasts and agricultural advice to approximately 1,000 cocoa farmers in Ghana. *Farmerline* is a two-way communication tool that enables agricultural specialists to deliver messages to farmers via SMS and farmers can also call back to ask questions. In 2012 it received an award from the US State Department App for Africa Climate Change. *GeoTraceability* is a GPS and specialized GIS based technologies that can be used to collect agricultural data from farmers and aggregate them to create a bigger picture about a specific commodity or area. As of June 2012, GeoTraceability had mapped 20,000 cocoa farmers in Ghana, covering 35,000 ha across 15 districts.

3.5.3. DONOR-FUNDED PROJECTS

A lot of Donor-Funded Projects also exist, which include Africa Cashew Initiative, B-BOVID, Freedom Fone, and Prep Eez. The German and international development cooperation (GIZ) in conjunction with the Government of Ghana, TechnoServe, and FairMatch Support, founded the *Africa Cashew Initiative (ACi)*. Through this initiative, cashew farmers in the Brong-Ahafo region receive SMS text messages, which reminds them of when to conduct key agricultural practices for increased productivity. The project, which has the potential to serve all cashew farmers, as of 2013, was serving approximately 400 farmers. Meanwhile, farmers enrolled on the platform have indicated that the information they receive is very useful and affordable since it only cost them 2Cedis per year. Since its inception in 2009, ACi has trained over 333,000 in only five countries including Ghana. This represent approximately 30% of all cashew farmers in Africa, with more than 2000 farmers received specialized training as experts who can train others. B-BOVID in partnership with TRACTOR launched the first ICT learning center for agriculture to allow small-scale farmers and the youth to receive training on how they could use ICT to improve productivity. The project, which was funded by the Ghana Rubber Estate Limited (GREL) have already worked with some 8,700 farmers. *Freedom fone* is an interactive voice-based communication system and an initiative of the African Farm Radio, Research Initiative (AFRRI). The platform enables callers to receive market information from Farm radio and to provide feedback on voicemails.

3.5.4. NON-GOVERNMENTAL ORGANIZATIONS

Non-Governmental Organizations' initiatives include Digital Green, Farm Radio International, mFarms, Community Green Agricultural Revolution Project (C-GARP) and Talking Book. Digital Green is a not-for-profit international development organization that uses digital platforms to share knowledge on improved agricultural practices and health issues among rural farming communities. Digital Green partners with public, civil and private sector extension agencies to bring together researchers, development practitioners, and rural communities to create and share knowledge through videos. Between 4-6 farmers within a given district are selected and trained to produce the videos themselves, which are usually short between 8-10 minutes. Afterwards, the videos are vetted by domain experts and redistributed on memory cards for playback on battery-operated pico-projectors to other farmers within the community or district (MEAS, 2016). In 2012, Digital Green in partnered with World Cocoa Foundation (WCF) to introduce the use of videos, which were locally produced to create and share knowledge to cocoa farmers in Ghana. They also initiated a social network platform called Farmerbook that was able to track data on farmers to be utilized by partner organizations. Farm Radio International is a Canadian-based non-profit organization that is using radio to educate farmers on value chain, production, and adaptation to climate change. It is unsurprising that the radio network reaches over 74% of farmers in Ghana since majority of the farmers have access to radio. The Community Green Agricultural Revolution Project (C-GARP), which is sponsored by the Global Media Foundation, also uses radio to link farmers to extension agents and agricultural information. The organization, which is based in Sunyani in the Brong-Ahafo region of Ghana use their radio drama look for farmers on their farms and record them while talking about their agricultural-related problems. The recordings are then played back during the radio shows while panel of extension officers and other farmers possible approaches and solutions to the problems at hand. mFarms is a mobile/web based platform developed by a Ghanaian company called Image-AD Ltd. The platform was developed to assist the International Fertilizer Development Center (IFDC) in the implementation of Linking Farmers to Markets project, which was funded by the Alliance for a Green Revolution in Africa (AGRA). The platform is designed with SMS and IVR technologies that allow its users to interact with farmers over dispersed locations. The mFarm systems was designed to serve as a decision support tool to help improve communications, build linkages and enhance operational efficiencies among the various actors on the agricultural value chain. As a decision support tool, mFarms can be used for the purposes of planning purchases, production, broadcasting alerts, extension information, verification of adherence to production techniques and schedules, and for the calculation of production and transaction cost (IFDC, 2012). The platform enhances operational efficiencies by allowing organizations, associations and identifiable groups to reach out to their members and affiliates dispersed over a wider space. In other to facilitate effective linkages among various stakeholders along the value chain, the database of mFarms is designed and structured in such a way that it is able to hold the complete profile including geo-referenced locations and mobile phone contacts of each category of its users. By linking value chain actors through the geo-referencing technology, they are able to communicate with each other and track the transaction of goods and services among themselves. Extension agents are able to track progress reports on their android phones, while farmers are also able to receive extension information via SMS and IVR technologies.

3.6. IMPACT OF ICT ON AGRICULTURE AND THE DEVELOPMENT OF RURAL AREAS IN GHANA

There are many challenges associated with assessing the impact of ICT usage in addressing the needs of smallholder farmers due to many factors that influence their outcome (Steinfield and Susan, 2013). Examining the impact of ICT in the agricultural sector requires a clear understanding of the farmers' context for the adoption and the adaptation of an ICT tool, which makes it difficult to assess the broader impact, since the social and cultural context in which the ICTs are embedded vary substantially (Gakuru et al., 2009). Although, many ICT initiatives for agriculture exist in Ghana they seem to be un-coordinated, which makes information on them not easily accessible and their impacts difficult to measure. Even those projects, which provide some impact assessment, they usually measure intermediate processes such as the number of farmers using the system instead of how the system could benefit in the farmers in the long term. That not withstanding, some of these initiatives have impacted the lives of farmers both socially and economically.

In Ghana majority of farmers live in the rural areas where access to market information poses a major constraint to the commercialization of their farm produce. This is because commercialization requires market participation. Before farmers can participate in the market effectively, they need to have access to reliable information about the markets. The transaction costs involved in obtaining reliable market information remains the fundamental challenge facing resource-poor smallholder farmers (Martey, 2014). Therefore interventions intended to reduce transaction cost could lead to increased farmers' participation in competitive market to meet the broader poverty reduction goals (Gakuru et al., 2009). The use of ICT applications such as radio, television, wireless technologies and Internet has become a major source of market information to farmers in the country (Martey et al., 2012). Martey et al. (2012) also recorded that the establishment of Agribusiness Centers (ABCs) are serving the market needs of farmers in the Brong-Ahafo region by providing them with market information through ICTs, thereby reducing the cost of acquiring market information. Access to reliable market information enhances farmers' ability to negotiate effectively by strengthening their bargaining power with middlemen. Access to information about markets also help farmers to meet market demands and, thus, help the farmers in dealing with glut situations, which mostly occur through oversupply of farm produce in a given market. Oversupply of farm produce, in turn, results in a downward pressure on the market price and subsequent falling in income. Receiving market information via ICT tools is also saving farmers money and time thereby contributing effectively in breaking the cycle of poverty. For instance by receiving market information, farmers are able to identify nearby markets where demand exists for their farm produce, saving them the time and cost for travelling all the way to big cities where there might not be any demand. In March 2014, Hershey Company announced the release of the CocoaLink Impact Evaluation in Ghana, which was a three-tear study conducted by a researcher in the Kwame Nkrumah University of Science and Technology by comparing users of the cocoalink platform with non-users in 15 cocoa farming communities in the country. According to the results of the study, Cocoalink registered 45,000 cocoa farmers in Ghana, and dispatched 1.2million free SMS in local languages to the farmers. The study findings indicated that farmers on the Cocoalink platform increased their yield with associated income by 10% greater than non-users. Overall, Cocoalink farmers increased their yields by 45.6% over the period of three years.

In 2009, a survey was conducted among 62 users of the Esoko platform and the results indicated that all the users claimed of obtaining some benefits from using the platform. Some participants of the survey indicated 20-40% improvement on their income through market and weather information they received from the Esoko platform (USAID and MEAS, 2013). Another studies conducted by the French National Institute for national Research, found that smallholder farmers in Northern Ghana received 10% increase in revenue by utilizing the market information on prices received through SMS from the same platform. Even though in some studies it was recorded that yam farmers using the Esoko platform experienced 7% increase in yam prices which translates into ($62-$69 USD) annual household income (Center for Technology and Economic Development, 2013), no price difference was recorded between treatment and control groups for maize, and cassava (Steinfield and Susan, 2013). The reason could be that these crops are more established and so information asymmetries may not be so high, which leaves less room for negotiations. In spite of some successes chocked in these areas, there are some critical issues that need to be addressed in order for Ghana to realize the full impact of ICTs in the agricultural sector and rural development. Among such factors is the availability of electricity since many rural areas are still living in the dark without reliable access to electricity. This could hamper the use of ICT applications like mobile phones, and television. Even though radios could be used without electricity, buying batteries could increase the operational cost of using radio in the rural areas. Another important issue is illiteracy. The low literacy rates in the rural areas in Ghana could inhibit the use of some of these initiatives. Majority of them are SMS-based and coupled with the complexity of phone operating systems could discourage farmers from taking up some of these initiatives to their advantage.

3.6.1. ICTS USED FOR THE TRANSFER OF COCOA-BASED KNOWLEDGE AND INFORMATION

ICTs for extension service delivery can be classified into two way ICTs such as Internet and mobile and one-way ICTs such as radio and video. Studies have found that the most frequently used source of cocoa-based knowledge and information by farmers in the Eastern region of Ghana was the mass media as mentioned earlier on (Nana et al., 2013). Within the mass media category the most frequently used channel were radio programs, followed by TV programs, video programs, agricultural manuals in that order. PC and Internet usage came last with agricultural course and farm demonstration following. Although the use of radio for extension delivery has been successful in the cocoa industry, the medium is considered as less appropriate for improving skills and decision-making capacity (S. David & Asamoah, 2011b)(David and Asamoah, 2013).

The use of video as an extension delivery tool has been deemed appropriate for less developed countries (Vidya et al., 2010). It is considered more suitable for the transmission of skills, information and knowledge, due to its ability to combine both visual and verbal communication methods (David and Asamoah, 2013). In a study to explore the effectiveness of video viewing clubs (VVCs) as a knowledge transfer tool, David and Asamoah, (2013) conducted a formal survey of 32 women who were given training on cocoa integrated crop and pest management (ICMP) using VVCs. The results show that VVCs provides effective interactive training for low literacy populations at a relatively low cost. It is capable for the transfer of skills, information and knowledge relating to complex technical topics. The study indicated that training through VVCs improved the knowledge of the farmers on the selected topics significantly, although there wasn't any significant difference between those trained with the VVCs and the controlled group. The effectiveness of the videos as a communication tool was improved through its participatory nature as farmers identified with the characters, however many challenges were found to be associated with the scaling up process of the methodology.

CHAPTER 4. SECI MODEL, AKIS MODEL, MEDIA RICHNESS, AND ICT USAGE FOR KNOWLEDGE TRANSFER

4.1. INTRODUCTION

The ability of organizations to consolidate and reconcile their knowledge assets is crucial to their survival within the exponentially growing knowledge-based economy. In order to do this, enterprises should have a way of collecting, organizing, clarifying, disseminating, transmitting and re-using information and knowledge. Prominent among these processes is the transfer of knowledge, which is considered as a primary process through which organizations manage knowledge (Grant, 1997; Alavi & Leidner, 2001a; Gupta & Govindarajan, 2000). There is a relationship between knowledge creation and knowledge transfer in the sense that knowledge after being created requires to be transferred to locations in the organization where it's needed the most. In this chapter, literature on organizational learning with a specific focus on knowledge transfer is discussed. The chapter begins with the definition and perspectives on knowledge, which is at the core of knowledge management processes. Some key concepts of knowledge transfer are discussed by highlighting on the use of ICT for organizational knowledge transfer. A section each is used for in-depth discussion of the SECI model and Media Richness Theory pointing out some critical issues regarding their application. The chapter ends with a section on the two theories and their relationship with ICT usage for knowledge transfer.

4.2. DATA, INFORMATION AND KNOWLEDGE

Some scholars define knowledge with emphasis on the distinction among data, information and knowledge (Becerra-Fernandez & Sabherwal, 2014; Hislop, 2002; Song, 2008; Nonaka, 1994). Data has been defined as raw numbers, images, words or sound, derived from measurement or observation (Song, 2008). Davenport and Prusak (2000) also offers another definition of data as "discrete, objective facts about events" with "no inherent meaning". Information is defined as data that has been processed, arranged in a meaningful pattern, through the application of some intellectual input (Alavi and Leidner, 2001; Song, 2008). Consequently, knowledge is defined as information that has been authenticated or upgraded with the addition of a further layer of intellectual input (Song, 2008; Alavi and Leidner, 2001). Although knowledge and information are sometimes used interchangeably, there exists a clear distinction between the two. In simple terms, information is regarded, as the flow of message while the very flow of messages anchored in the beliefs and commitment of the holders, is what creates and organizes knowledge.

The relationship among data, information, and knowledge is key for understanding the role of information technology in knowledge management (Alavi & Leidner, 2001; Song, 2008; Tuomi, 1999). Such relationship is often represented as a hierarchy and although different views have been expressed about such a hierarchical representation, this research is based on the standpoint that before information and data can emerge knowledge should be in existence as claimed by the positivism epistemology. According to this school of thought, "knowledge must exist before information can be formulated, and before data can be measured to form information" (Alavi and Leidner, 2001). This view of conversion among data, information and knowledge is represented as 'knowledge-information-data' hierarchy and is cited as being in conformity with organizational knowledge transfer (Song, 2008).

According to Tuomi (1999), when the existing knowledge is verbalized, articulated, expressed, and structured it becomes information, which when given a fixed representation and standard interpretation forms data (Alavi and Leidner, 2001). Again, the fact that knowledge is ineradicably shaped by the needs of their owners as well as the existing stock of knowledge initially held is an indication that knowledge cannot exist outside an agent (Tuomi, 1999; Alavi and Leidner, 2001). Consistent with this argument, Alavi and Leidner (2001) define knowledge as information that has gone through the cognitive process, which is activated by the inflow of new stimuli through the minds of people. Thus information can become knowledge after it has been processed through the minds of people and knowledge becomes information when it is expressed in the form of text, graphics, images and any other symbolic forms.

Following traditional epistemology, knowledge is defined as "justified true belief" (Nonaka, 1994). However, the main focus is on personal "belief" with emphasis on "justification" of knowledge rather than on "truthfulness" as argued by traditional epistemology. Doing so brings about two different ways of viewing knowledge. From the traditional epistemology perspective, knowledge is viewed as absolute, static, and nonhuman, which can mainly be expressed in propositional forms through formal logic. From the perspective of knowledge creation, however, knowledge is viewed as a "dynamic human process of justified personal beliefs as part of an aspiration for the "truth". In effect the organizational knowledge creation theory offered a three-part definition of knowledge (Nonaka & Krogh, 2009). First of all, knowledge is justified true belief. In other words, individuals justify the truthfulness of what they believe through their interactions with the World (Nonaka and von Krogh, 2009). Secondary, the knowledge of an individual could be recognized through the performance of a task. This also means that knowledge is the actuality of skills and the potentiality of defining a situation so as to permit a skillful action (Nonaka and von Krogh, 2009). Finally, knowledge is explicit and tacit continuum.

Knowledge has also been defined in diverse ways as Grant (1996) defines it as ‘that which is known’. In an attempt to clarify the sense in which knowledge becomes organizational, Tsoukas and Vladimirou (2001), defines organizational knowledge as “the capability members of an organization have developed to draw distinctions in the process of carrying out their work, in particular concrete contexts, by enacting sets of generalizations whose application depends on historically evolved collective understandings”. Bell (1999) defined knowledge as “the capacity to exercise judgment on the part of the individual, which is either based on appreciation of context or is derived from theory, or both”. The capacity to exercise judgment is based on the ability of the individual to draw distinction (Reyes and Zarama, 1998) as well as the individual’s location within a domain of action collectively generated and sustained (Tsoukas and Vladimirou, 2001). Based on the above analysis, Bell’s (1999) definition of knowledge could be modified as: “knowledge is the individual ability to draw distinctions within a collective domain of action, based on an appreciation of context or theory or both” (Tsoukas and Vladimirou, 2001). The question of what knowledge is has enthralled most of the world’s renowned great thinkers like Plato and Popper, yet without a compromise (Grant, 1996) leading to many epistemological dimensions and perspectives of knowledge (Alavi & Leidner, 2001; Song, 2008).

4.3. DIFFERENT PERSPECTIVES ON KNOWLEDGE

Different views and perspectives of knowledge have been expressed in literature. First to consider is the subjective and objective views of knowledge (Alavi and Leidner, 2001; Hislop, 2005; Song, 2008). These are referred to as the two broad perspectives of knowledge and are based on the split between the subject who knows and the object known by the subject, a tradition based on the ‘Cartesian dualism’ as posited by Descartes. The objective view considers reality as being independent on the perceptions of humans and “can be structured in terms of a priori categories and concepts” (Song, 2008). On the other hand, subjective view considers reality as being socially constructed through human interactions (Schultze & Cox, 1998). From the subjective perspective knowledge can be viewed as a state of mind or as a process (Song, 2008). The process perspective of knowledge focuses on the application of expertise(Alavi & Leidner, 2001; McQueen, 1998; Song, 2008) while viewing knowledge as a state of mind focuses on enhancing the individual’s state of knowing and understanding so as to apply to the needs of the organization with emphasis on personal beliefs of individuals (Alavi and Leidner, 2001). The object view of knowledge can be associated with viewing knowledge as an object, capability, and as a state of having access to information (Song, 2008). To view knowledge as an object is to treat knowledge as an entity that could be captured, stored, manipulated and transferred (Alavi & Leidner, 2001; Song, 2008; Zack, 1998).

Other views on knowledge include viewing knowledge as a condition of having access to information and knowledge as a capability. The former is considered as an extension of the view of knowledge as an object with emphasis on accessibility of the knowledge object while the latter focuses on applying knowledge to influence action (Alavi and Leidner, 2001). In this regard, the more knowledge is shared across the organization, the more that knowledge is applied or put to use and the availability of such additional knowledge leads to greater competitive advantage and therefore the value of such knowledge is greater for the organization (Dinur, 2009).

The various views of knowledge have different implications on the class of ICTs designed for the management of organizational knowledge. Viewing knowledge from one perspective can limit the role of ICT in organizational knowledge management. In viewing knowledge as a state of mind, its implication on the role of ICT is to provide access to sources of knowledge to enhance individual learning and understanding through the provision of information. The role of ICT within the perspective of knowledge as an object involves gathering, storing, and transferring knowledge from the knowledge stocks built within the organization. We wish to find out in this study how web 2.0 technologies can be used to provide links to various sources of knowledge to expand the breadth and depth of knowledge flows through the process of transferring knowledge. We suggest an enhanced version of Nonaka's SECI model, to posit the importance of media richness of web 2.0 technologies on their usage for the different types of knowledge transfer.

4.4. TYPE AND ATTRIBUTES OF KNOWLEDGE WITHIN THE FIRM

The knowledge of the firm can be analyzed along two dimensions: the epistemological and ontological. The epistemological dimension is drawn from the distinction between explicit and tacit knowledge while the ontological dimension is associated with the notion that knowledge resides at the individual level or at the level of the collective.

4.4.1. ONTOLOGICAL DISTINCTION OF ORGANIZATIONAL KNOWLEDGE

Most scholars identify knowledge as individual and collective (Grant, 1996; Tsoukas and Vladimirou, 2001). At the fundamental level, knowledge is believed to reside in the brains and bodily skills of the individuals who acquire it through formal education or practical experience (Lam, 2000). The difficulty then is in the understanding of when knowledge turns out to be an individual possession and when it becomes an organizational asset (Tsoukas and Vladimirou, 2001). There is the need, therefore to have a clear distinction between what the two forms of knowledge are and be able to establish a relationship between them. At the individual level, knowledge is discrete and self-contained and can be applied independently to perform specific types of task. Bell (1999) puts it like this "knowledge is the capacity to exercise judgment on the part of the individual, which is either based on appreciation of context or is derived from theory, or both". The capacity to exercise judgment is based on the ability of the individual to draw distinction (Reyes & Zarama, 1998)) as well as the individual's location within a domain of action collectively generated and sustained (Tsoukas and Vladimirou, 2001). Based on the above analysis, Bell's (1999) definition of knowledge could be modified as: "knowledge is the individual ability to draw distinctions within a collective domain of action, based on an appreciation of context or theory or both" (Tsoukas and Vladimirou, 2001). Other scholars have also focused on the individual as the agent of organizational knowledge creation. Grant (1996) assumes that the creation of knowledge is an individual activity. Simon (1991) also observes that learning actually takes place in the heads of the individual and that the organization only learns as its members learn and also by bringing in new members who have different knowledge from what the organization originally has. Even though knowledge at the individual level is characterized by autonomy in its application it can be transferred or shared among other members in the organization through social interactions.

Lam (2000) refers to collective knowledge as the totality of the knowledge of the organization stored in rules, procedures, routines, and shared norms to guide the behavior, problem-solving activities, and pattern of interaction among its members. It can also be referred to as the collective memory of the organization. Thus, the different ways in which individual knowledge is distributed and shared among other members of the organization constitute collective knowledge. In an attempt to clarify the sense in which knowledge becomes organizational, Tsoukas and Vladimirou (2001), also defines organizational knowledge as "the capability members of an organization have developed to draw distinctions in the process of carrying out their work, in particular concrete contexts, by enacting sets of generalizations whose application depends on historically evolved collective understandings". In a sense, what this definition suggests is that, individual knowledge translates to organizational knowledge based on the fact that it is generated, developed, and transmitted by the individuals within the organization. Arguably, even though individuals develop organizational knowledge, the organization has a role to play. The critical role played by the firm in developing organizational knowledge include articulating and amplifying the knowledge generated by the individuals in the organization, as well as, creating the necessary conditions required by multiple individuals to integrate their specialist knowledge (Grant, 1996; Nonaka, 1994). Social interaction among individuals provides the needed condition for the expansion of knowledge from the individual level to the collective level (Nonaka et al., 2000; Lam, 2000).

4.4.2. EPISTEMOLOGICAL DISTINCTION OF KNOWLEDGE

Dwelling on Polanyi's classification of knowledge, two types of knowledge have been identified as explicit knowledge and tacit knowledge. Explicit knowledge, which is also known as codified knowledge refers to knowledge that can be transmitted in formal systematic language (Nonaka, 1994). Alavi and Leidner (2001) provide similar definition of explicit knowledge as knowledge that can be transmitted in symbolic form and/or natural language and may include explicit facts, and axiomatic propositions. According to Stenmark (2000) and supported by Lam (1998), considering explicit knowledge as objective knowledge makes it possible for one to argue that it can be categorized, stored, documented, extracted, understood and shared independent of the knowing subject. Such form of knowledge is characterized by its ease of communication and transferability (Grant, 1996). In contrast, tacit knowledge is considered as having a personal quality, which makes it difficult to formalize and communicate (Nonaka, 1994). This type of knowledge is deep-rooted in action, commitment and involvement in a specific context (Nonaka, 1994). From Nonaka's perspective tacit knowledge can be classified into cognitive and technical elements. The cognitive dimension includes beliefs, ideas, paradigms, values, intuition, and mental models that represent an individual's image of reality and vision. The technical elements include know-how, crafts and skills that apply to specific contexts. Other scholars refer to tacit knowledge as being intuitive, difficult to express in words and not easily codified in documentation and regarded as the form of knowledge that is very difficult to share and transfer (Hislop, 2002; Lam 1998). Unlike explicit knowledge, tacit knowledge cannot be communicated, understood, or used without the knowing subject (Lam, 1998) because it's personal and therefore resides in the minds of the individual making it difficult to be disembodied (Hislop, 2002; Roberts, 2000). In order to gain a proper understanding and functioning of the main theoretical focus of the study, which is largely based on the SECI model developed by Nonaka (1994) and Nonaka and Takeuchi (1995), a clear distinction between the two forms of knowledge would be helpful. There are two different schools regarding the distinction of knowledge (Haldin-Herrgard, 2000). The theory of organizational knowledge creation belongs to the school of thought that views knowledge not as absolute, rather, as being in continuum with varying degrees of tacitness (Chennamaneni & Teng, 2011; Jasimuddin & Zhang, 2008; Roberts, 2000; Haldin-Herrgard, 2000). As Polanyi (1969) puts it "all knowledge is either tacit or rooted in tacit knowledge" and there is no such thing as absolute explicit knowledge. And so even though it's possible to make a distinction between tacit and explicit knowledge, such a distinction remains at the conceptual level, while in practice they don't represent two dichotomous states of knowledge (Alavi and Leidner, 2001; Hislop, 2002: Lam, 1998). The two forms of knowledge, thus, should be seen as inseparable and mutually constituted with reinforcing qualities of knowledge (Tsoukas, 1996; Hislop 2002; Alavi and Leidner, 2001). On the contrary, there is the other school of thought that views knowledge as a dichotomy between tacit and explicit knowledge. According to this school, knowledge should be viewed as a category (i.e. absolute tacit or absolute explicit) (Mohamed et al., 2006; Johannessen et al., 2001; Hislop, 2001). The proponents of this school of thought believe that the highly personal nature of tacit knowledge makes it nearly impossible for it to be made explicit since doing so can eliminate the tacit personal elements, which could be destructive to the knowledge. In fact they are of the view that, tacit knowledge can only be shared as tacit knowledge through personal experience and cannot be converted to explicit knowledge (Haldin-Herrgard, 2000; Panahi, 2013).

The distinction between tacit and explicit knowledge has important consequence on the analysis of how the two forms of knowledge can be transferred or shared (Roberts, 2000; Hislop, 2002). The difference between the two knowledge forms becomes even clearer when issues of transferability and the mechanisms for transferring them across individuals, space and time are considered (Grant, 1996). The different degrees of transferability between the different knowledge forms also suggest that, it requires different forms of supporting infrastructure and mechanisms for their transfer. Explicit knowledge, which can be codified into forms such as formulas, designs, reports, and so on, is relatively easy to transfer compared with tacit knowledge which represents ideas, experiences, and perceptions. Explicit knowledge is distinguished by its ease of communication while tacit knowledge is revealed through its application and acquired through practice making its transfer between people slow and uncertain (Kogut and Zander, 1992; Grant, 1996). Moreover, while explicit knowledge can be acquired through logical deductions and formal study, tacit knowledge is acquired only through practical experience within relevant context as a result of tacit knowledge being experienced-based and involving bodily action (Lam, 2000). The two knowledge forms also differ in their modes of aggregation and appropriation (Lam, 2000), in the sense that, because explicit knowledge can be codified, it could be easily aggregated at a given point, stored and applied without the involvement of the 'knower', whereas the personal nature of tacit knowledge makes it difficult to aggregate and stored in objective manner and can be appropriated through direct application usually with the involvement of the knowing subject (Lam, 2000).

4.4.3. FOUR CATEGORIES OF KNOWLEDGE

Based on the epistemological and ontological dimensions of knowledge four knowledge types could be derived at the cognitive level as: embrained knowledge, embodied knowledge, embedded knowledge and encoded knowledge. Collins (1993) was the first to make such a categorization to explain the psychological and behavioral aspects of knowledge. Later on Blacker (1995) adapted the categorization of Collins to develop the concept of 'images' of knowledge in organization.

Types of Knowledge	Individual	Collective
Explicit	Embrained Knowledge	Encoded Knowledge
Tacit	Embodied Knowledge	Embedded Knowledge

Table 4-1:Knowledge types based on ontological and epistemological distinction (Lam,2000) 1

Lam (2000) used the explicit-tacit dimension together with the individual-collective dimensions to build the typology in table 3-1to explain the socio-cognitive structures of knowledge by integrating the individual and collective dimensions organizational knowledge. *Embrained knowledge*, which refers to the individual-explicit form of knowledge, is the knowledge the type of knowledge that depends on the conceptual skills and cognitive abilities of individuals and can be referred to as ‘knowledge about’ (Blacker, 1995; Lam, 2000). In Nonaka’s (1994) terminology, embrained knowledge is characterized by ‘knowledge rationality’ and such knowledge is transferrable because it can be used and applied to different situations. *Embodied knowledge* or tacit-individual is the type of knowledge that Polanyi focused on, which is action oriented, practical, and is, represented as know-how technique. Nonaka (1994) refers to it as “knowledge of experience” to indicate the fact that its is created through hands-on-experience or learning-by-doing. *Encoded knowledge* (collective-explicit) refers to knowledge that can be codified and stored in blueprints, recipes, written rules and procedures and be conveyed by signs and symbols. Embedded knowledge refers to the collective tacit knowledge that resides in organizational routines, practices and shared norms (Lam, 2000). In relating these four forms of knowledge to the SECI model which we shall discuss later in the chapter, (Harorimana, 2010) describes embodied knowledge as highly tacit and contextualized, embrained and embedded knowledge as medium explicit and medium tacit and encoded knowledge highly explicit related to information.

4.5. ORGANIZATIONAL LEARNING

Organizational learning as defined by Argyris and &Schon (1996) is the ability of organizations to detect and correct errors. Error is defined as any feature of knowledge or knowing that inhibits learning (Argyris, 1996). Argyris and &Schon (1996) designed the single-loop and the double loop learning concepts to explain how organizations detect and correct errors through the norms, policies and objectives of the organization. In the single-loop or lower-level learning the organization identifies the process by which they detect and correct errors within existing definitions of norms, policies, and objectives (Cummings, 2001). When the process allows the organization to proceed with its current policies, or achieve its objectives it is called single-loop learning. Argyris (1996) compares single-loop learning with a thermostat, which is able to learn, through the information it receives (temperature of the room), and detect whether the room is hot or cold and take the necessary corrective action. This type of learning does not lead to changes in the norms or values of the firm, but focuses on repetitive behavior and routines within a given firm context of structure and rules (Cummings, 2001).

Double-loop or higher-level learning is the processes by which “error is detected and corrected in ways that involve the modification of an organization’s underlying norms, policies, and objectives” (Cummings, 2001). According to Argyris & Schön (1996)), the double-loop learning is a more comprehensive inquiry that involves the thermostat being able to question itself about whether it should be set at a specific temperature, say 68 degrees. Doing so would require it to go beyond error detection by questioning the underlying policies, and goals, as well as its own programs. That is to say that double-loop learning requires changes in the norms, values, and worldviews of the organization and implies an alteration of the organization’s mental models (Argyris and Schon, 1978; Cummings, 2001). Thus, to Argyris & Schön, (1978), and others (Prahalad and Bettis, 1986; Porac and Thomas, 1990; Huber, 1991; Fiol and Lyles, 1985; Epple, Argote, and Devadas, 1991) organizational learning involves error detection and correction within organizational understandings.

Dixon, (1999) took a slightly different approach to organizational learning by looking at it as the processes the organization employs to gain new understanding or to correct the current understanding at the individual, group, and system levels. According to Dixon (1999), organizations learn through the construction and reconstruction of meanings, to continuously revise or create knowledge. We create knowledge through learning and when knowledge is created it enables us to make changes in our environment either by reframing it or by altering it physically.

At the individual level, learning takes place through the interpretations of the experiences with the world. Individuals learn through direct experience, verbal transmission of information and reorganization of existing meanings. When individuals encounter data from the interactions with the world, they create their own unique interpretations and meaning structures that enable them to organize and make sense of it. Organizations may, thus, be seen as the collection of individual members who have the capacity to learn. However, organizational learning should not be understood as the sum total of what the members know, but the collective use of the members’ learning capabilities. The capabilities of the members include 1) developed and stored meaning structures, 2) capability to create new meaning from interfacing with the environment and each other, 3) capability to test existing meaning with current meaning structures and 4) capability to alter or reconstruct their meaning structures. Individual knowledge resides in three categories of meaning structures: Private, accessible, and collective (McClellan, 1983; Dixon, 1999; Cummings, 2001; Boateng, 2004). Private meaning refers to the meaning the individual constructs without making it accessible to other organizational members. Accessible meaning structures are those which individuals make it available to other members in the organization. Collective meaning structures, which is the third category is created by the members of the organization and codified into policies and procedures specifying how work gets done and what work is important. In other for Collective meaning to remain collective, it has to be codified not only into procedures and processes but also in the minds of the members who created it. They represent the norms, strategies and assumptions of the organization and can become very familiar and held tacitly by members in such a way that they may even forget that it was created by them. This can save the organization time and cost since there wouldn't be the need to have a lengthy discussions on the same issues which all members are familiar with and agree on. At the same time it can have a negative effect on the organization in the sense that the world is changing so fast that what used to work to the advantage of the organization at a point in time might have become obsolete and dysfunctional yet collective meaning may not be available for re-examination since it might be tacitly held in the minds of the organizational members.

Dixon (1999) argues that organizational learning can take place only within one space called the hallways. This is so because the hallways are the only places where ideas are connected and collective meanings constructed through the dialogue between organizational members. In the hallways, everyone seems a more equal participant and feels free to talk openly and conversations usually involve multiple perspectives since anyone passing by could just join in the conversation or pullout from it if the discussions seem irrelevant to him/her. Hallway conversations among organizational members can allow meanings that were once held privately by individuals to become accessible to other members. Doing so makes it possible for such ideas to be challenged, tested and adjusted until new meaning representing the collective develops. This joint construction of meaning by organizational members represents organizational learning (Dixon, 1999).

In other for organizational learning to occur, organizations should go beyond simply encouraging its members to exchange their accessible meaning structures. They should rather get actively involved in facilitating learning through the organizational learning cycle, which involves four steps (Cummings, 2002). Dixon (1999) refers to the first step of the organizational learning cycle as widespread generation of information. This stage of the learning cycle involves the collection of external data and the development of new ideas internally. Externally, data could be generated by crossing the boundaries of the organization to interact with sources external to the organization such as customers, suppliers, new technology, and economic conditions. External generation of information should be widespread to include all members of the organization and not limited to only specialized few. On the contrary, internal generation of information should be confined within the boundaries of the organization through the process of conducting the business of the organization by analyzing success and mistakes, and creating experimental designs to provide new information. When the knowledge available to one part of organization is not accessible to other parts of the same organization, it makes it impossible for the parts that do not know to learn from the part that knows. This results in the creation of the silo phenomenon. In other to curb the detrimental effect of this phenomenon, there is the need for the organization to integrate newly generated information both from the external and internal environments into the organizational context so that everyone understands the context of the whole picture and not only be aware of "a single piece of a jigsaw puzzle without access to the other pieces"(Dixon, 1999). In other words, integration, which represents the second stage of the collective learning cycle, is the process by which new knowledge is translated into organizational context so that "members can understand from both the big picture and focus perspective" (Cummings, 2002). After information have been generated and integrated into the organizational context, they have to be collectively interpreted by the organizational members and that is the third step of the organizational learning cycle. Collective interpretation can be enhance by conditions such as distributed information and expertise, egalitarian values, size and physical arrangement that support frequent interaction between subsystems, as well as, processes and skills that facilitate organizational dialogue. The final step in the organizational learning cycle involves authorizing members to take responsible action based on the interpreted meaning. If after going though the first three steps successfully, the organization fails to give its members sufficient discretion to act on the knowledge they have derived, the learning is lost.

In their approach to organizational learning, Yeung (1999) placed emphasis on fundamental learning capability. They argue that organizational learning capability of an organization depends on its ability to 1) generate ideas 2) generalize those ideas, and 3) identify learning disabilities. Idea generation involves acquiring, discovering, inventing and sourcing ideas. This includes centers of excellence, management innovation, creative new products, and the starting up of new plants. Idea generalization refers to the sharing of ideas across the internal boundaries of the organization (Yeung, 1999). Generalization involves the transfer of knowledge over time, physical space and/or organizational hierarchy. The building block of idea generalization is critical to the organizational learning process since without it collective learning cannot occur. The third building block is identification of learning disabilities, which may hamper the generation or generalization of ideas. According to Yeung (1999), true organizational learning occurs when all the three building blocks of idea generation, generalization and identification of learning disabilities are all put together.

In agreement with Dixon (1999) Yeung (1999), recognize in their theory of organizational learning capability that individual learning plays important role in the collective learning of the organization, however, organizational learning should not be misunderstood to be equal to the sum total of what individuals learn in the organization. Yeung (1999) is of the view that individual learning takes place through the knowledge they acquire through education, experience, and experimentation. On the other hand, Dixon (1999) argues that even though new experiences are critical to individual learning that alone is not enough to produce learning, until new experiences are related with existing ones in the processing space called working memory. Learning in the organizational context takes place when the organization is able to retain the knowledge acquired by its members through its systems and culture and transfer it beyond individual learners to other people, units, and functions (Yeung, 1999).

Both theorists recognize that in other for a collective learning to occur in organizations, knowledge should be generated and transferred from one point of the organization to another. Unless knowledge is transferred beyond the individual level, learning cannot occur (Yeung, 1999). According to Dixon (1999), this type of conversion could be achieved through what they refer to as the organizational learning cycle, which is composed of four steps of generation, integration, interpretation and experimentation. Yeung (1999) also postulates three building blocks: generation, generalization and identification of learning disabilities required for the conversion of knowledge from the individual level into the collective. Although these approaches are useful in terms dealing with various steps and stages the organization could follow through to build learning capabilities for effective organizational learning practices, failed to capture the manner in which the interaction between explicit and tacit types of knowledge, as well as, individual, groups and organization foster organizational learning as other scholars have realized in the literature. One approach that explains how organizational learning begins at the individual level transcends to the group level, and then to the firm level is Nonaka's (1994) spiral of knowledge creation. Given the focus of this study on knowledge transfer, Nonaka's (1994) SECI model is of specific interest. In the subsequent section, we discuss how Nonaka theorizes the different types of knowledge transfer that result from the interplay between tacit and explicit knowledge and the different Ba contexts that signify the knowledge creating place as explained in the SECI model.

4.6. THE SECI MODEL

The basic argument of the organizational knowledge creation theory hinges on the fact that knowledge creation is *"a synthesizing process through which an organization interacts with individuals and the environment to transcend emerging contradictions that the organization faces"* (Nonaka and Toyama, 2003). According to Nonaka and Toyama (2003), the primary elements of the SECI model consist of the SECI processes (Nonaka, 1991; Nonaka and Takeuchi, 1995) and Ba: the shared context of knowledge creation (Nonaka et al., 2000). Nonaka and Takeuchi (1995) found in their study of Japanese companies that their success in innovation and creativity stemmed from the processing of highly subjective knowledge rather than mechanistic processing of objective knowledge. Unlike the Western culture, which tends to separate the knower from the known and stresses on the importance of communicating and storing explicit knowledge the Japanese believe in oneness of humanity and nature, body and mind and self and other, which makes it easier for Japanese managers to engage in the process of indwelling to create knowledge. In such a cultural environment knowledge is considered principally as group knowledge, which makes it not only easily convertible from tacit to explicit, but transferrable from the individual level to the group level and to the organizational level.

Nonaka and Takeuchi (1995) argues that the initiation point of organizational knowledge creation and learning is the enlargement of the individuals' knowledge, which begins, with the creation of "field" or "self-organizing teams" where individuals can socialize to create new concepts within the organization (Nonaka, 1994). They refer to "The extent of social interaction between individuals that share and develop knowledge" as the ontological dimension of organizational knowledge creation. That was to say that the social interaction between individuals provides the ontological dimension needed for the expansion of knowledge. This dimension of the knowledge creation process is very important in the sense that although ideas are generated in the minds of individuals, it takes interaction between individuals for these ideas to be developed. "Communities of interaction", thus, play a critical role in the development and amplification of new knowledge (Nonaka, 1994). The ontological dimension of the knowledge creation process by Nonaka and Takeuchi (1995) agrees with what Dixon (1999) refers to as accessible meaning, which is analogous to the hallways of organizations. According to Dixon (1999), in other for collective meaning structures to be constructed, individuals' private meaning structures would have to be converted to become accessible to other members. This could only take place when the organization is able to create needed space (hallways) where individuals could come together and talk freely and openly to exchange ideas and construct meaning. Nonaka et al. (2000) refers to such a space where knowledge is created a "ba" which will be discussed into details later on in the chapter. Both Dixon (1999) and Yeungs et al. (1999) limited their discussions on organizational learning to the ontological dimension of the knowledge creation process. Meanwhile Nonaka and Takeuchi (1995) moved beyond the ontological dimension and another dimension called the epistemological dimension. The epistemological dimension of the knowledge creation process is responsible for providing ways by which the existing knowledge in the organization can be converted into new knowledge and is drawn from the distinction between tacit and explicit forms of knowledge. Nonaka and Takeuchi (1995) argued that it is the continuous interplay between tacit and explicit knowledge that drives the creation of new ideas and concepts.

Other researchers also agree on the individual as the agent of organizational knowledge creation. Grant (1996) affirms that the creation of knowledge is an individual activity. In the knowledge-based view of the firm, individuals are considered to be, in essence, responsible for creating and storing knowledge, 'since all learning takes place in the heads of individuals' (Grant, 1996; Simon, 1991). Simon (1991) observes that learning actually takes place in the heads of the individual and the organization only learns as its members learn and also by bringing in new members who have different knowledge from what the organization originally has (Simon, 1991). Duan et al. (2010) assert that knowledge transfer begins with the individuals within the organization since they possess, create, share, and leverage knowledge and without their involvement transferring knowledge will not be possible. Even though individuals develop organizational knowledge, the organization plays a critical role in articulating and amplifying the knowledge generated by the individuals in the organization (Nonaka, 1994), as well as, creating the necessary conditions required by multiple individuals to integrate their specialist knowledge (Grant, 1996). Individual knowledge, thus, translates into organizational knowledge based on the fact that it is generated, developed, and transmitted by the individuals within the organization.

4.6.1. THE SECI PROCESS OF ORGANIZATIONAL KNOWLEDGE CREATION

According to the ACT model from which the idea of knowledge conversion is developed, knowledge is categorized into declarative knowledge, and procedural knowledge. Declarative knowledge refers to knowledge that is expressed through propositions whereas procedural knowledge refers to knowledge, which is applied to activities such as remembering how to ride a bicycle or play the piano (Nonaka, 1994). The limitation of the ACT model developed by Anderson (1983) is based on the argument that cognitive skills are developed only when declarative knowledge (explicit) is converted into procedural knowledge (tacit) signifying that the transformation of knowledge is unidirectional. On the contrary, the knowledge creation theory argues that knowledge transformation is bidirectional, which means that declarative knowledge (explicit in nature) can be converted into procedural knowledge (tacit in nature) and vice versa (Nonaka, 1994). From this standpoint four modes of knowledge conversion were proposed as: tacit-to-tacit (socialization), explicit-to-explicit (combination), tacit-to-explicit (externalization) and explicit-to-tacit (internalization). In order for knowledge to move from the individual level to the organizational level it has to go through these four modes of conversion (Nonaka 1994; Dinur, 2002; Cummings, 2001).

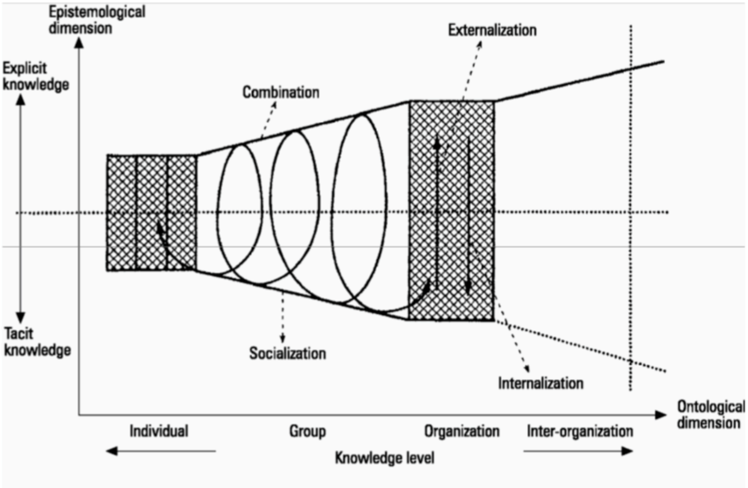

Figure 4-1. Spiral of Organizational knowledge creation (Nonaka andTakeuchi, 1995) 1

Through these conversions between explicit and tacit forms of knowledge new knowledge is created from existing knowledge (Nonaka, 1996; Alavi and Leidner, 2001; Dinur, 2002). As knowledge moves from the individual to the group and from group to organizational level, it is enriched and amplified through the interactions between the individuals and the organization (Cummings & Teng, 2003; Inkpen & Dinur, 1998; Nonaka, 1994). Organizations create new knowledge when all the knowledge conversion modes are managed continuously in a cycle (see Figure 3-1). This cycle is formed through a series of shifts between different modes of knowledge conversion (Nonaka, 1994).

4.6.2. MODES OF ORGANIZATIONAL KNOWLEDGE CREATION

The dynamic interplay between tacit and explicit knowledge results in four knowledge conversion modes: socialization, combination, externalization and internalization. **Socialization:** Socialization is defined as the “process of sharing experience and thereby creating tacit knowledge such as shared mental models and technical skills” (Nonaka and Takeuchi, 1995). The aim of socialization is to transfer tacit knowledge among individuals through shared experience in day-to-day social interactions (Nonaka et al., 2009). The term “socialization” is used to emphasize the fact that tacit knowledge involved in this mode of knowledge creation could only be exchanged through shared direct experience such as spending time together and living in the same environment rather than through written and verbal instructions (Nonaka and Toyama, 2003). The use of language is not a necessary requirement for socialization since it’s possible for an individual to acquire tacit knowledge without language. However, an important ingredient for a successful transfer of tacit knowledge is shared experience. In fact without some form of shared experience, it is nearly impossible for individual members of an organization to share each others thinking processes (Nonaka et al., 1994). For instance, long years of apprenticeship through observation, imitation, and practice makes it possible for: 1) apprentices to work with their mentors to learn craftsmanship and 2) new comers to understand the way other people think and feel in the organization (Nonaka and Konno, 1998). The process of socialization involves sharing and creating tacit knowledge through direct experience such as:

- Capturing tacit knowledge by walking around inside the company

- Capturing knowledge by walking around outside the company (e.g. through direct interaction with suppliers and customers)

- Transferring of tacit knowledge (e.g. transferring one's ideas or images directly to colleagues and subordinates)

- Sharing of personal knowledge to create a common place-*ba*

- Accumulating tacit knowledge (Nonaka and Toyama, 2003).

Externalization: Externalization is the process of articulating tacit knowledge into explicit concepts through dialogue and reflection. It involves two key factors:

- Articulating tacit knowledge and

- Translating tacit knowledge (Nonaka and Toyama, 2003).

Articulation of tacit knowledge refers to the conversion of tacit knowledge into explicit knowledge through dialogue is referred to as. Articulation of tacit knowledge involves the use of techniques that enable individuals to express images or ideas as words, concepts, visuals and figurative languages (such as metaphors, analogies, and narratives). The use of dialogue serves as an important method for articulating one's tacit knowledge and sharing it with others and therefore supports externalization. The translation of tacit knowledge involves the translation of highly personal knowledge or highly professional knowledge of customers or experts into explicit forms that are easy to understand (Nonaka et al., 2000; Nonaka et al., 2009). During the externalization stage of the knowledge creation process, individuals commit and become one with the group so that the sum total of their ideas and intentions is fused and become integrated with group's mental world (Nonaka and Konno, 1998).

Combination: Combination is the process of collecting explicit knowledge from inside and outside the organization and then combining, editing, or processing to form a more complex and systematic sets of explicit knowledge. The new knowledge could then be disseminated among the organizational members. The use of communication networks and large-scale databases can facilitate the combination mode of knowledge creation. Combination aims at combining different entities of explicit knowledge and involves systemizing and applying explicit knowledge and information by:

- Gathering and integrating explicit knowledge
- Transferring and diffusing explicit knowledge
- Editing explicit knowledge

Internalization: Internalization is the process of embodying explicit knowledge into tacit knowledge. Through the process of internalization, individuals convert the explicit knowledge created and shared throughout the organization into tacit knowledge. The internalization process serves as the stage where knowledge is applied and used in practical situations to become the base for new routines. At this stage explicit knowledge (e.g. product concepts, manufacturing procedures) are actualized through action, practice and reflection until it becomes one's own knowledge. Individuals can internalize explicit knowledge by reading documents or manuals written about their jobs or the organization and reflecting upon them to enrich their tacit knowledge base. Pragmatism learning-by-doing is an effective method for internalization because by that explicit knowledge is not only embodied but also tested and modified as well. Simulations and experiment can also be applied to embody explicit knowledge. In effect, internalization involves learning and acquiring new tacit knowledge through practice by:

- Embodying explicit knowledge through action and practice
- Using simulations and experiments

4.6.3. APPLICATION OF SECI MODEL IN REGIONAL KNOWLEDGE CREATION AND MANAGEMENT

The concept of knowledge as regional asset brings into discussion the nature of knowledge and its implication for regional development. The issue of how the SECI model which was originally developed for organizations with clear vision, leadership and hierarchical structure could be applied to a loose regional networks such as the case of the Cocoa Industry in Ghana, has been pointed out in the literature (Uotila, Melkas, & Harmaakorpi, 2005; Salonius and Käpylä, 2013). Some have argued that a regional innovative network, contrary to organizations, which the SECI model was, based lacks clear leadership and structure which would make it more difficult for the learning spiral to function. However, Uotila et al. (2005), argue that the SECI model is still applicable to regional development and networks in the sense that knowledge creation and transfer in these kinds of environment do not necessary differs essentially, even though we can observe some differences in the ways of practical application, as well as in leadership and general management (Uotila et al., 2005; Salonius Käpylä, 2013). Moreover, modern organizations where the SECI model was investigated no longer exist as hierarchical structures but rather are more of network entities (Uotila et al., 2005). However, in applying the SECI model to regional knowledge management would require some adjustment in order to avoid black holes in regional strategy. This led to the development of the 'rye bread model' for regional knowledge-based creation and management by (Uotila et al., 2005) as an extension of the SECI model. According to the model in order to have a clear understanding of regional knowledge based creation and management, there is the need to consider not only tacit and explicit knowledge but also a sub-category of explicit knowledge called sticky knowledge as well as the concept of 'Self-transcending knowledge'. Sticky knowledge is based on a high level of individual skills and experiences, collective learning and processes and a well-developed institutional framework (Uotila et al., 2005). Self-transcending knowledge is 'tacit knowledge prior to its embodiment' (Scharmer, 2001; Uotila et al., 2005). It refers to the ability to sense the presence of potential and to see what is not yet in existence (Uotila et al., 2005).

Thus the 'rye bread model' of knowledge creation, with inspiration from Scharmer's (2001) model of an iceberg is based on three forms of knowledge identified as explicit knowledge (including sticky knowledge), the embodied form of tacit knowledge and self-transcending knowledge (not yet embodied tacit knowledge). Uotila et al. (2005) argue that in order to apply SECI/ba model to lose regional network, there is the need to incorporate two additional modes, which are based on self-transcending knowledge, into the original SECI/ba model. These are the conversion of self- transcending knowledge into the embodied form of tacit knowledge and vice versa. The conversion of self-transcending knowledge into tacit knowledge is referred to as visualization and is seen as taking place in the 'imagination ba' while the conversion of tacit knowledge to self-transcending knowledge is called potentiality and takes place in the 'futurising ba'. The concept of knowledge vision was created by Nonaka et al (2000) to direct how the knowledge conversion processes cold occur in an interactive manner. In a regional multi-actor networks where knowledge actors have very different backgrounds, knowledge vision is of paramount importance, in synchronizing the various networks for successful knowledge creation and management. Salonius Käpylä, (2013) applied the extended SECI model together with Intellectual Capital (IC) framework to explore the requirements of knowledge-based management in the regional development network of the Tampere region in Finland.

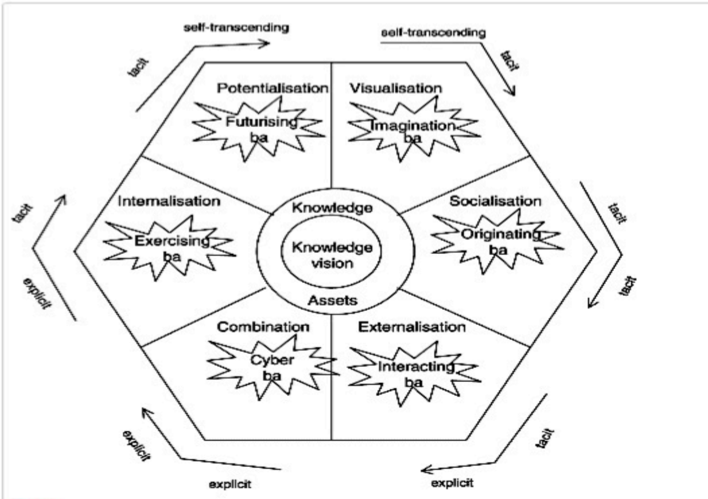

Figure 4-2. Adopted from Uotila et al. (2005) 1

The findings of the study indicates that different regions benefit from different knowledge-based management activities depending on their performance in the extended SECI model and the available intellectual capital (Salonius Käpylä, 2013). The current research applied the original SECI model instead of the extended SECI because self-transcendence knowledge is still considered as part of tacit knowledge and was not incorporated as a new form of knowledge and so each of the modes of knowledge conversion that involved tacit knowledge already had the self-transcendence knowledge embedded within it. According to Nonaka et al., (2000), in order for an individual to become committed and become one with a group, he/she has to transcend and the inner and outer boundary of the self. And this has to take place during the process of externalization. It therefore becomes problematic when self-transcendence is only incorporated into potentialisation and visualisation. In the same way that sticky knowledge was treated inherently within explicit knowledge, self-transcendence knowledge could be considered likely.

4.6.4. SECI MODEL AND ICT-BASED KNOWLEDGE TRANSFER

According to the extended SECI model, developed by Alavi and Leidner (2001) at any given point in time within any part of organizations, individuals and groups may be engaged in various aspects of knowledge management processes, which are embedded in individuals, groups and physical structures (Alavi and Leidner, 2001). Key among these processes is knowledge transfer, which is the focus of the current study. Figure 3-3 illustrates how transfer of knowledge can occur at various levels within and across the organization. The various levels of transfer may include the transfer between two individuals, from individuals to groups, between groups, across groups, from groups to the organization, and external to the organization. At the individual level, individual A can transfer tacit/explicit knowledge either to individual B's tacit knowledge base or B's explicit knowledge base. On receiving the knowledge, individual B would then have the choice to apply the knowledge directly, consult other members about it, or store the knowledge. Individual B could store the knowledge either as a private meaning (Dixon, 1999) or transfer the knowledge to the group collective memory (Alavi and Leidner, 2001) as collective meaning structure Dixon (1999). The group collective memory can be informally constructed through, for example, e-mail communication or formally constructed through knowledge repositories.

Individuals are able to connect to the group processes by transferring knowledge to either the group semantic memory or group episodic memory. The group episodic memory refers to the context-specific and situated knowledge such as a specific circumstance of an organizational decision and the outcome, place and time. The semantic memory also refers to the general explicit and articulated knowledge such as organizational archives of annual reports. Individual A can transfer tacit knowledge to a group's (1,2, or 3) episodic memory when, for example, he/she shares knowledge with the group during a decision-making meeting. Similarly, individuals can connect to the semantic memory of a group when he/she places for example, a computer file or a report he/she had prepared into centralized storage system for other group members to have access. Individuals can also call on the collective memory of a group to access knowledge and apply it for a given task or make decisions (arrow H). Through the application of the knowledge learning occurs (arrow I) and what they learn becomes embedded into not only their tacit knowledge space, but into the group's episodic memory as well. Knowledge transfer at the group level occurs when a group has acquired and applied knowledge to a given task and has coded the knowledge into routines.

Doing so would make it possible for such best practices to be transferred to other groups by giving them access to the group's memory systems. This type of intergroup transfer is represented by arrow J in figure 3-3**.** The sum total of both the individual and the intergroup knowledge transfer would then constitute organizational knowledge transfer. According to Alavi and Leidner (2001), ICTs can serve as transfer mechanisms for all the four types of knowledge transfer. As transfer mechanism, ICT is mostly applied to impersonal informal mechanisms and formal impersonal mechanisms of knowledge transfer (Alavi and Leidner, 2001). In this regard, ICT extends the individual's reach in search for knowledge sources through computer networks, which connects the knowledge seeker to those who have access to the needed knowledge. Again through formal impersonal means, ICT facilitates the creation of organizational knowledge maps that enable individuals to search for not only the knowledge they need but also other individuals who possess such needed knowledge. The creation of such metadata has proven to be as important as the original knowledge itself (Alavi and Leidner, 2001).

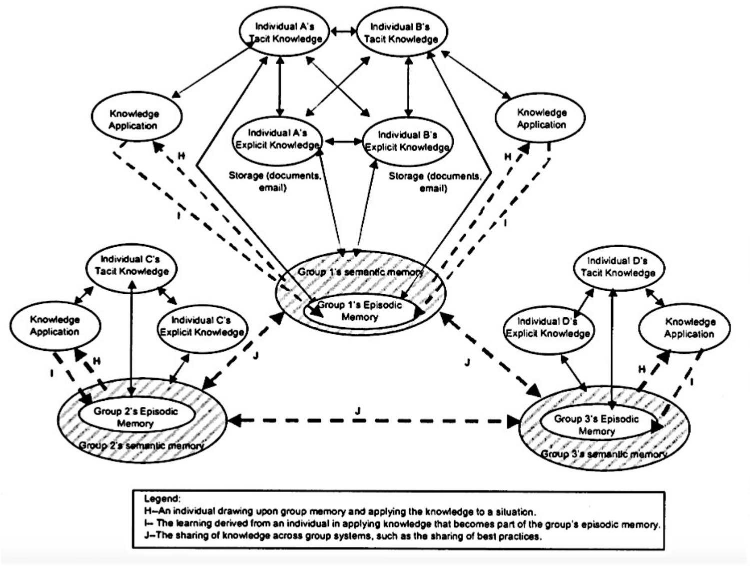

Figure 4-3. Source: Adopted from Alavi and Leidner (2001)

Past studies on KM have also demonstrated that ICTs can facilitate the transfer of knowledge through the SECI processes (Soto-Acosta and Lopez-Nicolas, 2010; Lee and Kelkar, 2013). In their study on the perception and use of ICTs for the SECI processes, Lee and Kelkar (2013) found that ICTs are highly useful for supporting all the types of knowledge transfer (socialization, externalization, internalization, and combination). Specifically, ICTs such as e-mail and telephone were mostly used to support socialization, knowledge repositories were useful for supporting externalization, e-collaborative systems and people finders were used to support combination, while repositories and e-learning systems were advocated for the transfer of knowledge involved in internalization (Lee and Kelkar, 2013).

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, Nonaka et al. (2000) argues that internalization and combination can be associated with systemising and exercising Bas respectively and can take place in virtual space or ICT supported medium (Nonaka et al. 2000). However, externalization and socialization, which are linked to originating and dialoguing Bas respectively, require the support of face-to-face interactions (Nonaka et al., 2000). Jasmuddin and Zhang (2008) also contend that soft mechanisms, which represent face-to-face based mechanisms, should be used for externalization and socialization whereas hard mechanisms (ICT-based) are suitable for combination and internalization.

Lopez-Nicolas and 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. Sarkiûnaitë and Krikðèiûnienë, (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 (Lee and Kelkar, 2013). As a conclusion of their study, Lee and Kelkar (2013) 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 social media could co-exist with traditional ICTs to support KM practices in organizations.

4.6.5. CRITICISMS OF THE SECI MODEL

The objective here is not to provide a through review of critical analysis of the SECI model but to discuss some aspects related to the current study. From Dalkir (2012) perspective, the strength of the SECI model lies largely in the simplicity of the model, which makes its application easier. According to Haag (2010), the SECI model integrates a wide variety of important concepts such as the two types of knowledge (explicit/tacit), the Ba context, and the four modes of knowledge creation, in knowledge creation and that serves as the main strength of the theory. Again, as a process model, SECI outlines what actually takes during knowledge creation rather than giving a description of what aspects are involved in knowledge creation and in so doing, it enables the individuals to understand knowledge development and the role they play in it (Haag, 2010).

In spite of the popularity enjoyed in its usage, the SECI model has also faced some criticisms as well in management and organizational studies. According to (Dalkir, 2012), a major weakness of the theory lies in the fact that it fails to explain all the stages involved in managing knowledge (Dalkir, 2012). The main focus of the theory is on the transformation between tacit and explicit knowledge but is deficient in explaining other issues regarding decision-making on how the two knowledge forms could be leveraged (Dalkir, 2012). Bratianu (2010) argues that although Nonaka mentioned four modes of knowledge conversion as socialization, combination, externalization and internalization, only two (externalization and internalization) represent actual transformation from one type of knowledge to the other, while combination and socialization represent processes of knowledge transfer (Bratianu, 2010). According to Bratianu (2010) the conversion from explicit to tacit (internalization) and from tacit to explicit (externalization) could be understood to develop at the individual level while the conversions involved in socialization and combination could be developed between two different individuals. Therefore integrating these four basic processes into a pattern of knowledge conversion is an attempt by Nonaka (1994) to blur the lines between individuals and groups (Bratianu, 2010).

Bratianu (2010) further argues that the SECI model can be well understood in the context of the Japanese culture but may fail to yield successful results in other cultures. This claim stems from the definition of knowledge as “justified true belief”, which according to Bratianu (2010), could mean that knowledge creation is justifiable within a given cultural framework both at the individual cultural horizon and the cultural horizon of a country. In the view of Haag et al. (2008), not only is the SECI model influenced by culture, but also the entire model originates from a particular culture and context. However, that does not mean that culture must be considered as a separate aspect of the model rather as a ‘pre-mode’ idea that organizational members and teams need to analyze how culture influences knowledge creation in the context within which they find themselves (Haag, 2010). Gourlay (2003) argues against the empirical evidence of the SECI processes as being weak and thus calls into question the entire theory of organizational knowledge creation. First of all, almost all of the data for the survey and case studies were derived from earlier studies of *information* creation rather than from *knowledge* creation. Secondly, the theory failed to sustain its claim that it has been validated in the sense that the survey found support for only socialization and combination of which one was also conceptually incoherent, according to Gourlay (2003). Moreover, the SECI model represented a process model, however, the survey used for its validation was concerned with the content of the processes. Thirdly, there are no convincing evidence regarding the detailed case materials used to illustrate the notions of combination, socialization, externalization and internalization (Gourlay, 2003).

The main flaw of the knowledge creation theory, however, is associated with the externalization (tacit-explicit) phase of the SECI process. Many scholars including Gourlay (2006) have argued that tacit knowledge cannot be converted to explicit knowledge, especially into verbal expressions. (Hildreth & Kimble (2002) argue that if tacit knowledge cannot be articulated then it cannot be eternalized. Tong and Jin Tong & Amit Mitra (2009) are of the view that in an attempt to make tacit knowledge explicit, Nonaka has ignored Polanyi's suggestion that "we can know more than we can tell". Johnson et al. (2002) stated that tacit and explicit knowledge should be considered as being complementary rather than contradictory. (Tsoukas, 2003) argues that instead of viewing the two knowledge types as representing the two ends of a continuum, they should be seen as two sides of the same coin, in that even the most explicit form of knowledge is underlain by tacit knowledge. In that case externalization does not only become impossible, but also unnecessary. Instead, the focus should be directed towards finding new ways of talking, fresh forms of interacting, and novel ways of distinguishing and connecting (Haag, 2010). These limitations affect the effectiveness of the externalization process and the SECI process as a whole since according to Nonaka and Takeuchi (2005), "externalization holds the key to knowledge creation, because it creates new, explicit concepts from tacit knowledge".

It should be stated that the theory of knowledge creation (SECI) does not view tacit and explicit knowledge as opposed, separated, and mutually exclusive, rather as mutually complementary (Nonaka, 1991; Hildreth and Kimble, 2002; Haag, 2010). In fact, it could be inferred from the SECI model that knowledge is neither fully tacit nor fully explicit but interacting with each other along a continuum with varying degrees of tacitness/explicitness (Nonaka and von Krogh, 2009; Haag, 2010, Chennamaneni and Teng, 2011; Ambrosini and Bowman, 2001). In applying the SECI model, we argue that tacit knowledge can still have explicit component (Hildreth and Kimble, 2002) and explicit knowledge also have tacit component but in varying degrees of tacitness or explicitness along a tacit-explicit continuum (Haag, 2010). This is in line with what Hildreth and Kimble (2002) conceptualized as the duality of knowledge. The implication of the duality concept of knowledge is that "all knowledge is to some degree both hard (explicit) and soft (tacit): it is simply that the balance between the two varies" (Hildreth and Kimble, 2002). There is therefore the need to be aware that in some situations there is a strong emphasis towards the explicit end of the continuum whereas in other contexts, emphasis is on the tacit end of the continuum (Haag, 2010). Even though this seems a way forward theoretically, empirically it is difficult to apply.

4.7. APPLICATION OF SECI MODEL FOR AGRICULTURAL AND RURAL DEVELOPMENT

The SECI model has been applied in different studies related to managing indigenous knowledge (IK) for agricultural and rural development (W. Boateng, 2006; Lwoga et al., 2010; Ha, Nnajiofor Okigbo, & Igboaka, 2008; Ngulube, 2003; Radcliffe et al., 2016). The circular knowledge management model, developed by Boateng (2006), which represents an extended version of the SECI model for agricultural extension practice, is adapted and partially applied for the study. According to the model, the knowledge creation and transfer process should begin with farmer-to-farmer communication within the communities of practice of the farmers. The externalization stage should involve the extraction of farmer's tacit knowledge by the extension experts. At the combination stage, it's expected that the tacit knowledge extracted from the farmers by the extension experts would be combined with the experts' explicit knowledge from the various research institutions and make them easily accessible to the farmers for experimentation, simulation, and practice by the farmers at the internalization phase of the knowledge creation and transfer process. Other views of the different modes of the knowledge creation and transfer process are discussed further.

Socialization: socialization has been the dominant mode of knowledge transfer in pre-colonial societies where oral transmission was the only means of preserving important knowledge (Ngulube, 2003). As a result, the main mechanisms used for socialization were based on face-to-face conversations, social interactions and storytelling as prescribed in the SECI model (Ngulube, 2003; Nonaka and Takeuchi, 2005). In such societies, knowledge was composed into songs, proverbs, myths, poems, folktales and riddles as a way of preservation. In a study to address how indigenous agricultural knowledge could be managed in developing countries, Lwoga et al. (2010) applied the SECI model in a local community context with a specific focus on Tanzania. Smallholder farmers in the selected local communities were found to create new knowledge through socialization by using individual interactions, social gatherings, farmer group meetings and observations. Communities of practice (CoP) already existed in the communities in the forms of formal and informal self-managed farmer groups. These forms of local CoPs, which were voluntary with members sharing common interest and language, could serve as effective mechanisms for tacit knowledge sharing. In a similar vein, Boateng (2006) seem to agree with Lwoga et al. (2010) on the fact that the creation of informal networks and CoPs among farmers at the community level should be encouraged by extension staff to facilitate the creation and sharing of new knowledge through socialization.

According to Boateng (2006), farmer cooperatives and associations could be used as the base for creating such CoPs to provide the environment where farmers could share their know-how (tacit knowledge) on farming practices among themselves. In the view of Boateng (2006), the tacit knowledge created through the practice of socialization among the farmers themselves could form the bedrock for further scientific analysis and investigations towards improved farming technologies. *Externalization*: Regarding externalization, the study found that even though the farmers converted their indigenous agricultural tacit knowledge into explicit forms via written formats, carvings and still pictures it was practice at a low degree. Carving formats such as utensils, hand mills, ornaments, and drawings on clay pots were used, however, lack of knowledge sharing culture could have limited the externalization process (Lwoga et al., 2010). Boateng (2006) suggested that extension staff could help famers improve on their practice of externalization by engaging them in extensive dialogue through enhanced communication. Doing so the extentionists could extract farmers' know-how gained through their experience on farming practice and used as the basis for further scientific enquiry. *Combination:* this phase of the knowledge creation process involves integrating the explicit knowledge of extensionists and research institutions and the farmers' as well (Boateng, 2006). In Boateng's view, this stage is very critical in the knowledge creation process since new technologies for agricultural practices are designed at this point. Consequently, it is expected that at this point, the knowledge of the farmers would have been inculcated in the knowledge generated through research.

The study by Lwoga et al. (2010) showed that farmers in the studied communities practiced combination by capturing and integrating new explicit knowledge obtained from printed materials they borrowed from other farmers and the library. However the use of print materials such as books, newsletters, newspapers and posters were used a low rate due to poor reading habits and knowledge culture. ICTs such as radio, cell phones, and e-mails were also used to share agricultural IK by some of the surveyed population with the oral media (radio, cellphones, and TV) toping the list whilst advanced ICTs such as email and the Internet were being rarely used.

Internalization: Internalization involves the farmers applying the explicit knowledge they have gained to their actual farming practice (Boateng, 2006). Regarding this mode of knowledge creation and transfer Lwoga et al. (2010) found that most farmers mainly applied the IK they received from tacit sources by oral communication and print media to their farming practices rather than the knowledge from explicit sources such as ICTs indicating that internalization was partially supported. Even though the farmers applied all the four modes of knowledge conversion (socialization, externalization, combination and internalization) for the creation and transfer of knowledge, they relied mostly on socialization (Ha et al., 2008).

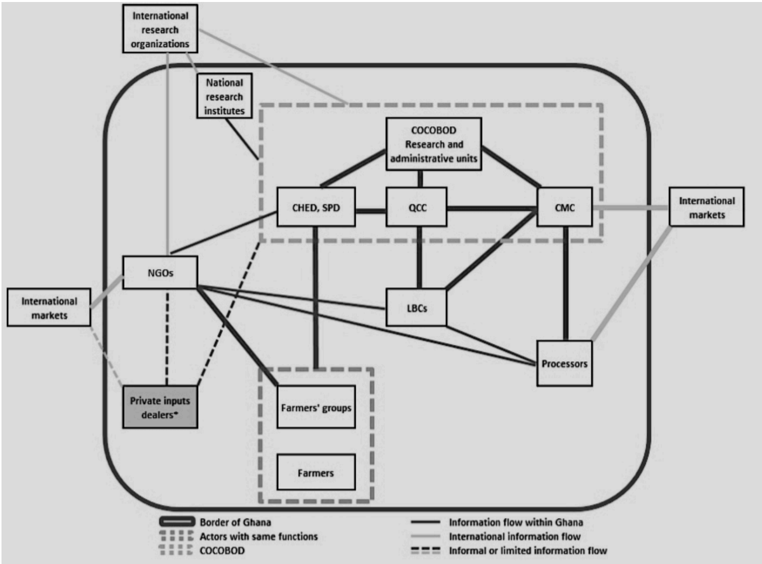

Figure 4-4. Source: Adapted from Monastyrnaya, (2016). Knowledge Flow Map of Ghana's Cocoa Value Chain

4.8. JUSTIFICATION FOR THE USE OF SECI MODEL IN THE STUDY

Although it is evident to argue that the original focus of the SECI model emphasized the implementation of knowledge creation and transfer for effective knowledge management in businesses and corporate organizations it is adopted in the context of the current study for two main reasons. First of all from the foregone discussions it is evident that in spite of the weaknesses and the fact that the model emphasizes the implementation of effective knowledge creation and transfer in organizations, the model has claimed useful and adaptable in other non-Japanese organizations and other non-organizational context including regional developments (Uotila et al., 2005; Salonius Käpylä, 2013; Rice and Rice, 2005; Kaplan, 2008; Lwoga et al., 2010). Other schools of thought have also argued that the theory can be adapted to the context of rural communities in developing countries such as South Africa (Ngulube, 2003), Tanzania (Lwoga, 2010), Nigeria (Ha et al., 2008) and Ghana (Boateng, 2006), and in agriculture and rural developments (Lwoga et al., 2010; Boateng, 2006; Radcliffe et al., 2016). Ha et al. (2008) believe that although knowledge management theories such as SECI model has a limitation of being rooted in organization that promote proprietary interest instead of social good, their suggestions for implementations could be borrowed as reference to other national related projects. Following similar line of argument, Ngulube (2003) cited that tacit indigenous knowledge could be managed using the SECI model and that the model provides a holistic approach to managing indigenous knowledge systems (IKS).

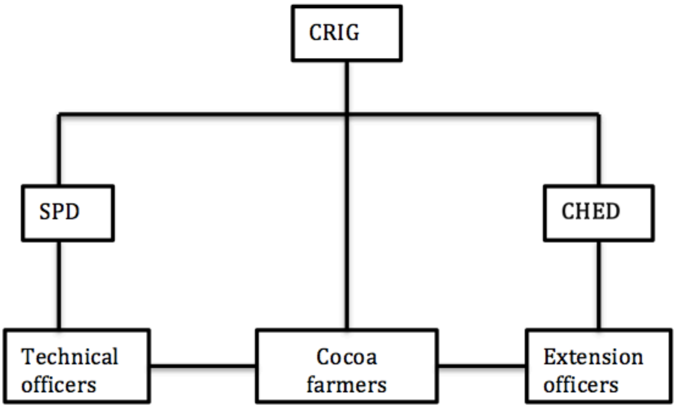

Figure 4-5: Hierarchical Knowledge Flow Map from COCOBOD to Cocoa farmers

In a study to assess the application of KM models in managing indigenous knowledge for sustainable agriculture in local communities, Lwoga et al. (2010) concluded from the findings of the study that with adequate and appropriate resources, the SECI model could be used to manage IK in the local communities.

Secondly, organizational structure is among the major factors that influences knowledge creation and transfer (Mahmoudsalehi, Moradkhannejad, & Safari, 2012; Schutz, 2013). Knowledge creation and sharing is affected by structural relationships such as how quickly knowledge flows through formal reporting relationships (Mahmoudsalehi and Moradkhannejad, 2012) and could serve as hindrances to the easy flow of knowledge within the organization (Jarvenpaa & Staples, 2000; Schutz, 2013). Organizational structure can either vary vertically in terms of hierarchy or horizontally in terms of geographic distribution (Schutz, 2013). The flow of knowledge in the cocoa industry is centralized in character with COCOBOD retaining the biggest share of the knowledge within the cocoa value chain (Monastyrnaya, 2016). And the way and manner knowledge flows from COCOBOD to cocoa farmers in terms of structure is similar to the structural relationships in businesses and corporate organizations (see figure 4). As a matter of fact, knowledge flows in a hierarchical manner (see Figure 5) similar to many businesses and corporate organizations and so applying the SECI model in the Cocoa industry may not be considered as being too farfetched. Knowledge flows to cocoa farmers either from CRIG directly or through two other divisions of COCOBOD: CHED and SPD. As stated earlier on, CRIG conducts research on almost all aspects of cocoa production including pest and diseases, yield improvements, suitable inputs for cocoa and socio-economic issues on cocoa farming as well. The research recommendations from CRIG are passed down to CHED, which is the custodian of the extension arm of the Board for dissemination to the farmers. Recommendations regarding the new hybrid seedlings are also passed down to the SPD for multiplication and distribution and to the cocoa farmers through the technical officers who have direct contact with the farmers on the field. The study is aimed at assessing the use of ICTs, web 2.0 applications in particular in creating and transferring knowledge to cocoa farmers who are mostly living the rural communities in Ghana. The SECI model was adopted to provide theoretical guidance for the use of ICTs in managing the knowledge creation and transfer processes in the cocoa sector of Ghana. The study thus focuses on the four modes of knowledge creation and transfer (socialization, externalization, combination and internalization) to enable knowledge actors (cocoa farmers, extension officers, and researchers) in the Ghanaian cocoa sector to manage knowledge creation and transfer based on predetermined principles (Lwoga, et al., 2010) through the use of ICTs such as web 2.0 applications.

4.9. ORGANIZATIONAL KNOWLEDGE TRANSFER

In order for organizations to create new applications and survive the turbulence of the emerging business environment, they need to create new knowledge (Henderson and Cockburn, 1994). Knowledge after being created needs to be successfully transferred in other to create organizational learning capability (Yeungs et al., 1999; Alavi and Leidner, 2001; Kogut & Zander, 1992). Achieving success in knowledge transfer can be a driving force for knowledge creation endeavor (Kang et al., 2010). Knowledge transfer has been identified as a critical discipline for disseminating new product development (Khumalo, 2012). The practice of knowledge transfer can lead to avoidance of duplication of roles, creation of mutual understanding, ambiguity reduction, and translation of individual learning into social learning (Palanisamy, 2007). Lack of knowledge transfer in organizations may result in “lost knowledge” (DeLong, 2004). Lost knowledge could lead to reduction in organizations ability to innovate and create new products, which in-turn may result in the decline of competitive advantage in the market (DeLong, 2004).

Knowledge transfer is defined in organizations as the process through which a group, department, or division is affected by the experience of another (Argote and Ingram, 2000). William R. King provides another working definition of knowledge transfer in the Schwartz encyclopedia of knowledge management, (2006) as “the focused, unidirectional communication of knowledge between individuals, group, or organizations such that the recipient of knowledge has a cognitive understanding, has the ability to apply the knowledge, or applies the knowledge”. The study agrees with the definition of knowledge transfer provided by Cummings (2004) as “the provision or receipt of task information, know-how, and feedback regarding a product or procedure”. In our estimation, this definition is deemed fit due to its broad context which makes it applicable to both intra-firm and inter-firm knowledge transfer.

Knowledge transfer has been investigated at various levels referred to as paths of knowledge transfer. The various paths of knowledge transfer include transfer at the individual level, intra-organizational level and inter-organizational level. Considerable studies on knowledge transfer at the individual level have been done within the arena of cognitive psychology. The focus of these studies has been directed towards how the experiences gained by individuals on a particular task affect their performance in another (Singley and Anderson, 1989; Argote and Ingram, 2000). Knowledge at the individual level has been classified into declarative and procedural (Winograd, 1975) while transfer at this level is categorized into general and specific transfer (Postman, 1971). In their work on transfer of cognitive skills, Gray and Orasanu (1987) used the above-mentioned concepts to what they called "symbiotic relationship between theories of learning and transfer". Salomon and Perkins (1987) also used what they termed as "low road" and "high road" transfer to describe two distinct individual transfer mechanisms. Knowledge transfer as a process may begin at the individual level, before transcending to higher levels such as the group, product line, department, division, or the organization as a whole.

Organizations can learn directly from their own experiences or indirectly from the experiences of other organizations through knowledge transfer (Argote and Epple, 1990; Huber, 1991; Levitt and March, 1988). Thus, knowledge transfer at the organizational level can be viewed from two broad perspectives: intra-firm transfer process and inter-firm transfer process. Internally generated and transfer of knowledge is characterized by features (such as uniqueness, tacitly held) that make it difficult for business rivals to imitate, since it is geared towards securing the competitiveness of the firm (Spraggon and Bodolica, 2012; Corredoira and Rosenkopf, 2010; Kogut and Zander, 2003). Intra-firm knowledge transfer is manifested through changes in knowledge or performance of the recipient unit (group, department or division) (Argote and Ingram, 2000). In simple terms, intra organizational knowledge transfer is said to have occurred when one unit of the organization is affected by the experiences of another (Argote and Ingram, 2000).

It is of necessity that firms complement their own capabilities with those of others due to the high degree of specialization among themselves (Husman, 2001). Knowledge transfer between firms is thus necessary, because it allows those firms involved to have access to knowledge that is otherwise outside their reach. From the inter-organizational perspective, knowledge transfer may be described as "a process of dyadic exchanges of knowledge between a sender and receiver, where the effectiveness of transfer depends to some extent on the disposition of and ability of the source and recipient, on the strength of the tie between them, and on the characteristics of the object that is being created" (Szulanski, 2003; Minbaeva, 2007). The current study may be situated at the intersection region between intra and inter-firm knowledge transfer in the sense that both concepts were incorporated to gain a holistic understanding of the context under consideration.

4.9.1. APPROACHES TO ORGANIZATIONAL KNOWLEDGE TRANSFER

The study of knowledge transfer may be approached in one of two ways: communication model and the SECI model (Dinur, 2002). The communication approach views the process of knowledge transfer as a dyadic communication process involving the transmission of messages from a source to recipient (Dima and Stancov, 2008). Knowledge transfer is, thus, referred to as "a process of dyadic exchanges of knowledge between the sender and the receiver, where the effectiveness of transfer depends to some extent on: the disposition of and ability of the source and recipient; the strength of the tie between them, and on the characteristics of the object that is being created" (Szulanski, 2003; Minbaeva, 2007). From the perspective of the communication model, knowledge transfer is composed of stages, processes and categories of factors (Szulanski, 1993; 1996; Dinur, 2002).

According to Szulanski (1993; 1996), four stages are involved in the knowledge transfer process. These are: initiation, implementation, ramp-up, and integration. The first stage of the transfer process involves the decision to transfer and all the events that lead to taking such a decision is referred to as the initiation stage. The implementation stage begins with both the source and recipient units agreeing to proceed with the transfer of the resource between them. Emphasis is placed on the establishment of strong social ties between the source and the recipient, which has the potential to facilitate the flow of knowledge. The ramp-up stage begins with the receiving unit applying the knowledge received for the first time (Voigt, 2009). The integration stage, which represents the final stage is where the recipient obtains satisfactory results from the application of the transferred knowledge and thus forms part of the organizational routine (Szulanski, 1999).

These stages can be achieved through four sets of processes: initiation, adaptation, translation and implementation (Dinur, 2002). Through adaptation and translation processes, which occur at both the source and recipient of knowledge, the implementation and ramp-up stages can be accomplished. Adaptation refers to the process where knowledge is manipulated at the knowledge source to the perceived knowledge need of the recipient while translation involves the overall alterations on the knowledge received at the recipient in relation to solving general problems of adaptation to new context (Dinur, 2002).

Alongside the stages and processes involved in organizational knowledge transfer, Gabriel Szulanski, identified four main difficulties that can be associated with knowledge transfer, which he also referred to as knowledge stickiness (Szulanski, 1995, Szulanski, 1996, Szulanski, 2000, Szulanski et al., 2004). Four factors identified to influence the difficulty of the transfer process are related to the source, recipient, the knowledge itself, and context related factors (Dinur, 2002; Schuller, 2014). The knowledge related factors were identified as causal ambiguity and unproved knowledge; source related attributes were lack of motivation and source not perceived as reliable; recipient related factors were absorptive capacity, retentive capacity, and lack of motivation; context related factors include arduous relationship and barren organizational context. Scholars have also explored how these factors affect the transfer process within the organization.

Kang et al., (2010) analyzes the effect of knowledge characteristics on organizational effort for knowledge transfer and found that organizations put in more effort in acquiring knowledge which are tacit, difficult and important. Foss and Pederson (2002) investigates the effect of the characteristics of the knowledge source on the transfer process. Other scholars have empirically studied the effect of absorptive capacity on the transfer process (Minbaeva et al., 2003; Pak and Park, 2004) as well as the organizational context (Simonin 1999a; 1999b). Eisenhardt and Santos (2002) examined the influence of characteristics of knowledge, sender, receiver and their mutual relationships on the knowledge transfer process.

In spite of the important contributions made by the various studies towards knowledge transfer, it seems that most attention have been given to the factors that promote and hinder the various stages and processes involved in knowledge transfer. Cummings (2001) conceptualized a research model which included ten contextual factors that impact on both intra and inter-organizational knowledge transfer as: articulability, embeddedness, organizational distance, physical distance, institutional distance, knowledge distance, relationship distance, transfer activities, motivation of the recipient, and organizational learning culture. In a similar fashion, Dinur (2002) clustered the factors that determine an organization's ability to hold, utilize and transfer knowledge into five contextual dimensions as cultural, decision-making, technological, environmental, and strategic.

Gupta and Govindarajan (2000) conceptualizes factors that affect knowledge flow in terms of five elements: perceived value of the source unit's knowledge, motivational disposition of the source, existence and richness of transmission channels, motivational disposition of the receiving unit and the absorptive capacity of the receiving unit. In their study of a state-owned Brazilian oil company, Joia and Lemos (2009) identified the following as pertinent factors that influence tacit knowledge transfer: individual management of time, common language, mutual trust, relationship network, reward, type of training, knowledge transference, knowledge storage, power, favorable environment for questioning, type of valued knowledge, and media. In their study to identify key factors that affect transnational knowledge transfer, Duan et al. (2010) categorized into four: actors, context, media and content and found the selection of the appropriate media for communication to be vital for the success of knowledge transfer.

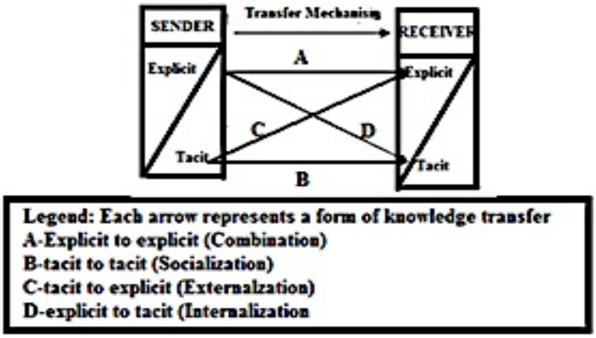

Figure 4-6: Interaction between two-knowledge transfer approaches 1

We argue here that both SECI and Communication models should not be viewed as mutually exclusive but interactive. We suggest that after all the conditions proposed in the communication model are satisfied, a lack of understanding of the interplay between the two types of knowledge-tacit and explicit- as discussed in the SECI model could affect the overall knowledge transfer process. Because along the path of the transfer between the sender and the receiver, knowledge would have to interact along the knowledge continuum as seen in Figure 3-2. However, the SECI model is focused on largely in this study to enable us to go beyond the stages and processes involved in the transfer process in the general sense and to look at the factors the affect the different types of knowledge transfer, which results from the interplay between tacit and explicit knowledge. Prominent among those factors is the selection of the appropriate media for the different types of knowledge transfer. According to the SECI/ba model, two types of media that can be used to support the four different types of transfer are recognized as face-to-face and virtual media (Nonaka et al., 2000). Nonaka et al. (2000) restricted the use of virtual media for only internalization and combination while face-to-face media was recommended for socialization and externalization. The above claim of Nonaka et al. (2000) has a dual consequence. First it suggests that the richness of the media can be a determining factor in the selection of the appropriate media for the different types of knowledge transfer and secondary, the use of virtual space, which comprise of ICT usage should be restricted to internalization and combination. In as much as the current study agrees with Nonaka et al. (2000) on the former, studies have yielded mixed findings on the latter. These issues are dealt with in the subsequent sub-sections on media choice and ICT usage for SECI.

4.9.2. HUMAN-BASED VERSUS TECHNOLOGY-BASED KNOWLEDGE TRANSFER

The SECI/ba model recognize two types of media that can be used to support the four different types of knowledge transfer as face-to-face and virtual media (Nonaka et al., 2000). Depending on whether the communication media is face-to-face based or ICT-based, knowledge transfer has been classified as human-based process or technology-based process (Spraggon and Bodolica, 2012). According to Spraggon and Bodolica (2012), technology-based processes stress on the use of information technology tools as channels for knowledge transfer whereas people based processes emphasize on face-to-face interactions among knowledge senders and knowledge receivers (Spraggon and Bodolica, 2012). The technology-based processes can be further sub-divided into static virtual processes and dynamic virtual processes while people-based processes are known as canonical face-to-face process and non-canonical face-to-face process (Spraggon and Bodolica, 2012). In a similar vein, Broucker (2010) referred to the people-based processes of knowledge transfer as interactive experience and the technology-based knowledge transfer as passive (Stones, 2014). In interactive knowledge transfer, an understanding of the critical knowledge needed by the organization and a level of trust are important ingredients required for the transfer to occur (Broucker, 2010). Passive knowledge transfer involves the use of IT tools that provide repositories for the capture, storage and transfer of knowledge (Stones, 2014). Transferring knowledge by the use of technology begins with the establishment of knowledge database that can serve as the foundation of organizational knowledge management and a resource for training employees (Khumalo, 2012).

Consistent with Nonaka et al., (2000), Jasmuddin and Zhang, (2008) refer to knowledge transfer mechanisms that rely on face-to-face media platform with direct human interactions for media support as soft mechanisms while referring to ICT-based mechanisms as hard mechanisms (Jasimuddin & Zhang, 2008). However, Courtney & Anderson (2009) assert that the advancement in electronic communication technologies provide a way to combine both soft and hard mechanisms into hybrid soft and hard transfer mechanisms, thereby blurring the demarcation between the two categories of mechanisms making it possible for ICTs to be used for the transfer of knowledge involving both tacit and explicit knowledge. The technology-based approach is adopted for the study taking into consideration the fact that the Cocoa Industry in Ghana is replete with traditional mechanisms for knowledge transfer, which is proving not to be much effective (Baah and Anchirinah, 2011) and thus can be supported or even replaced with ICTs. Consistent with Nonaka et al. (2000) it is argued here that media choice can influence the type of knowledge transfer as proposed in the SECI model. We based this claim on the fact that the communication process involved in the tacit knowledge processes (for example socialization) may differ, in terms of the richness of the media used, from those involved in explicit knowledge transfer (for example combination). The study, thus, applies the media richness theory (MRT) to investigate whether the richness and usage of the media employed for the different types of knowledge transfer impact on the overall success of the knowledge transfer process. The key argument here is that the communication process involved in the transfer of tacit knowledge differs in terms of media selection and usage from that involved in the transfer of explicit knowledge.

4.10. THE MEDIA RICHNESS THEORY

Media has been identified in both the SECI/ba and the communication model as a key factor that affects knowledge transfer. Media is considered very important because the process of knowledge transfer 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 et al., 2000). In fact the choice of appropriate media for knowledge transfer is deemed as important as the process itself (Murray and Peyrefitte, 2007; Joia and Lemos, 2009; Duan et al., 2010; Spraggon and Bodolica, 2012; 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 transferred. According to the Media Richness Theory (MRT) (Daft and Lengel, 1984, 1986; Daft et al. 1987), communication media differ in their ability to process information and facilitate understanding regarding situations in communication characterized by uncertainty and equivocality (Daft et al. 1987; Suh, 1999). Based on the capacity to facilitate shared understanding and insight, media channels can be classified as low or high in richness. The richness of media is the capacity of the media to process rich information and depends on a combination of four characteristics (Daft and Lengel, 1984; Daft et al. 1987):

- 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 (Daft and Lengel, 1986). Among the shortcomings of the MRT is the exclusion of new media such as e-mail and video conferencing 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.

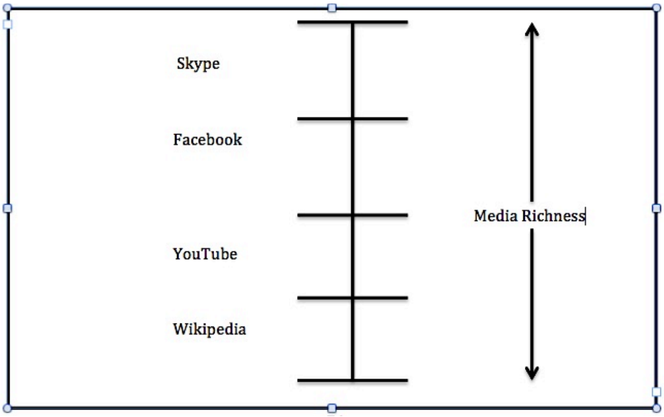

Figure4-7: Proposed Media Richness Hierarchy for the selected Web 2.0 Applications

Among these CMC modalities, Schwartz (2007), rated VVOIP as having the highest level of media richness, followed by VoIP, chat, IM, portal, forum, and email in that order (Schwartz, 2007). 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.

4.10.1. MEDIA RICHNESS AND MESSAGE AMBIGUITY

According to the MRT, the main causes of information processing are uncertainty and equivocality (Daft et al. 1987; Koo, et al., 2011). Uncertainty is defined as "the difference between the amount of information required for performing a task and the amount of information already possessed by the organization". While equivocality refers to "the existence of multiple conflicting interpretation of organizational situation" (Galbraith, 1973, Daft et al. 1987). The major difference between uncertainty and equivocality is related to the approach of information processing used to respond to them. When there is uncertainty, managers respond through data acquisition but when equivocality issues arise, they resort to the sharing of subjective views among themselves. In other words organizations respond to uncertainty by acquiring large amounts of data through conventional information systems. Where as situations of equivocality require much deep thinking and brainstorming to define problems and resolve disagreements.

According to the MRT, information processing by managers is characterized by a positive relationship between media richness and message equivocality (Daft et al. 1987). When managers use richer media for equivocal task and lean media for unequivocal task, they improve performance (Dennis & Kinney, 1998). Using richer media for equivocal task enables users to gain a better understanding of ambiguous messages quicker leading to a better performance of the task. On the other hand, using leaner media for unequivocal messages can facilitate understanding in curtailing information overload provided through richer media. Media with high degrees in richness (e.g. video) is more efficient for resolving issues with subjective and divergent perspectives while lean media (e.g. text) is used appropriately for objective data communication in support of routine decisions (Daft et al. 1987). The main barrier confronting new media has got much to do with the issue of equivocality than uncertainty (Daft et al. 1987). According to Schwartz (2007), the MRT can be employed through the use of CMC modalities such as VVOIP, VOIP, chat, IM and so on, which also represent the features of Web 2.0 applications like Facebook, Skype, YouTube and Wikipedia to mitigate knowledge transfer barriers related to context and knowledge ambiguity thereby enhancing knowledge transfer success.

4.10.2. MEDIA RICHNESS AND TASK CHARACTERISTICS

According to the MRT the technologies used in organizations represent a key source of uncertainty and equivocality (Daft and Lengel, 1986). Organizational technologies include the knowledge, tools, and techniques used to convert inputs into outputs in the organization. Resolving the issues of uncertainty and equivocality relating to the use of technology requires the appropriate fit between media richness and the underlying task characteristics (Daft and Lengel, 1986). Depending on the characteristics of the task, managers may rely on the use of rich or lean media for the reduction of equivocality and uncertainty associated with the task (Koo et al., 2011). According to Perrow (1967), two task characteristics underlying the use of organizational technologies are task analyzability and task variety (Daft and Lengel, 1986).

Task analyzability relates to the way individuals respond to problems (Daft and Lengel, 1986). When task is analyzable, individuals rely on objective and computational laid down procedures to resolve them. On the other hand when task is unanalyzable, individuals are unable to develop exact procedures that will enable them to resolve the issue and so they would have to rely on judgments and experiences. When task is analyzable, individuals may resort to using media, which is low in richness to study and resolve problems, whereas unanalyzable tasks require the use of media of higher richness (Suh, 1999). Task variety refers to the frequency of unexpected issues that arise in the course of the transfer process. When the transfer process is such that individuals are unable to predict problems in advance, then there is a high task variety. High task variety is associated with large amounts of information in other to deal with exceptions where as low task variety relates to small amount of information.

Other studies have contradicted some of the propositions of MRT. In an experiment to study the effects of media richness on decision making, using Computer Mediated Communication (CMC) and video communication, Denis and Kinney, (1998) found that even though subjects recognized the differences in the richness of the media, the central claim of the MRT that richer media use for equivocal task and leaner media use for unequivocal task improves performance, was not supported by the study. In a laboratory experiment conducted a on MRT to investigate the effect of media characteristics (text, audio, video, and face-to-face) on task performance and satisfaction using intellective and negotiation task, Suh (1999) found that the type of communication media used had no effect on decision quality in terms of both intellective and negotiation tasks as claimed by MRT. In effect, the study was not supportive of the MRT. The propositions of the theory seems to be limited to traditional media such as telephone and letters, but fail to hold when applying to contemporary media such as e-mail and video conference technologies (Lee, 1994; Kock, 2005; Simon, 2006; Garza, 2011). On the other hand, some current studies have applied the MRT in relation to video, voice, graphics and other web 2.0 technologies such as RSS and IM (Lo and Lie, 2008; Liu et al., 2009; Lan and Sie, 2010). Results from these studies also confirmed the standpoint of MRT that communication situations in organizations vary in their levels of equivocality and therefore require varying degrees of richness.

1.1. RESEARCH ON MEDIA RICHNESS THEORY AND SECI MODEL

The MRT proposes that the choice of media for a given communication task depends on the richness of the media and the characteristics of the task. Meanwhile most of the existing studies have focused on the relationship between the SECI processes and various task characteristic groups, leaving almost no evidence in literature that seeks to relate the knowledge transfer types with the richness of the media used for these processes (see figure 3-4). The top section of figure 3-4 represented by broken arrows indicates the focus of existing studies, while the bottom part indicates the focus of the current research. Becerra-Fernandez and Sabherwal (2001) applied the SECI model to assess the impact of the knowledge conversion processes on knowledge transfer effectiveness for different task characteristics. The study distinguished between task orientation and task domain and sub-categorize each of them into process and content orientation for task orientation, and focused and broad domain for task domain for four cells. The cells were then linked to the four knowledge conversion modes with internalization representing focused, process-oriented task, externalization for focused, content-oriented task, combination for broad, content-oriented task and socialization for broad, process-oriented task. The results indicated that each of the four modes of conversion had a positive impact on the in the expected cell except externalization (Becerra-Fernandez and Sabherwal, 2001).

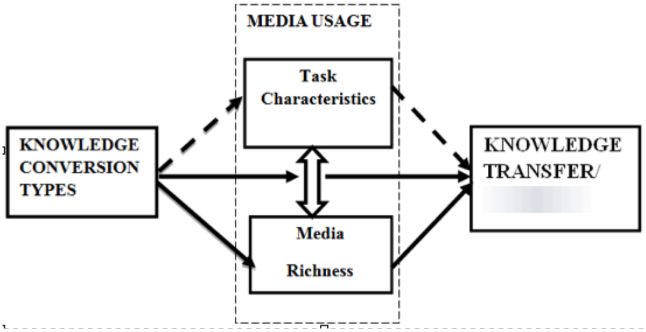

Figure 4-8: Interaction among key constructs showing the focus of current and existing studies

Anothayanon (2006) enhanced the study of Becerra-Fernandez and Sabherwal (2001) to explore whether the impact of knowledge conversion on knowledge transfer and creation differ according to the type of task characteristic, using Perrow's (1967) theory to distinguish task characteristics as craft, non-routine, engineering, and routine to explore the impact of the knowledge four knowledge transfer types proposed in the SECI. The analysis of the results also proved a positive relationship between the proposed match between the knowledge transfer types and the various task characteristic groups. Deutch (2014) built on the Becerra-Fernandez and Sabherwal (2001) knowledge satisfaction contingency model and the model by Anothayanon (2006) to establish the possible predictive relationship between knowledge conversion and task characteristics on knowledge satisfaction in virtual and non-virtual teams. The current research moves beyond the relationship between the SECI-based knowledge transfer types and task characteristics to examine how the richness of the media influence their choice and usage for the different types of knowledge transfer for knowledge transfer and creation. We propose that the richness of the media affect its selection and usage for the different types of knowledge transfer as proposed in the SECI model.

4.11. AN OVERVIEW OF THE AKIS FRAMEWORK

Nagel (1979) was the first to introduce and describe the characteristics of the Agricultural Knowledge Systems (AKS). Röling (1987) developed the AKS 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 (Figure 3), to harness knowledge and information from multi-sources for improved farming practices and better livelihood (FAO and World Bank, 2000).

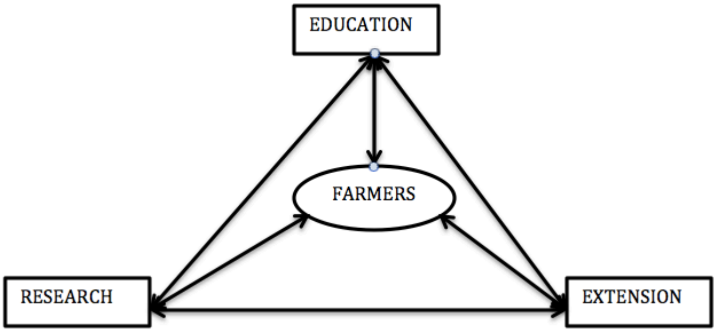

Figure 4-9:AKIS Framework

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, dissemination and utilization. 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 utilization of knowledge. In order 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.

4.12. THE COCOA-BASED AKIS MODEL IN 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 transfer 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. 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 3.1). 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. Sources of Knowledge and Information to Cocoa Farmers

Knowledge is an important concept in agriculture since it has the capacity to influence the process of equivocality and uncertainty reduction. Knowledge remains a critical ingredient for improved cocoa productivity (Baah, 2007). In order for cocoa farmers to respond successfully to challenges and opportunities of their environments, there is the need to provide them with the needed knowledge and information (Nana et al., 2013). Knowledge gap has been cited as a key-contributing factor to the annual yield gap between Ghana (350 kg/ha), Cote d'Ivoire (800 kg/ha) and Malaysia (1700 kg/ha) (Nana et al., 2013). It is argued that in spite of the various intervention programs rolled out by government and COCOBOD towards increase productivity, lack of adequate knowledge and informational bottleneck can hinder the sustainability of the objectives of the programs (Nana et al., 2013). Knowledge and information sources in the cocoa industry accessible to cocoa farmers can be categorized into four: personal, private, public and mass media (Nana et al., 2013). Under each of these knowledge sources, cocoa farmers have a wide variety of channels, which they can use to access and satisfy their knowledge needs. The main channels under the personal information sources include family members, colleague farmers, and what is referred to as village extension animators. The private source of knowledge consists of farmer association experts, Licensed Buying Companies (LBCs), cocoa farm input dealers, and communication networks. Mass media include the use of television, video, radio programs, newspapers/journals, and PC/internet. The public knowledge source involves District Extension officers, Community Extension Agents, University researchers and staff of public research institutes (CRIG). In spite of these sources and channels of knowledge, extension remains the main approach used for the transfer of research findings and innovative technologies to cocoa farmers in Ghana (Baah & Anchirinah, 2011; Baah et al., 2009). Extension agents are considered as the knowledge repositories by which resource-poor cocoa farmers look up to for meeting their required knowledge needs. Meanwhile, the extension service delivery in the sector is confronted with numerous challenges mostly associated with how knowledge is transferred between them researchers and the cocoa farmers.

4.13. CHALLENGES IN EXTENSION SERVICES DELIVERY IN THE GHANAIAN COCOA SECTOR

Policy makers and researchers in the industry have attributed the huge knowledge deficit to the malfunctioning of the extension support received by cocoa farmers in Ghana. This section presents some key challenges confronting extension service delivery in the sector and how ICT usage could impact on extension activities. Prior to the year 2000, the extension services for cocoa farmers were undertaken solely by COCOBOD under the now defunct Cocoa Services Division (CSD). CSD used to have huge frontline extension agents of 2,400 in number. The main extension approach employed by CSD was a modified form of training and visit (T&V) using methods such as demonstrations, rallies, and forums with farmers. In addition to that CSD was also responsible for the identification and removal of swollen shoot infected cocoa tress. This is a viral infection and so the only means of controlling it from spreading to other parts of the cocoa farm was by cutting down the trees, which have been infected. However, this huge size of frontline extension agents didn't translate into provision of satisfactory advisory service to the cocoa farmers. On the contrary it was realized that CSD was not giving cost-effective cocoa extension services to the cocoa farmers and their services were also marked by inefficiencies and ineffectiveness. This resulted in a merger with the extension services division of the Ministry of Food and Agriculture (MOFA) with the objective to provide cost effective and efficient service delivery to the farmers. It turned out that the Agricultural Extension Services of MOFA became the sole provider of cocoa extension (Baah and Anchirinah 2011). A situation, which made farmers, continued to suffer poor extension services due to poor extension-to-farmer contact, lack of technical knowledge on cocoa husbandry to new cocoa farmers, ineffective system for the transfer scientific research results to farmers.

In a research conducted by Baah and Anchirinah (2011) to investigate stakeholders' perception on extension constraints in the sector during the term of MOFA it became apparent that MOFA was not adequately resourced to add such a huge additional responsibility to their already over-burdened task of providing services to other farmers in the country. It was concluded by the study that, MOFA expected COCOBOD to provide some resources in terms of funding and the needed technology and knowledge to augment the additional task, which COCOBOD declined so technically they stopped providing services to cocoa farmers (Baah and Anchirinah 2011). The collapse in the cocoa extension service delivery to cocoa farmers gave rise to various extension services delivery by a number of interests groups in cocoa communities with many challenges. In 2010, the Government of Ghana embraced the concept of Public Private Partnership Extension (CEPPP) called the New Cocoa Extension System (NCES) (COCOBOD News, 2013). The new extension delivery system is undertaken the Cocoa Health and Extension Division of the COCOBOD (CHED). NCES is to be guided by the principle of lean staff members who are highly motivated, professionally trained, and qualified and are capable of delivering cost-effective and efficient services. The cocoa farmers who qualify for their services should be business oriented and ready to demand their services so that they can eventually own the cocoa extension (COCOBOD News, 2013). COCOBOD and its subsidiary divisions represent the public sector of CEPP while Kraft Foods (Cadbury), Solidaridad (West Africa), World Cocoa Foundation/Cocoa Livelihood Program (WCF/CLP) and allied agencies such as Armajaro Ghana Limited, Rainforest Alliance and farmers constitute the private arm (e-Agriculture, 2014). In spite of the new arrangements coupled with the training and skills given to the extension agents, approaches and methods they use to interact with the farmers still play critical role in attaining successful knowledge transfer. The methods and approaches they employ should help in building rapport between them and the farmers.

4.13.1. APPROACHES AND METHODS USED FOR EXTENSION SERVICE DELIVERY

Different approaches to tackle the farmers' needs of knowledge have a long history. Approaches used to augment extension activities include: Training and Visits (T&V), Farmer-Field School (FFS) and the commodity approach. *Training and Visit Approach:* The T&V focused on using the 'top-down' one-size-fits-all approach in transfer knowledge and technology to farmers. T&V approach basically was designed as cost efficient extension system to provide large amounts of farmers with modern technical knowledge towards increase in productivity. The emphasis of this approach is on frequent in-service training for staff, regular visits to the farms of the farmers, and to promote extension-research linkage. The process begins with a subject matter specialist (SMS) giving training to the frontline extension agents on the new technologies. The extension agents then proceed to train farmers on the new technology. The methods employed under this type of extension program include group discussions, seminars, and in-service training courses, on-farm demonstrations, and farmer field days. The main tool that was applied under the T&V approach is face-to-face contact supported with handouts and technical facts sheet. In Ghana, the approach came under serious financial attack coupled with criticisms such as irrelevance, inefficiency, ineffectiveness, and lack of equity. This failure has been attributed to the fact that the approach was funded by the World Bank and couldn't be sustained at the end of the funding period.

Farmer Field School Program: The FFS is a form of participatory approach largely based on experiential learning towards technology development and dissemination. The FFS approach was originally designed as an investment towards capacity building to improve the knowledge and decision making skills of farmers (David & Asamoah, 2011). Under this approach, the farmers are supposed to meet for an entire cropping season for a particular crop from pre-planting to harvesting to learn by observation what happens on the field and have group discussions on what they observe. Participants are empowered through the group interactions by learning communication, leadership and management skills thereby sharpening their decision-making skills as well. In the Cocoa sector, FFS has been used to educate farmers on variety of topics including Integrated Production and Pest Management (IPPM), integrated crop and pest management (ICMP), soil management, gender awareness, HIV/AIDS and so on. Even though FFS offers a platform that empower farmers to be better managers of their farms by making informed decisions it cannot serve as the ultimate solution towards the search for an 'ideal' extension strategy or approach (Baah, 2006). Moreover, the main objective of the FFS program was to empower the farmers so that they in-turn would disseminate the knowledge they acquired to other farmers, however, this has not been realized.

The Commodity Approach: The basic characteristics underlying this approach is that the farmers produce certain quantities of cocoa to their partners who are private sector organizations for purchasing, and the organizations in turn provide them with farm inputs, credit, quality management, and extension service to augment the support received from COCOBOD. The idea behind the support is to enable the farmers to increase their levels of production, which in turn enable the sponsors to continue their stay in the business. Companies running this type of out-grower scheme in the industry include the Licensed Cocoa Buyers (LBCs) as well as private multinational companies. The sustainability of these approaches depends on an effective two-way communication among all the various stakeholders involved in the creation and transfer of knowledge and technology to the farmers.

The findings of other studies indicate that 75% of extension agents who participated in the study rely only on one-on-one visits to interact with farmers while the remaining 25% use group meetings and demonstration farms, which is also done through face-to-face interaction (Baah et al., 2009). According to the approach and methods currently being used for extension activities, if the extension agents are unable to meet cocoa farmers one-on-one, then definitely they couldn't interact with them. The results didn't imply absence or inadequate number of extension officers in the various cocoa growing regions as perceived. According to Baah et al. (2009), even though extension agents were present, they were unable to reach out to cocoa farmers due to logistical constraints amongst other factors.

Other research findings conducted by the Ministry of Manpower and Youth Employment (2008) have recorded that over 70% of cocoa farmers, had not met an extension agent in the preceding year of the study. Another study confirmed that 84% of farmers had not had contact with an extension agent in the preceding year (Baah, 2007). The implication is that farmers haven't benefitted sufficiently from many years of cocoa research findings and this has created a huge knowledge gap between researchers and cocoa farmers. Such a gap in knowledge has contributed to low adoption of agricultural technologies and low productivity and consequently resulted in the disparity between yields obtained on research stations and farmers' farm. While on research sites, a yield of 1 ton per hectare has been attained, in practice it dwindles to less than 400kg/ha.

4.13.2. APPROACHES USED BY CRIG FOR EXTENSION DELIVERY

Extension is not supposed to be the responsibility of extensionists alone but researchers as well (Baah, 2006). Researchers, for that matter CRIG have equal responsibility of sharing knowledge with their clients in an interactive manner even though extension agents are supposed to mediate between them and the farmers. Doing so would help CRIG to appreciate the way and manner farmers acquire and apply knowledge so as to be informed of how to format her recommendations. Consequently, CRIG employs what they refer to as ‘plurality of methods and approaches’ to enhance interaction with its clientele, the cocoa farmers and to also meet their knowledge needs. In a study to review the various methods and approaches employed by CRIG in the interaction with its clientele, the cocoa farmers, Baah and Anchirinah (2011) identified farmer’s educational campaigns as the main approach, which involved the use of methods such as radios, posters, leaflets, flyers, production guides, on-farm engagements and cocoa farmers’ newspapers. Radio has been cited as the most important medium for communication with the rural cocoa farmers due to the fact that most cocoa farmers have access to radio and they also find it easy to use. Moreover, most of the farmers regard the radio as a reliable source of information and at the same time you can reach a larger proportion of farmers at the same time. A disadvantage in using the radio is that it’s a one-way communication medium. However, with the improvement in the telecommunication systems in rural Ghana, most farmers could call into the program to ask questions and receive answers at the same time (Baah and Anchirinah, 2011; Nana et al., 2013). The cocoa farmers’ newspaper is an educational newspaper designed solely for cocoa farmers to educate them on pertinent issues such as how to control cocoa pest and diseases with information on recommended pesticides and its application (Baah and Anchirinah, 2011). The language of the paper is made simple for the farmers’ children and grand children to even read and understand, so that in situations where farmers are unable to read and understand due to illiteracy, the children/grand children could read and interpret to them. A challenge cited with this method is related to limited circulation. Additionally, most farmers are illiterate, as studies have shown that majority of cocoa farmers only had primary education and adult literacy education (Baah and Anchirinah, 2011; Nana et al., 2013) and so they cannot read and write. Another approach used by CRIG is the on-farm trial. This involves the use of farmers’ farmlands in a study controlled and directed by the researchers themselves as a way to validate and evaluate research recommendations and modification of technology to match the socio-economic context of farmers. Baah and Anchirinah (2011) recommended that such methods should be planned and coordinated in a way that enhances the building of partnership between the researchers and the famers.

Open days are also used to allow researchers to interact with cocoa farmers. On that day, researchers open their doors to allow farmers to visit them and interact with them directly while showcasing current developments of research technologies to them. However, this is organized as an annual event to allow the researchers to obtain feedback from farmers and other stakeholders to incorporate them in future research. Meanwhile, studies have shown lack of such direct interaction between farmers and the researchers in the industry (Nana et al., 2013). Lack of close interaction denies researchers the potential of knowing the exact knowledge needs of farmers to help them design their research to answer the specific needs of the farmers. This claim can be corroborated by empirical studies where majority of the cocoa farmers were in support for the call for regular and timely interaction session with researchers by way of updating their knowledge base (Baah, 2006). The inability of the researchers reaching out to the farmers even those very close to their environments has been attributed to lack of effective communication tools that would allow them to interact with farmers without necessarily having to move away from their offices to have one-to-one interaction with the farmers (Baah, 2007; Nana et al., 2013).

Farmers have direct contact with researchers mainly through on-farm studies and open days (Baah, 2006). The question one needs to ask is how many farms could researchers visit within a year and how many open days are organized by CRIG? There is a clear indication that directs interaction between researchers and cocoa farmers are nearly non-existent due to lack of supportive interactive communication mechanisms.

CHAPTER 5. MANAGING AND TRANSFERRING KNOWLEDGE IN THE WEB 2.0 ENVIRONMENT

5.1. INTRODUCTION

The traditional knowledge management systems (KMS) positioned knowledge management and knowledge management tools in a distress state with some analysts giving titles like “Is knowledge management dead (Levy, 2009)?” These systems were based largely on the epistemology of possession, which views knowledge as object that can be captured through expert systems and intranets. This resulted in the creation of knowledge repositories that can be transferred through communication channels into other units of the organization. The content generated through traditional knowledge management systems was, thus, centrally controlled, validated and lacked interactivity making it ineffective for transferring knowledge with high degree of tacitness (Levy, 2009; Panahi et al., 2012). Some scholars are of the view that these systems lack the human agent, which is one of the main components of KM processes (Haldin-Herrgard, 2000; Panahi et al., 2012).

On the contrary, the epistemology of practice views knowledge as subjective and so instead of managing knowledge as an object or entity, tools that are designed for KM should focus on nurturing social interactions that enables people to build strong relationships to enable them to share practices. The dawn of social media technologies comes as a sort of rescuer to assist in rebirthing knowledge management (Levy, 2009; Spanbauer, 2006). Managing knowledge in the light of social media technologies is described as Knowledge Management 2.0 (Levy, 2009; Ribiere & Tuggle, 2010) or KM 2.0 (Boughzala & Limayem, 2012; Shimazu & Koike, 2007).

5.2. IMPLICATIONS OF SOCIAL MEDIA PRINCIPLES ON KNOWLEDGE MANAGEMENT

Bowley (2009) defined social media based on five specific sets of characteristics as “collaborative online applications and technologies, which enable and encourage participation, conversations, openness, creation, and socialization amongst a community of users”. In principle, social media is designed in such a way that any individual can send and receive knowledge from anywhere at any time. In the context of knowledge transfer, social media serves as a communication medium that connects knowledge senders to their prospective recipients. In doing so, they enrich their experiences harnessed through collective intelligence (Shang et al., 2011; Schutz, 2013).

The principle of collective intelligence of web 2.0 strongly encourages user-generated content through active participation of users (Bowly, 2009; Panahi et al., 2012). Users are considered as co-creators of content by serving as a channel for them to provide feedback and share knowledge and information. This creates a collaborative and participatory culture where creation and sharing of knowledge among users across the world is made possible. Unlike the previous version of the web, which mainly allowed users to be connected to content through static web pages, with the connectivity capability of social media, users are not connected to content alone but to a global-based users in an interactive manner (Panahi et al., 2012). The networking feature of social media, allow communities of users to be built by gathering users with a common interest together at a common virtual space. Within these online communities users are able to locate each other, share profiles, discuss freely, and transfer knowledge and experiences. This characteristic feature is essential in facilitating transfer of implicit knowledge through expert location in a knowledge community (Gordeyeva, 2010). When people stay connected in real-time via peer-to-peer communication, it enhances knowledge transfer and sharing.

Social media provides a user-friendly platform for the sharing and transfer of knowledge. Sharing knowledge on a web platform previously required some specialized skills in web designs, which limited users to consuming knowledge with no chance to collaborate. Lack of collaboration hinders the functioning of communities, since users are unable to effectively harness their collective intelligence and the wisdom of the crowd. Social media not only enhances collaboration but they also provide a multimedia platform that enables users to transfer and store knowledge in multiple formats, which include texts, image, video, and audio easily and interactively. Levy, (2009) analyzed the principles and functions of web 2.0 from a knowledge management perspective and found them to be closely related. In fact many of the attributes and features of social media tools were found to be rooted in the classical knowledge management tools although some gaps still persist according to Levy (2009). This suggests that, with some caution, social media tools and principles can be adopted into knowledge management endeavors.

Boughzala and Limayem, (2012) is of the view that adopting social media principles into knowledge management gives birth to a new generation of KM (KM 2.0) in organizations. A situation Boughzala and Limayem (2012) think calls for a redesign of the study and scope of the traditional ways of managing knowledge in organizations. Boughzala and Limayem, (2012) outlines some of the key changes that KM 2.0 can cause and their implications to organizations, research and technology. First and foremost, KM 2.0 changes the scope of traditional KM, from knowledge capital, comprising of impersonal and personal forms of knowledge to social capital, which focuses on interpersonal knowledge (Gandih, 2008; Boughzala and Limayem, 2012). Interpersonal knowledge is communicable implicitly through the conversation and connection of people and more so related to relationships and interactions of people. This situation makes it difficult for the traditional knowledge management systems to capture interpersonal knowledge. Secondly, with KM 2.0 the focus shifts from individual intelligence to collective intelligence by regarding the connection, interaction and collaboration of individuals and their relationships as constituting a source of knowledge known as the intelligence of the collective. The place of individuals who mainly used to be users of knowledge (knowledge workers) has shifted to knowledge generators with less structured processes (knowledge pull) rather than more structured processes in KM (knowledge push).

In terms of technology the web 2.0 on which the KM 2.0 is based is more user centered, flexible to use, and easy to install and use compared to traditional KM tools which are more task oriented, overly complex with rigid tools (Boughzala and Limayem, 2012). These attributes of KM 2.0 position socialization (a type of knowledge transfer that traditional KMSs argued as failure) as the most important mode of knowledge creation in the KM 2.0 arena. This indicates that KM 2.0 has the potential to thrive in areas where traditional KMS has struggled (Boughzala and Limayem, 2012).

5.3. MANAGING AND TRANSFERRING KNOWLEDGE VIA CORPORATE SOCIAL MEDIA PLATFORMS (E 2.0)

Realizing the enormous potential of public social media for knowledge transfer, organizations have adopted social media technologies such as wikis, blogs, social bookmarking, and social networking sites for organizational communications. Generally, the adoption of social media tools for external and or internal communication purposes is referred to as enterprise 2.0 or social software (Cook, 2008; McAfee, 2006). External use of corporate social media enables organizations to reach out to new customers and at the same time reinforces existing ones through business-to-consumer (B2C) interactions (Schutz, 2013). Internally, organizations connect with their employees through their corporate social media platforms (E2E) in various ways (Jarrahi, 2013; Schutz, 2013). Benefits from such connections include collaboration, innovation, and enhanced productivity. Collaboration between highly skilled workers via social media platforms can result in refining the existing knowledge through experience sharing resulting in increased tacit knowledge sharing (KPMG, 2011; Panahi et al., 2012). The main function of Enterprise 2.0 is to support knowledge management activities both internally and externally (Alqahtani et al., 2010).

5.3.1. RESEARCH ON CORPORATE SOCIAL MEDIA USAGE FOR KNOWLEDGE MANAGEMENT AND TRANSFER

In their proposed model for Enterprise 2.0 user adoption for knowledge management grounded in Theory of Planned Behavior (TPB), Alqahtani et al., (2010), discussed six factors that influence E 2.0 usage for knowledge management. These factors, categorized into technology (ease of use), knowledge management (knowledge sharing and trust), social influence and control factors (self-efficacy and resource availability) were mapped to the TPB constructs as worth considering when adopting E 2.0 for KM.

Nath (2012) examined how web 2.0 technologies are used in ICT organizations for knowledge management at individual, group, project and organizational levels. From their findings they were able to establish empirically that using web 2.0 technologies for KM:

1. Can facilitate tacit knowledge sharing among employees within the organization

2. Allow individuals to specialize in the use of these tools thereby earning them some reputation as experts in the usage of web 2.0 tools within the organization (Nath, 2012)

3. Give employees the opportunity to acquire knowledge by linking with the experts in the various fields within the organization

The use of KM context variables such as incentives for participating in activities associated with web 2.0 usage for KM, as well as supervisor and co-workers support for using web 2.0 for KM were also found to influence KM outcomes at the individual level (Nath, 2012). At the project level, Nath (2012) found that web 2.0 usage for KM enhances knowledge transfer between projects, as well as, learning of project team members. The leadership of project managers was also found to be key determinant in the transfer of knowledge between projects. The stability, familiarity, and the leadership of the project manager were shown to be important context variables that affect the adoption of web 2.0 technologies for KM at the project level (Nath, 2012). At the group level, Kumar, (2012) found that the use of web 2.0 for KM within groups increases the performance and effectiveness of the group. The social capital of a group plays an important role between the use of web 2.0 for KM at the group level and the performance and effectiveness of the group. Technical and social KM resources are important context variables for the adoption of web 2.0 for KM at the different levels within the organizations (Nath, 2012).

Murphy & Salomone (2013) investigated how Enterprise 2.0 usage enhances knowledge transfer within selected complex engineering companies. According to

Murphy and Salomone (2013), the adoption of Enterprise 2.0 technologies into an organization facilitates the management of large amounts of tacit knowledge. The use of these technologies can be advantageous in a number of ways, which include:

1. An effective approach to improving the sharing and utilization of tacit knowledge in complex environments

2. Flexibility in configuration and desired intent

3. Scalability to the size of operation and resource availability (Murphy and Salomone, 2013)

The nature of the tools enhances interaction by serving as “boundary spanning mechanisms” for linking employees and otherwise dissimilar groups and sources of insights and knowledge. All the case examples proved that the collaborative and interactive nature of Enterprise 2.0 enhance the capacities of those organization as far as knowledge sharing of is concerned. This increased knowledge sharing capacity facilitates their problem solving skills by reducing duplication of effort and increasing business agility (Murphy and Salomone, 2013). Some implementation challenges identified include: implementation strategy, user readiness and the choice of E 2.0 applications. Among these, the issue of deciding on using existing social web applications versus customized in-house application was cited as critical.

Janes et al., (2014) conducted a case study to investigate how a medium-sized law firm makes an explicit use of enterprise 2.0 technologies to manage and transfer knowledge. By employing participatory action research, the study uncovered some of the key issues that senior management may consider when introducing web 2.0 into the work place. These involve the various methodologies and approaches such as consultation, technology selection and user adoption used by the firm to facilitate the adoption process. The key findings from the qualitative study regarding barriers include: the technology itself, time, lack of clear business requirement, and lack of training. Leadership, culture and business requirement were discovered as factors that could facilitate the implementation of the KM 2.0 technology (Janes et al., 2014). In conclusion the study stated that a blended approach between the traditional management strategies and emergent methodologies is required to ensure that the technology is embedded in the business requirement of the firm and user adoption is also encouraged. The selection of the various web 2.0 technologies should be based on the understanding of the characteristics of the tools and the behavior they encourage (Janes et al., 2013).

Baxter &Connolly, (2013) examined the potential challenges that impact on the implementation of web 2.0 technologies into organizations. By conducting a scoping literature review of the subject area, Baxter and Connolly, (2013) developed a web 2.0 technologies implementation model that accommodates the key factors to consider when introducing web 2.0 tools into organizations. In addition, they found that:

1. Although some conceptual models and frameworks do exist in literature, they were not empirically tested to demonstrate their validity in the organizational context.

2. The main barriers that hamper the implementation of web 2.0 technologies in organizations are predominantly cultural and societal.

3. In spite of the evidence that organizations are unique in size, industry and culture, there exist some commonalities, which could serve as "best practices", towards the implementation of web 2.0 tools in organizations.

Meanwhile the use of public social media websites by organizations as a strategic communication channel for reaching out to strategic external and internal audiences has consistently been on the rise (Wright, & Hinson, 2010; 2011; 2012). Most contemporary business and organizations are seeing Web 2.0 applications as important platforms for communication, marketing and public relations (Xin Tan et al, 2012). Organizations described as social web superstars for their extensive use of Web 2.0 applications according to Fortune (2014) include Autodesk, Whole Foods Market, Kimpton Hotels and Restaurant, and Boston Consulting Group. The current research focuses on how the cocoa industry in Ghana can likewise utilize this platform to enhance collaboration and transfer of knowledge between researchers and cocoa farmers. The subsequent sections review literature on the usage of public social media platform for knowledge transfer.

5.3.2. RESEARCH ON PUBLIC SOCIAL MEDIA USAGE FOR KNOWLEDGE TRANSFER

Perceived risk of security and privacy issues on the public social media platforms is among the reasons for corporations building their own private social media platforms. The idea of the data being shared on the public Web 2.0 applications remaining in the databases and knowledge repositories of the owners of the social platforms and the possibility of private information of users being viewed or used by other users raises some concerns for social web usage by organizations. Even though users have these concerns about their privacy, empirical evidence shows that those concerns on users' privacy are not directly affecting their acceptance of social networking sites (Xin Tan et al, 2012). Prior studies on the use of public Web 2.0 applications by organizations to communicate showed more activity on the external measurement than the internal indicating that organizations are getting more interested in their use of social media towards their external audience (Wright and Hinson, 2009; 2010; 2011; 2012; 2013). And a sizeable number of public relations officers of organization are spending not less than 25% of their average workday interacting on Web 2.0 applications (Wright and Hinson, 2013). Some scholars believe that it may be due to the fact that organizations have realized that the benefits accrued from using these technologies both private and public outweigh the risk (KPMG, 2011). Other studies have found that there has been a continuous improvement in the use of Web 2.0 applications in the areas of accuracy, credibility, honesty, trust and telling of truth (Wright and Hinson, 2013). Nasr & Ariffin (2008) are of the view that Sharing knowledge on social web yield better outcome than on corporate social media platforms in the sense that they provide more informal means of knowledge sharing than in organizations where, for example, blogging is assigned as official duty to people.

Social interaction is among the important features of social media in the sense that not only does it allow individuals and groups of individuals to connect and share experiences and form informal relationships and networks but also it connects them to digital knowledge repositories making it possible for them to collaborate and share to create new knowledge (Panahi et al., 2012). Interaction with individuals may take the form of user-to-user interactions and user-to-expert interactions (Anderson-Wilk, 2009; Cline, 2011) both of which facilitate knowledge transfer. According Nonaka et al., (2000), such interactions at the individual level forms the backbone of the four modes of knowledge conversion processes. It is of no surprise that most studies conducted in the arena of social media usage for knowledge transfer, have found support in one way or the other for these knowledge conversion processes.

5.4. SECI-BASED KNOWLEDGE CREATION AND TRANSFER IN THE WEB 2.0 ENVIRONMENT

There are some existing web-based SECI models The ESCIE model developed by Bryceson (2007a, 2007b) is a model of knowledge acquisition in e-learning environments and is based on the SECI model. Bryceson (2007a, 2007b) modified the SECI model into ESCIE arguing that in order for the SECI model to fit in the online environment there should be some modifications. The acronym ESCIE was chosen to represent the five stages of the model namely Explicitisation, socialization, combination, internalization, and socialization. The ESCIE knowledge cycle begins with explicititisation, which refers to students familiarizing themselves with the course content by visiting the website to access the externalized version of the tutors knowledge on the subject matter (Haag, 2010). Explicititisation is followed by socialization, where students discuss their ideas in an online discussion forums or using similar tools. While discussing ideas on the forum, students can at the some time combine various pieces of information such as discussion postings, texts, videos, etc. afterwards internalization phase could follow through the giving of assignments that accompany the learning progress. The final step then involves the externalization of the internalized knowledge through report writing and further assignments (Bryceson, 2007a).

In a study to investigate personal knowledge development 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. Further more, 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. This limits the PKD model to externalization, combination and internalization, with externalization and combination-constituting PKD processes while internalization is considered as a PKD outcome (Haag, 2010).

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 (Chatti et al., 2007).

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.

The scholars categorized the existing Web 2.0 applications into service models and mapped them to specific type(s) of knowledge-creating process as a way to provide a roadmap for adaptation of the web 2.0 technologies so as to align business objectives with the various knowledge conversion processes for knowledge-creating services (Shang et al., 2011). Exchanger platforms refer to the Web 2.0 applications like MSN and Skype that allow users to exchange information via written or voice messages. They usually have instant messaging features and are characterized with low control mechanism. The types of knowledge-creating processes mainly supported by exchangers are socialization and externalization (Shang et al., 2011). The aggregator platform refers to the Web 2.0 applications that can be used to support socialization, externalization and combination and have low control mechanisms. Web 2.0 applications like Facebook, YouTube and Twitter, which allow individual to publish knowledge regarding their expertise, experience and skills via an allocated storage space in multiple formats (audio, video and text) belong to this category (Shang et al., 2011).

Mode of knowledge transfer supported	Type of service model	Example of web 2.0 application
Socialization	Exchanger, Aggregator, Collaborator, Liberator	Skype, Facebook, YouTube, Wikipedia, Linux
Externalization	Exchanger, Aggregator, Collaborator, Liberator	Skype, Facebook, YouTube, Wikipedia, Linux
Combination	Aggregator, Collaborator, Liberator	Facebook, YouTube, Wikipedia, Linux
Internalization	Collaborator, Liberator	Wikipedia, Linux

Table 5-1: Source: Adapted from Shang et al., (2011)

Collaborators are platforms, which can support all the four knowledge conversion processes from socialization, externalization through combination to internalization with relatively high control mechanisms. The liberator service model involves the open source communities such as Linux and Open Office that apply low control mechanisms to open their source codes for scrutiny as a means of upgrading their quality. They also support all the four knowledge conversion processes just like the collaborators.

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. Boateng et al. (2009) differentiated Web 2.0 applications into five categories: communicative, collaborative publishing, documentative (content management), generative and interactive (see table 4-2). Communicative Web 2.0 applications comprise of web applications that make use of web 2.0 technologies like social networking, blogs, Podcast, IM and web-conferencing. These platforms allow users to share both tacit and explicit forms of knowledge and are suitable for supporting all the four knowledge conversion processes (Murphy & Salomone, 2013).

Collaborative publishing involves social web applications that allow users to work together towards specific purpose in a shared workspace. They allow people to externalize their experiences by way of documentation of lesson learned through social interactions. Collaborative publishing platforms such as Wikipedia can support socialization and externalization and by merging and reclassifying existing knowledge they are able to facilitate combination (Murhpy and Salomone, 2013).

Conversion	Processes in the SECI Model	Type of Tools
Socialization	1. Capturing Individual Knowledge 2. Sharing Individual Knowledge 3. Interaction of Shared Experiences 4. Feedback Without Criticism	a. Communicative b. Interactive c. Generative d. Collaborative Publishing
Externalization	1. Communication (Dialogue) 2. Capturing Collective Knowledge and Explicit Knowledge Creation 3. Diffusion of Knowledge at the Collective Level 4. Instantaneous Feedbacks and Exchange	a. Communicative b. Collaborative Publishing c. Documentative
Combination	1. Organizing and Categorizing Of Knowledge 2. Integration of Sources Of Knowledge 3. Platform for Collective/Collaborative Knowledge Creation 4. Searchable/Accessible and Distribution 5. Collecting Internal and External Knowledge	a. Generative b. Collaborative Publishing c. Communicative d. Documentative
Internalization	1. Access to Explicit Knowledge 2. Re-Experience Others Explicit Knowledge 3. Asynchronous Learning (Any Place Any Time) 4. Experiential (Actualizing Concepts and Methods)	a. Communicative, b. Generative c. Interactive

Table 5-2. Source: Adopted from Boateng et al., 2009

Documentative (Content Management) Web 2.0 applications like Google Docs uses tools like blogs and video blogs to allow individuals and groups to exhibit and store thought processes over a period of time (Boateng et al., 2009; Murhpy and

Salomone, 2013) the type of knowledge conversion supported include externalization and combination.

Generative social web platforms can support all the knowledge conversion modes with the exception of externalization. Such applications make use of the wiki technology as well as other authoring and editing tools and are suitable for creating collective intelligence. Interactive platforms involve the use of social media technologies like social bookmarking, RSS feeds, VCOPs, and VLWs and can support internalization and socialization. Facebook, Twitter, and MySpace belong to this category of Web 2.0 applications (Boateng et al., 2009).

None of these models, despite their enormous contribution to literature on organizational learning didn't bring to attention, the impact that media richness of the various web 2.0 applications could have on the SECI processes. The current research will help in gaining further clarity in that direction. Other studies on social media for knowledge sharing have focused on diverse topical issues such as emergency management (Vieweg et al., 2010; Yates & Paquette, 2011); education (Lenartz, 2012; Ma et al., 2012; Okoro, 2012; Seechaliao, 2014); Health (Lefebvre & Bornkessel, 2013) and Agriculture (Baumgarten, 2013; Červenková et al., 2011; Stanley, 2013). Studies of knowledge sharing in emergency management using social media as communication platform focuses on using social media for collaborative knowledge sharing among individuals and institutions in the face of emergencies and disasters (Jarrahi, 2013).

The emergence of social media has affected learning and instructional delivery in most educational settings and so studies on the use of social media for education focus on how these technologies enhance instructional delivery between teachers and students (Baird & Fisher, 2006). The use of social media in healthcare is reported as on the rise, with the evidence of hundreds of social media platforms created with focus on healthcare and medical issues (Lefebvre & Bornkessel, 2013). From the analysis of the content of the video site YouTube video relating to mental health, Foster (2013) found that there exists a wealth of health material on health with the mental health community exploring the site and connecting with others who share their experience. Bouldrick (2014) emphasizes the inappropriate and unprofessional sharing of content on Web 2.0 applications like Facebook and Twitter and the implications on patient privacy violations on the use of social media for sharing healthcare.

Shimazu and Koike, (2007) demonstrated processes of building collective intelligence architecture or business knowledge sharing through four steps of disclosure, linking, selection and evaluation. To begin with, knowledge sources including those obtained from both individual communication and job systems should be made accessible to users within the organization. This is followed by "linking" the two knowledge sources, individual communication and job systems.

The relative importance of each item of information is determined at the selection stage while the assessment of the selected information and knowledge sources are made at the evaluation stage. According to Shimazu and Koike, (2007), the concept of collective intelligence as a feature of web 2.0 has exerted the biggest impact on KM.

Prior research shows an extensive use of social network sites like LinkedIn and Facebook by organizations for human resource management and career development. Organizations use social networking websites like Facebook and LinkedIn for recruitment and business purposes and also as a way of way of extending and maintaining professional relationship while exploring and advancing career opportunities organizations (Budden & Budden, 2011; Jarrahi, 2013). In the area of marketing, companies are found using Web 2.0 applications to promote their brands, monitor trends among customers and even research new product ideas through market intelligence research. Business decision-makers are provided with wealth of knowledge based on the enormous amount of information generated by users on Web 2.0 applications (Li & Li, 2013). Web 2.0 applications commonly used by rankings shows social networking site Facebook on top with, micro blogging site Twitter, video-sharing site YouTube, LinkedIn, blogs and Podcast following in that order (Wright and Hinson, 2013).

5.5. TRANSFERRING AGRICULTURAL KNOWLEDGE ON SOCIAL MEDIA WEBSITES

The use of Web 2.0 applications in agriculture knowledge sharing is not widely accepted as in other business and consumer practices. With the advent of smartphones, the situation is likely to change especially in the area of agribusiness uptake (Stanley, 2013). The use of social web in agriculture is likely to help in establishing 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). Networking on Web 2.0 applications doesn't only allow knowledge shared to be re-used over and over again by large audiences at the same time but also allows farmers to have access and creation of new knowledge. Networking on Web 2.0 applications can also lead to knowledge being transformed to a stronger output than when it was first put out as new ideas are being added through social interactions (Stanley, 2013).

Using Web 2.0 applications enhance agricultural extension activities by enabling the transfer of knowledge to take place through different communication channels in many different fields (Stanley, 2013). The use of mobile extension is doing well in transferring knowledge on mobile devices to farmers who are spread over wide distances in India (Cole and Fernando, 2013). This means that stakeholders in agricultural extension activities can look at the use of social media applications on mobile platforms considering the number of mobile phone user projections in developing countries such as India, which is estimated between 194 million to 364 million by 2014 (Stanley, 2013).

Farmers realizing the usefulness and power behind networking as an effective means for sending and receiving knowledge have established the AgChat concept, which is, established on Twitter online discussion forum used for facilitating discussions between farmers and agribusiness on a range of issues related to the industry (Stanley, 2013; Cline, 2013). The AgChat foundation is basically designed to educate farmers and empower them with the skill set needed to make effective use of Web 2.0 applications like Facebook, Twitter, YouTube and LinkedIn to tell their own agricultural stories. Story telling is cited as one of the effective mechanisms for transferring knowledge to farmers due to its ability to create emotional connection that draws people into the story being told. This is because stories tend to provide both context and vivid details that stay longer on the minds of recipients than lectures. Social web provides the platform on which farmers can use to tell their own stories to consumers. Storytelling on social web is the result of combing social media applications and storytelling to share experiences.

In a broader sense, it encompasses the use of images, sound, and video to create a digital story, which can then be shared on social websites such as YouTube, Facebook, as a blog post, or as a wiki edit. Traditionally speaking, storytelling can make people feel connected as though they are part of the story. Reaching out to consumers with social web storytelling can help in making them locate themselves within the story and can therefore facilitate the “Agvocacy” concept. The “Agvocacy” concept represents Advocacy in the Agricultural Industry, to discuss farmers’ interest while guarding against anti-agricultural organizations (Payn-Knoper, 2013; Stanley 2013; Cline, 2011). The limited research in this arena is centered on how to use social web to guard against anti- agricultural activists using social media platforms to portray a negative imagery of factory farming (Payn-Knoper, 2013; Stanley 2013; Cline, 2011).

Cline (2011) analyzed the user profiles of some Twitter handlers (@AgChat, and @ FollowFarmer) dedicated to agricultural knowledge sharing and stressed on the need of “Agvocay”. Stanley, (2013) opined that agricultural industries could gain numerous benefits from integrating social media in agricultural communication and knowledge transfer. Such benefits include using (1) social media websites to transfer knowledge to a wider audience, (2) connecting farmers to industry knowledge, extension and marketing, (3) establishment of consumer engagement and (4) engaging in crisis communication.

CHAPTER 6. RESEARCH MODEL AND HYPOTHESES

6.1. INTRODUCTION

The research model is primarily based on the Media Richness Theory (Daft and Lengel, 1986; Daft and Lengel, 2007) and the SECI model from the Dynamic theory of Organizational Knowledge Creation (Nonaka, 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka et al., 2000; Nonaka et al., 2009). According to Nonaka et al., (2000), 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 transfer (Nonaka et al., 2000). According to the MRT, the choice of appropriate media for a given communication task depends on the characteristics of the communication task and the richness of the media used for the task (Daft and Lengel, 1986). The types of knowledge transfer that involve the conversion of tacit knowledge requires media with high richness whereas media with low richness can be used for the conversion that involve explicit knowledge (Murray, 2003). Different tasks performed within the organization may also require the use of different modes of knowledge transfer for their accomplishment (Becerra-Fernandez and Sabherwal, 2001; Anothayanon, 2006; Deutch, 2014). In this chapter, the relationships among media richness, task characteristics, the four modes of knowledge conversion and knowledge creation and transfer are discussed as the conceptual framework of the study. The main aim of the study is to explore how the use of Web 2.0 applications for the four modes of knowledge conversion can influence the creation and transfer of knowledge in the cocoa sector in Ghana. We, thus, seek to explore the possible relationships that exist between:

- Media richness of Web 2.0 applications and their use for the different modes of knowledge conversion
- Web 2.0 usage for SECI processes and knowledge creation and transfer
- Effect of task analyzability on the relationship between web 2.0 usage for knowledge conversion and knowledge creation and transfer
- Web 2.0 usage for knowledge creation and transfer and interactions among cocoa farmers, extension agents and researchers in the cocoa industry

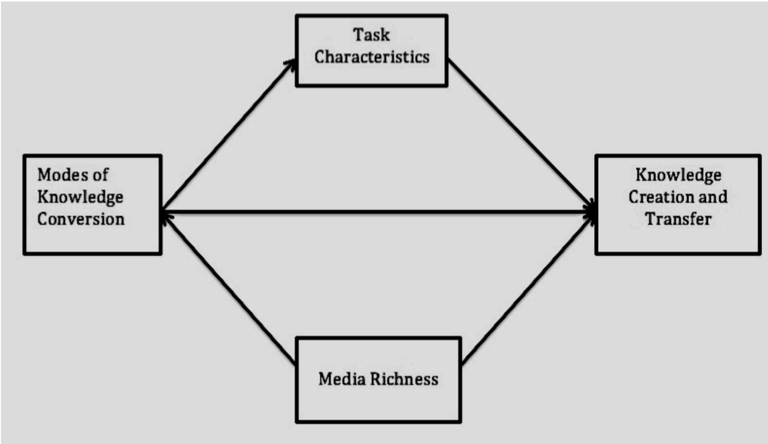

Figure 6-1: Interaction among key constructs

6.2. THE KEY CONSTRUCTS OF THE MEDIA CHOICE FOR KNOWLEDGE TRANSFER MODEL

Basically, the research model is made up of four key constructs namely: modes of knowledge transfer (SECI processes), task characteristics, media richness and knowledge creation and transfer. The different modes of knowledge transfer were obtained from the SECI model, media richness and task characteristics from the MRT and knowledge creation and transfer from the theory of organizational knowledge creation (see table 5-1).

6.2.1. KNOWLEDGE CREATION AND TRANSFER

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 (Bolisani and Scarso, 1999; Alavi and Leidner, 2001; Dinur, 2002; Cummings, 2001; Dayasindhu, 2002; Holden and Kortzfleisch, 2004). The use of technology for managing knowledge in organizations dates back to the era where companies like Microsoft, SAP, PeopleSoft, Baan, and Oracle use Enterprise Resource Planning (ERP) software as an enterprise-wide database, in which all business functions were integrated (Khumalo, 2012). Knowledge is 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 (Jasimuddin et al., 2005; Chennamaneni and Teng, 2011). 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).

Key Constructs	Indicator Variables	Theoretical Support	References
Media Richness	Media Richness (MR)	Media Richness Theory (MRT)	Daft and Lengel (1987); Daft and Lengel (1984)
Task Characteristics	Task Analyzability (TA)		
Modes of Knowledge Conversion	Socialization (SOC) Externalization (EXT) Internalization (INT) Combination (COM)	Theory of Organizational Knowledge Creation (SECI)	Nonaka and Takeuchi (1995) Nonaka et al., (2000), Nonaka and Toyama (2003)
Knowledge Creation and Transfer	Knowledge creation and Transfer (KCT)	SECI Model	Nonaka et al. (1994)

Table 6-1: Key constructs of the study

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 (Murray and Peyrefitte, 2007; Chatti et al., 2007, Lopez-Nicolas and Soto-Acosta, 2010; Panahi et al., 2012; Harris and Lecturer, 2009; Falconer, 2006). ICT can, thus, be used to facilitate the transfer of both explicit and tacit knowledge even though the level of richness wouldn't be the same as face-to-face interactions (Alavi & Leidner, 2001; Lopez-Nicolas & Soto-Acosta, 2010; Marwick, 2001; Mcdermott, 2000; Sarkiûnaitë & Krikðèiûnienë, 2005). In a study to examine the effect of ICT adoption/support and ICT use on organizational learning (OL), Lopez-Nicolas & Soto-Acosta (2010) found through the results from a hierarchical regression analysis that companies who adopt ICTs for knowledge management endeavors enhanced their knowledge creation and OL activities.

6.2.2. MODES OF KNOWLEDGE CONVERSION

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 knowledge. 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. Four types of knowledge transfer could, thus, be derived from the SECI model as: socialization, combination, externalization and internalization as stated previously. Moreover, the different modes of knowledge transfer require the use media with some required degree of richness according to Nonaka et al., (2000). According to Nonaka et al., (2000), socialization and externalization types of knowledge transfer require the use of face-to-face media, which represent at the highest point on the media richness hierarchy, according to the MRT, whereas internalization and combination could take place in virtual space. It could be implied therefore that the transfer modes that require the conversion from tacit knowledge require the use of rich media while for those involving the conversion from explicit knowledge, the use of lean media would be appropriate. The use of the appropriate media for the given conversion mode can, thus, affect the performance and outcome of the knowledge transfer process. We posit that there is a direct relationship between the usage of web 2.0 applications for knowledge transfer and knowledge transfer success as discussed further on in this sub-section.

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 (Alavi and Leidner, 2001). The socialization mode of conversion could lead to the creation of tacit knowledge in the sense that upon receiving tacit knowledge from A, B's knowledge processes could be triggered leading to the creation of *new* tacit knowledge in B. Thus, the creation of new knowledge in B is as a result of the knowledge transfer of A (Alavi and Leidner, 2001). Socialization, thus, require direct transfer of tacit knowledge in an informal cultural environment where individuals can share experiences by spending time together (Nonaka et al., 2000). Nonaka et al. 2000 theorized that this mode of knowledge transfer is supported within the context of originating Ba, 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, Haefliger et al. (2005) explain how socialization takes place in web-based Open Source software development communities where distance impedes the possibility of experiential sharing through direct contact. Defining micro-communities as small group of individuals who are engaged in knowledge creation in an organization, the scholars agreed to the fact that close social ties are important foundation for tacit knowledge exchange in micro-communities. Such close social ties can be achieved through internet-based contacts as well as in web-based and computer-mediated environment (Haefliger et al., 2005).

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 (Shang et al., 2011). 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 (Boateng et al., 2009). Previous research on web 2.0 technologies has found positive relationship between the use of web 2.0 technologies and tacit knowledge transfer (Kumar, 2012; Murphy and Salomone, 2013).

Externalization: Externalization requires a space where collective mental models of individuals could be shared and articulated through dialogue and interactions (Nonaka et al., 2000). 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 (Nonaka et al., 2000). These forms of dialogues and discussions trigger the process of concept creation by capturing context-rich knowledge, involved in new product development (Nonaka et al., 2000; Shang et al., 2011). 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 (Boateng et al., 2009; Shang et al., 2011). 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 (Boateng et al., 2009). Web 2.0 platforms, which have the capacity for supporting the externalization process, include exchangers (Skype), aggregators (Facebook and YouTube) and collaborators (Wikipedia).

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. Exercising ba offers the context for internalization by enabling individuals to embody explicit knowledge aggregated through virtual media such as written manuals and simulation programs (Nonaka et al., 2000). Web 2.0 technologies like social networking, tagging, and RSS can be useful for supporting internalization.

Web 2.0 applications like 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. For example, visitors have to create accounts with editing rights by following a standard process, articles are well organized and categorized within a content thereby helping users to acquire related knowledge and before any change can be made in an article it has to go through an approval process (Shang et al, 2011). 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. Other applications that support internalization include communicative, generative, and interactive platforms.

The use of Web 2.0 applications for internalization can be related to task with high analyzability (analyzable task). When task is analyzable, it means objective and computational procedures for resolving the task do exits and so they can be studied and resolve the problems thereby. Internalization mode of transfer allows individuals to solve problems through learning-by-doing activities and experimentation.

Combination: The combination mode of conversion 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 (Nonaka et al., 2000).

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 (Shang et al., 2011). 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 (Boateng et al., 2009; Shang et al., 2011). Collaborators and aggregators are the common web 2.0 platforms proposed for the combination mode of knowledge transfer (Shang et al., 2011). Collaborators like Wikipedia provides functionalities for organizing and categorizing complex information while allowing users to review, edit, recreate and generate content. Aggregator platforms like YouTube and Facebook gather syndicated web content into a common location while providing storage space for knowledge, expertise and skills provided by its users.

6.2.3. MEDIA RICHNESS

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. 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 (Daft et al., 1987; Joia & Lemos, 2010).

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 (Daft et al., 1987). 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 (Daft et al., 1987).

The main challenge regarding ICT usage for knowledge transfer is related to tacit knowledge transfer. Meanwhile, scholars have conceptualized tacit knowledge into varying degrees of tacitness, which may be classified as high, medium, and low (Chennamaneni & Teng, 2011). 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. Doing so makes it possible for one to argue that, although it might not be possible to use ICT for tacit knowledge classified as highly tacit, medium to low forms of tacit knowledge can be transferred through the use of ICT, even though it might not be as rich as face-to-face. And also, a positive correlation can be shown to exist between the degree of knowledge tacitness and media richness (Chennamaneni and Teng, 2011). Knowledge with high degree of tacitness requires the use of rich media for its transfer while media with low richness can be used to transfer knowledge with low degree of tacitness (Chennamaneni and Teng, 2011; Panahi et al., 2013).

In their study to investigate the relationship between communication media choice and the type of knowledge to be transferred, Murray and Peyrefitte (2007), found that generally, there was a relationship between media richness of the selected communication media types and the type of knowledge transferred being it explicit or know-how. In the advent of web 2.0, scholars have argued that the use of Web 2.0 applications can facilitate the transfer of all the four knowledge transfer modes from socialization through externalization to combination and internalization (Shang et al., 2011; Chennamaneni and Teng, 2011; Panahi et al., 2013; Boateng et al., 2009). We propose that a positive relationship exists between the media richness of Web 2.0 applications and their usage for the different modes of knowledge transfer (socialization, externalization, internalization and combination) and that people would use rich Web 2.0 applications for socialization and externalization and lean media for internalization and combination.

6.2.4. THE MODERATING EFFECT OF TASK ANALYZABILITY

There is a relationship between the use of rich media for socialization and unanalyzable task (Daft et al., 1987; Anothayanon, 2006; Muray and Peyreffite, 2007). 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 (Daft and Lengel, 1986). 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.

In a study to examine the modes of knowledge transfer that are most frequently adopted for different task characteristics, Anothayanon (2006) found that different task characteristic groups moderate the relationship between knowledge transfer modes and knowledge transfer and creation. According to the study, craft technology moderated the relationship between socialization and knowledge transfer, while non-routine technology moderated the relationship between externalization and knowledge transfer. In conclusion, socialization and externalization were recorded as being the most frequently adopted strategy for resolving equivocality issues related to craft and non-routine technologies respectively. The common underlying factor for the two task characteristics groups is that they both have low task analyzability. 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

The following hypotheses are proposed regarding the media richness of web 2.0 applications and their usage for knowledge transfer:

H1: Media richness of Web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) is positively related to their usage for the socialization mode of knowledge transfer.

H2: Media richness of Web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) is positively related to their usage for the externalization mode of knowledge transfer.

H3: Media richness of Web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) is positively related to their usage for the internalization mode of knowledge transfer.

H4: Media richness of Web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) is positively related to their usage for the combination mode of knowledge transfer

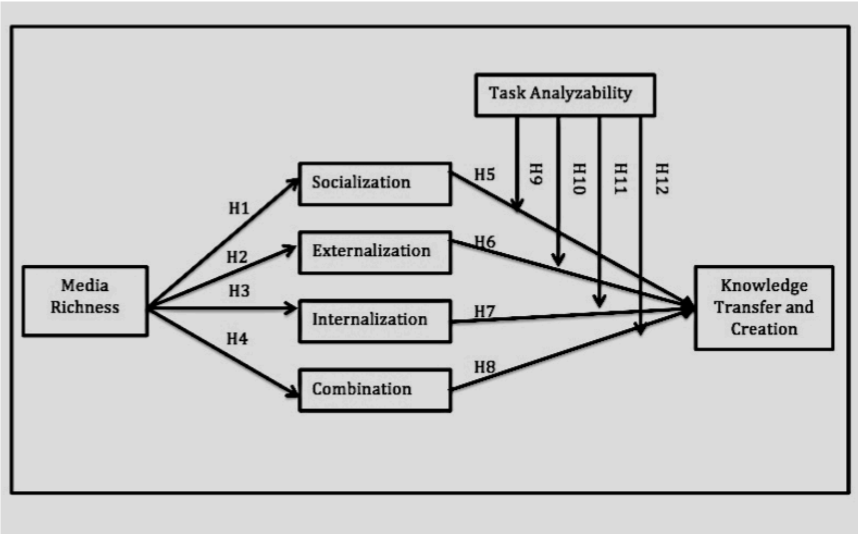

Figure 6-3: Detailed hypothesized model

The following hypotheses are proposed regarding Web 2.0 applications usage for knowledge transfer and knowledge transfer success:

H5: The use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for socialization is positively related to knowledge transfer and creation.

H6: The use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for externalization is positively related to knowledge transfer and creation.

H7: The use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for internalization is positively related to knowledge transfer and creation.

H8: The use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for combination is positively related to knowledge transfer and creation.

The following hypotheses are proposed regarding web 2.0 usage for knowledge transfer and task analyzability:

H9: Task analyzability inversely moderates the relationship between the use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for socialization and knowledge transfer and creation

H10: Task analyzability inversely moderates the relationship between the use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for externalization and knowledge transfer and creation

Hypothesis	Dependent Variable	Mediating Variable	Independent Variable	Moderating Variable
H_1	SOC		MR	
H_2	EXT		MR	
H_3	INT		MR	
H_4	COM		MR	
H_5	KTC		SOC	
H_6	KTC		EXT	
H_7	KTC		INT	
H_8	KTC		COM	
H_9	KTC		SOC	TA
H_{10}	KTC		EXT	TA
H_{11}	KTC		INT	TA
H_{12}	KTC		COM	TA

Table 6-2: The relationship among the different types of variables used in the study

H11: Task analyzability directly moderates the relationship between the use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for internalization and knowledge transfer and creation

H12: Task analyzability directly moderates the relationship between the use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for combination and knowledge transfer and creation

6.2.5. EFFECT OF WEB 2.0 USAGE FOR KNOWLEDGE CREATION AND TRANSFER ON INTERACTION AMONG KNOWLEDGE ACTORS

The following hypotheses were proposed to examine the relationship between the use of web 2.0 applications for knowledge creation and transfer and interactions among cocoa farmers, extension agents and researchers in the cocoa industry in Ghana.

H13: The use of web 2.0 applications for knowledge creation and transfer affects the nature and level of interaction between cocoa farmers and extension officers in the cocoa industry in Ghana

H14: The use of web 2.0 applications for knowledge creation and transfer affects the nature and level of interaction between farmers and researchers in the cocoa industry in Ghana

H15: The use of web 2.0 applications for knowledge creation and transfer affects the nature and level of interaction between extension officers and researchers in the cocoa industry in Ghana

CHAPTER 7. RESEARCH METHODOLOGY

7.1. INTRODUCTION

In order to test the research hypotheses that were posed in the previous chapter, the choice of appropriate research methodology is crucial (Creswell, 2009; Song, 2008) since it affects what one can say with regards to factors that can influence a phenomenon. It determines the kind of conclusions that can be made about a phenomenon to a large extent. In selecting the right method from the numerous methods, techniques, and procedures available to guide the conduct of a specific research one has to take many factors into account and evaluate those factors. These involve a clear understanding of research philosophies and choice of approach; choice of appropriate strategy for the collection and analysis of data; formulation and implementation of the research design and considering data validity and reliability while taking into account the suitability analysis techniques chosen. This chapter explores the overall research paradigm briefly and the appropriateness of the selected paradigm in answering the research questions and meeting the objectives of the study.

7.2. RESEARCH APPROACH

The term research design refers to the plan and procedures the researcher intends to use in answering the research question, right from the choice of broad assumptions to detailed data collection techniques and analysis procedures (Saunders et al., 2012; Creswell, 2009). It can also mean the various ways in which the individual quantitative and qualitative techniques and procedures can be combined in a single piece of research (Tashakkori & Teddlie, 2002; Saunders et al., 2007). The overall plan should include the type of research design the researcher wants to use to understudy the research topic. The choice of design should then be informed by the philosophical assumptions, the selection of the appropriate research strategy to ensure coherence, the selection of data collection methods and analysis procedures, as well as, ethical considerations (Saunders et al., 2012; Creswell, 2009). These and other issues such as potential practical constraints are discussed further in the subsequent sections of this chapter of the thesis.

7.2.1. TYPES OF RESEARCH APPROACHES

In selecting the approach for a research, it is possible to either use the mono method or the multiple methods. Conducting the mono method involves the use of a single data collection technique and the corresponding analysis procedure. There are two possibilities of the mono method design, namely quantitative study and qualitative study (Saunders et al., 2012). The choice of multiple methods also involves the use of more than one data collection technique and analysis procedure. Conducting a multiple method research consists of four different possibilities namely: multi-method quantitative, multi-method qualitative, mixed-method research and mixed model (Saunders, 2007). The three main types of design advanced in this study are quantitative, qualitative and mixed method research designs (Saunders et al., 2012).

7.2.2. QUANTITATIVE RESEARCH APPROACH

Quantitative research is defined as ‘a type of educational research in which the researcher decides what to study; asks specific, narrow questions; collects quantifiable data from participants; analyzes these numbers using statistics; and conducts the inquiry in an unbiased, objective manner’ (Creswell, 2007). Conducting a quantitative research, generally involves the use of instruments and the corresponding analysis procedure as a means of examining relationships among variables (Creswell, 2009). Quantitative research is usually associated with positivism, with the assumptions of using data to test theories deductively (Saunders et al., 2012). The principal strategies associated with quantitative research are surveys and experimental designs. Instruments used in conducting surveys include questionnaires, structured interviews and possibly structured observations. The quantitative approach used in this research is descriptive in nature and makes use of graphical and numerical summaries to satisfactorily test research hypothesis posed.

7.2.3. QUALITATIVE RESEARCH APPROACH

Qualitative research is ‘a type of educational research in which the researcher relies on the views of participants; asks broad, general questions; collects data consisting largely of words (or text) from participants; describes and analyze these words for themes; and conducts the inquiry in a subjective, biased manner’ (Creswell, 2007). Philosophically, the qualitative research is typically associated with constructivism with an inductive research approach. However, in practice, most qualitative research are seen to be using the abductive approach which involves both inductive and deductive inferences, where inductive inferences are developed and deductive ones iteratively tested throughout the research (Saunders et al., 2012). Qualitative research strategies include but not limited to action research, case study research, ethnography, grounded theory and narrative research. In this research, qualitative data, primarily interviews, were collected to support the quantitative data.

7.2.4. MIXED METHOD RESEARCH APPROACH

Mixed-method research is the use of both qualitative and quantitative methods either parallel or sequential in a single piece of research. It should be noted, however, that in the mixed method research, qualitative data collected are analyzed qualitatively whereas quantitative data techniques employed are also analyzed accordingly, either at the same time or one after the other. The philosophical tenet of this study is pragmatism with a mainly deductive theoretical approach. However, even though the qualitative component was used as a support to the quantitative data, it was nevertheless conducted in such a way that all the principles of qualitative research were strictly adhered to.

7.3. PHILOSOPHICAL WORLDVIEWS

“A paradigm is defined as the worldviews or belief systems that guide researchers” (Tashakkori and Teddie, 1998; Guba & Lincoln, 1994). The three major perspectives of research under consideration as far as this study is concerned are positivism, constructivism, and pragmatism. The positivist has a basic belief that the world is external and objective and so they prefer working with facts rather than impression and feelings. The positivist researcher, therefore, undertakes research, as far as possible, in a way that can be described as value-free (Remenyi et al., 1998; Saunders et al., 2007). On the other hand, constructivists believe that the world is socially constructed and subjective and focuses their research on meanings.

However, research into knowledge management is trans-disciplinary in nature (Kakabadse et al., 2003; Song, 2008), which lies within the prefecture of natural science, as well as social, business and management science (Corbetta, 2003; Song, 2008). This is partly because knowledge management has emerged as building on the theoretical foundations of many disciplines such as information economics, strategic management, organizational theory, organizational culture, organizational behavior, organizational structure, human resource management, artificial intelligence, philosophy, psychology, and cognitive science (Baskerville & Dulipovici, 2006; Kakabadse et al., 2003).

In conducting a study into knowledge management, there is the need, therefore, to combine the philosophical tenets that can satisfy the philosophical stances of the different disciplines on which the theories of knowledge management are built (Song, 2008). Hence, the study upholds the five main ‘axioms’ of ontology, epistemology, axiology, logic, causal linkages and methods of the pragmatists’ worldview of research (Tashakkori and Teddie, 1998). Epistemology refers to what constitutes acceptable knowledge in a field of study.

Source: Adapted from Tashakkori and Teddie, 1998

Paradigm	***Positivism***	***Constructivism***	***Pragmatism***
Methods	Quantitative	Qualitative	Quantitative+ Qualitative
Logic	Deductive	Inductive	Deductive+ Inductive
Epistemology	Objective point of view	Subjective point of view	Both objective and subjective points of view
Axiology	Inquiry is value-free	Inquiry is value-bound	Values play a large role in interpreting results
Ontology	Naïve realism	Relativism	Accept external reality, choose explanations that best produce desired results
Causal Linkages	Real causes temporally precedent to or simultaneous with effect	It's impossible to distinguish causes from effects	There may be causal relationships, but we will never be able to pin them down

Table 7-1:Comparison among the three major paradigms and their fundamental beliefs

Ontology is concerned with the nature of reality and with the kind of assumptions researchers have about how the world operates and their commitment to particular views held, while axiology is a study of judgment about value. With regards to methods, logic and epistemology, the pragmatist points of view is illustrated as embracing the points of view of both positivism and constructivism, while rejecting the strict choice between the two points of view as well as rejecting the 'either-or' stance of the incompatibility thesis.

7.4. RESEARCH STRATEGIES

Another important consideration regarding the design of this research was the choice between the uses of inductive approach versus deductive approach. In a deductive research, a conceptual or theoretical structure is developed which is then tested by empirical observations through the design of a research strategy (Hussey & Hussey, 1997; Saunders et al., 2007). Deductive research is described as moving from the general to the specific. On the other end, inductive research involves building a theory from empirical observation and is the reverse of deductive research since it involves moving from individual observations to general statements.

Pragmatists accepts the combination of inductive and deductive logic in the same piece of research by arguing that, at some point of a research process, it might be necessary to use both inferences simultaneously (Tashakkori and Teddie, 1998). Combining deduction and induction has also been proven to be advantageous to do so (Cavaye, 1996; Saunders et al., 2007). The main objective of the study is to identify and recommend the web 2.0 technologies that can facilitate the transfer of knowledge to cocoa farmers in the Ghanaian cocoa industry. Such an investigation calls for a deep understanding of the context and environment in which web 2.0 can be used to support knowledge transfer activities as well as operationalization of concepts to ensure clarity of definition. Consequently, the combined approaches of inductive and deductive paradigms were considered appropriate for achieving the objective of the research. However, the overall theoretical drive of the research is the deductive approach.

7.5. RESEARCH PURPOSE

The purpose of a research in research methods' literature has been classified in threefold as exploratory, descriptive and explanatory (Saunders et al., 2007). Exploratory study is a means of finding out 'what is happening to seek new insights; to ask questions and to assess phenomena in a new light' (Robson, 2002; Saunders et al., 2007). The purpose of a descriptive research is 'to portray an accurate profile of a person, event or situations' (Robson, 2002; Saunders et al., 2007) while a study that seeks to investigate the causal relationships between variables may be described as explanatory studies (Saunders et al., 2007). According to Tashakorri and Teddie (1998), the absence of a hypothesis in a research qualifies it as exploratory investigation whereas the presence of hypotheses qualifies it as confirmatory investigation. The type of research question posed can also be used to clarify the purpose of the research. How and what questions usually suggest exploratory study; why questions usually characterize explanatory questions; while descriptive studies tend to answer questions of how many/how much, when, who, and where (Saunders et al., 2007; Song, 2008). The study purpose of this research can be considered as explanatory. Typically speaking, explanatory research is quantitative in nature and involves the testing of prior stated hypotheses, which is analyzed using statistical techniques. The study is intended to explain a phenomenon by using causal modeling and structural equation modeling to identify causal relationships through analysis of the correlation between dependent and independent variables.

7.6. RESEARCH DESIGN

Generally, a research design provides the plan of action that directs a researcher on how to go about answering his/her research question(s). It provides the specific methodological direction from philosophy to the choice of methods used to collect and analyze data (Denzin & Lincoln, 2011). The overall research design of the current study is composed of a survey conducted within a case (Yin, 2013). Specifically, a holistic embedded case study design combined with concurrent embedded data collection strategy.

In choosing a research design, however, one shouldn't only consider the fact that it helps to answer specific research question(s) and achieve research objectives, but also be guided by how the selected research strategy helps to achieve some reasonable level of coherence between your research questions and the philosophical underpinnings, as well as the research approach and purpose (Saunders et al., 2012). In view of this the combination of case study and survey strategies was considered appropriate for this research not only to help in answering the type of the research questions posed, but to also enforce some level of coherence from the research philosophy through to the choice of methods for the collection and analysis of data.

There are a number of possible research designs as a result of the different research paradigms: experiments, survey, archival research, case study, ethnography, action research, grounded theory, and narrative enquiry (Robson, 2002; Saunders et al., 2012). However, considering the amount of time and other resources available for this study, as well as access to potential participants and other sources of data, some of the research strategies could not be considered as suitable for this study. For instance, conducting a research with ethnographic strategy consumes time and takes place over an extended time period, since it requires that the researcher should find a group he can build a high degree of trust, to negotiate for full access for being a full time member as well as a researcher within the social context in which the research is undertaken.

The focus of undertaking action research is usually linked to the transfer of knowledge gained from a specific context to another which is the focus of students undertaking research in their own organizations and consultants (Saunders, et al., 2007). This strategy also requires the involvement of practitioners in the research (Song, 2008) and therefore not the option for this research. The design of experimental research often requires that samples selected should be small and atypical which in turn gives rise to the problem of external validity (Saunders, et al., 2007). On the other hand, selecting a large and representative sample to overcome this mishap is also costly and may lead to complexities (Hakim, 2000) making this strategy not suitable for this research due to both time and economic constraints.

Grounded theory is more often used for theory building, which is not the focus of this research. Archival studies involve the use of administrative records and documents, which necessitates that you establish the kind of data that would be available to you before you design your research to make the best use of it. This strategy is not suitable for this research because the researcher believes that contextual conditions can have influence on the outcome of this study and would therefore like to capture those conditions as well.

The choice of research design is also shown to be relevant depending on the nature of the research question(s) posed. The study is about how researchers and extension officers can use web 2.0 applications to improve knowledge transfer to the cocoa farmers in Ghana, and the researcher wants to investigate the extent to which researchers and extension officers in the industry have access to social media applications, as well as, the extent to which they use the social media applications to improve the transfer of knowledge to the Ghanaian cocoa farmers. The study questions, thus, have a 'how' question as the main research question, and 'what' questions as sub-questions which makes it possible to combine a case study with survey, but in this case the survey was conducted within the case study (Saunders et al., 2012; Yin, 2009).

7.6.1. CASE STUDY RESEARCH DESIGN

Robson (2002) defines case study as a strategy for conducting research that involves an empirical inquiry of a particular phenomenon within its real life context using multiple sources of evidence. Case study design is appropriate when the boundary between the phenomenon and the context is not apparent. The case of this study, which is knowledge transfer in the cocoa industry in Ghana, could not be considered without its context, the Ghana COCOBOD, which is the central governing body of the entire cocoa industry. It is in this setting that the transfer of knowledge from researchers, and extension officers to cocoa farmers takes place and would therefore be impossible for the researcher to have a true picture of knowledge transfer in the industry without considering the context within which the phenomenon occurs. Yin (2013) highlights the fact that, in real life situations, phenomenon and context are not always clearly revealed and thus defines a case study to technically comprise of logic of design, data collection techniques, and specific approaches to data analysis.

7.6.2. TYPE OF CASE STUDY DESIGN AND THE UNIT OF ANALYSIS OF THE STUDY

Yin (2013) distinguishes four major types of case study designs based on two discrete dimensions as single-case holistic design, single case embedded design, multiple-case holistic design, and multiple-case embedded design. A single-case design may be deemed appropriate when it provides the researcher with an opportunity to investigate a phenomenon that few have considered before (Saunders et al., 2008). On the other hand, a multiple case design incorporates more than one case in the design with the rationale of examining whether the findings can be replicated across cases, which is not the focus of this study. The other dimension of the distinction is a holistic versus embedded designs, which depends on whether the study applies a unitary or multiple units of analysis (Yin, 2013). Yin (2013) terms a single-case study that involves more than one unit of analysis as an embedded case study design whereas a study that examines an organization or a public program as whole, by looking at its global nature is said to have used a holistic design (Saunders et al., 2012).

The researcher is interested in looking at the issue of knowledge transfer via web 2.0 platforms from the perspectives of the researchers and extension agents in the cocoa industry. This phenomenon has attracted the least of attention in empirical research. Even though there are five main divisions in COCOBOD, the researchers and extension agents who the targeted respondents for the study are attached to three main divisions. In this regard we had to rely on a holistic case study with embedded units to enable us to explore the case to its full potential. The primary unit of analysis of the case is the Ghana COCOBOD with three sub-units namely: Cocoa Research Institute of Ghana (CRIG), the Seed Production Unit (SPU) and the Cocoa Swollen Shoot Virus Disease Control Unit (CSSVD CU). These are the main divisions of COCOBOD where researchers and extension officers who form the basic unit of analysis for this study belong.

7.6.3. SURVEY RESEARCH

Survey research provides a means for collecting quantitative data and analyzing those quantitatively using descriptive and inferential statistics (Saunders et al., 2012). In doing so, a survey can be used to generate a numeric description of trends, attitudes, or opinions of a population by studying a sample of the population (Creswell, 2014). By using sampling techniques, a survey can be used to generate findings that are representative of a sizeable population at a reduced cost. In conducting a research of this nature, the constraint of both time and financial resource was limited and hence the decision to combine both case study and survey strategies.

The strength of the survey method includes its versatility, its efficiency and its economy (Bryman & Bell, 2015). A survey can be suitable for providing answers to exploratory questions, since it provides a broad picture of the experiences of the respondents (Song, 2008). This also can serve as a basis for a major weakness, since the quality of information provided, to a large extent, depends on the respondents' ability and willingness to cooperate. To minimize some of these limitations to ensure reliability and validity of the research findings, the design of the questionnaire as well as the method for the selection of the targeted respondents, and the conduct of the pilot survey was carefully planned.

According Yin (2013), it is possible to combine a case study with a survey in a single study, and in doing so researchers are able to address more complicated research questions. Such a mixed strategy has an advantage over any single method in collecting richer and stronger chains of evidence (Yin. 2013). Yin (2013) again contends that combining case study with a survey can be done in one of two ways: conducting a survey within a case study or conducting a case study within a survey. The later, according to him refers to a situation where the case study forms part of a larger mixed method study, which is not the situation in this research. This study uses the Ghana COCOBOD as the main case with three of its sub-divisions as the embedded units of and therefore requires a survey to collect data about the embedded units.

7.7. RESEARCH METHODS

The next major component that was considered in the conduct of this research was the methods comprising of the forms of data collection, analysis and interpretation to be used (Creswell, 2014). The research method is the blueprint for the collection, measurement and analysis of data (Cooper & Emory, 1995; Song, 2008).

7.7.1. DATA COLLECTION

Basically, depending on the timing where mixing occurs and the weight or priority given to the quantitative and qualitative data, the mixed method approaches for data collection can be classified as: concurrent triangulation design, concurrent embedded design, sequential explanatory design, sequential exploratory design, and sequential multi-phase design (Saunders et al., 2012; Creswell, 2014). The data collection strategy used in this study is the concurrent mixed method approach also known as concurrent triangulation design which involves the use of a single instrument for the collection of both quantitative and qualitative forms of data or the collection of both quantitative and qualitative data separately within a single phase of the research process (Creswell, 2009; Saunders et al., 2012). This strategy was chosen basically due to resource constraints since it allows the qualitative aspect to be embedded in the quantitative questionnaire or separated and administered concurrently (Saunders et al., 2012; Creswell, 2009). In this study, part of the qualitative data were embedded in the quantitative instrument and some conducted separately in the form of interviews. The qualitative data was then analyzed to support the quantitative data.

7.7.2. DATA COLLECTION INSTRUMENTS

The main instrument used for the study is a survey questionnaire, which comprised of both open and closed ended questions. The quantitative aspect of the questionnaire consisted of closed ended questions to investigate the use of web 2.0 service models including Facebook, YouTube, Skype, and Wikipedia for a better understanding of knowledge transfer from the Information Technology (ICT) perspective. It's used to examine the users' experience, perception, and opinions about the use of web 2.0 applications at both individual and departmental levels of three divisions in the Ghana COCOBOD that relate to the study. The open-ended questions were also designed for investigating how the use of social media in the cocoa industry can be directed at improving knowledge transfer activities.

7.7.3. DEVELOPMENT AND LAYOUT OF THE QUESTIONNAIRE

Survey questions are commonly compiled in a questionnaire to ensure the standardization of questions, which is considered to be the minimum criterion for using data to test hypotheses (Axinn & Pearce, 2006). This is because using questionnaires to gather data makes it very difficult if not impossible, for new hypotheses or research questions to evolve, and even if it does appear, it can only be measured with a revised survey instrument. This makes questionnaires appear to be structured instruments and can therefore be administered by well-trained interviewers without the researcher getting directly involved in its administration. Thus, it is possible for questionnaires to be used to collect data from a large representative sample of a population, which is a positive sign of using questionnaires because inferences based on large representative samples are generally considered as more reliable than those from small representative samples (Axinn and Pierce, 2005).

With the pervasive application of information technologies, web 2.0 applications are readily available and accessible to both researchers and extension officers in the cocoa industry in Ghana. The most common ones among social media applications include Facebook, YouTube, Wikipedia, and Skype. Therefore the questionnaire survey chose the use of these web 2.0 applications as means to gain further insight into the knowledge transfer process involving the use of web 2.0 technologies for the four knowledge conversion modes.

The entire questionnaire used for the study consisted of four constructs: Media richness, task characteristics, knowledge transfer success, and knowledge transfer modes. In the knowledge conversion model, four modes of knowledge transfer are identified as socialization, combination, externalization and internalization. From the MRT, two factors: media richness and task characteristics impact on the usage of communication media for a given communication task. Two types of task characteristics (task analyzability and task variety) are mentioned by the MRT as having effect on media usage, however the focus of this research is on task analyzability due to its direct relationship with the richness of the selected media. These factors are proposed to influence knowledge transfer success within the web 2.0 environment.

The content of the questionnaire was divided into four dimensions as follows: Media Richness (Facebook, Wikipedia, YouTube and Skype), web 2.0 usage for the knowledge transfer modes (socialization, externalization, internalization, and combination), task characteristics (task analyzability) and Knowledge Transfer Success. The first section of the questionnaire involving task analyzability was made up of four questions adopted from Anothayanon (2007). This was followed by the second construct, which contained seven questions that were modified from Cummings and Teng (2003) for knowledge transfer success. The third construct consisting of five questions was used to determine the media richness of each of the four selected web 2.0 applications (Skype, Facebook, Wikis, and YouTube). The questions that were used for this construct were adopted from Saeed & Sinnappan, (2009). The last section consisting of 20 questionnaire items was designed to determine the patterns of web 2.0 usage for socialization, externalization, internalization, and combination were modified from the survey instrument that was developed and validated by Bercerra-Fernandez and Sabherwal (2001), and used again by Anothayanon (2007).

7.7.4. ADMINISTRATION OF THE QUESTIONNAIRE

The data collection process began with negotiating access to the case organization, which in this case was the Ghana COCOBOD. To do this, a letter of introduction that was written and signed by Aalborg University, explaining the purpose of the study and addressed to the CEO of Ghana COCOBOD, was delivered physically by the researcher at the headquarters of the Ghana COCOBOD in Accra also known as the Cocoa House. When the approval was granted, a letter of acceptance was handed to the researcher to take to all the various division of the board authorizing him to gather the relevant data for the study and also requesting all the various divisions to assist him in the data collection exercise. A copy of the letter of approval can be seen in the appendix.

Overall, the administration of the questionnaire was done in parallel and sequential manner, in the sense that, same questionnaire was administered to all the three groups but at different times. The administration of the questionnaire began with the researchers at the R&D section of the headquarters of the board. This was used as a pilot study to test the questions to see if there were issues regarding the individual questions such as mistakes and vagueness. Based on the results of the pilot study the final version of the questionnaire was developed for the main targeted respondents. The pilot study was very useful since it helped the researcher to cut down on the number of questions because most of the researchers complained that it took them too much time to complete the questionnaires, which could discourage most of the targeted respondents. It again helped the researcher to revise some of the open-ended questions to make them sharper as advised by most of the researchers who took part in the pilot study. Prior to the pilot study a draft of the questionnaire was given to the colleague PhD fellows to critically review its themes and contents for the appropriateness of contexts and ease of completion by respondents as suggested by (M. David & Sutton, 2004). The researcher physically administered the survey, with the help of a National Service Personnel assigned to him by CRIG to help in identifying the target respondents who were individual researchers and extension agents working in the Ghana COCOBOD. The population of the researchers stood at 82, whereas that of the extension agents also stood at 275 making an overall total of 357 according to the interviewees at both CRIG and CHED. Almost all the Cocoa Researchers were stationed at CRIG in Akim-Tafo, in the Eastern region of Ghana.

The extension officers, on the other hand are spread throughout all the cocoa production regions and so the researchers visited the six cocoa-growing regions and shared the questionnaires to the regional heads. The regional extension heads in turn redistributed the questionnaires to the individual extension officers who had to send their reports to their regional heads monthly. The regional heads also converge in Accra to report to the national level heads. That was where the researcher picked the filled-out questionnaires. A copy of the acceptance was attached to each of the questionnaires and handed in to them to fill at their own convenience. Questionnaires were given to the respondents and they were given enough time to complete them, but it took quite a lot of time to collect all of them since it was very difficult to get all of them in their offices at the same time.

The collection of data on cocoa farmers was carried out within the Atiwa and East-Akim districts, both in the Eastern region of Ghana. These districts together represent 10 cocoa communities in the region. A total of 120 respondents, 60 from each district were selected. The eastern region was selected purposefully for two reasons. First, because it is the first place where cocoa was introduced in Ghana and, thus, one of the important cocoa producing regions. Secondary, due to closeness of the region to CRIG and so it's assumed that cocoa farmers within the region would have access to research recommendations and new technologies developed by CRIG than those in other regions. An important farmer characteristic that was considered was the farmer category. There are three main categories of cocoa farmers. The first category refers to those who own both the plantation and the farmland. The second group is called *abunu* farmers and they are sharecroppers contracted to manage the farm and have 50% of the farm when it matures. The last category is the *abusa* farmers and they represent farmers who manage the farms for their owners and are entitled to a third of the harvest only. All three categories were included in the study.

Before the questionnaires were handed over to the respondents, the researcher took time to explain the context, especially regarding the usage of the web 2.0 applications to the respondents. Moreover, the various key concepts such as socialization, externalization, internalization and combination, were thoroughly explained to the respondents before the questionnaires were handed out to the respondents. At CRIG where the respondents were mostly researchers, this was done on one-to-one basis through face-to-face interaction. This was possible because they were also chosen as the respondents for the interviews that were used for the study. And so this allowed the researcher to take time to clarify almost all the ambiguity that might have surrounded the questionnaire items. The researchers adopted this approach, knowing very well that some of the terms couldn't be well explained on the questionnaire and could be best understood through physical interaction with the respondents. With the extension officers, these discussions were done at the regional level to be passed down to the local extension agents since it was nearly impossible for the researchers to reach-out to all the respondents physically. In all the data collection exercise took 3-6 months and overall, 344 out of the 357 representing

96.4% were returned with none of them being wrongly filled. The operationalized definitions of the various terms used in the study are outlined in appendix C.

7.7.5. SAMPLING

Since no study can involve everyone or everything (Punch, 2005), there was the need to obtain a representative for the population to be able to conduct an effective study. The process of selecting which people, settings, events, behaviors, or social processes to observe in a study from an entire population is known as sampling. Researchers use sampling techniques or census, to obtain information about the characteristics of a population Malhotra & Birks, (2007). Two main types of sampling techniques are probability sampling and non-probability sampling. Probability sampling is the sampling technique where each member of the population has an equal chance of being selected whereas in non-probability sampling the researcher uses his own judgments to select a representative of the population.

The entire sample of the study comprised of three divisions of the Ghana COCOBOD: CRIG, CHED and SPU from a population of six divisions comprising of 82 researchers, and 275 extension agents. Purposive sampling was used to select three out of the six divisions of COCOBOD to reflect on the subject and purpose of the study. These divisions were also seen as very useful in helping the researcher to answer the research questions of the study. Researchers and extension agents were purposefully selected within the three divisions due to their level of involvement in the knowledge transfer process to the cocoa farmers and their exposure to the use of social media.

The researchers are the main producers of exogenous knowledge in the cocoa industry and their active involvement in the process of knowledge creation contributed immensely to the objectives of this study and also provides relevant information on knowledge transfer. After researchers have generated the knowledge that farmers need, extension agents are the key linking agents who transfer the knowledge generated to the cocoa farmers. They have direct contact with the farmers through face-to-face interactions, also they are well educated and conversant in the use of the social media, and therefore their inclusion in the sample helped in providing the needed information for answering the questions posed in the study.

7.7.6. RESPONSE RATE

Generally the response rate of a survey represents the number of targeted respondents who answered and returned the questionnaire to the researcher per the number who were eligible for the survey. The overall response rate was 93.1% representing 444 responses out of 477 with no questionnaire being filled wrongly. The results and response rate are summarized in table 6.2.

Group	Questionnaire Administered	Questionnaire Received	Response Rate (%)
Farmers	120	100	83.3
Researchers	82	80	97.6
Extension	275	264	96.0
Total	477	444	93.1

Table 7-2: Summary of Responses and Response Rate

The response rate of a survey for some time was viewed as an important indicator of survey quality. For instance, some people accept that a low response rate has the tendency to generate sampling bias and that higher response rate promises more accurate results (Babbie, 1990).

7.7.7. INTERVIEWS

The researcher also conducted face-to-face semi-structured interview alongside the survey with some selected senior researchers and extension agents to gain more insight into the subject of improving knowledge transfer through the use of social media. In effect, both quantitative and qualitative data were collected in a single phase of the data collection exercise and in this case the qualitative data was analyzed to support the quantitative data (Saunders et al., 2012). While the questionnaires were being administered, a request was made for an interview with some of the researchers and extension agents on a number of pressing issues that couldn’t be dealt with in the questionnaire. Some of the researchers accepted to grant me an interview while others couldn’t due to their tight schedules. In some cases some of the respondents also indicated that they wanted to grant the researcher an interview themselves to further elaborate on some of the questions that they were limited in their write-ups for which the researcher obliged. We sought for permission from the respondents to record the interviews before conducting the interview with each interview lasting between 30-45 minutes. This enabled us to record the views of the respondents with a voice recorder, which was later transcribed and analyzed. A total of 28 face-to-face semi-structured interviews were held with the extension agents and researchers in the three divisions of COCOBOD (7 researchers from CRIG, 3 researchers from SPU, and 10 extension agents from CHED). Some challenges encountered include interruptions during the interview mainly caused by colleagues and subordinates as well as phone calls. These became unavoidable because the interviews were held in the offices of the respondents. To avoid deviations, the interview questions were handed to them at the same time as the questionnaires but we had to fix a different time for the interview sessions. The interviewees were also politely prompted when they were going off tangent.

Interviews had to be rescheduled in many times due to the numerous travels most of the respondents had to make and because of that one interview couldn't take place since a respondent kept postponing our meeting dates and opted for a phone call interview which I granted.

A researcher who also works at the office of the CEO of the COCOBOD asked the researchers to email the interview questions to him for him to respond due to his tight schedule. But due to his experience in the design of communication strategies for the cocoa farmers we accepted his request and forwarded him the question for which he responded with elaborate discussions on the subject. To guard against further delays, the time allotted for each interview was agreed upon right from the onset, even though in some cases interruptions by colleagues and phone calls couldn't make such plans successful.

7.7.8. OBSERVATIONS

The recording of events as observed by an outsider is referred to as observation (Bless et al., 2006). Observational research involves observing behaviors and recording what you observed in an objective manner (Stangor, 2011). As part of the data collection process, the researcher took part and observed a farmer field school exercise, which is a practical knowledge transfer activity that involves extension agents using a farmer's farm as a 'classroom' to explain some of the agronomic practices to a group of farmers gathered in the selected farm. This observation helped me to understand some of the traditional mechanisms that are used to transfer knowledge to the cocoa farmers. This observational exercise also helped the researcher to observe how farmers mix with extension officers to interact both formally and informally during the knowledge transfer process.

7.7.9. ANALYSIS OF DOCUMENTARY INFORMATION

One source of data deemed important in case study design is documentary or secondary data (Yin, 2013). According to Yin (2013), no single source of data has an overall advantage over others, and therefore all available sources of data should be used to complement each other in a case study. Moreover reviewing documents in research can be advantageous as being reliable considering the fact that it could be reviewed repeatedly as a source of information. The study made use of some documentary evidences to corroborate and enrich the evidences from the other sources of data. These documents that include the Cocoa manual, handbooks of the various divisions, annual reports were mainly obtained from the libraries of CRIG and COCOBOD, with permission granted through the letter of acceptance, which was obtained from the Board.

7.8. DATA ANALYSIS

Both qualitative and quantitative data were collected concurrently and separately using the concurrent triangulation mixed method strategy after which they were independently analyzed and merged afterwards by comparing the results of the two datasets. This is known as the triangulation approach to data analysis and its use can be traced back as far as Campbell & Fiske (1959) who believed that the convergence of two methods is an indication that the "results are valid and not a methodological fit". The triangulation approach was used in this study because the use of complementary methods is generally seen as being capable to provide valid results compared with the mono methods and also to try and "capture a holistic and contextual picture of the unit(s) under study" (Jick, 1979). The qualitative data captured in the study was analyzed thematically and emerging themes were then identified to enable a comparison to be made between the different divisions in the Ghana COCOBOD. The analysis on quantitative side of the research was also done mainly with the use of SmartPLS version 3.0, and other software packages such as the Statistical Package for Social Science (SPSS). The SPSS was basically used for the data entry that was saved in the appropriate format for the use of the SmartPLS.

7.9. ETHICAL CONSIDERATIONS

Ethical issues in research involve morality and relates to matter of right and wrong (Babbie, 2010). Issues such as voluntary participation, protection from harm of all forms, confidentiality, anonymity, informed consent, privacy, as well as the conduct of the researcher are considered as ethical (Babbie, 2010; David and Sutton, 2004). It requires the need to do what is good and avoid causing harm to those who take part in the research. This is to ensure that individual and organizational privacy are well protected and preserved. Since privacy entails anonymity and confidentiality, the researcher ensured that the identities of all respondents remained anonymous and all documentations and other information provided by the case organization treated as confidential.

Assuring participants of anonymity and confidentiality paved the way and facilitated their willingness to share their experiences and to respond to questions from both the questionnaire and interviews. This created the necessary social interactions, which was vital for free flow of information from respondents to the researcher. The researcher also attached a cover letter to the questionnaire spelling out the objectives of the study, the form and purpose of the study, and stating also that participation was absolutely voluntary, as a way of seeking the consents of the participants. To obtain an informed consent from research objects, David and Sutton (2004) advice that the participants should be given enough time to consider their participation in the research. The questionnaires were therefore given to the participants at least two weeks before collection to ensure that they had enough time to consider their decision to take part in the research.

Ethical considerations with regards to anonymity require that participants should remain nameless with unknown identity as far as a study is concerned (Neuman, 2006). The researcher ensured that no one could identify any research participant by name or associates any data with the name of a participant (Babbie, 2010). This was evident in the final report that no one who interacts with this study including the researcher himself could associate any response with a respondent.

7.10. RELIABILITY AND VALIDITY

Reliability refers to the degree to which the results of a research can be reproduced if another researcher follows the same steps or procedures as described in the study by the researcher, at a different time with a different sample of respondents ((David and Sutton, 2004; Ticehurst & Veal, 2000). Basically, the goal of reliability is to reduce errors and biases in a research to the barest minimum (Yin, 2013). Reliability is concerned with consistency, dependability, and reproducibility (Neuman, 2006; Cooper and Emory, 1995). Validity refers to the extent to which the data you collect reflects on the phenomenon you are studying (Ticehurst and Veal, 2000). In other words it is a check on whether the researcher measures what he/she claims to be measuring and the instruments designed to measure the concepts really measures that towards achieving the research objectives. Without rigor, a research is deemed as valueless, worthless and a fiction which cannot be used (Morse et al., 2008).

To enhance reliability, validity and generalizability the following were considered: Documentation and operationalization of major steps was key in ensuring that any other researcher could follow them and achieve same results as obtained in this research. This was mainly achieved through the use of case study protocol and design of case study database as suggested by Yin (2013). For example all interviews were recorded with a voice recorder and carefully transcribed. As indicated earlier, a pilot study was conducted before the actual survey to ensure that the survey instrument contained straightforward and unambiguous questions to avoid chance of respondents giving different interpretations to the questions. Multiple sources of evidence were used in the collection of data as a way of ensuring convergence in the lines of inquiry (Yin, 2013).

The tests for generalizability or external validity is concerned with demonstrating whether the findings from a study can be generalized beyond the immediate case study and apply to other groups. This test has been a major challenge for conducting case study since critics of case studies design contend that using a single case, as a basis for generalization is unacceptable. However, proponents of case study research believe that generalization from single case studies is based on analytical generalization rather than on statistical generalization in which a sample is supposed to be generalized to a larger population. The study applied theory and a mixed-method design in a single case study to ensure external validity (Yin 2013).

CHAPTER 8. ANALYSIS I: ANALYSIS AND RESULTS OF QUANTITATIVE DATA

8.1. INTRODUCTION

The current chapter presents the results of the analysis conducted in the study using the conceptual model proposed in chapter six. The proposed model is used for testing the hypotheses for the study by way of gaining further clarity on the relationship among media richness, knowledge conversion processes, task characteristics and knowledge transfer success. The chapter 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. The general objective as outlined at the initial stages of the study is to assess the impact of media richness of web 2.0 applications on knowledge creation and transfer through the different modes of knowledge conversion and task characteristics.

And so we first modeled the study 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 is also examined. 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. In effect 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.

8.2. DESCRIPTIVE PROPERTIES OF INDICATORS

First of all the estimation of the descriptive properties of the indicator variable were obtained and recorded. Table 8-1 shows the descriptive properties of the statistical data, which forms the continuous variables of the study. The results in table 8-1 indicate an appreciable level of skewness and kurtosis for all the measures used in the study.

Descriptive Statistics							
	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
MR1	344	4.99	1.460	-.567	.131	-.078	.262
MR2	344	2.94	2.101	.574	.131	-1.131	.262
MR3	344	4.81	1.454	-.275	.131	-.568	.262
MR4	344	5.59	1.216	-.654	.131	-.100	.262
SOC1	344	4.65	1.435	-.264	.131	-.324	.262
SOC2	344	5.42	1.377	-.566	.131	-.616	.262
SOC3	344	5.22	1.460	-.677	.131	-.188	.262
SOC4	344	4.24	1.471	-.042	.131	-.383	.262
SOC5	344	3.08	1.654	.497	.131	-.564	.262
EXT1	344	3.99	1.481	-.061	.131	-.468	.262
EXT2	344	3.13	1.464	.197	.131	-.463	.262
EXT3	344	3.98	1.585	-.042	.131	-.696	.262
EXT4	344	4.99	1.291	-.142	.131	-.629	.262
INT1	344	5.13	1.508	-.795	.131	.296	.262
INT2	344	5.28	1.736	-.956	.131	.076	.262
INT3	344	4.58	1.550	-.405	.131	-.399	.262
INT4	344	4.25	1.850	-.312	.131	-.901	.262
COM1	344	4.48	1.873	-.325	.131	-.941	.262
COM2	344	4.62	1.393	-.202	.131	-.355	.262
COM3	344	5.07	1.334	-.440	.131	-.195	.262
COM4	344	4.72	1.507	-.422	.131	-.344	.262
TA1	344	4.92	1.436	-.462	.131	-.182	.262
TA2	344	4.97	1.442	-.459	.131	-.299	.262
TA3	344	5.98	.981	-.756	.131	-.080	.262
TA4	344	5.05	1.399	-.647	.131	.244	.262
KTC1	344	4.37	1.497	-.292	.131	-.539	.262
KTC2	344	5.08	1.473	-.681	.131	-.014	.262
KTC3	344	4.41	1.490	-.216	.131	-.389	.262
KTC4	344	5.01	1.424	-.532	.131	-.346	.262
KTC5	344	4.92	1.537	-.440	.131	-.545	.262
KTC6	344	4.40	1.556	-.225	.131	-.478	.262
KTC7	344	4.84	1.417	-.198	.131	-.576	.262
KTC8	344	6.03	1.020	-.865	.131	.243	.262
Valid N (listwise)	344						

Table 8-1: Descriptive statistics of indicator variables

1.1. ANALYTICAL APPROACH: PARTIAL LEAST SQUARE STRUCTURAL EQUATION MODELING (PLS-SEM)

PLS-SEM with SmartPLS version 3 was deemed suitable for the study for the reason that many interaction variables were involved due to the measurement of the moderating effect of the task analyzability. This makes the use of first generation techniques like correlations, regressions or ANOVA and t-tests limited in this study, since they are more suitable for modeling simple scenarios (Lowry & Gaskin, 2014) and are very limited, when it comes to causal or complex modeling especially with regards to modeling latent variables, interaction effects (mediation and moderation) and assessing the "goodness of fit" of the proposed model (Becker et al., 2012). Moreover, the study involves the testing of the plausibility of a number of theoretical propositions at the same time. First generation statistical tools allow the testing of the plausibility of single theoretical propositions at a time and could only test a complex theoretical model in piecemeal. On the other hand, the use of PLS-SEM enables the testing of the plausibility of entire set of propositions while generating the convergent and discriminant validity of the latent constructs altogether at the same time. This is important in the sense that when theory and measures are separated it may lead to error in measurements and predictions.

8.2.1. MODEL SPECIFICATION

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. In modeling a model of this nature, there is the need to specify whether the indicator variables are reflective or formative. This is necessary because it can affect the kind of results obtained. More so, the approach used for establishing the factorial validity of reflective indicators is not the same as that used for formative indicators and wrongly specifying them may lead to both Type I and Type II errors (Becker et al., 2012; Lowry and Gaskin, 2014). In this study, all the indicators were modeled as reflective indicators for both exogenous the endogenous constructs, as well as the moderating variable. Figures 9-1 to 4 represent the model specifications of each of the web 2.0 applications without the moderating variables.

8.2.2. RESULTS FOR THE ANALYSIS OF THE MEASUREMENT MODEL

SmartPLS3 (Ringle et al., 2013) was used for the estimation of the model. The testing of the entire path model together with the establishment of validity were all obtained once for each application by running a PLS Algorithm of the model. Following the guidelines outlined in literature, the following estimates were conducted: Construct validity of reflective indicators; convergent validity of reflective constructs; reliability of reflective constructs; and test for common method bias. These estimates were obtained for each of the four web 2.0 applications under the initialization options shown in table 8-2.

Parameter	Selection
Weighting method	**Path weighting scheme**
Data metric	**M=0, SD=1**
Initial value for outer loadings	**+1**
Stop criterion	**0.00001**
Max. Number of iteration	**500**

Table 8-2: Initialization options

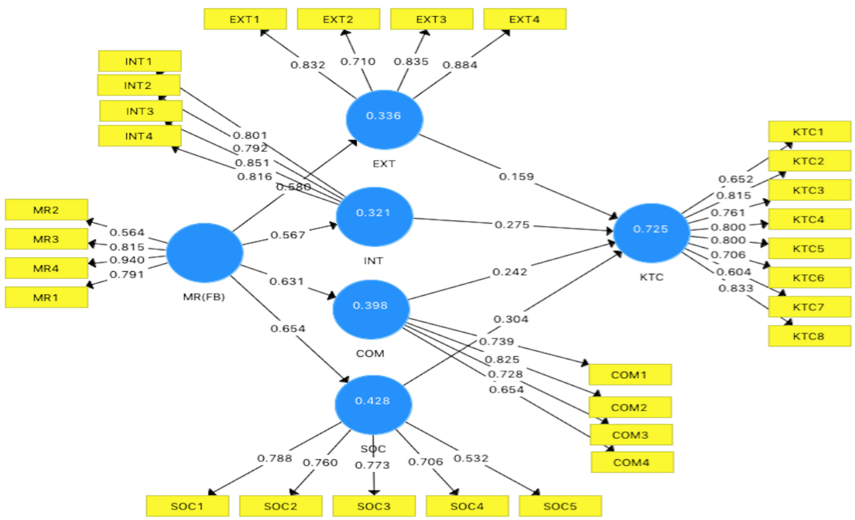

Figure 8-1: Measurement Model and Specifications (Facebook)

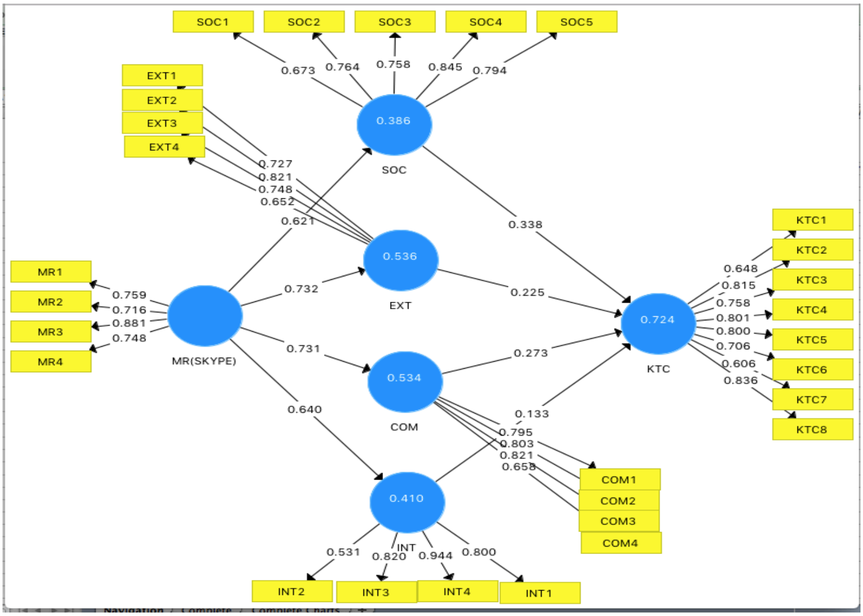

Figure 8-2: Measurement Model and Specifications (Skype)

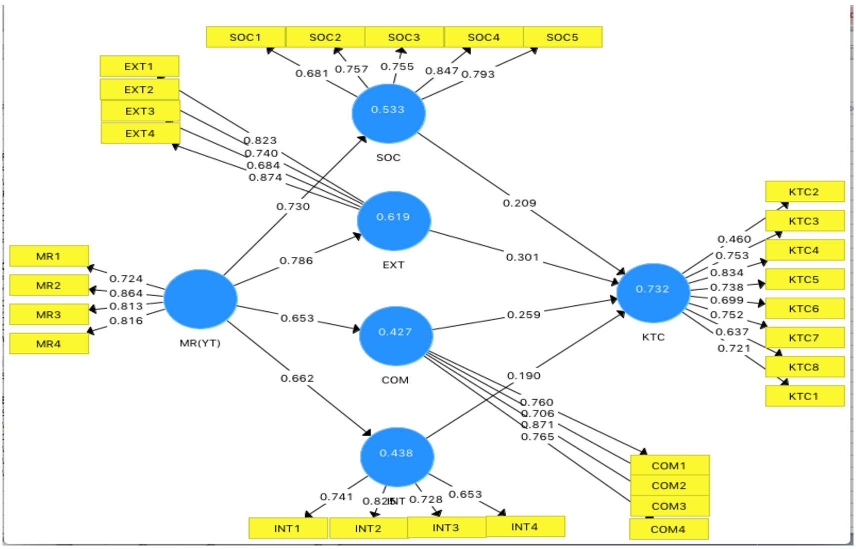

Figure 8-3: Measurement Model and Specifications (YouTube)

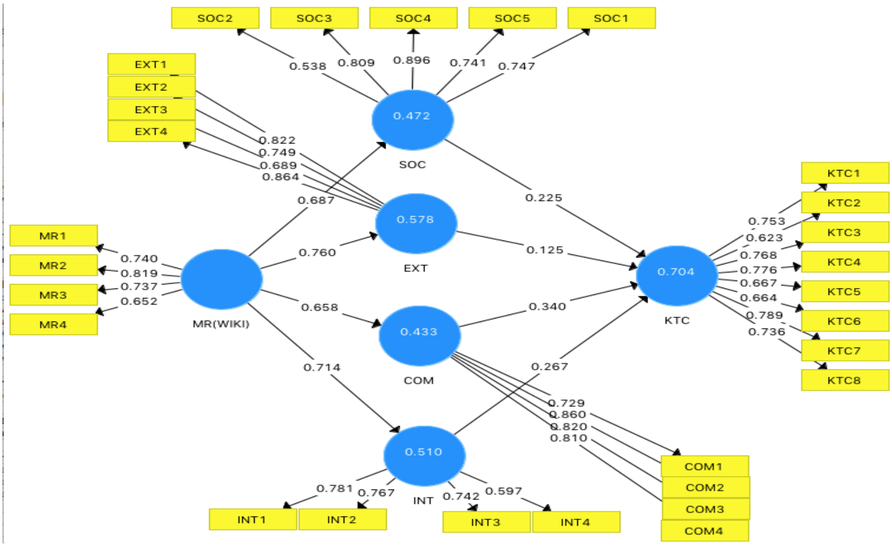

Figure 8-4: Measurement Model and Specifications (Wikipedia)

8.2.3. CONSTRUCT VALIDITY OF REFLECTIVE INDICATORS

In order to establish the construct validity scores of the reflective indicators, we first conducted the construct reliability test to examine the internal consistency of the measures. We followed on to estimate the convergent validity test for the reflective indicators as a means of checking if each of the measurement items loaded on their theoretical constructs with significant t-values. Finally the discriminant validity of the reflective indicators was also determined.

8.2.3.1 Model Quality Criteria

This involves conducting the reliability test for the reflective constructs. Reliability of the scale of measurement refers to the degree to which the measure of the scale is stable and consistent over time. The reliability of the reflective constructs is computed as composite reliability scores in SmartPLS. The composite reliability score (similar to Cronbach's alpha) is used to demonstrate the measures of internal consistency. Each of the reflective constructs was found to be above the required 0.70 thresholds (see table 8-3).

	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

Table 8-3: construct reliability and validity

8.2.3.2 Convergent Validity Estimation

Assessment of the convergent validity is conducted by first running the PLS Algorithm for the default report. The information required for the convergent validity test was then obtained from the t-values of the outer loadings (mean, STDEV, t-value). For an indicator to pass the convergent validity test, it has to be significant at 0.05 alpha protection level which means that indicator should have a t-value of at least 1.96 in absolute terms otherwise it's regarded as not having a convergent validity on that factor. It was found that all the outer loadings in our model were significant at the 0.05 alpha-level of significance. The outer loadings and their corresponding t-statistics are represented in tables 8-4 and 8-5 respectively.

8.2.3.3 Discriminant validity

Discriminant validity indicates the uniqueness of a construct compared to the other constructs in the model. This could be estimated either by the Fornell-Larcker criterion or by examining the cross-loadings of the indicators (Hair et al., 2014). To determine the discriminant validity we conducted a confirmatory factor analysis using the average variance extracted (AVE). On SmartPLS, "AVE is calculated by computing the variances shared by the other items of a particular construct" (Lowry and Gaskin, 2014). The correlations of each variable with each other variable represented as off-diagonal figures were then compared with the square root of the AVE for each construct (represented on the diagonal in parentheses) (see table 8-5). As a discriminant validity test, the diagonal figures representing the square roots of the AVE have to be greater than the off-diagonal figures, which would suggest a strong confirmation of discriminant validity for all sub-constructs. The results of the Fornell-Larcker criterion reported in table 8-5 indicate that all the constructs meet the discriminant validity assessment since all the values lying across the diagonal of the table for each of the web 2.0 applications is greater than the expected 0.5 threshold established for the criterion (see table 8-5).

LATENT VARIABLES	INDICATORS	FB	WIKI	YT	SKYPE
COM	COM1	0.739	0.729	0.760	0.795
	COM2	0.825	0.860	0.706	0.803
	COM3	0.728	0.820	0.871	0.821
	COM4	0.654	0.810	0.765	0.658
EXT	EXT1	0.832	0.822	0.823	0.727
	EXT2	0.710	0.749	0.740	0.821
	EXT3	0.835	0.689	0.684	0.748
	EXT4	0.884	0.864	0.874	0.652
INT	INT1	0.801	0.781	0.741	0.800
	INT2	0.792	0.767	0.825	0.531
	INT3	0.851	0.742	0.728	0.820
	INT4	0.816	0.597	0.653	0.944
KTC	KTC1	0.652	0.753	0.721	0.648
	KTC2	0.815	0.623	0.460	0.815
	KTC3	0.761	0.768	0.753	0.758
	KTC4	0.800	0.776	0.834	0.801
	KTC5	0.800	0.667	0.738	0.800
	KTC6	0.706	0.664	0.699	0.706
	KTC7	0.604	0.789	0.752	0.606
	KTC8	0.833	0.736	0.637	0.836
MR	MR1	0.791	0.740	0.724	0.759
	MR2	0.564	0.819	0.864	0.716
	MR3	0.815	0.737	0.813	0.881
	MR4	0.940	0.652	0.816	0.748
SOC	SOC1	0.788	0.747	0.681	0.673
	SOC2	0.760	0.538	0.757	0.764
	SOC3	0.773	0.809	0.755	0.758
	SOC4	0.706	0.896	0.847	0.845
	SOC5	0.532	0.741	0.793	0.794

Table 8-4: Outer loadings for convergent validity (All Web 2.0 applications)

CONSTRUCT (Latent Variable)	INDICATOR	T Statistics			
		FaceBook	**Skype**	**Wiki**	**YouTube**
COMBINATION	**COM1**	22.137	28.833	19.581	23.747
	COM2	51.009	38.574	54.021	16.612
	COM3	22.215	41.894	31.958	68.344
	COM4	15.700	16.152	31.352	29.101
EXTERNALIZATION	**EXT1**	44.267	22.652	39.846	45.169
	EXT2	22.739	48.534	31.343	27.836
	EXT3	46.165	24.119	18.601	18.912
	EXT4	68.231	15.422	58.274	70.832
INTERNALIZATION	**INT1**	30.597	10.596	34.001	25.550
	INT2	29.221	42.712	27.223	49.149
	INT3	50.231	136.242	24.713	20.675
	INT4	37.677	14.963	12.396	14.565
KNOWLEDGE TRANSFER/CREATION	**KTC1**	15.749	41.277	27.037	9.361
	KTC2	40.649	27.761	17.530	25.059
	KTC3	29.179	28.955	32.270	39.268
	KTC4	31.731	33.066	36.524	22.286
	KTC5	37.280	25.723	18.484	23.308
	KTC6	24.911	15.138	17.983	29.473
	KTC7	15.823	49.912	31.014	17.510
	KTC8	46.787	23.112	25.739	19.287
MEDIA RICHNESS	**MR1**	13.196	17.656	24.781	63.384
	MR2	39.239	76.183	44.493	32.289
	MR3	131.808	23.219	23.020	35.919
	MR4	28.209	19.504	14.517	21.262
SOCIALIZATION	**SOC2**	27.306	25.070	11.791	25.774
	SOC3	29.397	28.833	35.809	25.075
	SOC4	19.948	38.574	72.481	46.828
	SOC5	10.646	41.894	24.403	31.512
	SOC1	28.405	16.152	23.929	20.234

Table 8-5: t-Statistics of outer loadings for convergent validity (All web 2.0 applications)

8.2.3.4 Cross Loadings Between Latent Variable

Moreover, to pass the test of discriminant validity, the loadings of the measurement items on their corresponding primary latent constructs should be larger than their cross-loadings on the other latent constructs. As seen in table 7, which represents the matrix of loadings and cross-loadings for the reflective indicators, the difference between the loadings of a given item on its primary latent construct and the cross-loading on any other latent construct is at least 0.1 in absolute terms which make them adequate for discriminant validity (Lowry and Gaskin, 2014)

		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 8-6: Fornell-Larcker Criterion for discriminant validity (All web 2.0 applications)

YOUTUBE	COM	EXT	INT	KTC	MR (YT)	SOC
COM1	0.760	0.556	0.478	0.556	0.455	0.450
COM2	0.706	0.489	0.496	0.492	0.420	0.450
COM3	0.871	0.660	0.697	0.665	0.511	0.529
COM4	0.765	0.649	0.578	0.624	0.619	0.504
EXT1	0.601	0.823	0.641	0.671	0.688	0.643
EXT2	0.500	0.740	0.571	0.576	0.588	0.576
EXT3	0.551	0.684	0.532	0.544	0.448	0.442
EXT4	0.732	0.874	0.632	0.690	0.708	0.600
INT1	0.503	0.563	0.741	0.576	0.506	0.670
INT2	0.635	0.658	0.825	0.654	0.637	0.603
INT3	0.560	0.564	0.728	0.523	0.397	0.456
INT4	0.443	0.432	0.653	0.464	0.365	0.352
KTC2	0.221	0.310	0.305	0.460	0.343	0.365
KTC3	0.586	0.593	0.569	0.753	0.563	0.590
KTC4	0.597	0.605	0.564	0.834	0.496	0.531
KTC5	0.584	0.651	0.591	0.738	0.639	0.648
KTC6	0.615	0.601	0.579	0.699	0.421	0.465
KTC7	0.636	0.611	0.592	0.752	0.448	0.470
KTC8	0.404	0.526	0.511	0.637	0.508	0.561
MR1	0.451	0.507	0.420	0.444	0.724	0.514
MR2	0.573	0.684	0.561	0.582	0.864	0.615
MR3	0.476	0.622	0.538	0.533	0.813	0.593
MR4	0.590	0.701	0.595	0.629	0.816	0.623
SOC1	0.489	0.616	0.578	0.651	0.537	0.681
SOC2	0.445	0.499	0.465	0.457	0.515	0.757
SOC3	0.391	0.447	0.453	0.421	0.529	0.755
SOC4	0.555	0.632	0.652	0.649	0.668	0.847
SOC5	0.485	0.558	0.574	0.557	0.527	0.793
KTC1	0.522	0.513	0.503	0.721	0.418	0.442

Table 8-7: cross loadings for discriminant validity (YouTube)

WIKI	COM	EXT	INT	KTC	MR	SOC
COM1	0.729	0.505	0.407	0.545	0.416	0.440
COM2	0.860	0.681	0.509	0.616	0.559	0.571
COM3	0.820	0.623	0.481	0.633	0.536	0.525
COM4	0.810	0.700	0.545	0.619	0.595	0.604
EXT1	0.687	0.822	0.618	0.669	0.641	0.619
EXT2	0.587	0.749	0.529	0.609	0.570	0.543
EXT3	0.447	0.689	0.543	0.458	0.533	0.482
EXT4	0.705	0.864	0.619	0.602	0.631	0.630
INT1	0.418	0.600	0.781	0.471	0.580	0.501
INT2	0.447	0.610	0.767	0.477	0.593	0.579
INT3	0.509	0.528	0.742	0.621	0.511	0.520
INT4	0.371	0.383	0.597	0.513	0.369	0.356
KTC1	0.515	0.566	0.569	0.753	0.523	0.544
KTC2	0.413	0.411	0.456	0.623	0.404	0.430
KTC3	0.613	0.580	0.578	0.768	0.546	0.542
KTC4	0.538	0.617	0.717	0.776	0.577	0.582
KTC5	0.515	0.499	0.350	0.667	0.465	0.466
KTC6	0.528	0.448	0.327	0.664	0.452	0.429
KTC7	0.668	0.632	0.584	0.789	0.650	0.625
KTC8	0.527	0.561	0.495	0.736	0.573	0.543
MR1	0.506	0.564	0.552	0.651	0.740	0.534
MR2	0.636	0.658	0.575	0.629	0.819	0.620
MR3	0.395	0.565	0.536	0.473	0.737	0.434
MR4	0.365	0.434	0.438	0.366	0.652	0.413
SOC2	0.343	0.310	0.318	0.387	0.304	0.538
SOC3	0.562	0.593	0.524	0.610	0.568	0.809
SOC4	0.495	0.603	0.562	0.558	0.562	0.896
SOC5	0.638	0.651	0.592	0.667	0.590	0.741
SOC1	0.417	0.515	0.517	0.449	0.503	0.747

Table 8-8: Cross loadings for discriminant validity (Wikipedia)

SKYPE	COM	EXT	INT	KTC	MR	SOC
COM1	0.795	0.589	0.533	0.683	0.581	0.646
COM2	0.803	0.581	0.450	0.543	0.616	0.463
COM3	0.821	0.593	0.533	0.563	0.634	0.468
COM4	0.658	0.510	0.478	0.548	0.402	0.555
EXT1	0.560	0.727	0.480	0.567	0.502	0.670
EXT2	0.615	0.821	0.569	0.685	0.633	0.601
EXT3	0.549	0.748	0.393	0.511	0.565	0.455
EXT4	0.439	0.652	0.400	0.423	0.445	0.350
INT2	0.306	0.300	0.531	0.345	0.221	0.365
INT3	0.561	0.567	0.820	0.612	0.584	0.589
INT4	0.589	0.561	0.944	0.583	0.596	0.529
KTC1	0.421	0.414	0.382	0.648	0.445	0.514
KTC2	0.561	0.558	0.491	0.815	0.570	0.614
KTC3	0.501	0.535	0.463	0.758	0.471	0.592
KTC4	0.603	0.593	0.535	0.801	0.587	0.622
KTC5	0.672	0.641	0.538	0.800	0.600	0.641
KTC6	0.551	0.569	0.490	0.706	0.497	0.574
KTC7	0.528	0.534	0.457	0.606	0.549	0.440
KTC8	0.669	0.631	0.580	0.836	0.729	0.598
MR1	0.564	0.480	0.441	0.536	0.759	0.450
MR2	0.442	0.497	0.453	0.481	0.716	0.450
MR3	0.653	0.701	0.552	0.621	0.881	0.528
MR4	0.595	0.575	0.537	0.671	0.748	0.502
SOC1	0.641	0.577	0.529	0.611	0.487	0.673
SOC2	0.420	0.463	0.408	0.536	0.446	0.764
SOC3	0.391	0.448	0.372	0.516	0.391	0.758
SOC4	0.621	0.646	0.552	0.687	0.554	0.845
SOC5	0.529	0.568	0.480	0.575	0.484	0.794
INT1	0.523	0.502	0.800	0.494	0.520	0.441

Table 8-9: Cross loadings for discriminant validity (Skype)

FACEBOOK	COM	EXT	INT	KTC	MR	SOC
COM1	0.739	0.504	0.657	0.567	0.482	0.581
COM2	0.825	0.559	0.556	0.685	0.568	0.619
COM3	0.728	0.435	0.403	0.510	0.389	0.545
COM4	0.654	0.339	0.309	0.423	0.398	0.439
EXT1	0.524	0.832	0.498	0.572	0.483	0.598
EXT2	0.405	0.710	0.390	0.435	0.414	0.445
EXT3	0.546	0.835	0.517	0.631	0.465	0.616
EXT4	0.577	0.884	0.479	0.611	0.530	0.709
INT1	0.465	0.402	0.801	0.537	0.411	0.415
INT2	0.452	0.403	0.792	0.516	0.373	0.390
INT3	0.652	0.556	0.851	0.688	0.554	0.640
INT4	0.574	0.500	0.816	0.576	0.481	0.547
KTC1	0.420	0.477	0.492	0.652	0.382	0.451
KTC2	0.561	0.503	0.595	0.815	0.493	0.577
KTC3	0.538	0.574	0.550	0.761	0.465	0.527
KTC4	0.595	0.510	0.591	0.800	0.536	0.606
KTC5	0.641	0.590	0.599	0.800	0.536	0.677
KTC6	0.571	0.558	0.522	0.706	0.489	0.567
KTC7	0.532	0.416	0.397	0.604	0.454	0.544
KTC8	0.631	0.524	0.544	0.833	0.578	0.658
MR2	0.305	0.349	0.339	0.345	0.564	0.334
MR3	0.569	0.539	0.545	0.612	0.815	0.570
MR4	0.564	0.521	0.469	0.582	0.940	0.591
SOC1	0.591	0.581	0.605	0.683	0.533	0.788
SOC2	0.579	0.414	0.421	0.541	0.447	0.760
SOC3	0.592	0.415	0.431	0.561	0.528	0.773
SOC4	0.511	0.667	0.427	0.549	0.480	0.706
SOC5	0.369	0.589	0.313	0.399	0.329	0.532
MR1	0.503	0.391	0.408	0.494	0.791	0.526

Table 8-10: Cross loadings for discriminant validity (Facebook)

8.2.4. TEST FOR COMMON METHOD BIAS

Because data for both the endogenous and exogenous variables came from the same respondents at the same time using the same survey instrument, there was the need to test for common method bias to ensure that common method variance do not influence some of the postulated relations in the path model. We first applied Harman's, (1976) single factor test with the first factor accounting for only 26.8% of the entire variance which indicates that the results didn't suffer from common method bias. However, due to the some limitation suffered by the Harman's single-factor and the growing dispute about its merits, we corroborated the results from that with marker variable approach using (Lohmöller, 1989) PLS algorithm with marker variables. We estimated and compared the loadings of the items with and without the marker variable and found no significant difference between the two results. Moreover there was no notable difference in the levels of the statistical significance of all the theorized paths. The two tests together suggest that there was no strong evidence for the existence of common method bias (Podsakoff et al., 2003).

8.3. SIGNIFICANCE TESTING RESULTS OF THE STRUCTURAL MODEL PATH COEFFICIENTS OF FIRST-ORDER CONSTRUCTS

Testing the structural model involved the estimation of the path coefficients for predicting the strength of the relationship between the dependent and independent variables as well as the interaction effect of the moderation variable. The bootsraping algorithm in SmartPLS 3 was used to evaluate the significance of the hypothesized relationships among the constructs. Two models are involved for each of the four web 2.0 applications. The first model involves the relationships between the independent and dependent variables without the moderating variable and is referred to as the baseline model. The second model involves the addition of the moderating variable and corresponding interaction effect of the moderating variable. For each model, the results for the individual web 2.0 applications are recorded and the summarized results are also computed for clarity of interpretations.

Model 1

The following linear regression models were used for testing the strength of the relationships between the dependent, moderating, and independent variables of the original predictor variables for each of the four social media applications:

Knowledge transfer and creation

$=\alpha + \beta_1 * \text{media richness} + \beta_2 * \text{web 2.0 use for externalization} + \beta_3 *$

$\text{web 2.0 use for internalization} + \beta_4 * \text{web 2.0 use for combination} + \beta_5 *$

$\text{web 2.0 use for socialization} + \varepsilon$

PREDICTOR VARIABLES	VIF VALUES				
	MR	Facebook	Skype	YouTube	Wiki
SOC	1.000	2.683	2.421	2.469	2.482
COM	1.000	2.305	2.677	2.762	2.729
EXT	1.000	1.987	2.758	3.463	3.884
INT	1.000	3.079	1.974	3.078	2.425
MR	1.000	1.000	1.000	1.000	1.000

Table 8-11: Results of test for collinearity 1

The bootsraping criterion was completed with 5000 subsamples and the path coefficients (*β)* and t-values were obtained. Regarding the path coefficients, the closer the value to 1, the stronger the relationship and for the t-statistic, a minimum of 1.96 is required. The results of the analysis of the selected Web 2.0 applications usage for knowledge transfer and their effect on knowledge transfer success as well as the moderation and interaction effects are discussed in the sections following.

8.3.1. TEST FOR COLLINEARITY

Collinearity is measured based on the tolerance levels and the variance inflation factor (VIF). Issues of collinearity exist if the tolerance level falls below 0.2 and the VIF is above 5.00 for the predictor variables. The VIF values for the MR (exogenous) construct were found to be unity and constant for all the SECI processes (endogenous) LV, regarding all the web 2.0 applications. None of the VIF for the SECI processes (exogenous) variables and the KTC (endogenous) variable was found to be more than 5.00 (see table 8-5).

8.3.1.1 Facebook Usage for Knowledge Transfer and Creation

The path model for the use of Facebook for the SECI processes is represented as Figure 8-5. It depicts the relationship between media richness of Facebook and the SECI processes as well as the relationship between the use of Facebook for the SECI processes and knowledge transfer and creation. The path coefficients are represented by t-values and recorded in table 8-11. The results of the analysis show strong relationships between the media richness of Facebook and its usage for the SECI processes since all the t-values were above the 1.96 threshold. Similarly the t-values for the relationships between the use of Facebook for the SECI processes and knowledge transfer and creation are also all above the 1.96 and significant at 5% indicating a strong relationship between them.

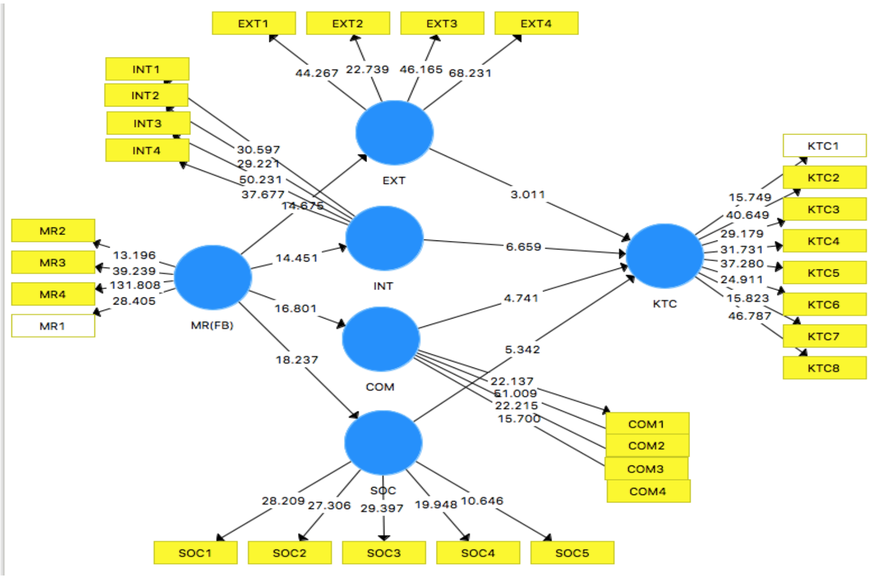

Figure8-5: path model with t-values (Facebook)

Facebook	Path coefficient	t-Statistics	Significance Level	P Values
MR (FB) -> COM	0.631	16.801	P<0.001	0.000
MR (FB) -> EXT	0.580	14.675	P<0.001	0.000
MR (FB) -> INT	0.567	14.451	P<0.001	0.000
MR (FB) -> SOC	0.654	18.237	P<0.001	0.000
SOC -> KTC	0.304	5.342	P<0.001	0.000
COM -> KTC	0.242	4.741	P<0.001	0.000
EXT -> KTC	0.159	3.011	P<0.05	0.003
INT -> KTC	0.275	6.659	P<0.001	0.000

Table 8-12: significance of path coefficients (Facebook) 1

8.3.1.2 Wikipedia Usage for Knowledge Transfer and Creation

The results of the bootstrapping criterion are recorded in table 8-13 and the path model with the corresponding path coefficients of Wikipedia usage for is also represented in Figure 8-6. All the path coefficients (β) are closer to 1 than to 0, while the t-values are all above 1.96 and below 0.05 levels of significance. Thus the results obtained from the bootstrapping criterion indicate a strong relationship between media richness of Wikipedia and its usage for the SECI processes and also a strong relationship between the use of Wikipedia for the SECI processes and knowledge transfer and creation.

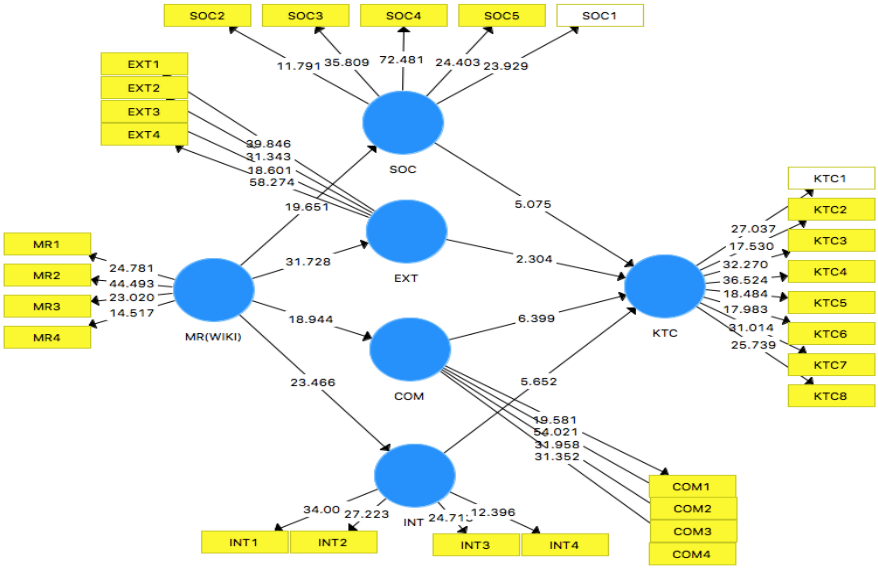

Figure8-6: path model with t-values (Wikipedia)

Wiki	Path coefficient	t-Statistics	Significance Level	P Values
MR (WIKI) -> COM	0.658	18.944	P<0.001	0.000
MR (WIKI) -> EXT	0.760	31.728	P<0.001	0.000
MR (WIKI) -> INT	0.714	23.466	P<0.001	0.000
MR (WIKI) -> SOC	0.687	19.651	P<0.001	0.000
SOC -> KTC	0.225	5.075	P<0.001	0.000
COM -> KTC	0.340	6.399	P<0.001	0.000
EXT -> KTC	0.125	2.304	P<0.05	0.022
INT -> KTC	0.267	5.652	P<0.001	0.000

Table 8-13: significance of path coefficient (Facebook)

8.3.1.3 YouTube usage for Knowledge Transfer and Creation

Regarding the use of YouTube for knowledge transfer and creation, the results recorded from the bootsrapping analysis indicate a strong relationship between the media richness of the platform and its use for SECI processes and between its use for SECI processes and knowledge transfer and creation. All the t-statistics recorded are above the 1.96 threshold and below 0.05 levels of significance as seen in table 8-14 and depicted in Figure 8-7.

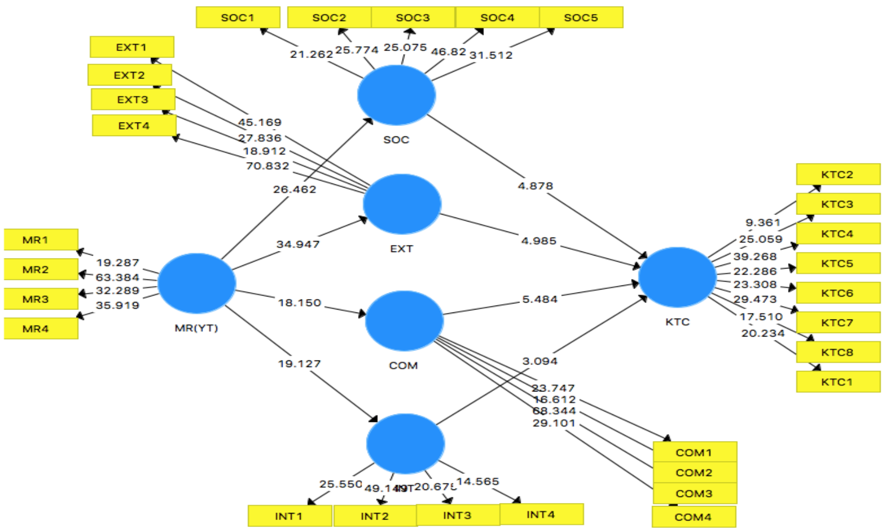

Figure 8-7: Significance of path coefficients with t-values (YouTube)

YouTube	Path coefficient	t- Statistics	Significance Level	P Values
MR (YT) -> COM	0.653	18.150	P<0.001	0.000
MR (YT) -> EXT	0.786	34.947	P<0.001	0.000
MR (YT) -> INT	0.662	19.127	P<0.001	0.000
MR (YT) -> SOC	0.730	26.462	P<0.001	0.000
SOC -> KTC	0.209	4.878	P<0.001	0.000
COM -> KTC	0.259	5.484	P<0.001	0.000
EXT -> KTC	0.301	4.985	P<0.001	0.000
INT -> KTC	0.190	3.094	P<0.05	0.002

Table 8-14: significance of path coefficient (YouTube)

8.3.1.4 Skype Usage for Knowledge Transfer and Creation

The bootsraping results regarding Skype usage for knowledge transfer and creation are recorded and depicted in table 8-15 and Figure 8-8. Both the path coefficients (β) and t-values indicate strong relationships between the media richness of Skype and the use of Skype for the SECI processes. Moreover, the results of the analysis also demonstrated a strong relationship between the use of Skype for the SECI processes and knowledge transfer and creation (see table 8-15).

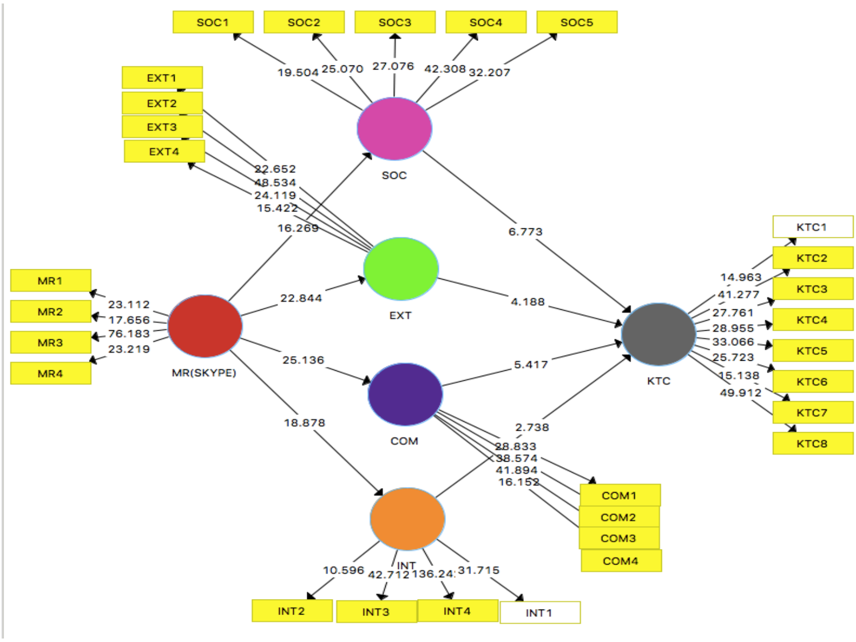

Figure 8-8: Significance of path coefficients with t-values (Skype)

Skype	Path coefficients	t-Statistics	Sig. Level	P Values
MR (SKYPE) -> COM	0.731	25.136	P<0.001	0.000
MR (SKYPE) -> EXT	0.732	22.844	P<0.001	0.000
MR (SKYPE) -> INT	0.640	18.878	P<0.001	0.000
MR (SKYPE) -> SOC	0.621	16.269	P<0.001	0.000
SOC -> KTC	0.338	6.773	P<0.001	0.000
COM -> KTC	0.273	5.417	P<0.001	0.000
EXT -> KTC	0.225	4.188	P<0.001	0.000
INT -> KTC	0.133	2.738	P<0.05	0.006

Table 8-15: significance of path coefficient (Skype)

8.4. TEST OF MODERATION FOR TASK ANALYZABILITY

Moderation effect is tested by statistically measuring the interaction effects among independent variables. Testing the moderation effect of task analyzability on web 2.0 applications usages for SECI processes towards knowledge transfer and creation involve creating two models, one with the moderator relationship also known as the baseline model and the other without (Gaskin and Lowry, 2014). The creating of the baseline model should include the main effects of the interaction terms. These interaction terms were entered simultaneously, for the avoidance of multi-collinearity issues. The model involving all the interaction terms, was then measured using the product-indicator (PI) approach proposed by Chin et al., (2003) which is effective for identifying interaction terms for complex path models (Gaskin and Lowry, 2014). The bootstrapping algorithm in SmartPLS3 was used for the estimation of the significance of the path coefficients. Figures 9-9 to 9-12 depict the resulting path model with the moderating factor (TA) and the corresponding interaction terms, for each of the web 2.0 applications used in the study. The results of the bootstrapping algorithms for each of the web 2.0 applications are recorded in tables 8-17 to 8-20.

Step 2: Addition of interaction terms

$$\begin{aligned}\mathbf{KTC} = \alpha + \beta_1 &* \text{Media richness} + \beta_2 * \text{web 2.0 use for socialization} + \beta_3 \\ &* \text{web 2.0 use for externalization} + \beta_4 * \text{web 2.0 use for internalization} + \beta_5 \\ &* \text{web 2.0 use for combination} + \beta_6 * (\text{task analyzability}) * (\text{socialization}) + \beta_7 \\ &* (\text{task analyzability}) * (\text{externalization}) + \beta_8 * (\text{task analyzability}) \\ &* (\text{internalization}) + \beta_9 * (\text{task analyzability}) * (\text{combination}) + \varepsilon\end{aligned}$$

8.4.1.1 Moderating effect of task analyzability on Facebook usage for knowledge transfer

Figure 8-9 is the path model representing the use of Facebook for the SECI processes including task analyzability and the interaction effects. The path coefficients are indicated by the t-values in the paths between the interaction terms and the endogenous LV (KTC). The inclusion of the interaction terms increased the total number indicators to 125. This explains the choice of PLS over CBS. The results of the moderating effects are recorded in table 8-17. As indicated on the path model and recorded in the table, the t-values and the path coefficients of all the interaction terms are not significant and therefore the moderating effect of task analyzability on the relationship between Facebook usage for all the SECI processes is not significant.

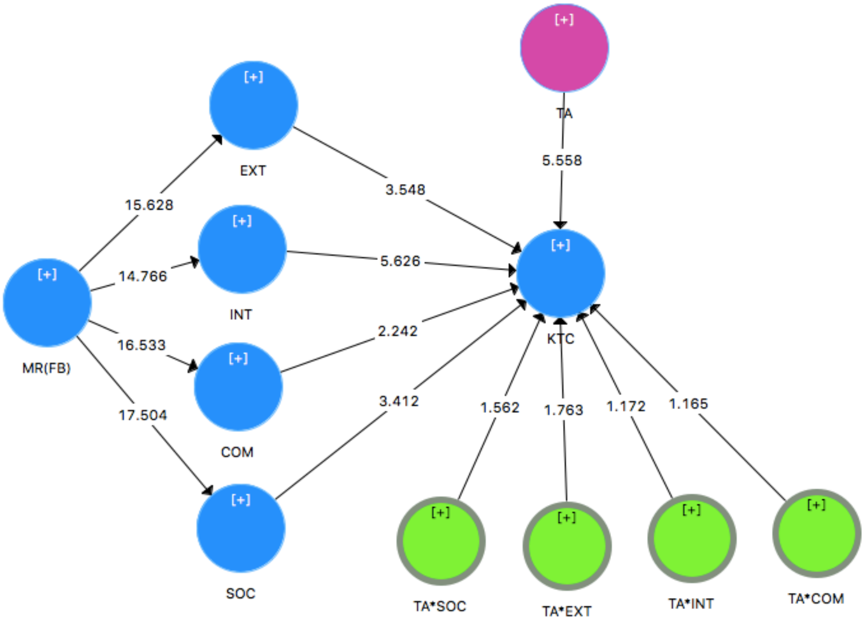

Figure 8-9: path model with interaction effect of task analyzability (Facebook)

FACEBOOK	Path Coefficient	t-Statistics	Significance Level	P Values
MR (FB) -> COM	0.631	16.533	P<0.001	0.000
MR (FB) -> EXT	0.580	15.628	P<0.001	0.000
MR (FB) -> INT	0.567	14.766	P<0.001	0.000
MR (FB) -> SOC	0.654	17.504	P<0.001	0.000
SOC -> KTC	0.185	3.412	P<0.05	0.001
COM -> KTC	0.131	2.242	P<0.05	0.026
EXT -> KTC	0.177	3.548	P<0.05	0.000
INT -> KTC	0.246	5.626	P<0.001	0.000
TA -> KTC	0.278	5.558	P<0.001	0.000
TA*COM -> KTC	-0.056	1.165	NS	0.245
TA*EXT -> KTC	-0.081	1.763	P<0.1	0.079
TA*INT -> KTC	0.043	1.172	NS	0.242
TA*SOC_ -> KTC	-0.072	1.562	NS	0.119

Table 8-17: Path coefficients significance of interaction model (Facebook)

8.4.1.2 Moderating effect of task analyzability on Wikipedia usage for knowledge transfer

The interaction model regarding the moderating effect of task analyzability on the use of Wikipedia for knowledge transfer based on SECI processes is illustrated in Figure 8-10. The results from the bootstrapping algorithm are recorded in table 8-17. According to the outcome of the analysis, all the t-values of the interaction terms are below the 1.96 threshold and are considered as non-significant. The relationship between Wikipedia usage for the SECI processes and knowledge creation and transfer is not dependent on the analyzability of the task as proposed.

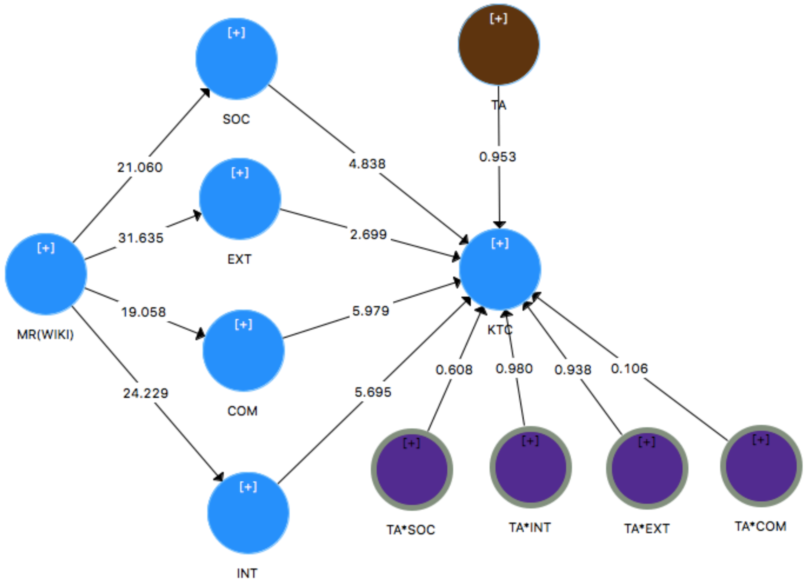

Figure 8-10: path model with interaction effect of task analyzability (Wikipedia)

WIKIPEDIA	Path Coefficient	t-Statistics	Significance Level	P Values
MR (WIKI) -> COM	0.658	19.058	P<0.001	0.000
MR (WIKI) -> EXT	0.760	31.635	P<0.001	0.000
MR (WIKI) -> INT	0.714	24.229	P<0.001	0.000
MR (WIKI) -> SOC	0.687	21.060	P<0.001	0.000
SOC -> KTC	0.233	4.838	P<0.05	0.000
COM -> KTC	0.345	5.979	P<0.001	0.000
EXT -> KTC	0.159	2.699	P<0.05	0.007
INT -> KTC	0.273	5.695	P<0.001	0.000
TA -> KTC	-0.050	0.953	NS	0.341
TA*COM -> KTC	0.010	0.106	NS	0.916
TA*EXT -> KTC	0.084	0.938	NS	0.349
TA*INT -> KTC	-0.048	0.980	NS	0.327
TA*SOC -> KTC	-0.029	0.608	NS	0.544

Table 8-17: Path coefficients significance of interaction model (Wikipedia)

8.4.1.3 Moderating effect of task analyzability on YouTube usage for knowledge transfer

According the results recorded for the moderating effect of task analyzability on the use of YouTube for the SECI processes and knowledge transfer and creation, task analyzability failed to moderate the relationship between YouTube usage for SECI processes and knowledge transfer and creation.

YouTube	Path Coefficient	t-**Statistics**	Significance Level	**P Values**
MR (YT) -> COM	0.653	17.681	P<0.001	0.000
MR (YT) -> EXT	0.786	33.935	P<0.001	0.000
MR (YT) -> INT	0.662	19.923	P<0.001	0.000
MR (YT) -> SOC	0.730	27.144	P<0.001	0.000
SOC -> KTC	0.127	2.569	P<0.05	0.011
COM -> KTC	0.279	5.771	P<0.001	0.000
EXT -> KTC	0.274	4.696	P<0.001	0.000
INT -> KTC	0.172	2.988	P<0.05	0.003
TA -> KTC	0.137	3.045	P<0.05	0.002
TA*COM -> KTC	0.027	0.533	NS	0.594
TA*EXT -> KTC	0.080	1.249	NS	0.212
TA*INT -> KTC	-0.102	0.985	NS	0.325
TA*SOC -> KTC	-0.040	0.615	NS	0.539

Table 8-18: Path coefficients significance of interaction model (YouTube)

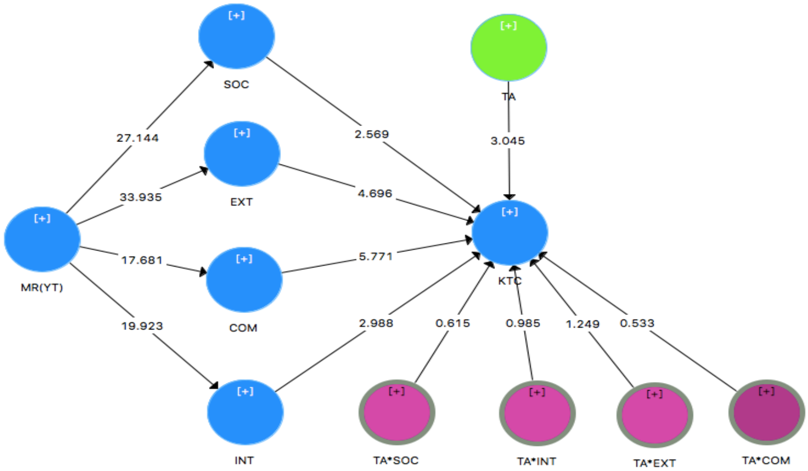

Figure 8-11: path model with interaction effect of task analyzability (YouTube)

8.4.1.4 Moderating effect of task analyzability on Skype usage for knowledge transfer

SKYPE	Path Coefficient	t-Statistics	Significance Level	P Values
MR (SKYPE) -> COM	0.731	27.339	0.027	0.000
MR (SKYPE) -> EXT	0.732	25.944	0.028	0.000
MR (SKYPE) -> INT	0.640	20.295	0.032	0.000
MR (SKYPE) -> SOC	0.621	17.450	0.036	0.000
SOC -> KTC	0.279	6.002	0.046	0.000
COM -> KTC	0.233	4.225	0.055	0.000
EXT -> KTC	0.213	4.082	0.052	0.000
INT -> KTC	0.117	2.454	0.048	0.014
TA -> KTC	0.139	3.178	0.044	0.002
TA*COM -> KTC	0.016	0.328	0.049	0.743
TA*EXT -> KTC	0.042	0.592	0.070	0.554
TA*INT -> KTC	0.008	0.154	0.050	0.877
TA*SOC -> KTC	0.004	0.068	0.059	0.946

Table 8-19: Path coefficients significance of interaction model (Skype)

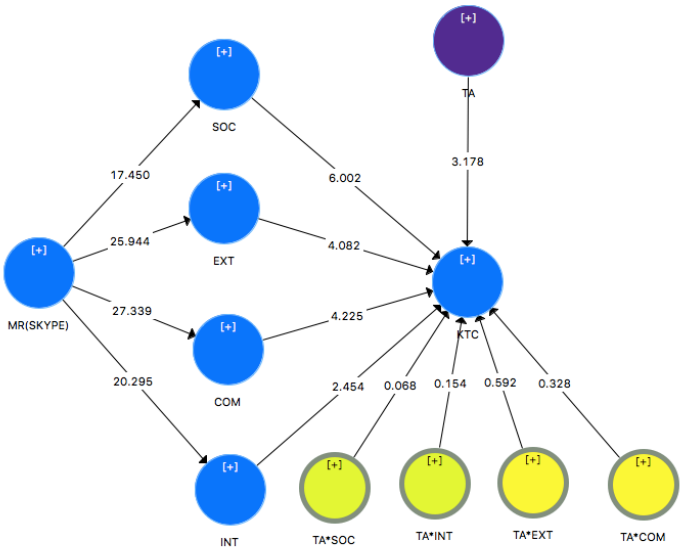

Figure 8-12: path model with interaction effect of task analyzability (Skype)

According to The results of the PLS run for the interaction model of Skype, all the t-statistics and the β- path coefficients recorded in table 8-19 failed to reach the acceptable threshold. All the t-values fall below the 1.96 threshold and are found to be non-significant at the 5% level of significance. This implies that the relationship between Skype usage for SECI processes and knowledge transfer and creation doesn't depend on the analyzability of the task.

8.4.2. FINDINGS FROM COCOA FARMERS' PERSPECTIVE ON SOCIAL MEDIA USAGE FOR KNOWLEDGE TRANSFER AND CREATION

The results from the farmers' side regarding the usage of social media for knowledge transfer was not very different from the perspective of the researchers and extension officers except in very few cases where the use of individual applications for the SECI processes were found not to support knowledge transfer and creation. This sub-section begins with the summary of the results followed by the detailed results for the individual applications and the test of moderation.

Summary	Skype	Facebook	Wiki	YouTube
COM -> KTC	0.321(2.722)**	0.172(1.747)*	0.541(5.544)***	0.436(4.368)***
EXT -> KTC	0.247(2.435)**	0.054(0.489) NS	-0.056(0.436) NS	0.173(1.66)*
INT -> KTC	0.056(0.596) NS	0.232(3.412)**	0.377(4.192)***	0.155(1.597) NS
MR (SKYPE) -> COM	0.781(19.455)***	0.624(8.786)***	0.714(11.286)***	0.702(13.077)***
MR (SKYPE) -> EXT	0.765(17.087)***	0.652(10.72)***	0.807(25.428)***	0.809(19.696)***
MR (SKYPE) -> INT	0.685(12.483)***	0.488(6.34)***	0.751(17.350)***	0.716(11.169)***
MR (SKYPE) -> SOC	0.573(7.790)***	0.642(8.775)***	0.697(12.393)***	0.751(17.744)***
SOC -> KTC	0.220(2.240)**	0.232(1.865)*	0.377(3.663)***	-0.014(0.123) NS
TA -> KTC	0.127(1.255) NS	0.292(2.973)**	-0.288(2.589)**	0.268(2.844)**
TA*COM -> KTC	0.066(0.439) NS	-0.085(0.646) NS	-0.227(0.975) NS	0.108(0.945) NS
TA*EXT -> KTC	-0.118(0.689) NS	0.186(1.485) NS	0.191(1.009) NS	-0.019(0.152) NS
TA*INT -> KTC	0.022(0.238) NS	0.067(0.542) NS	0.071(0.465) NS	0.044(0.388) NS
TA*SOC -> KTC	-0.004(0.038) NS	-0.202(1.503) NS	-0.050(0.385) NS	-0.165(1.056) NS

Table 8-20: Summary of results from cocoa farmers 1

The results (see table 8-20) indicate that the there is a positive relationship between media richness of web 2.0 applications (Skype, Facebook, YouTube and Wikipedia) and their usage for the SECI processes (socialization, externalization, combination and internalization). This further strengthens the acceptance of hypotheses H1-H4, which was based on the perception of extension officers and researchers. The rejection of hypotheses H9-H12 was also confirmed by the results obtained from the cocoa farmers. The main difference between the results of the two sets of data occurred in regards to the hypotheses H5-H8. From the farmers' responses, the use of Skype for internalization was found not to have led to knowledge transfer and creation. The relationship between Facebook and Wikipedia usage for externalization and knowledge transfer and creation also failed to gain support. Finally, the test of relationship between the use of YouTube for internalization and socialization and knowledge transfer and creation also failed to gain support. In effect, based on the results of the analysis of the data on farmers perspective, hypotheses H5-H8 was partially supported. The detailed results of the analysis follow subsequently.

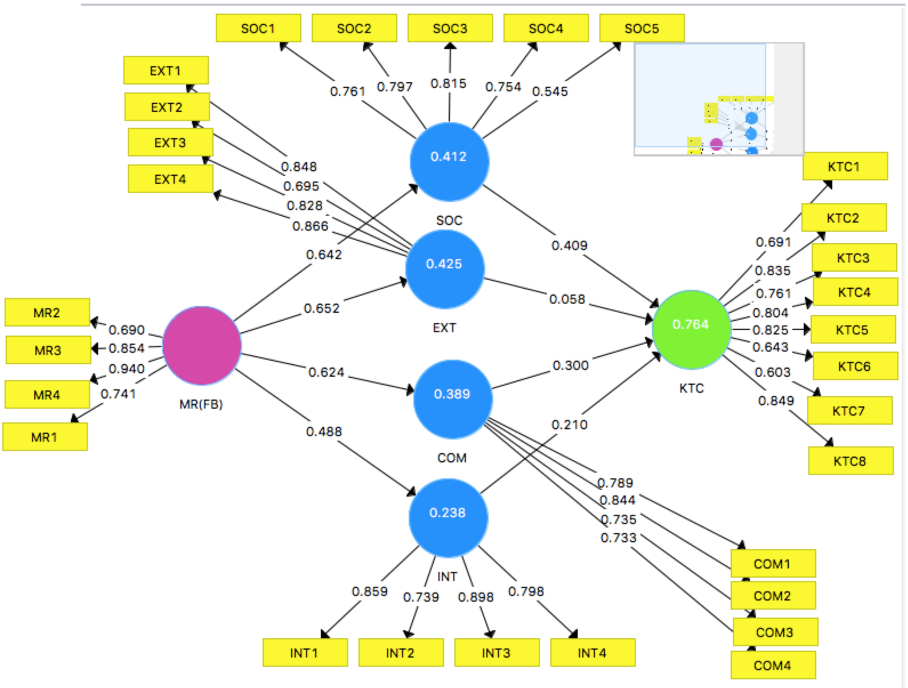

Figure 8-12: significance of path coefficients with t-values (Facebook) 1

Facebook	Path Coefficient	t-Statistics	Significance Level	P Values
MR(FB) -> COM	0.624	8.278	P<0.001	0.000
MR(FB) -> EXT	0.652	11.380	P<0.001	0.000
MR(FB) -> INT	0.488	6.319	P<0.001	0.000
MR(FB) -> SOC	0.642	8.695	P<0.001	0.000
SOC -> KTC	0.409	3.917	P<0.001	0.000
COM -> KTC	0.300	3.143	P<0.05	0.002
EXT -> KTC	0.058	0.577	NS	0.564
INT -> KTC	0.210	3.085	P<0.05	0.002

Table 8-21: Significance of path coefficients (Facebook) 1

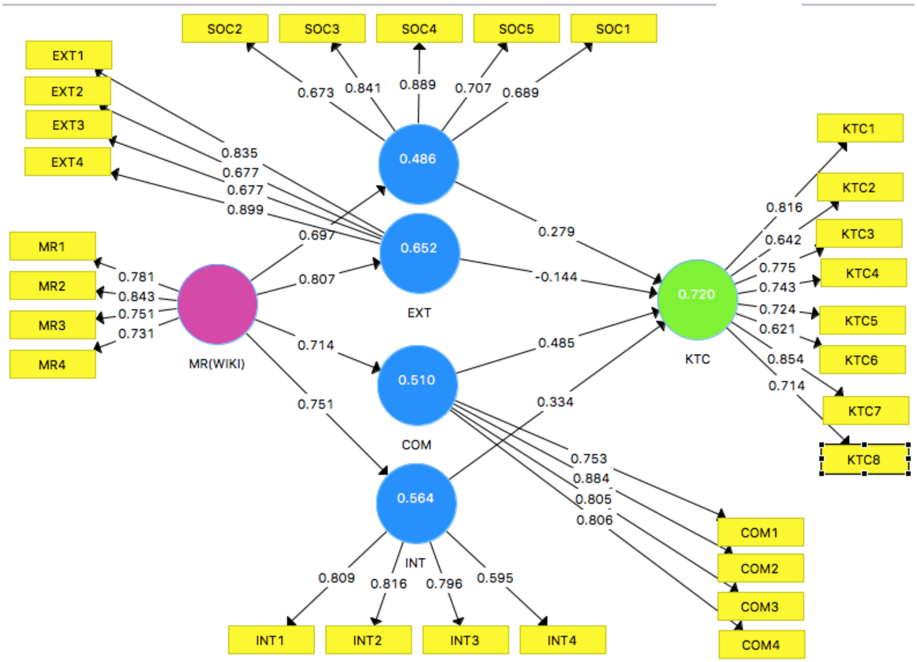

Figure 8-13 significance of path coefficients with t-values (Wikipedia) 1

Wikipedia	Path Coefficient	t-Statistics	Significance Levels	P Values
MR(WIKI) -> COM	0.714	10.615	P<0.001	0.000
MR(WIKI) -> EXT	0.807	23.763	P<0.001	0.000
MR(WIKI) -> INT	0.751	16.622	P<0.001	0.000
MR(WIKI) -> SOC	0.697	12.290	P<0.001	0.000
SOC -> KTC	0.279	3.471	P<0.05	0.001
COM -> KTC	0.485	5.614	P<0.001	0.000
EXT -> KTC	-0.144	1.275	NS	0.203
INT -> KTC	0.334	3.554	P<0.001	0.000

Table 8-22: Significance of path coefficients (Wikipedia) 1

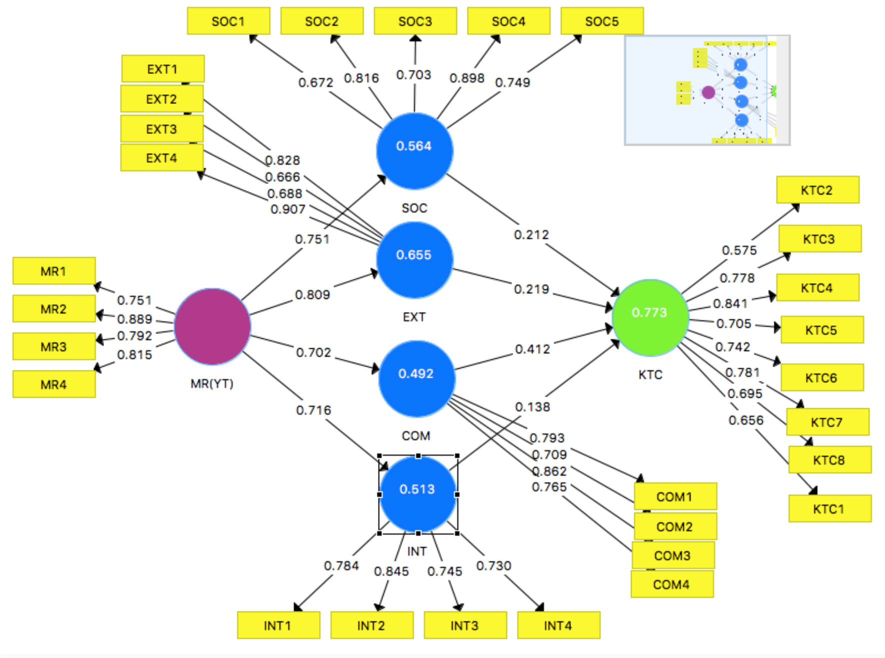

Figure 8-14: Significance of path coefficients (YouTube) 1

YouTube	Path Coefficients	T-Statistics	Significance Level	P Values
MR (YT) -> COM	0.702	12.413	P<0.001	0.000
MR (YT) -> EXT	0.809	17.197	P<0.001	0.000
MR (YT) -> INT	0.716	10.684	P<0.001	0.000
MR (YT) -> SOC	0.751	18.706	P<0.001	0.000
SOC -> KTC	0.212	2.645	P<0.05	0.008
COM -> KTC	0.412	4.038	P<0.001	0.000
EXT -> KTC	0.219	1.907	P<0.1	0.057
INT -> KTC	0.138	1.233	NS	0.218

Table 8-23: Significance of path coefficients (YouTube) 1

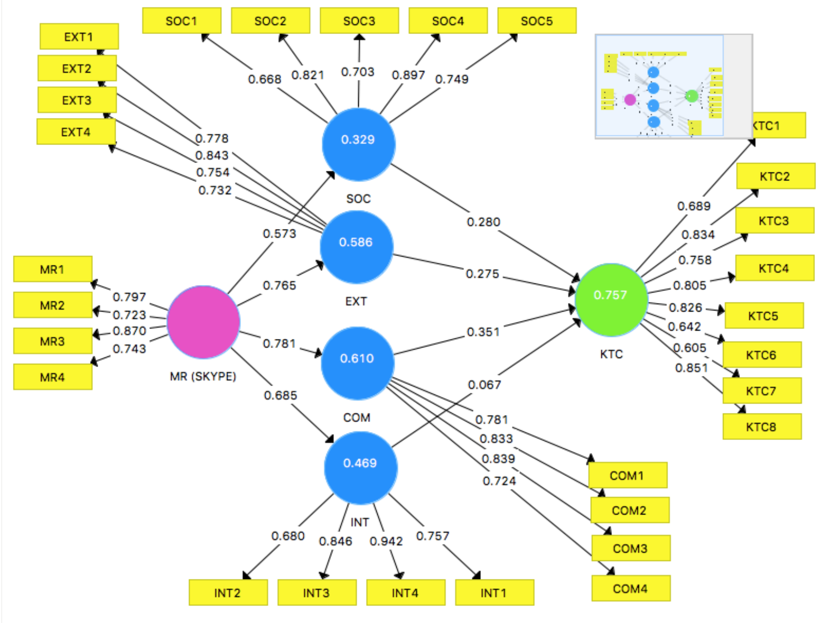

Figure 8-15: Significance of path coefficients (Skype) 1

Skype	Path Coefficient	t-Statistics	Significance Levels	P Values
MR(SKYPE) -> COM	0.781	19.225	P<0.001	0.000
MR(SKYPE) -> EXT	0.765	15.955	P<0.001	0.000
MR(SKYPE) -> INT	0.685	12.460	P<0.001	0.000
MR(SKYPE) -> SOC	0.573	7.420	P<0.001	0.000
SOC -> KTC	0.280	3.418	P<0.05	0.001
COM -> KTC	0.351	3.553	P<0.001	0.000
EXT -> KTC	0.275	2.584	P<0.05	0.010
INT -> KTC	0.067	0.783	NS	0.434

Table 8-24: Significance of path coefficients (Skype) 1

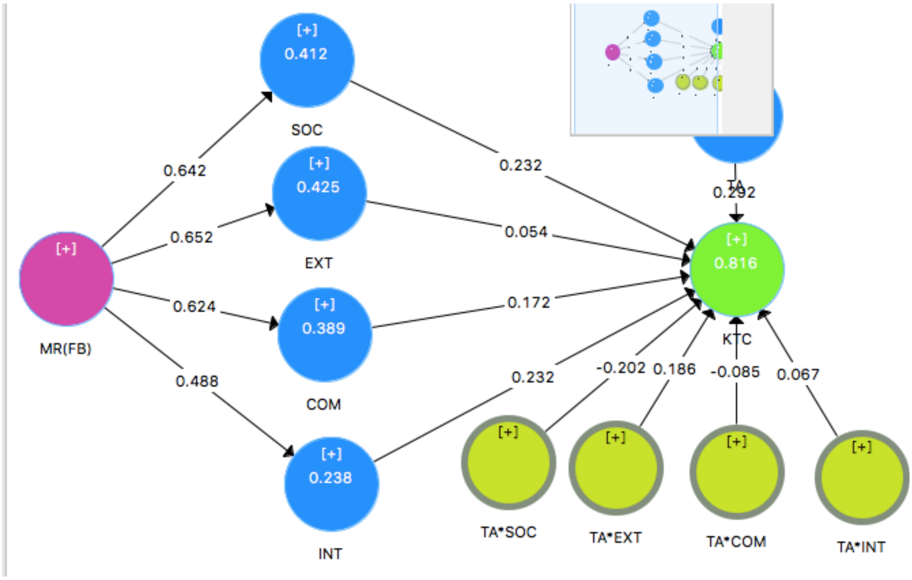

Figure 8-16: path model with interaction effect of task analyzability (Facebook) 1

Facebook	Path Coefficients	T Statistics	Significance Levels	P Values
COM -> KTC	0.172	1.747	P<0.1	0.081
EXT -> KTC	0.054	0.489	NS	0.625
INT -> KTC	0.232	3.412	P<0.05	0.001
MR (FB) -> COM	0.624	8.786	P<0.001	0.000
MR (FB) -> EXT	0.652	10.72	P<0.001	0.000
MR (FB) -> INT	0.488	6.34	P<0.001	0.000
MR (FB) -> SOC	0.642	8.775	P<0.001	0.000
SOC -> KTC	0.232	1.865	P<0.1	0.063
TA -> KTC	0.292	2.973	P<0.05	0.003
TA*COM -> KTC	-0.085	0.646	NS	0.518
TA*EXT -> KTC	0.186	1.485	NS	0.138
TA*INT -> KTC	0.067	0.542	NS	0.588
TA*SOC -> KTC	-0.202	1.503	NS	0.134

Table 8-25: Significance of path coefficients with interaction effect of task analyzability (Facebook) 1

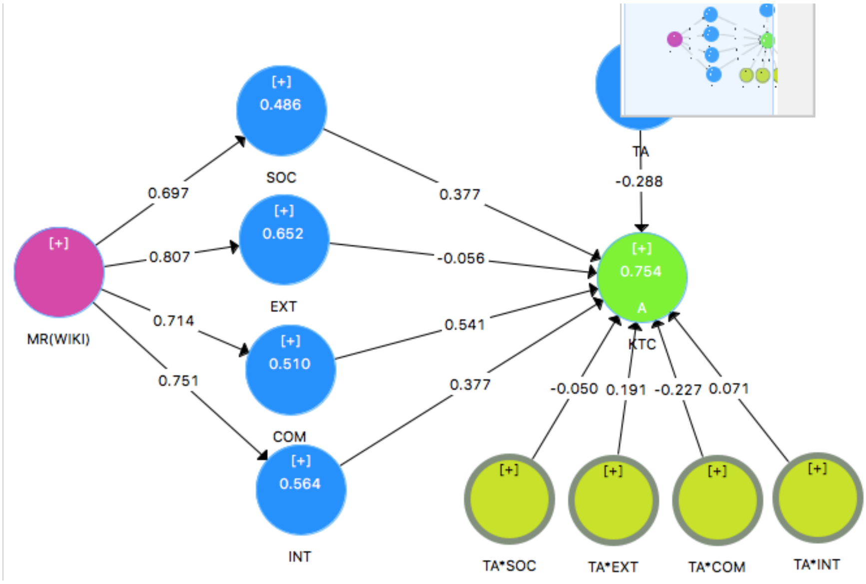

Figure 8-17: path model with interaction effect of task analyzability (Wikipedia) 1

	Path Coefficients	T-Statistics	Significance Levels	**P Values**
COM -> KTC	0.541	5.544	P<0.001	0.000
EXT -> KTC	-0.056	0.436	NS	0.663
INT -> KTC	0.377	4.192	P<0.001	0.000
MR (WIKI) -> COM	0.714	11.286	P<0.001	0.000
MR (WIKI) -> EXT	0.807	25.428	P<0.001	0.000
MR (WIKI) -> INT	0.751	17.350	P<0.001	0.000
MR (WIKI) -> SOC	0.697	12.393	P<0.001	0.000
SOC -> KTC	0.377	3.663	P<0.001	0.000
TA -> KTC	-0.288	2.589	P<0.05	0.010
TA*COM -> KTC	-0.227	0.975	NS	0.330
TA*EXT -> KTC	0.191	1.009	NS	0.314
TA*INT -> KTC	0.071	0.465	NS	0.642
TA*SOC -> KTC	-0.050	0.385	NS	0.700

Table 8-26: Significance of path coefficients with interaction effect of task analyzability (Wikipedia) 1

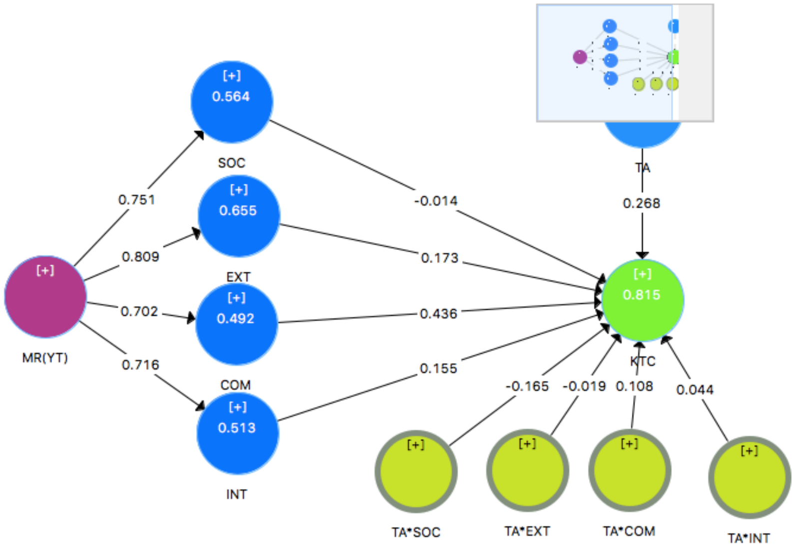

Figure 8-18: path model with interaction effect of task analyzability (YouTube) 1

	Path Coefficients	T-Statistics	Significance Levels	P-Values
COM -> KTC	0.436	4.368	P<0.001	0
EXT -> KTC	0.173	1.66	P<0.1	0.098
INT -> KTC	0.155	1.597	NS	0.111
MR (YT) -> COM	0.702	13.077	P<0.001	0.000
MR (YT) -> EXT	0.809	19.696	P<0.001	0.000
MR (YT) -> INT	0.716	11.169	P<0.001	0.000
MR (YT) -> SOC	0.751	17.744	P<0.001	0.000
SOC -> KTC	-0.014	0.123	NS	0.902
TA -> KTC	0.268	2.844	P<0.05	0.005
TA*COM -> KTC	0.108	0.945	NS	0.345
TA*EXT -> KTC	-0.019	0.152	NS	0.879
TA*INT -> KTC	0.044	0.388	NS	0.698
TA*SOC -> KTC	-0.165	1.056	NS	0.291

Table 8-27: Significance of path coefficients with interaction effect of task analyzability (YouTube) 1

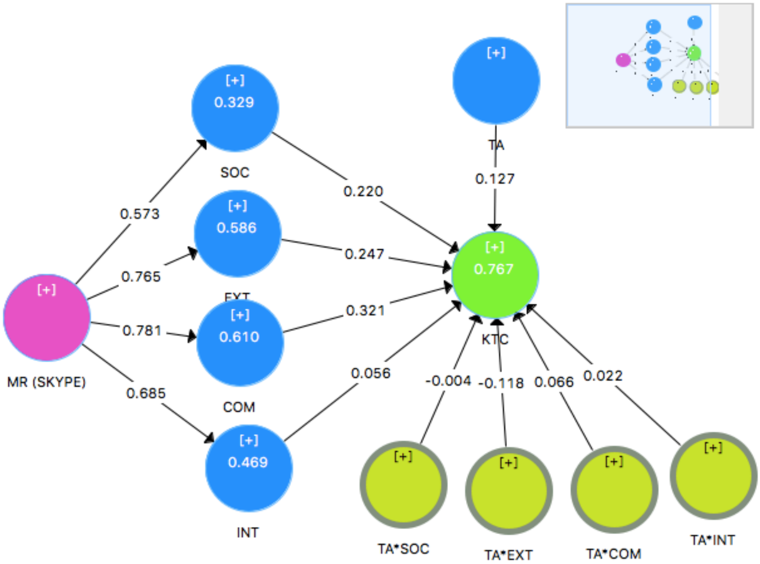

Figure 8-19: path model with interaction effect of task analyzability (Skype) 2

	Path Coefficients	T-Statistics	Significance Levels	P-Values
COM -> KTC	0.321	2.722	P<0.05	0.007
EXT -> KTC	0.247	2.435	P<0.05	0.015
INT -> KTC	0.056	0.596	NS	0.552
MR (SKYPE) -> COM	0.781	19.455	P<0.001	0.000
MR (SKYPE) -> EXT	0.765	17.087	P<0.001	0.000
MR (SKYPE) -> INT	0.685	12.483	P<0.001	0.000
MR (SKYPE) -> SOC	0.573	7.790	P<0.001	0.000
SOC -> KTC	0.220	2.240	P<0.05	0.026
TA -> KTC	0.127	1.255	NS	0.210
TA*COM -> KTC	0.066	0.439	NS	0.661
TA*EXT -> KTC	-0.118	0.689	NS	0.491
TA*INT -> KTC	0.022	0.238	NS	0.812
TA*SOC -> KTC	-0.004	0.038	NS	0.970

Table 8-28: Significance of path coefficients with interaction effect of task analyzability (Skype) 2

8.4.3. ESTIMATION OF COEFFICIENT OF DETERMINATION (R^2) AND EFFECT SIZE (F^2)

The coefficient of determination (R^2) is used to measure the predictive accuracy of the path model (Hair et al., 2014). The values of (R^2) ranges from 0 to 1 and are interpreted as 0.75 being substantial, 0.5 as moderate and 0.25 as weak. The R^2 values for all the endogenous latent variables of all the four web 2.0 applications are recorded in table 8-20. All the R^2 values are above the 0.25 threshold and therefore meet the predictive accuracy requirement. The corresponding effect sizes (f^2) are also recorded in table 8-21.

R-square	Skype	FB	Wiki	YouTube
SOC	0.384	0.428	0.472	0.533
COM	0.532	0.398	0.433	0.427
EXT	0.535	0.336	0.578	0.619
INT	0.408	0.321	0.510	0.438
KTC	0.728	0.763	0.708	0.751

Table 8-29: R-square coefficients of endogenous LVs 1

Results of f-square effect sizes

f-square	**Skype**	**FB**	**Wiki**	**YouTube**
MR (SKYPE) -> COM	1.145	0.662	0.765	0.744
MR (SKYPE) -> EXT	1.155	0.507	1.368	1.621
MR (SKYPE) -> INT	0.695	0.473	1.039	0.780
MR (SKYPE) -> SOC	0.629	0.749	0.895	1.142
SOC -> KTC	0.099	0.040	0.070	0.021
COM -> KTC	0.071	0.023	0.147	0.101
EXT -> KTC	0.059	0.055	0.019	0.077
INT -> KTC	0.025	0.126	0.100	0.037
TA -> KTC	0.034	0.110	0.003	0.034
TA*COM -> KTC	0.001	0.004	0.000	0.001
TA*EXT -> KTC	0.005	0.013	0.005	0.008
TA*INT -> KTC	0.000	0.004	0.003	0.033
TA*SOC -> KTC	0.000	0.007	0.001	0.003

Table 8-30: Effect sizes for all exogenous LVs including interaction effects 1

The effect size measures the extent to which an endogenous construct is affected upon the removal of a specific exogenous LV from the path model (Hair et al., 2014). The effect sizes were calculated using Cohen's formula for measuring hierarchical multiple regression, which is defined as:

$$f^2 = \frac{\mathrm{R^2}_{\mathrm{AB}} - {R_A}^2}{1 - \mathrm{R^2}_{\mathrm{AB}}}$$

Where f^2 = effect size, R^2_{AB} =variance explained of the reaction model, R^2_A = variance explained of the baseline model.

Q² (=1-SSE/SSO)	FB	YouTube	Wiki	Skype
COM	0.211	0.250	0.279	0.317
EXT	0.224	0.376	0.353	0.289
INT	0.207	0.231	0.267	0.249
KTC	0.424	0.362	0.361	0.406
SOC	0.218	0.307	0.263	0.221

Table 8-31: Predictive Relevance of the path model 1

The change in R^2 is used to estimate the effect size since the change in β is considered less accurate in regression especially, in case multicollinearity is found to exist. An f^2 value of 0.02 indicates a small effect while 0.35 represent a large effect with the medium effect being 0.15. The results of the analysis shows that task analyzability moderate the relationship between SECI 2.0 and KTC with small to almost no effect. However, the addition of the interaction terms to the baseline model didn't show any significant effect on all the variance explained terms (R^2) regarding the usage of Web 2.0 applications for SECI towards knowledge transfer and creation as seen in table 8-21. All the effect size values were not significant according to Cohen's approach, which is an indication that the effect of web 2.0 usage for the SECI processes on TA towards the achievement of KTC is not significant. In other words if the TA interaction terms were omitted from the model, they would have had no significant effect on the exogenous LVs (SECI processes).

8.4.4. ASSESSMENT OF THE PREDICTIVE RELEVANCE OF THE PATH MODEL

The predictive relevance of the model (Q^2) is estimated through the blindfolding algorithm in SmartPLS. The criterion can be used to estimate how well the path model can be used to predict the empirical observation. The default conditions were used for the blindfolding procedure with omission distance of 7 in the SmartPLS 3. In order for the path model to have a predictive relevance, the Q^2 values of the endogenous LVs should be above zero. The results of the blindfolding criterion on the SmartPLS 3 for all the four web 2.0 applications are recorded in table 8-23 and are found to be greater than 0 indicating that all the endogenous LVs have path model predictive relevance.

8.5. SUMMARY OF FINDINGS OF THE PROPOSED HYPOTHESES

This section is used to summarize the statistical analysis results and findings of the various hypotheses proposed in the study.

	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**

*Table 8-32: Summary of results of model 1(t-values) for all the applications (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)*

8.5.1. 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. 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. We can interpret this to mean that the respondents perceive that the media richness of each of the four web 2.0 applications employed in the study, make them suitable for the different knowledge transfer modes. That implies that each of the four applications have the required level of richness that makes it appropriate to be used for any of the four selected web 2.0 applications.

Hypotheses	Relationship	Facebook	Wiki	YouTube	Skype
H_5	SOC -> KTC	5.342***	5.075***	4.878***	6.773***
H_6	COM -> KTC	4.741***	6.399***	5.484***	5.417***
H_7	EXT -> KTC	3.011**	2.304**	4.985***	4.188***
H_8	INT -> KTC	6.659***	5.652***	3.094**	2.738**

Table 8-33: Summary of findings for model 1

8.5.2. RESULTS OF HYPOTHESES 5-8

The results of the analysis of model 1 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 (H_5-H_8) (see table 8-23). In other words, the use of web 2.0 applications for SECI processes could lead to knowledge transfer and creation.

Consistent with these findings, ICTs have been found in other studies to play a crucial role in knowledge creation and transfer by supporting all the SECI processes (García-Álvarez, 2014; Lopez-Nicolas and Soto-Acosta, 2010). Lopez-Nicolas and Soto-Acosta (2010) found that the adoption and use of ICTs positively influence knowledge creation and transfer among Spanish SMEs, however they noted that the positive effect on combination and internalization was higher than on socialization and externalization, stating that as social networks are developed these shortcomings are likely to disappear. In the study on Zara group, García-Álvarez (2014) came into conclusion that the combined use of series of ICTs has positive effect on socialization, exteriorization, combination and interiorization, which are the same as SECI processes. These results contrast the findings of earlier study by Lee and Choi (2003) in listed companies in Korea. Lee and Choi (2003) found that ICT adoption/support has no impact on socialization, externalization and internalization. Possible explanation to these contrasting findings could be that Lee and Choi (2003) focused on general ICTs while the focus of the current study is on web 2.0 applications. Secondary Lee and Choi (2003) analyzed listed companies whereas our focus was on non-organizational context.

8.5.3. RESULTS OF HYPOTHESES 8-12

The objective of hypotheses (H_8-H_{12}) 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 transfer and creation. 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 (H_8-H_{12}) (see table 8-34).

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

Table 8-34: Summary of results from interaction models 1

The results summarized in table 8-25, indicate that all the t-values of the interaction terms involving task analyzability and the SECI terms fell below the 1.96 threshold at 5% significance required for acceptance for all the four web 2.0 applications. The interpretation to these findings is that the use of web 2.0 applications for SECI processes will lead to knowledge transfer and creation irrespective of the analyzability of the task. The analyzability of the task performed by cocoa farmers does not affect the use of the web 2.0 platforms for the transfer and creation of knowledge as perceived by the study. The findings suggest that no matter the type of task the knowledge is transferred to accomplish, web 2.0 applications could be used to facilitate the knowledge transfer process among the key knowledge actors in the industry. In all eight out of the twelve hypothesis proposed for the study were supported while the hypotheses relating to the moderation of task analyzability failed to gain support and were rejected. The summary of the findings of the proposed hypotheses is shown in table 8-26.

Research Question	Hypothesis	Dependent Variable	Independent Variable	Moderating variable	Results
RQ1	H1-H4	SOC, EXT, COM. INT	MR		Accepted
RQ2	H5-H8	KTC	SOC, EXT, COM. INT		Accepted
RQ3	H9-H12	KTC	SOC, EXT, COM. INT	TA	Rejected

Table 8-35: Summary of Findings of Hypotheses

8.6. ANALYSIS OF THE SECON-ORDER HIERARCHICAL AKIS-BASED MODEL

8.6.1. MODEL SPECIFICATION

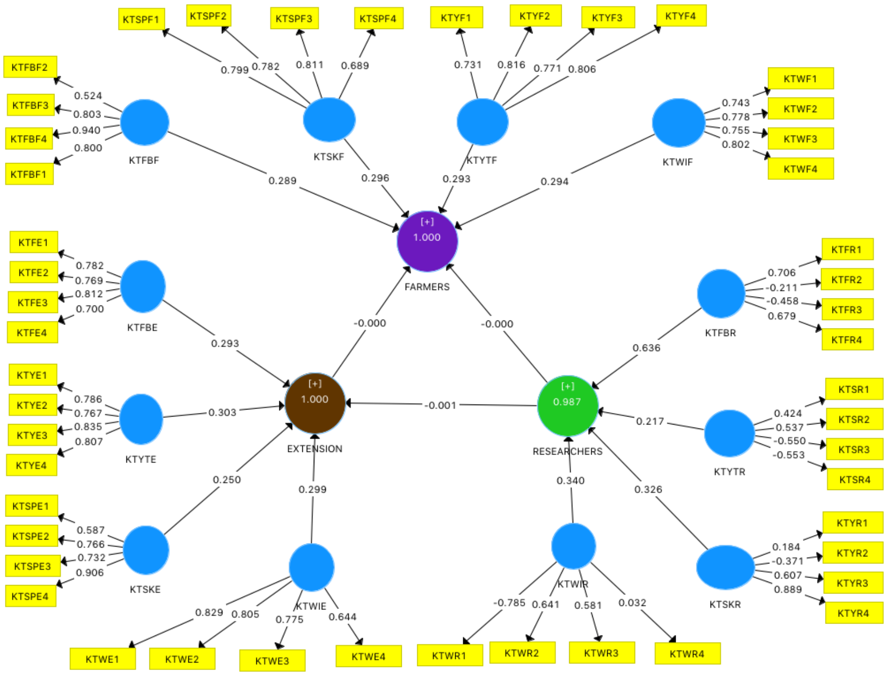

Figure 8-20 Specified model 1

The model is composed of two elements: a higher–order component and a lower-order component. The higher-order component consists three second-order constructs: Farmers, Extension and Researchers. Each second-order component consists of four subdivisions of lower-order components (first-order), which makes a total of twelve. The lower-order component are represented as $KTC_{FB,}$ $KTC_{YT,}$ $KTC_{WI,}$ and KTC_{SK} and interpreted respectively as the use of Facebook, YouTube, Wikipedia and Skype for knowledge transfer and creation. As can be seen from figure… the model represents a reflective-formative type of hierarchical component models.

This type of arrangement indicates that the relationship between the second-order and first-order components is formative (arrows pointing from First-order to second-order) while each construct is measured by reflective indicators (arrows pointing from constructs to indicators) (see model specs.). The repeated indicators approach was then used to establish the measurement model. By the repeated indicator approach, all the indicators of the first-order constructs are combined and assigned to the second-order component. In order to ensure that the relationships between the first-order and the second-order are not biased, we made sure that equal number of indicators is assigned to each first-order. In this case four indicators were assigned to each of the first-order. This means a total of sixteen indicators (sum of indicators of first-order constructs) were assigned to each second-order component. Analyzing a model of this nature using the repeated indicators approach requires particular attention. Since the sum-total of the indicators of the first-order constructs are assigned to the second-order component, all the variances of the second-order components are completely explained by their first-order constructs (R^2=1). As a result, the path relationship between the second-order as endogenous variable and any other latent variable as a predecessor is always approximately zero (see figure).

Consequently, a two-stage approach is required. First, the indicator approach is used to obtain the latent variable scores for the first-order constructs. These results are then used as manifest variables in the second-order measurement model at the second stage of the analysis. In doing so, the second-order components become embedded in a nomological net to allow other latent variables to serve as predecessors and explain some of their variances (see figure).

8.6.2. RESULTS OF THE SECOND-ORDER ANALYSIS 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

	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 8-36: Summary of finding of second-order analysis 1

CHAPTER 9. DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

9.1. SUMMARY OF FINDINGS

The current chapter provides further insights into the findings as presented in chapter eight. These findings were interpreted in the light of the theoretical framework and the specific objective of the study through the research questions and the hypotheses. The study argues that the use of web 2.0 applications for knowledge creation and transfer through the SECI processes could influence interaction among the primary knowledge actors in the cocoa industry in Ghana. A web 2.0-based KM model for the creation and transfer of knowledge among the primary knowledge actors in the cocoa industry in Ghana is thus, proposed. The process of knowledge creation and transfer depends on the choice of the appropriate media for the different modes of knowledge transfer as postulated in the SECI model. Media choice depends on media richness and task characteristics. In effect there exists a relationship among the media richness, task analyzability, SECI processes and knowledge transfer and creation within the web 2.0 space. Answers to the following research question were sought after in the study:

- RQ1: What is the effect of media richness of web 2.0 applications on their usage for socialization, externalization, combination and internalization (SECI)?
- RQ2: What is the effect of the use of web 2.0 applications for socialization, externalization, combination and internalization on knowledge transfer and creation?
- RQ3: What is the moderation effect of task analyzability on the relationship between the use of web 2.0 applications for socialization, externalization, combination and internalization and knowledge transfer and creation?
- RQ4: What is the effect of web 2.0 usage for knowledge creation and transfer on the nature and level of interaction among the knowledge actors in the cocoa industry in Ghana?

In answering these questions, three sets of composite hypotheses were proposed for the study:

- H1-H4: Media richness of Web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) is positively related to their usage for (socialization, externalization, combination, internalization) modes of knowledge transfer

- H5-H8: The use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for (socialization externalization, combination, internalization) is positively related to knowledge transfer and creation.

- H9-H12: Task analyzability moderates the relationship between the use of web 2.0 applications (Skype, Facebook, YouTube, Wikipedia) for (socialization, externalization, combination, internalization) and knowledge transfer and creation.

Research Question	Hypothesis	Dependent Variable	Independent Variable	Moderating variable	Results
RQ1	H1-H4	SOC, EXT, COM. INT	MR		Accepted
RQ2	H5-H8	KTC	SOC, EXT, COM. INT		Accepted
RQ3	H9-H12	KTC	SOC, EXT, COM. INT	TA	Rejected

Table 9-1: Summary of results of analysis for the hypotheses 1

A combination of statistical software including Microsoft Excel, IBM SPSS and SMartPLS 3 were used for the analyze of the data collected from a survey, which was based on a conceptual model developed for the study. The summary results of the findings from the statistical analysis for the proposed hypotheses are recorded in table 10-1. The results obtained from the analysis led to the acceptance of hypotheses H1-H4 and H5-H8 while rejecting hypotheses H9-H12. Consequently, the results from the findings confirm study claim that media richness of web 2.0 applications would affect their use for socialization, externalization, combination and internalization, while rejecting that task analyzability moderates the relationship between web 2.0 use for SECI and knowledge transfer and creation.

9.2. DISCUSSIONS OF KEY FINDINGS FROM THE RESEARCH

The answer to the first research question of the study relates to the choice of appropriate media for the processes involved in knowledge creation and transfer (SECI). Regarding the choice of the media, the study proposed a direct relationship between the richness of the media and their usage for the SECI processes. Media richness is one the factors that according to the SECI model theorized by Nonaka et al. (2000) affects the choice and usage of media for knowledge creation and transfer through the SECI processes. When knowledge creation and transfer process involves the conversion of tacit knowledge, a media with a high degree of richness is appropriate and when the process involves the conversion of explicit knowledge, lower media richness is required (Nonaka et al., 2000). From the media richness perspective, when a task is equivocal, media with higher degree of richness is required since it requires the sharing of experiential knowledge, which is tacit in nature, due to unavailability of laid down rules (Daft and Lengel, 1987). In other words, it would involve the conversion of tacit knowledge to tacit knowledge (socialization) or tacit knowledge to explicit form (externalization). On the other hand, when a task is ambiguous, media with low richness would be suitable since there is an availability of laid down rules for resolving issues related to the task. It's implied that knowledge would be converted from explicit to either explicit (combination) or tacit (internalization). The richness of a media is a measure of its ability to provide instant feedback, multiple cues, language variety, and personal focus (Daft and Lengel, 1987).

9.2.1. MEDIA RICHNESS OF WEB 2.0 APPLICATIONS

The primary objective of any extension system is to be effective in creating and transferring knowledge that would help knowledge actors in their decision-making process (Munyua et al., 2002). Interaction among knowledge actors is key in the agricultural knowledge and information systems (AKIS). The findings of the preliminary study revealed that interaction among knowledge actors was poor based existing extension approaches and mechanisms (Baah, 2006). Findings from other studies on cocoa-based AKIS in the Ghanaian sector have also indicated that the level of interactions between farmers and their key partners in the AKIS is very weak and ineffective in enhancing knowledge flow (Baah, 2006). With the existing mechanisms and approaches (mainly T&V and FFS) used for creating and transferring knowledge in the industry knowledge actors could communicate in an interactive manner only through face-to-face and physical contact with each other. This is problematic considering the ratio of extension officers and researchers to cocoa farmers and other resource constraints. The study findings revealed through personal interviews at the CHED headquarters, that there were 800, 000 cocoa families with 256 extension officers, which comprises of community extension agents (CEA), district extension coordinators (DEC) and regional extension officers. Out of the 256, COCOBOD employs 192 while the rest belong to private organizations. Farmers are split into 16 groups of 30 farmers with each extension agent taking care of 15 communities. It's unsurprising that 84% of farmers in a findings study reported that hey had not met an extension officer for a whole year Baah, 2006).

According to the study findings, other mechanisms used including cocoa farmer newspaper, posters, leaflets, flyers, radio, and even the mobile-based Cocolink have poor media richness in the sense that they don't allow knowledge actors to send and receive instant feedback, tailor interactions to suit their personal requirements, to communicate using variety of cues, and to communicate in a language of their choice. As a researcher at CRIG indicated in the course of the interview:

"Most cocoa farmers cannot read and understand what is written in the cocoa farmers newspaper even though they are distributed to them free of charge".

These methods and approaches used for knowledge creation and transfer mostly allow only one-way communication and serve as broadcasting/push technologies leaving very small room for cocoa farmers to interact with other knowledge actors (Baah and Anchirinah, 2011; Yaw et al., 2013). Findings obtained from the preliminary interviews also indicated that the radio has the broadest appeal in reaching a large audience quickly, however, it was realized through observation that only small room is given to the audience to contribute by allowing them to call-in to the programs to send and receive feedback through phone calls.

Meanwhile the based on findings of the study related to the use of web 2.0 it became evident that the media richness of the web 2.0 applications made it possible for the knowledge actors (cocoa farmers, extension officers, and cocoa researchers) to interact and are able to use it to tailor the interactions to suit their personal needs. Moreover, the knowledge actors are able to use web 2.0 applications to send and receive feedbacks in a timely manner, communicate using variety of different cues and are able to communicate in a language of their choice. According to study findings not a single web 2.0 application was ranked highest in all the four measures of media richness indicating that different applications are best suited for different media related activities. For example, Facebook was ranked highest in media richness among the group of web 2.0 applications regarding its ability to allow respondents to adjust interaction to suit their personal needs. Wikipedia, Skype, YouTube and followed it in that order. Knowledge actors prefer to use YouTube the most when choosing media for sending and receiving feedback with Wikipedia, Skype, and Facebook following in that order. The findings revealed knowledge actors using Skype the most when selecting media to communicate in a variety of different cues. Facebook was again rated highest regarding its ability to allow users to communicate in rich and varied languages.

In effect, the evidence presented suggests that media richness of existing knowledge creation and transfer mechanisms in the Ghanaian cocoa industry is adversary affecting interactive communication among knowledge actors. On the other hand, the introduction of web 2.0 applications could help in offsetting some of the issues related to media richness of the communication channels that knowledge actors in the Ghanaian cocoa sector use in creating and transferring knowledge. Knowledge creation and transfer is largely dependent on interactions among knowledge actors through the interplay between tacit and explicit knowledge (Nonaka et al., 2000). When interactions among knowledge actors are almost in non-existent (Baah, 2006) due to poor media richness it could negatively affect the entire knowledge creation and transfer process. However, these issued could be resolved by augmenting the existing mechanisms with media, which are higher in richness as demonstrated by, web 2.0 applications based on the findings of the present study.

Media richness of web 2.0 applications influences their usage for socialization, externalization, combination and internalization.

On the basis of our empirical data, the results of the analysis confirm the study proposition that the media richness of web 2.0 applications affect their usage for the SECI processes leading to knowledge creation and transfer in the Ghanaian cocoa industry.

Socialization: In order to create and transfer knowledge, there is the need to create space where individuals could exchange tacit knowledge through socialization. Theoretically, it was expected that the media richness of the web 2.0 applications would make it possible for knowledge actors to use them for socialization (Shang et al., 2011; Boateng et al., 2009; Kumar, 2012; Murphy and Salomone, 2013; Nonaka et al., 2000; Daft et al., 1987). The findings of the study has indicated that already, the space for socialization has been created in the sense that, cocoa farmers have been divided into smaller groups of thirty members per group with extension agents assigned to these groups at the community level. Creating such groups constitutes communities of practice (CoPs), which are crucial for the socialization process (Boateng, 2006). According to expert information gathered from personal interviews with regional extension officers, it was expected that at this stage farmer-to-farmer interaction is encouraged the most to help them to deepen their understanding on their own farming practices with extension agents serving as moderators to encourage dialogue among the farmers. Therefore face-to-face interactions were required the most, since it's the richest form of media required for tacit-tacit knowledge creation and transfer.

However, these findings are in connection with farmer-to-farmer interaction at the community levels. Meanwhile it's expected that other knowledge actors (researchers and extension) should be involved, though not as teachers but as observers and imitators to learn from the experiential tacit reasoning behind their practice. This could serve as the foundation for deeper scientific analysis directed towards improved farming technologies in the cocoa sector (Boateng, 2006). However, for researchers to take part in any activities at the community level of the cocoa farmers would mean travelling hundreds of kilometers or more to observe and interact face-to-face with the cocoa farmers. This is because the researchers are mostly based in the Eastern region of Ghana where they have their head-office while the farming communities are scattered across six regions in the country.

On the other hand, the findings related to web 2.0 usage also indicated that based on the media richness of the web 2.0 applications, the knowledge actors could use them for socialization. Knowledge actors were found to be familiar with using these applications to share their experiences, communicate through direct conversation, come up with new ideas, and gain experiences through observations and imitations. However, these experiences were more widespread within the different groups (i.e. farmer-farmer, extension-extension and researchers-researcher) than at the intergroup level (e.g. farmer-extension, farmer-researcher, and extension – researcher). But that could be improved when all the groups of knowledge actors agree to use these applications. These findings indicate that, although emphasis could be placed on face-to-face interactions for socialization within groups, the use of web 2.0 applications could help knowledge actors to effectively communicate among themselves both within groups and between groups by providing a range of meanings for a better understanding of a broader set of concepts and ideas regarding research findings and innovative technologies.

Externalization: The externalization process involves the articulation of tacit knowledge into explicit form. This phase of the knowledge creation and transfer process takes place when an individual farmer decides to put his/her tacit knowledge into readable format to make it easily accessible and available so that other farmers could retrieve and make use of even in the absence of the holder. Findings from personal interactions with some cocoa farmers indicate that this stage of the knowledge creation and transfer process is the least and most challenging among the others that farmers are able to practice due to unavailability of effective mechanisms to help farmers to externalize their tacit knowledge. At this point it's expected that extension officers would be able to have extensive dialogue through enhanced communication with cocoa farmers to help them to articulate their tacit knowledge into explicit form (Boateng, 2006). However, as the findings indicated, the current extension to cocoa farmer ratio of 255:800,000 makes it nearly impossible for such extensive dialogue between cocoa farmers and their other AKIS partners to be sustained only through face-to-face contact. Baah (2006) also confirms the unavailability of any such extensive interaction among knowledge actors. A farmer retorted in the course of the interview:

How often are extension agents able to visit farmer groups at the community levels to have face-to-face interactions that would enable farmers whose tacit knowledge is needed the most at this stage of the knowledge creation and transfer process?

Meanwhile it was established that farmers have been using various artifacts, analogies and metaphors such as paintings on walls, rocks drawings on clay pots, telling stories while sitting by the fireside in the evenings and so on, to make their tacit knowledge explicit. On the other hand we expected that the media richness of the web 2.0 applications would make it possible for knowledge actors to articulate their tacit knowledge and make it available in explicit form (Shang et al., 2011; Boateng et al., 2009; Kumar, 2012; Murphy and Salomone, 2013; Nonaka et al., 2000; Daft et al., 1987). The findings of the study revealed that the media richness characteristics of the web 2.0 applications could allow knowledge actors to create and transfer knowledge through the externalization process. The use of web 2.0 applications enabled individual knowledge actors to share their tacit knowledge through dialogue with others. Knowledge actors were able use pictures and images (metaphors) to share ideas. The study findings showed that knowledge actors have been taking and sharing photos and videos on web 2.0 platforms. By capturing pictures of some of the drawings recorded on clay pots and the rocks etc. on cameras, farmers could be asked to interpret those symbolisms to other members in the group while recording videos of their interactions. These videos and pictures could then be posted and shared on web 2.0 platforms with other farmer groups. By sharing the pictures and videos, other knowledge actors could give their comments, thereby increasing learning.

Combination: The combination process involves combining discrete pieces of explicit knowledge into systematic and complex sets of explicit knowledge (Nonaka and Takeuchi, 2005). At this stage of the knowledge creation and transfer process, it is expected that the explicit knowledge of extension personnel, as well as knowledge from CRIG be combined with the explicit knowledge of the cocoa farmers (Boateng, 2005). In effect, combination involves knowledge integration of all the different knowledge actors that constitute the knowledge triangle. As part of the findings of the study, it was discovered that most of the channels used for embodying explicit knowledge in the industry were in print format such as newsletter, cocoa farmer newspapers, annual reports, flyers and so on. Meanwhile most of the farmers who are the chief beneficiaries of the embodied knowledge are illiterate and can neither read nor write making these formats unsuitable for them.

The Cocolink could have been a useful platform for combination, however, it is based on the push technology making it impossible for other knowledge actors to pull and access knowledge from its database as and when needed. Moreover, it is also text-based making it equally difficult for cocoa farmers to read and understand the content. Yet another interesting initiative was the digital green project, which was introduced by the World Cocoa Foundation (WCF) through its "Cocoa Livelihoods Program". The videos are developed in a way to reflect on the concept of participatory extension whereby representative of all the knowledge actor groups come together to produce to produce videos on a number of subjects such as shade management, pruning, correct use of fertilizers and so on using local community farmers. The videos are produced in local languages and many community farmers are also featured. the videos are used to put together, the otherwise scattered explicit knowledge on various farming practices into a systematic and comprehensive explicit knowledge within a localized community context.

This was what a cocoa farmer remarked when interviewed on the videos:

"Before I watched the videos, my farm was in distressed state due to overcrowding of cocoa trees. It was so because I was relying on the knowledge my grandfather passed on to me that the more the trees I have, the higher the productivity. But after watching the video and receiving the training, I learnt I had to space-out the cocoa tress and also learnt about good pruning practices. So this year I really had a good harvest".

However, dissemination of the videos to the cocoa farmers was challenging, according to Mr. F Aneani, an interviewee at the Social Science and Statistical Unit of CRIG.

Meanwhile other findings of the study revealed that knowledge actors know how to use the web 2.0 applications to create and transfer knowledge through the process of combination by converting one form of explicit knowledge into another form of explicit knowledge. According to the findings, knowledge actors have been uploading videos on YouTube and sharing videos on Facebook and other web 2.0 platforms. The media richness of the web 2.0 applications enables them to edit and modify existing documents and to create new materials by gathering existing materials. These discussions gives clear indications that the use of web 2.0 applications could enhance knowledge actors' ability to create and transfer knowledge through combination.

Internalization: The internalization process allowed knowledge actors to apply their gained explicit knowledge into actual farming practice. The study findings shown that knowledge actors in the Ghanaian cocoa sector understand the possible usage of web 2.0 applications for knowledge creation and transfer through the internalization process. The media richness of the web 2.0 application enabled knowledge actors to search for ideas from existing materials, to have discussions with others to deepen their understand of the materials, to conduct experiments to embody the knowledge, to learn by doing and observation. Knowledge actors demonstrated this through the use of the digital green videos, some of which they could download and watch on the YouTube and other web 2.0 platforms.

In effect, the use of these applications to support existing mechanisms could enhance interactive communication among the key knowledge actors, which is critical for effective knowledge transfer and creation. Other scholars have expressed similar views regarding the use of these four web 2.0 applications for SECI processes towards effective knowledge transfer and creation (Shang et al., 2011). One could argue that these findings don't offer full support to the propositions in the SECI model. According to the SECI model, socialization and externalization require the use of rich media while lean media are appropriate for combination and internalization. These two modes of knowledge transfer have tacit knowledge as inputs and are considered as the main processes for tacit knowledge transfer, while combination and internalization constitute explicit knowledge transfer (Panahi et al., 2013). Regarding tacit knowledge transfer the higher the richness of the media, the better while for explicit knowledge, lean media are preferred to rich media. It would be expected that only the web 2.0 applications considered as rich media (Skype and Facebook) could be used to support tacit knowledge transfer while (Wikipedia and YouTube) considered to be of lower degrees of richness would be suitable for explicit knowledge creation and transfer. 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. According to the deductions made from the media richness hierarchy for the study, Skype and Facebook were qualified as rich media due to their abilities to be used to provide instant feedback and multiple cues, while Wikipedia and YouTube were regarded as lean media. Consistent with the findings, other studies have found that know-how (tacit knowledge) should be transferred with rich media, while information (explicit knowledge) should be transferred with lean media (Murray, 2003). Socialization and externalization are considered as types of tacit knowledge transfer whereas internalization and combination are also regarded as explicit knowledge transfer.

9.2.2. WEB 2.0 USAGE AND KNOWLEDGE CREATION AND TRANSFER

The second proposition was to seek further understanding about the relationship between knowledge actors' use of Web 2.0 for the SECI processes and how they would influence knowledge creation and transfer in the cocoa industry in Ghana. Hypotheses H5-H8 were proposed with the aim to test whether the use of the selected web 2.0 applications for socialization, externalization, combination and internalization (SECI) would lead to knowledge transfer and creation in the cocoa industry in Ghana. By accepting these hypotheses the results from the analysis of the structural model reveal that the use of Web 2.0 applications for the SECI processes would lead to knowledge transfer and creation by positively influencing the processes of socialization, externalization, internalization and combination as proposed in the study. Here we are looking at the combined effect of knowledge actors' use of web 2.0 applications on knowledge creation and transfer, not as separate processes.

The findings of the present study have revealed that knowledge actors' use of web 2.0 applications for socialization would lead to knowledge creation and transfer in the cocoa industry in Ghana. As the findings indicated earlier on, socialization takes place within the various groupings of cocoa farmers at the community levels where interactions are supposed to be one-on-one basis with extension agents and researchers serving as moderators to encourage cocoa farmers to engage in extensive dialogue among them. At this stage the extension agents and researchers are to learn from the tacit knowledge base of the cocoa farmers through observation, imitation and practice. Doing so they become socialized into the tacit knowledge base of the cocoa farmers based on which further research analysis could be developed. However, the knowledge created at this stage could not be leveraged by the industry as a whole until it becomes explicit.

In order for knowledge actors to convert their individual tacit knowledge into a explicit form, extension agents are supposed to help cocoa farmers to articulate their tacit knowledge by engaging them in extensive dialogue. As the study findings indicated in the previous section, (9.2.1) cocoa farmers have been using different artifacts to articulate their knowledge into explicit forms. Moreover, they are also familiar in sharing and posting videos and photos on various web 2.0 platforms. Similarly extension agents could assist cocoa farmers to use web 2.0 platforms to share images and videos of various artifacts they have been using to articulate their tacit knowledge into explicit forms. Various analogies and metaphors including such as writings on clay pots, designs on rocks, could all be recorded in videos, together with their interpretations and shared on various platforms in the form of virtual communities of practice. In doing so they would be able to convert their tacit knowledge base into shared experiences with other knowledge actors within and between groups. Thus, knowledge actors' use of web 2.0 applications for externalization enables them to generate new ideas, create innovative processes, and identify improvements to reduce inefficiencies. Once tacit knowledge has become explicit, web 2.0 applications could then be used extensively to combine various pieces of explicit knowledge from all groups of knowledge actors, which constitute the knowledge triangle into a new whole of explicit knowledge. After explicit knowledge has been embodied and disseminated (for example through videos) extension agents could then use these videos to train cocoa farmers on various subjects related to improved farming practices using experimentations and simulations to guide farmers towards actual farming practices.

Consequently these results suggest that the adoption and use of the web 2.0 applications by the Cocoa industry in Ghana would enhance knowledge creation and transfer by positively influencing socialization, externalization, combination and internalization. The use of these technologies would facilitate knowledge creation and transfer through SECI processes by serving as communication platforms for effective dialogue among the key knowledge actors in the industry. Dialogue among researchers, extension agents and cocoa farmers are crucial for knowledge transfer and creation, in the sense that through effective dialogue individuals are able to listen to others and also contribute to the discussion for each other's benefit (Nonaka and Konno, 1998). In doing so, tacit knowledge is transferred from individuals to groups through shared experiences. Consistent with our findings, earlier studies have found similar results that indicate that the use of ICTs play a crucial role in knowledge transfer and creation (García-Álvarez, 2015; Soto-Acosta and Lopez Nicolas, 2010; Davenport and Prusak, 1998) by serving as a mechanism to facilitates the capturing, storage and exchange of knowledge (Alavi and Leidner, 2001). Contrasting results regarding ICT usage for tacit knowledge transfer through socialization, externalization, and internalization also exist in literature (Lee and Choi, 2003). These contrasting results may be due to the fact that the ICTs that were considered for the previous studies were based on web 1.0 applications and traditional knowledge management systems (KMS1.0), which lacked the human agent, necessary to facilitate KM processes. The current study is based on web 2.0 applications and for that matter KM2.0 which focus on nurturing social interactions that enables people to build strong relationships and thus capable of supporting the transfer of tacit knowledge better.

9.2.3. MODERATING EFFECT OF TASK ANALYZABILITY ON KNOWLEDGE CREATION AND TRANSFER

The following proposition was stated to examine the possible effect of task analyzability on the relationship between web 2.0 usage for SECI processes and knowledge creation and transfer.

Task Analyzability moderate the relationship between web 2.0 usage for SECI processes and knowledge transfer and creation

The findings of the study failed to establish our 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 study proposed that in the absence of laid down procedures which knowledge recipients including cocoa farmers could rely on when they encounter issues in the course of performing their daily farming activities, they would prefer to rely on personal information sources such as family members and colleague farmers rather than relying on personal computers and internet as prior studies on Cocoa-based AKIS have found (Nana et al., 2013). Since in that case recipients among knowledge actors would have to rely on their own experiences and skills, which involve the sharing of tacit knowledge or know-how. And that would have adversary affected the creation and transfer of knowledge through web 2.0 usage for SECI processes. However, the findings of the study have indicated that that wouldn't be the case since task analyzability proved not to have any effect on the relationship between web 2.0 usage for SECI processes and knowledge creation and transfer. In other words, knowledge creation and transfer through web 2.0 usage for the SECI processes do not depend on the availability or non-availability of laid down procedures for guiding farmers in performing their farming activities. Possible reasons could be that as a result of the continual interactions among knowledge actors through the use of web 2.0 applications, knowledge actors would have most of their issues resolved beforehand and wouldn't have to wait for any eventualities to contact each other. Moreover, the reason why Internet and personal computers could have received poor ranking in Nana et al. (2013) study could be due to inaccessibility of web 2.0 applications on other mobile devices and also knowledge actors have been using other ICTs such as radio to share cocoa-based knowledge and information with cocoa farmers and not Internet-based applications.

As discussed in the previous chapter, the existing mechanisms, which are mainly based on face-to-face interactions, have not been supportive in this direction due a number factors including lack of adequate personnel, and resource constraints. Inclusion of these and other modern forms of ICTs could support interactive communication among the knowledge actors, thereby improving knowledge creation and transfer through SECI processes. Not only will the introduction of web 2.0 technologies improve interactions among knowledge actors, necessary to facilitate transfer of knowledge through socialization and externalization, which have tacit knowledge as inputs, but also combination and internalization, which require virtual platforms for their support (Nonaka and Takeuchi, 1995). The fact that emphasis has been laid on the use of face-to-face interactions among knowledge actors in the industry also suggests that the combination phase of the knowledge creation cycle is in distress state. Since according to (Nonaka and Konno, 1998) combination takes place in the space where the use of ICTs is paramount. This is because the combination phase involves capturing and integrating discrete pieces of explicit knowledge (such as public data) into a new whole. It also involves editing and processing of explicit knowledge such as market data, reports, etc. to make it more usable. These tasks could best be accomplished through the use of technologies such as web 2.0 applications. In this regard, if these web 2.0 applications are adopted and used in the industry it would facilitate the combination phase of knowledge transfer and creation through the collection and dissemination of public data among researchers, extensionists and cocoa farmers.

9.2.4. EFFECT OF WEB 2.0 USAGE FOR KNOWLEDGE CREATION AND TRANSFER ON LEVEL OF INTERACTION AMNONG KNOWLEDGE ACTORS

At the center of the knowledge creation and transfer process is interaction. 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: cocoa farmers and extension agents, researchers and cocoa farmers, and researchers and extension officers. We theorized that knowledge actors' use of web 2.0 applications for knowledge creation and transfer would affect the level of interactions between cocoa farmers and extension agents, researchers and cocoa farmers, and researchers and extension officer and the findings of the study confirmed that. The media richness of the web 2.0 applications according to the findings of the study made it easily 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. The use of web 2.0 applications for socialization, allows cocoa farmers to have one-on-one interactions freely in the farmer groups at the community level, while allowing researchers to observe, imitate, and practice without necessarily having to be present physically at those communities even though being there face-to-face would be the ideal situation sometimes.

Research Question	Hypothesis	Independent variable	Dependent variable	Results
RQ4	H13	Extension	Farmers	Supported
	H14	Researchers	Farmers	Supported
	H15	Researchers	Extension	Supported

Knowledge actors' use of web 2.0 for externalization, allows extension agents to engage in extensive dialogue with cocoa farmers thereby helping them to convert their tacit knowledge base into shared experiences. Doing so enhances interaction among knowledge actors across the knowledge triangle. The use of web 2.0 applications for combination and internalization also involves interactions between knowledge actors and in one-way or the other. So in effect the findings have indicated that the ability of web 2.0 applications supporting all the four types of knowledge creation and transfer. And each mode of knowledge creation and transfer involves interaction among the different groups of knowledge actors. Therefore it's unsurprising that the use of web 2.0 applications for knowledge creation and transfer through SECI processes could enhance interactions among various groups of 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 (Codjoe, Brempong, & Boateng, 2013; Nana et al., 2013). Reasons for the seemingly contrasting findings could be mainly due to the degree of media richness between the existing ICT-based channels and

9.2.5. PROPOSED AKIS 2.0 MODEL FOR WEB 2.0 USAGE FOR KNOWLEDGE CREATION AND TRANSFER

The last objective of the study was to recommend a knowledge creation and transfer model based on web 2.0 usage for the cocoa industry in Ghana. This section is used to present a Web 2.0 based AKIS model for analyzing the choice and use of appropriate media for knowledge creation and transfer in the cocoa industry in Ghana. The model presented in figure 9-1 represents an amalgamation of the SECI model, AKIS model and the Media Richness Theory based on the survey results and the theoretical framework as presented in chapter 4. It constitutes a working tool for ICT-based knowledge management practice in the Cocoa industry in Ghana. According to the AKIS 2.0 model, the knowledge creation and transfer process involves four modes of conversion (socialization, externalization, combination and internalization). These processes involved in the knowledge creation and transfer requires the choice and use of media with appropriate richness. The model indicates that the knowledge creation and transfer process should be conceptualized within the framework of the key knowledge actors represented in the knowledge triangle (i.e. farmers, extension experts, and researchers).

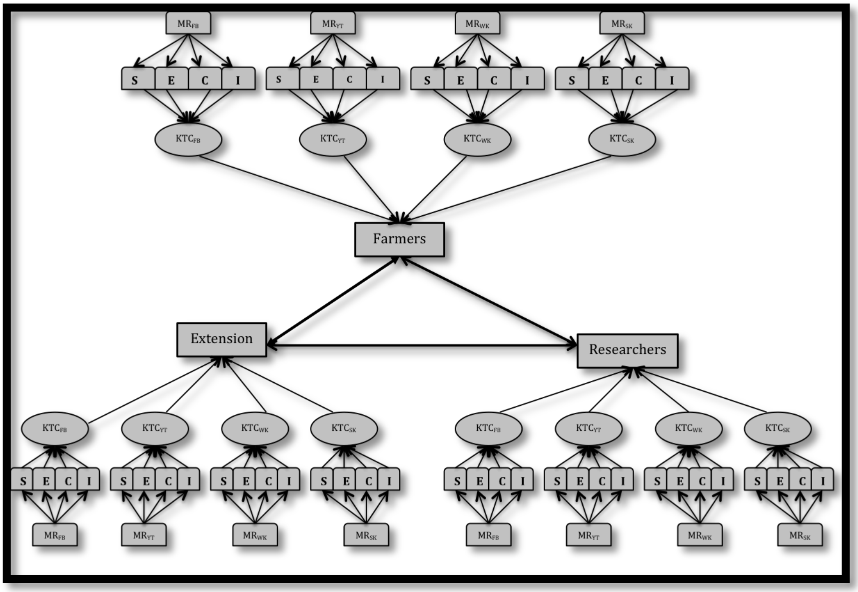

Figure 9-1:Proposed AKIS 2.0 Model for Web 2.0-based Knowledge Creation and Transfer in the Cocoa industry in Ghana 1

The study showed that knowledge of cocoa farmers is mostly tacit in nature and embedded in oral traditions. As a result, they could mainly interact and share their experiences through face-to-face communication, making socialization their major vehicle for knowledge creation and transfer. Consequently, the remaining processes (i.e. externalization, combination, and internalization) required to complete the knowledge creation cycle have remained in distressed states. Although farmers have been divided into groups within farming communities, the high extension: farmer ratio and logistical constraints makes it nearly impossible for extension experts to have any meaningful interactions with the cocoa farmers at the community levels. The distance between farming communities and researchers also makes it nearly impossible for the researchers to visit and interact with farmers since they could only do that through face-to-face via physical contact.

The study has shown that the media richness of the web 2.0 applications would make it possible for knowledge actors to use them to support knowledge creation and transfer activities through socialization, externalization, combination and internalization. It is expected that the introduction of web 2.0 application, would enhance individual farmer-to-farmer interactions required mostly at the socialization phase of the process, although not to the same degree as face-to-face physical contact. Moreover, they would also support farmer-to-extension communication, which would enable extension experts to extract farmers' tacit knowledge into readable forms as required at the externalization stage. As extension experts interact with farmers extensively through web 2.0 applications, they would be able to gain a deeper understanding of their tacit knowledge base and incorporate into the mainstream knowledge system by combining the extracted farmers knowledge with the expert scientific knowledge base. Extension experts in turn could inform researchers of the farmers knowledge needs through extension-to-researcher interaction. However, it's also expected that the researchers themselves should have interactive discussions with cocoa farmers from time to time to become abreast with the real needs of the farmers to able to design research strategies that would address the specific demands of the cocoa farmers. When farmers recognize that the knowledge generated has their input, they would be more willing to use it for improved productivity. The continuous use of web 2.0 applications for knowledge creation through SECI processes is expected to improve interaction among knowledge actors in the cocoa industry thereby strengthening the linkages between them required for effective AKIS for agricultural development.

The AKIS 2.0 model suggest that knowledge creation and transfer in the cocoa sector should begin at the levels of the communities focusing on the primary knowledge actors (cocoa farmers, extension agents and researchers) represented with the triangle at the center before transcending to the entire sector (Baah, 2006; Nana et al., 2013). Farmers are the major recipients of knowledge created through research. The knowledge creation and transfer process should be interactive two-way communication to allow all knowledge actors, especially cocoa farmers to play an active role and not act as passive recipients. The use of web 2.0 applications shouldn't be the focus of the knowledge creation and transfer process but should serve as an enabler of the process. The focus of knowledge actors' use of web 2.0 applications should be to enhance the processes involved in the creation and transfer of knowledge. Thus the use of web 2.0 applications should focus on facilitating the SECI processes by enabling the knowledge actors to create and transfer knowledge through socialization, externalization, combination and internalization. According to the study, the ability of the web 2.0 applications to facilitate the SECI processes depends on their degree of their media richness, which is based on four key characteristics: instant feedback, multiple cues, language variety, and personal focus.

9.3. IMPLICATIONS OF FINDINGS

The implications of these findings for policy, research, extension and cocoa farmers are discussed in the subsequent sub-sections.

9.3.1. POLICY IMPLICATIONS

Knowledge creation and transfer process involves active interaction among all the primary knowledge actors at the community level. This has some implications on policy. The first stages of knowledge creation and transfer should focus on the various farmer groups at the communities where the use of face-to-face communications is emphasized regarding farmer-to-farmer and farmer-to-extension interactions. At these stages the web 2.0 usage should focus on enabling researchers and extension agents to observe, imitate, and learn from the tacit knowledge base of farmers and their practices. The overreliance on face-to-face interactions at the communities has implications on government to alleviate all possible resource constraints that limits extension agents and researchers from interacting with farmers at the community level. Government should therefore step-up on providing the needed resources that would help researchers and extension officers to get closer to cocoa farmers at the community levels and have effective interactions with the various farmer groups. Interactive communication with cocoa farmers should not be left to extension officers alone but researchers equally have the responsibility of interacting with the farmers at the community levels to learn from their tacit knowledge base and use it as the basis for further research and analysis. Government should therefore create the needed environment with the required resources to enable researchers to have effective interaction with the various groups of cocoa farmers at the community level as well.

Moreover, the study provides a model to guide in the selection of appropriate media (web 2.0 applications) for the different modes of knowledge transfer towards knowledge transfer and creation, and in turn organizational learning, in the cocoa industry in Ghana. This could serve as a roadmap for the adoption of the appropriate web 2.0 technologies for knowledge management endeavors in the industry. It provides the various stakeholders responsible for ensuring effective transfer of knowledge and new agricultural technologies and innovations to cocoa farmers with information regarding the potential impact the adoption and use of web 2.0 applications could have on knowledge transfer and creation in the industry through socialization, externalization, combination and internalization.

9.3.2. IMPLICATIONS FOR RESEARCH

The findings established from the study indicated that web 2.0 usage for knowledge creation and transfer enhanced interaction among key knowledge actors in the knowledge triangle. This again has implications on research activities in the Ghanaian cocoa industry. The implication for research is that the use of web 2.0 applications would enable researchers to interact effectively with farmers at the community and group levels, without necessarily having to be in face-to-face contact with cocoa farmers, even though that presents the ideal situation. In doing so, researchers could learn from the tacit knowledge base of the farmers and use it as the basis to further their scientific analysis. Implication is that research-based knowledge would be generated on the tacit knowledge base of the farmers. Such knowledge has the potential of being more familiar and acceptable to farmers since it is based on their own experiences. Besides farmers would see such innovations as being developed with them and not for them, thus shifting their thinking from research-based knowledge as a product transferred to them top-down to seeing knowledge as a process involving multiple stages with different actors. Researchers would, thus, be able to develop innovations that lend themselves to the needs, capabilities, and resource realities of the farmers.

9.3.3. IMPLICATIONS FOR EXTENSION ACTIVITIES

The importance of media selection for the different stages and modes of knowledge creation and transfer revealed in this study has implications for the training of extension agents and officers. The era where extension agents saw themselves as carriers of agricultural information to cocoa farmers should come to an end. Instead, they should begin to see themselves as co-creators of knowledge and not as knowledge transferors. They should therefore become abreast of new media technologies that would enhance their interactions with the cocoa farmers at various stages of the knowledge creation and transfer process. They should be well versed in understanding the different phases and stages of the knowledge creation and transfer processes and the appropriate media that would enhance their interaction at each stage of the process. Extension agents should be well knowledgeable about the different roles they play at the various phases of the knowledge creation and transfer process. For instance they should understand their role as dialogue 'motivators' at the socialization stage, as tacit knowledge 'extractors' at the externalization stage, as knowledge 'integrators' at the combination phase and as 'facilitators' of experimentation and simulation at the internalization phase.

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 replaced with new media technologies, but at least they need to be complemented when replaced where necessary with new media such as web 2.0 applications especially on mobile phone platforms. Extension agents should also be made aware that not all the stages involved knowledge creation and transfer required face-to-face interactions, and so overreliance on face-to-face based mechanisms for all the different modes of knowledge transfer could impede the entire process.

9.4. CONCLUSION

The focus of the study has been on the use of web 2.0 applications and knowledge creation and transfer in the cocoa industry in Ghana. It's believed that in spite of the unusual characteristics associated with cocoa production and marketing structure of the sector, the approach and findings of the study have relevance in extension activities related to other cash crops in Ghana and the cocoa sector in other countries with similar socio-economic environment striving to improve extension activities towards increased productivity at the farm-level. The evidence adduced in the study findings suggests that the use of web 2.0 applications for knowledge creation and transfer activities could present a unique opportunity for a more efficient agricultural knowledge and information system by strengthening linkages through effective interactions among key knowledge actors towers improved cocoa productivity.

Developing cocoa production technologies requires the creation and transfer of knowledge through effective interaction among key knowledge actors and requires the use of appropriate media (media richness) for the different stages of the process (SECI) beginning with farmer-farmer interactions within specific groups, extending to various communities and transcending to the industry at large. The study provides the basis for assessing the existing mechanisms used for knowledge creation and transfer in the Ghanaian cocoa sector, while taking into consideration farmers' constraints related to resources, old age, illiteracy etc. as against the levels of interactions required for efficient functioning of the cocoa-based AKIS system. It could then assist in determining whether the introduction of new media such as web 2.0 applications to complement existing channels and mechanisms, would be able to strengthen interactive communication among various stakeholders involved in the knowledge creation and transfer process

By employing 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 the web 2.0 applications would enable knowledge actors to use them for all the SECI processes to achieve effective knowledge creation and transfer and that the use of these applications for knowledge creation and transfer would lead to improved interaction among knowledge actors. The proposition of the study regarding the effect of task analyzability on the web 2.0 usage for knowledge creation and transfer in the cocoa sector was not validated.

9.5. RESEARCH CONTRIBUTIONS

The study contributes to the existing body of literature of the fields of knowledge management, information systems and communications. It has given further clarity regarding the relationship between media choice and the knowledge creation and transfer 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 transfer. 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.

9.6. 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 access the impact the use of web 2.0 applications could have on the transfer of knowledge in other industries.

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APPENDICES

Appendix A. Survey Instrument

Task Characteristics

Please indicate the degree of analyzability of the tasks that are performed by the cocoa farmers in your team by indicating on a scale of 1-7, with 1 representing very little and 7 representing very much.

1. **Not at all**
2. **Very little**
3. **Somewhat little**
4. **Little**
5. **Moderately**
6. **Much**
7. **Very much**

Task Analyzability

1. To what extent are there clearly laid down procedures used by farmers to perform their major activities on their farms?	1	2	3	4	5	6	7
2. To what extent is there a clearly defined body of knowledge of subject matter, which can guide farmers in performing their farm-related activities?	1	2	3	4	5	6	7
3. To what extent is there a clearly understood sequence of steps that farmers can follow in performing their farm-related task?	1	2	3	4	5	6	7
4. To what extent can farmers actually rely on established procedures and practices to perform their farm-related task?	1	2	3	4	5	6	7

Knowledge transfer and creation

Please indicate how frequently you perform each of the following activities by indicating on a scale of 1-7, with 1 representing **very seldom** and 7 representing **always.**

1. **Never**
2. **Very seldom**
3. **Seldom**
4. **Sometimes**
5. **Often**
6. **Very often.**
7. **Always**

Knowledge Transfer: *In transferring knowledge to cocoa farmers in my team, we*

5. Regularly share knowledge and experience with each other.	1	2	3	4	5	6	7
6. Transform individual knowledge to shared knowledge.	1	2	3	4	5	6	7
7. Regularly talk with each other to share knowledge	1	2	3	4	5	6	7
8. Learn from each other	1	2	3	4	5	6	7
9. Offer and/attended training	1	2	3	4	5	6	7

Knowledge Creation: *In creating new knowledge in my team, we*

10. Generate new ideas	1	2	3	4	5	6	7
11. Create innovative processes	1	2	3	4	5	6	7
12. Identify improvements to reduce inefficiencies	1	2	3	4	5	6	7
13. Suggest ways of accomplishing tasks more	1	2	3	4	5	6	7

effectively and efficiently							

Media Richness

Based on your experience and perception, please kindly circle the choice that you mostly agree with

1. **Strongly disagree**
2. **Disagree**
3. **Somewhat disagree**
4. **Neither agree nor disagree**
5. **Somewhat agree**
6. **Agree**
7. **Strongly agree**

14. Social media allow me to tailor interaction according to my personal requirements							
a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7
15. Social media allow me to give and receive timely feedback							
a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7
16. Social media allow me to communicate a variety of different cues (such as emotional tone, attitude and formality)							

a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7
17. Social media allow me to use rich and varied language during communication.							
a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7

Social Media Usage for Knowledge Conversion Processes

Please indicate to what extent you agree with the statements below regarding social media usage on a scale of 1-5 with 1 representing **strongly agree** and 5 representing **strongly disagree**.

1. **Strongly disagree**
2. **Disagree**
3. **Somewhat disagree**
4. **Neither agree nor disagree**
5. **Somewhat agree**
6. **Agree**
7. **Strongly agree**

Socialization: In transferring tacit knowledge (e.g. research idea) social media usage allow you to:

25. Share experiences with each other							
a. Skype	1	2	3	4	5	6	7

	b. YouTube	1	2	3	4	5	6	7
	c. Facebook	1	2	3	4	5	6	7
	d. Wikipedia	1	2	3	4	5	6	7
26. Communicate by direct conversation								
	a. Skype	1	2	3	4	5	6	7
	b. YouTube	1	2	3	4	5	6	7
	c. Facebook	1	2	3	4	5	6	7
	d. Wikipedia	1	2	3	4	5	6	7
27. Spend time together and be together to come up with new ideas								
	a. Skype	1	2	3	4	5	6	7
	b. YouTube	1	2	3	4	5	6	7
	c. Facebook	1	2	3	4	5	6	7
	d. Wikipedia	1	2	3	4	5	6	7
28. Gain expertise through practice, observation, and imitation								
	a. Skype	1	2	3	4	5	6	7
	b. YouTube	1	2	3	4	5	6	7
	c. Facebook	1	2	3	4	5	6	7
	d. Wikipedia	1	2	3	4	5	6	7
29. Use apprenticeship and mentoring in training farmers especially new ones								
	a. Skype	1	2	3	4	5	6	7
	b. YouTube	1	2	3	4	5	6	7

c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7

Externalization: In converting tacit knowledge (e.g. research idea) to explicit knowledge (e.g. manuals) social media usage allow you to:

30. Use analogies to convert tacit knowledge into readable forms							
a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7
31. Use metaphors (e.g. pictures and images) to transfer ideas to farmers							
a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7
32. Use expert location systems that point experts to farmers							
a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7
33. Problem-solving based learning like case-based reasoning							

a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7

Combination: In converting one form of explicit knowledge (e.g. manuals) to another form of explicit knowledge (e.g. newspaper) social media usage allows you to:

34. Edit and modify existing documents (e.g. reports and best practices) Create new materials by gathering existing documents							
a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7
35. Build presentations to share documents							
a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7
36. Use repositories of information, best practices, and lessons learned							
a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7

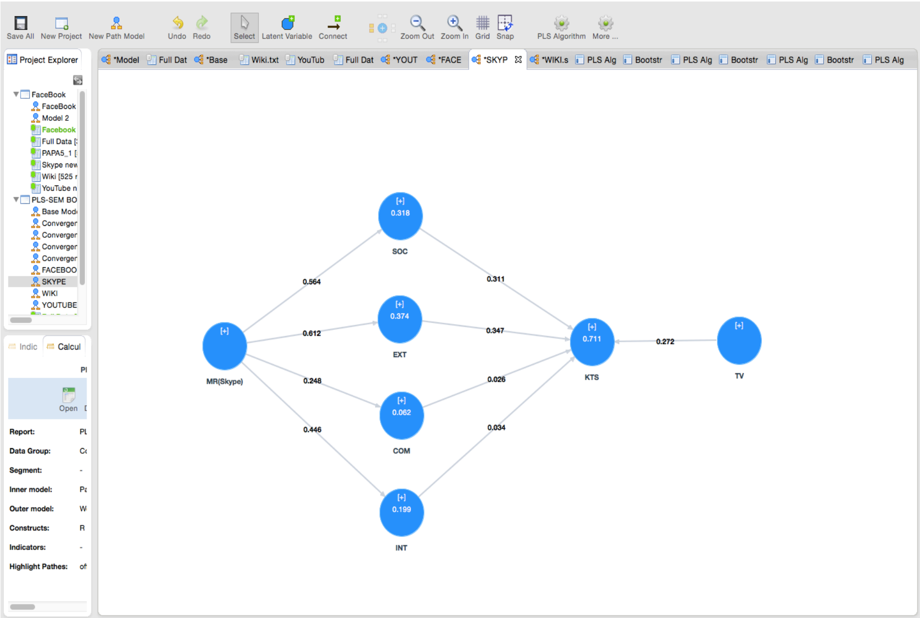
	d. Wikipedia	1	2	3	4	5	6	7
37. Use databases								
	a. Skype	1	2	3	4	5	6	7
	b. YouTube	1	2	3	4	5	6	7
	c. Facebook	1	2	3	4	5	6	7
	d. Wikipedia	1	2	3	4	5	6	7

Internalization: In converting explicit knowledge to tacit knowledge, social media usage allows you to:

38. Search for ideas from existing materials								
	a. Skype	1	2	3	4	5	6	7
	b. YouTube	1	2	3	4	5	6	7
	c. Facebook	1	2	3	4	5	6	7
	d. Wikipedia	1	2	3	4	5	6	7
39. Have discussions with others to deepen your understanding of materials and documents								
	a. Skype	1	2	3	4	5	6	7
	b. YouTube	1	2	3	4	5	6	7
	c. Facebook	1	2	3	4	5	6	7
	d. Wikipedia	1	2	3	4	5	6	7

40. Conduct experiments to embody knowledge								
a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7
41. Learn by doing							
a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7
42. Learn by observation							
a. Skype	1	2	3	4	5	6	7
b. YouTube	1	2	3	4	5	6	7
c. Facebook	1	2	3	4	5	6	7
d. Wikipedia	1	2	3	4	5	6	7

Appendix B. User interface of SmartPLS3



Appendix C. Definition of terms used in the survey

Variable	Measure	Description	Reference
Socialization	Tacit knowledge accumulation	Refers to the extent to which the use of web 2.0 applications (Skype, Facebook, Wikis, YouTube) enable researchers and extension agents to gather information from other divisions of the Board, share experiences and engage in dialogue among themselves and cocoa farmers,	Nonaka et al. (1994); Lopez- Nicolas &Soto-Acosta (2010); Haag (2010)
	Extra-firm social information gathering	Refers to the extent to which the use of web 2.0 applications (Skype, Facebook, Wikis, YouTube) enable researchers and extension agents to have interaction and informal meetings with external experts and cocoa farmers	
	Intra-firm social information collection	Refers to the extent to which the use of web 2.0 applications (Skype, Facebook, Wikis, YouTube) enable researchers and extension agents to gather information inside the Board	
	Transfer of tacit knowledge	Refers to the extent to which the use of web 2.0 applications (Skype, Facebook, Wikis, YouTube) create work environment that allows farmers to understand technical knowledge and expertise through practice and demonstration by researchers and extension agents	
Externalization	Externalization	Refers to the extent to which the use of web 2.0 applications (Skype, Facebook, Wikis, YouTube) facilitate: creative and essential dialogue, use of inductive and deductive thinking, use of metaphors in dialogues for concept creation, exchanging various ideas and dialogues	Nonaka et al. (1994); Lopez- Nicolas &Soto-Acosta (2010); Haag (2010)
Combination	Acquisition and Integration	Refers to the extent to which the use of web 2.0 applications (Skype, Facebook, Wikis, YouTube) enable researchers and extension agents to assemble internal and external data by using published literature, computer simulation and forecasting	Nonaka et al. (1994); Haag (2010)
	Synthesis and processing	Refers to the extent to which the use of web 2.0 applications (Skype, Facebook, Wikis, YouTube) enable researchers and extension agents to build and create manuals, documents, and databases on their research findings and technical knowledge	
	Dissemination	Refers to the extent to which the use of web 2.0 applications (Skype, Facebook, Wikis, YouTube) assist researchers and extension agents to engage in planning, implementation of presentations to transmit newly	
Internalization	Personal experience. Real world knowledge acquisition	Refers to the extent to which the use of web 2.0 applications (Skype, Facebook, Wikis, YouTube) enable researchers and extension agents to search and share new values through communication among themselves and cocoa farmers	Lopez- Nicolas &Soto-Acosta (2010); Haag (2010)
	Simulation and experimentation. Virtual world knowledge acquisition	Refers to the extent to which the use of web 2.0 applications (Skype, Facebook, Wikis, YouTube) enable researchers and extension agents to form teams as a model and conduct experiments and share results with themselves and cocoa farmers	
Media Richness		Media richness defines the extent to which the use of web 2.0 applications (Skype, Facebook, Wikis, YouTube) enable researchers and extension agents to give and receive timely feedback, to communicate in a variety of different cues (such as emotional tones, attitude, or formality), to tailor tailor interactions according to personal requirements, and to use rich and varied language during communication	Saeed and Sinnappan (2009); C.Koo et al. (2010); Daft et al. (1987)
Task Analyzability		Task Analyzability refers to the extent of availability of systematic solutions to potential problems, extent to which there is a clearly known way to do the work they are supposed to do, and the extent of clearly defined body of knowledge of the subject to guide their work.	Daft and Lengel (1986); Anothayanon (2002)
Knowledge Transfer Satisfaction			

Appendix D. Raw Data From Analysis

Facebook farmer (100).xlsx

Facebook farmers (moderation).xlsx

FACEBOOK FINAL (Bootstrap Results).xlsx

FACEBOOK FINAL (MODERATION).xlsx

Skype Farmers (100) moderation.xlsx

Skype Farmers (100).xlsx

SKYPE FINAL (Bootstrap Results).xlsx

SKYPE FINAL (INTERACTION).xlsx

SKYPE FINAL REPORT.xlsx

WIKI FINAL (INTERACTION).xlsx

WIKI FINAL (MODERATION).xlsx

WIKI FINAL REPORT.xlsx

Wikipedia farmers (100).xlsx

Wikipedia farmers (100) moderation.xlsx

YouTube Farmers (100).xlsx

YOUTUBE FINAL (MODERATION).xlsx

YOUTUBE FINAL REPORT.xlsx

YOUTUBE FINAL(Bootstrap Results).xlsx

YOUTUBE FINAL(INTERACTION).xlsx

YT farmers (Moderation).xlsx

SECOND ORDER ANALYSIS FINAL.xlsx

SECOND ORDER ANALYSIS FINAL.xlsx

MULTIGROUP 1.xlsx

MULTIGROUP 2-order.xlsx

Appendix E. Preliminary Study Questionnaire

Appendix F. LETTERS OF INTRODUCTION FOR DATA COLLECTION

Aalborg University Copenhagen
CMI | Frederikskaj 12, 3rd Floor
A. C Meyer Vænge 15, DK 2450
Copenhagen SV
+ 45 9940 3661
www.aau.dk , www.cmi.aau.dk

2nd June, 2012

TO WHOM IT MAY CONCERN

COCOA RESEARCH INSTITUTE
DATE RECEIVED 3/7/13

Dear Sir,

INTRODUCING MR. ALBERT GYAMFI (PhD Fellow)

This serves to formally introduce the above named as a full time PhD student in the Doctoral School of Engineering and Science, Aalborg University, Denmark. Mr. Albert Gyamfi is conducting a research project with the theme "***Web 2.0 technologies that can influence Knowledge Transfer from Researchers to Cocoa farmers in Ghana***"

Mr Gyamfi would like to collect data for the above research project by way of interviewing staff who have specialized tacit knowledge and skills in different areas of specialization in your institution. We kindly request that you assist Mr. Gyamfi to distribute questionnaires and/or conduct face-to-face interviews in your research institute. This vital, but humble request would enable him to recommend web 2.0 technologies that could be implemented for the transfer of knowledge from research institutes to cocoa farmers in Ghana. Any additional assistance given to Mr. Gyamfi would be highly appreciated.

We fervently believe that your kind support and keen interest in this respect will go a long way to ensure the success of his research. For any further information about Mr. Gyamfi, please do not hesitate to contact the undersigned.

Thank you for your kind assistance.

Yours sincerely,

Anders Henten

Anders Henten, (Professor)

R O'ers
Pls assist gentleman
UA Johna
03-06-13

(3) Sc-Sy
P) deal.
3/7/13

GHANA COCOA BOARD

COCOA HOUSE
P. O. BOX 933
ACCRA
GHANA

TEL: 233-302-661752/661872/
661757/678916/678972
FAX: 233-302-667104/669808
E-mail: cocobod@cocobod.gh
WEBSITE: www.cocobod.gh
CABLE: COCOBOD, ACCRA.

IN YOUR REPLY
PLEASE QUOTE: PER/INT/AT/V.20/201

DATE: 18/07/13

THE DIRECTOR, RM&E, COCOBOD
THE EXECUTIVE DIRECTOR, CRIG
THE AG. EXECUTIVE DIRECTOR, SPU
THE AG. EXECUTIVE DIRECTOR ,CSSVD CONTROL UNIT
THE PUBLIC AFFAIRS MANAGER, COCOBOD

LETTER OF INTRODUCTION

We forward, herewith, an introductory letter dated 22nd June, 2013, in respect of **Mr. Albert Gyamfi**, who is a full time PhD student in Doctorial School of Engineering and Science, Aalborg University, Denmark.

Kindly assist him in the collection of data for his research project on the theme **"Web 2.0 technologies that can influence Knowledge Transfer from Researchers to Cocoa farmers in Ghana"**.

We would also appreciate it, if staff with specialized knowledge could grant interview to Mr. **Albert Gyamfi (Phd. Fellow)** and fill the questionnaire accordingly.

We rely on your co-operation.

F. A. TEMENG
AG. DIRECTOR, HUMAN RESOURCE

cc: Deputy Chief Executive (F&A, A & QC, Ops)
Human Resource Manager
Mr. Albert Gyamfi (Phd. Fellow)

*** *Cal/al*

APPENDIX F. LETTERS OF INTRODUCTION FOR DATA COLLECTION

SECTION A

INTRODUCTION

Background Information

1. Please kindly indicate your level of formal education by ticking (√) any of the following:

Certificate	
Diploma	
Bachelors	
Master's	
PhD	
Postdoctoral	

2. For how many years have you been performing in your current position?

0-5	
6-10	
11-20	
21-30	
31-40	
Other (please specify)…………………… ……………………………………………	

SECTION B

Organizational Knowledge Transfer

Organizational knowledge transfer is the process of exchanging knowledge (explicit/implicit) between two agents during which one agent applies the knowledge provided by the other agent.

3. What knowledge needs is your department supposed to provide for cocoa farmers?

Quality control	
Pest management	
Post harvest management	
Seed production	
Marketing research	
Any other (please specify) …………………………………………………………………………………….. ……………………………………………………………………………………..	

4. How much new knowledge is your institute capable of generating to cocoa farmers?

Nothing	
Very little	
Average	
A lot	

Don’t know	

5. In your own estimation, is transferring knowledge to cocoa farmers a priority in your organization?

Yes	
No	

6. How much of the knowledge you generate are you able to transfer to cocoa farmers?

Nothing	
Very little	
Average	
A lot	
Don’t know	

7. Are there some difficulties your organization face in transferring knowledge to cocoa famers?

Yes	
No	

8. How would you describe the level of difficulty in transferring knowledge from your institute to cocoa farmers?

Moderately difficult	
Difficult	

Very difficult	
Extremely difficult	
Don't know	

9. Please can you mention precisely, what some of these difficulties of transferring knowledge from your institute to cocoa farmers are?

   ……………………………………………………………………………………

   ……………………………………………………………………………………

   ……………………………………………………………………………………

10. Which of the following would you consider as barrier(s) for your organization in transferring knowledge to cocoa farmers? Please tick all that apply

The kind of knowledge we generate is difficult to codify and articulate	
The knowledge we generate is too complex to be transferred to cocoa farmers	
We don't have enough time and resources to transfer the knowledge we generate to the farmers	
Cocoa farmers don't trust in the knowledge we generate	
It requires too much time and cost to meet the cocoa farmers face-to-face in order to share knowledge	
It is difficult for cocoa researchers to develop interpersonal relationships with cocoa farmers and exchange knowledge informally	
Cocoa farmers are not self-motivated to acquire new knowledge from the cocoa research institutes	
Cocoa farmers don't recognize the value of new knowledge provided	

by the cocoa research institutes	
Lack of motivation for researchers in transferring knowledge to cocoa farmers	
Any other? Please specify……………………………………………………………………. ……………………………………………………………………………………… ………………………………………………………………………………………	

11. Which practical steps would you suggest to research institute to take to eliminate some of these barrier(s)? Please tick all that applies.

Research institutes should transfer new knowledge in simple, precise and clear in language that cocoa farmers can understand	
Research institutes should transfer knowledge that is easy for cocoa farmers to adopt and utilize	
Research institutes should make relevant new knowledge more available and accessible to cocoa farmers	

Research institutes should allocate more time and resources to transfer of knowledge to cocoa farmers	
Research institutes should give incentive packages to their researchers in order to encourage them to engage in knowledge transfer activities to the farmers	
Research institutes should use more interactive transfer mechanisms (e.g. internet applications) to transfer knowledge to cocoa farmers	

12. In your opinion which of the following are the most important factors in the transfer of knowledge from research institutes to cocoa farmers? ***(Please circle the appropriate number according to their order of importance to you on a scale of 1-6, where 1 represent the least important and 6 denotes the most important)***

Research institutes should transfer new knowledge in simple, precise and clear in language that cocoa farmers can understand	1	2	3	4	5	6
Research institutes should transfer knowledge that is easy for cocoa farmers to adopt and utilize	1	2	3	4	5	6
Research institutes should make relevant new knowledge more available and accessible to cocoa						

farmers	1	2	3	4	5	6
Researcher institutes should allocate more time and resources to transfer of knowledge to cocoa farmers	1	2	3	4	5	6
Research institutes should give incentive packages to their researchers in order to encourage them to engage in knowledge transfer activities to the farmers	1	2	3	4	5	6
Research institutes should use more interactive transfer mechanisms (e.g. internet applications) to transfer knowledge to cocoa farmers	1	2	3	4	5	6

13. Please are there some incentives for researchers who devote time and resources to transfer knowledge to cocoa farmers?

Yes	
No	

14. a) If YES, which of the following motivational incentives are available to researchers for transferring knowledge to cocoa farmers? Please tick all that applies.

Monetary rewards such as bonuses	

Opportunity to enhance their career	
Praise and public recognition	
Promotion	
Don't know	

14 b) Any other? Please specify

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

SECTION C

Knowledge Transfer Mechanisms

Knowledge transfer mechanisms refers to all the various means through which knowledge moves from along the knowledge transfer process

15. a) Which of the following tools do you commonly use as a mechanism for transferring knowledge from your organization to cocoa farmers? Please tick all that applies.

	1	2	3	4	5
1. How many of the task the farmers perform on their farms are the same from time to time?					
2. To what extent would you say that the farmers' activities are routine?					
3. The farmers in your group perform the same activities in the same way most of the time					
4. Farmers in your unit perform repetitive activities in taking care of their cocoa farms					

5. How repetitive would you describe the activities of the farmers in your unit?					
Informal face-to-face interactions					
Conferences					
Seminars					
Workshops					
Newsletters					
Newspapers					
Brochures					
Training sessions					
Reports					
Radio					
Mobile phones					

b) Any other? Please specify………………………………………………………..

……………………………………………………………………………………

16. In your opinion, which ***five*** of the following are the most effective means for transferring knowledge from your research institute to cocoa farmers?

Please circle only five according to the order of importance to your institute, from 1-5, ***where 1 denotes the least important and 5denotes the most important.***

On farm engagements	1	2	3	4	5
Informal face-to-face interactions	1	2	3	4	5
Conferences	1	2	3	4	5
Seminars	1	2	3	4	5
Workshops	1	2	3	4	5
Newsletters	1	2	3	4	5
Newspapers	1	2	3	4	5
Brochures	1	2	3	4	5
Training sessions	1	2	3	4	5
Reports	1	2	3	4	5
Radio	1	2	3	4	5

Mobile phones	1	2	3	4	5
Other	1	2	3	4	5

17. Are there some difficulties your organization face in using these tools for transferring knowledge to cocoa famers?

Yes	
No	

18. If YES, can you please mention some of the difficulties you face in transferring knowledge to cocoa farmers with these tools

....

……………………………………………………………………………………..

……………………………………………………………………………………..

………………………………………………………………………………………

19. How much does the use of these tools affect the amount of knowledge your institute wishes to transfer to cocoa farmers?

Nothing	
Very little	
Average	
A lot	

Don’t know	

20. Would you prefer to use any other tools to transfer knowledge to cocoa farmers?

Yes	
No	

21. If YES, can you suggest some additional tools other than the ones you use?

…………………………………………………………………………………

…………………………………………………………………………………

SECTION D

The possibility of using Web 2.0 tools as knowledge transfer Mechanism

Web 2.0 technologies are internet tools that allow internet users, who used to be only consumers of information on the internet, to now create and share contents such as video, audio or text on the internet without having any specialized skills to do so.

These Internet tools include:

Blogs: *Blogs* are personal Web diaries that allow individuals to bring up their ideas, experience and opinions on a subject to bear. Blogs can combine texts, images, sound, and video.

Wiki: is a co-authorship tool used to build up shared knowledge within the web 2.0 environment. The most popular example of a wiki web application (website) is Wikipedia, which is an internet encyclopedia that is co-authored by users.

Media sharing tools**:** Digital content management refers to the group of websites that allow users to share videos, sounds and images being it personal or professional with other end-users. Popular websites that use these media sharing tools include YouTube and PodcastAlley.

Social networking tools: allow users to connect on shared interest, hobbies, values or friends via online. Example of social networking websites is Facebook.

22. Does your organization have access to Internet connectivity?

Yes	
No	

23. If YES, does every researcher have access to the Internet in your organization?

Yes	
No	

24. Which of these Internet tools are you familiar with? Please tick all that applies.

Web portals (websites)	
Wikis (e.g. Wikipedia)	
Blogs	
Social networks (e.g. Facebook)	
Media sharing (e.g. YouTube and Podcast)	
Discussion forums	
Skype	

Video conferencing	
None of these	

25. Any other? Please specify……………………………………

26. In your own opinion, do you think it is possible to use the internet to transfer knowledge to cocoa farmers?

Yes	
No	

27. If NO, could you please state some reasons why you think is not possible?
……………………………………………………………………………………

…………………………………………………………………………………...

……………………………………………………………………………………

28. If YES, which of the following Internet tool(s) would you recommend to use to transfer knowledge to cocoa farmers? (Please tick (√) all that apply)

Web portals (websites)	
Wikis (e.g. Wikipedia)	
Blogs	

Social networks (e.g. Facebook)	
Media sharing (e.g. YouTube and Podcast)	
Discussion forums	
Skype	
Virtual conference rooms	
Other, please specify………………………………………………………. ……………………………………………………………………………….	

29. If your organization decides to use these tools to transfer knowledge to cocoa farmers, what are some of the challenges your organization is likely to face?
………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

30. In spite of the challenges, would you suggest to your organization to use web 2.0 tools to transfer knowledge to cocoa farmers?

Yes	
No	

31. If NO, can you please state why?

....

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

32. If YES, which of these categories of web 2.0 internet tools would you recommend for your organization to use for transferring knowledge to cocoa farmers? Please tick all that applies

Collaboration tools (e.g. wikis)	
Cooperation tools (e.g. media sharing)	
Communication tools (e.g. blogs)	
Connection tools (e.g. Facebook)	
Other, please specify……………………………………………………………… ………………………………………………………………………………………	

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