Developing a Framework of Agriculture Knowledge Management Process in Indian context

by

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Declaration

I hereby declare that

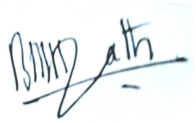
i) the thesis comprises of my original work towards the degree of DOCTOR OF PHILOSOPHY at Dhirubhai Ambani Institute of Information and Communication Technology and has not been submitted elsewhere for a degree,

ii) due acknowledgment has been made in the text to all the reference material used.

Ram Naresh Kumar Vangala

Certificate

This is to certify that the thesis work entitled DEVELOPING A FRAMEWORK OF AGRICULTURE KNOWLEDGE MANAGEMENT PROCESS IN INDIAN CONTEXT has been carried out by RAM NARESH KUMAR VANGALA for the degree of DOCTOR OF PHILOSOPHY at *Dhirubhai Ambani Institute of Information and Communication Technology* under our supervision.



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Abstract

In the current economy of global competition, many organizations are using knowledge as one of the means to gain sustainable competitive advantage. Knowledge is becoming a critical success factor for organizational performance.

Knowledge management (KM) has evolved as a significant process for managing and exploiting organizational knowledge. However, the literature relating to KM in agricultural organizations is limited that to specific to Indian agricultural organization is too little. The sustainability of agriculture relies on the effective use of the organization's knowledge assets and resources. KM therefore has a major role in assisting Indian agricultural organizations to achieve performance excellence. The first objective of this study is to develop a context-aware framework to guide organizations in their efforts to manage knowledge (both tacit and explicit), and thus contribute to the development of organizations and farm communities in the global knowledge economy. To achieve the main goal, multiple case studies was conducted in Indian milk cooperatives and non-profit organizations. The analysis of the data reveals some local contextual issues and assumptions that are of importance in developing KM framework to support agricultural organizations. The framework constructed in the study embeds organizational variables - which includes farmers, experts, policy makers and information and communication technology (ICT) etc. It allows organizations to identify which knowledge processes needed to be addressed to achieve their goals.

Like any other management initiative, implementing and measuring the KM process in agricultural organization is one of the important decisions. To measure the success or failure of the AKM process an organization also needs to develop a set of metrics. Thus, the second objective of the study is to proposed metrics

for measuring effectiveness of AKM process in agricultural organizations. Literature review for the current research indicated that widely-accepted performance measures have been developed for organizations like the IT sector, Automobile etc. From the secondary resource data, the study has proposed 16 items or criteria for measuring AKM process in agricultural organizations. These 16 items can be determined by using quantitative or qualitative approaches.

The third objective of the study was to determine the linkage between ICT and AKM processes in Indian agricultural organizations. To achieve this objective, a mixed method (qualitative and quantitative) approach was used. Responses from a sample of 283 respondents was collected from four different organizations. The analysis and hypothesis testing were implemented using structural equation modeling (SEM). The analysis shows that there is a significant and positive relationship between ICT and AKM processes. The approach used in this study may be replicated by managers to effectively use ICT in the AKM process of their organizations. They could also fine tune their existing ICT infrastructure and tools to achieve greater effectiveness of their AKM processes.

This thesis contributes to ICTD and KM research and practice through the empirical findings, the design of AKM process framework, the development of metrics for measuring AKM process in agricultural organizations, and analytical tool developed for studying the relationship between ICT and AKM process in agricultural organizations. Its major contributes include development of AKM framework, and understanding of affect of ICT on AKM process in the context of Indian agriculture.

Keywords: Knowledge management (KM), Agriculture, Information and communication technology (ICT), Milk cooperatives, Non-government organizations (NGOs), Structural equation modeling (SEM),

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CHAPTER 1

Introduction

1.1 Background

In the modern era of globalization, knowledge has been recognized as a valuable organizational resource from a strategic perspective [1] and an important factor for competitive advantage, effective organizational performance and success [2]. Hence knowledge has become a precious asset and its management i.e, knowledge management (KM) has been widely practiced by many organizations, research institutions and academia as one of the most promising ways of achieving success in the information age.

Knowledge Management (KM) is a dynamic and continuous set of the processes that enables the organization to enhance and expands their innovation processes [3] [4] and ensure that people have the right knowledge, in the right place and at the right time [5]. It typically focuses on the organizational objectives such as to improve performance, to establish an environment in which people are encouraged, as individuals and groups, to create, learn, share and use knowledge for the benefit of people within and outside the organization.

ICT stands for Information and Communication Technology used both as singular and plural nouns. According to United Nation Development Program (UNDP)[1], ICT has been defined as "the combination of microelectronics, computer hardware and software, telecommunications, and storage of huge amounts of information, and its rapid dissemination through computer networks". The widely

[1] http://hdr.undp.org/en/content/human-development-report-2001 (accessed on July 2016)

availability of ICT, such as the Internet has enabled the development of communication and collaboration tools such as e-mails, on-line discussion forums, net meetings, webinars and video conferencing [6]. It has played important roles in enabling and supporting knowledge management in organizations [7][8][5]. ICT support for KM has been recognized as contributing factor to the success of different companies such as IBM, Hewlett Packared, Texas Instruments and Buckman Labs [9].

Agriculture is the backbone of the Indian economy, as it support the rural livelihood security. More than 60 percent of Indian population depends on agriculture and its allied fields. The Green Revolution in the late 1960s resulted in the increase of productivity of major cereals in irrigated areas and as transformed Indian agriculture from food deficit to becoming food sufficient. Despite periods of strong growth in the past, currently this sector faces various challenges like climate change, declining water availability, degradation of land, increased biotic pressure, high cost of cultivation, environmental degradation etc. The Central and state government have different schemes to benefit farmers. But the benefits of the schemes do not reach the farmer nor are the majority of the farmers aware of the schemes. The National Commission on Farmers opined that the knowledge deficit severely constrains the agricultural productivity. This also highlighted the failure of public extension system and inability of extension workers to enrich the farmers with knowledge of new technologies [10] that can enable farmers to improve their productivity.

India has been practicing agriculture since ancient times, hence it has a vast amount of knowledge in agriculture domain. Management of agricultural knowledge takes place at different levels: individual, within communities, within organizations or institutions and networks of them [11]. There are different state and non-state actors like Government, Co-operative sector, Private entities, Non-Government Organizations (NGOs), etc. operating in Indian agricultural sector with different objectives like productivity enhancement, the well-being of the farming community and creating and enhancing agri-business opportunities [12]. Knowledge Management in agriculture has been reported to be in a developing

stage [13] while the amount of knowledge available in agricultural related organizations is enormous when compared to the other sectors like service, manufacturing, and health care. The agriculture knowledge has often not been created, documented or disseminated by one single source or organization, and it has been also stated that a large part of knowledge utilized by the organization is not explicit but tacit, that resides with individuals [14]. Moreover, different types of organizations produce different kinds of knowledge and the lack of co-ordination or linkages between public, private, agricultural research and extension institutions are often cited as a reason for ineffective knowledge transfer to farmers [15]. Therefore while KM in agriculture has an immense scope and it still poses challenges for managing agricultural knowledge in public, private and non-government organizations in India [13].

Agriculture Knowledge Management (AKM) is the process of generating, creating knowledge repositories, improving knowledge access, sharing and disseminating and effective utilization to meet current and emerging challenges in agricultural development and enhancing the knowledge environment in rural communities [16]. Given that utlization of natural resources like land and water are almost reaching their limits, "knowledge resources" and "technological innovations" are required to achieve food security [15]. It has been widely recognized that transfer of relevant knowledge can play an important role in the organizations' growth and productivity and can help small and marginal farmers to improve their yields and get better market prices [17]. In this scenario, AKM with support of ICT can enhance the traditional agriculture extension system to deliver good practices to the farmers. ICT has the potential to make AKM more substantive by providing affordable, relevant, searchable and up-to-date agriculture information service to farm communities [17] and can accelerate Indian agricultural development by facilitating knowledge management [18].

Kissan Kerala is an integrated, multi-modal delivery of agricultural information system, which provides several dynamic and valuable information and advisory services to the farming community across Kerala. The project provides authentic agricultural information though various delivery methods like televi-

sion, Internet, telephone and mobile phones. An extensive location-specific crop database has also been prepared under the project. The portal provides dynamic agri-advisory services like market information, market location and crop-wise weather alerts. It also provides an on-line query management system through which experts answer the queries of farmers, particularly about fertilizer recommendations (in local language) for preferred crops. Farmers can ask any questions to the agricultural scientists through telephone and seek their advice. Location-specific Short Message Service (SMS) alerts are also provided in the project. A weekly agriculture television program of 30 min duration is also broad-casted on Asia-net in Malayalam language, which provides selective information on the dissemination of market analysis, best practices, success stories, departmental news, news on various schemes and cultivation methods [16][82]

However, few studies have been reported that to assess the extent to which indigenous knowledge (IK) can be managed through KM approaches in the developing countries. Noeth (2006), has reported that the available information and knowledge was not managed effectively, and suggested that a generic KM model (knowledge identification, knowledge mobilization, knowledge generation/elaboration, knowledge application and knowledge evaluation) could be an effective way to improve KM activities and delivery of services in the rural communities of South Africa [26]. Boateng (2006), revealed that the circular KM model can be used by agricultural extension officers to inform farmers' regarding improved technologies, and to incorporate farmers' knowledge in the design and development of such technologies in Ghana [27]. Rajasekaran (1993), has proposed a framework for incorporating indigenous knowledge systems into agricultural research and extension organizations for sustainable agricultural development in India [28].

1.2 Motivation for this research

During the last decade, KM has been witnessing significant interest from research communities and has been rapidly emerging as a formal discipline in organiza-

tional studies. Since agricultural organizations differ from organizations in other sectors in terms of their knowledge needs and in terms of the context for KM they provide, the studies of KM in agriculture are limited in Indian context.

Information and knowledge required for agriculture production, generally comes from research organizations, government and private sector, NGOs and institutional establishments. This can be enhanced by using ICT activities through the integration of these organizations along with farm communities. There is a need to understand how to convert required information into knowledge by acquiring, transmitting, altering and integrating it into conceptual systems among individuals, groups and organizations. The AKM can be improved by breaking down the barriers of knowledge exchange between expert group and farm communities. The AKM can be more effective by the use of ICT by allowing for farmers' participation in developing the best solution to make decisions more effective [19].

Many authors have focused on the importance or impact of ICT in Indian agriculture. For example, Gummagolmath *et al* (2011), discussed ICT initiatives in Indian agriculture [12]. Xiaolan Fu and Shaheen Akter (2012), examined the impact of a mobile phone technology-enhanced service delivery systems on agricultural extension service delivery in India [20]. Patil *et al* (2011), had discussed about the AKM portals like AGROPEDIA, aAQUA, AKM India which are developed with collaboration of state agriculture universities and Indian Institute of Technologies (IITs). These platforms have provided very useful tools for effective transfer of agriculture knowledge in India [16].

Literature study, research analysis and study of various ICT projects in Indian AKM revealed that most of these are focused on aspects of transfer or dissemination of agriculture information and knowledge which has been predominantly used to support traditional extension system. Yadav *et al* (2015), explored the challenges in using ICT for AKM by using the case of AGROPEDIA. The authors have argued that AKM is no longer a technical challenge but is rather constrained by social and organizational barriers. Without initiating institutional framework and policy changes to address these barriers, ICT cannot contribute significantly

to KM [21].

Organizations in Indian agriculture, have realized the importance of knowledge management (Tacit and Explicit; Internal and External) for creating, organizing and dissemination purposes [22][23]. Knowledge Management in the context of Indian agriculture has been reported to be still in a nascent stage i.e, it is relatively a new concept and its potential has not been fully utilized [13][24][25]. The concept of KM in agriculture extension is emerging as a viable factor of production in the developing countries like India [24].

It has been stated that ICT can offer a wide range of opportunities for institutionalizing KM for agricultural development and their implementation needs to be addressed independently in three institutional environments viz public, private and NGOs." [19]. Kale *et al* (2015), suggested the is need to develop an integrated policy framework to link the ICT based initiatives for faster dissemination of agriculture knowledge among the various stakeholders in agriculture sector (public, private, NGOs, farm communities etc.) [10].

1.3 Research questions and objectives

From the literature, several models and frameworks have been identified to guide KM processes in organizations. These are mostly based on experiences and studies in Western Industrialized countries that are already becoming knowledge economies. For agricultural organizations in developing countries like India to participate in this new economy, there is a need for KM process models that take into account the local context.

It is evident that there are few notable studies to understand the principle in managing IK in the local communities. But there is a lack in the studies related to flow and management of knowledge at organizational level in Indian agriculture sector. The studies have not focused on KM process at organizational level and constraints they face in KM process. Moreover, fewer studies have concentrated on the relationship between ICT and knowledge management process at agricultural organization level in the Indian context. It is not clear about the nature of the

relationship between ICT competency and agriculture knowledge management process. Hence, empirical studies in this area are required.

Arising from the gaps identified above, the following research questions are framed

- How knowledge (both tacit and explicit) flow within and outside organization?
- What are the knowledge management processes (from acquisition to application) needed in agricultural organizations?
- What are the knowledge management processes (from acquisition to application) taking place in agricultural organizations?
- Are there any metrics for measuring knowledge management performs in agriculture organization?
- How do the knowledge enablers like ICT influence knowledge management process in organization?

The above questions are investigated by means of three objectives. The findings have been reported in four publication and are further discussed in this thesis. These three objectives are:

1. To develop a agricultural knowledge management framework to guide organizations in their efforts to manage both tacit and explicit knowledge.
2. To develop metrics for measuring knowledge management performance in agriculture organization.
3. To understand the linkage between ICT and agriculture knowledge management process in agricultural organization.

1.4 Significance and contribution of the study

This study sought to assess the application of KM approaches and ICT in managing both tacit and explicit knowledge in Indian agricultural organizations and

introducing relevant metrics for measuring AKM performance in agricultural organizations. The study findings were thus of significance by providing the empirical evidence of how KM principles and ICTs can be applied to manage both tacit and explicit knowledge by integrating knowledge to the organizational knowledge system for improved agricultural activities. The finding of the study were thus expected to be significant:

- as it provides the the empirical evidence of how ICT effects the AKM process in agricultural organization.
- to academia, researchers and practitioners of KM and ICTD in understanding the comprehensive view of the challenges and scope of AKM in developing countries like India .
- as it provides practitioners with an understanding of how to utilize AKM initiatives in their organizations.

A further discussion about the significance and contribution of the study is presented in Section 6.4 of Chapter Six

1.5 Organization of dissertation

This dissertation consists of six chapters, the current chapter 1 provides a background of the problem addressed by the research study. It includes motivation for the research, research objectives that frame the investigation. Furthermore, it presents the significance of the study

Chapter 2 provides a literature review of the relevant areas addressed in this research including key definitions. It covers importance of KM, various definitions of knowledge, classification of knowledge, definitions of KM. It talks about Indian agriculture, types of organizations in Indian agriculture. The chapter concludes with mention of some of the ICT projects in Indian agriculture.

Chapter 3 proposes the theoretical framework of agriculture knowledge management process. In this chapter, the various KM models reported in the literature have been critically reviewed to understand them. Furthermore, it includes

methodology adopted in developing the framework and case studies of organizations. The chapter concludes with the new proposed theoretical framework of agriculture knowledge management process.

Chapter 4 presents a set of metrics for measuring AKM performance. Before proposing the metrics for AKM process, various indicators proposed in the literature have been discussed. A discussion on the importance of the metrics for AKM process has been presented in this chapter. At the end, a set of metrics for AKM processes for agricultural organizations have been proposed and discussed.

Chapter 5 discusses about the relationship between ICT and AKM process in agricultural organizations. This chapter presents the research framework and hypothesis for studying the effect of ICT on AKM process, research methodology, developing questionnaires for both dependent and independent variables, methods for statistical analysis, and finally discusses the results.

Chapter 6, gives the conclusion, contribution of this research and limitations and future work.

1.6 Chapter summary

This chapter has laid the foundation for this thesis to communicate how this research has been designed, developed and conducted. From introducing the research background into how this research objectives has been identified, it has provide an overviews of the contents of each chapter that gives a chance for researcher to review this research as whole process and gain better understanding of the study.

CHAPTER 2

Literature Review

2.1 Introduction

We present the literature relevant to the research undertaken in this thesis organized along three sections: knowledge management (KM), Indian agriculture and information and communication technology (ICT). The discussion of first section starts by defining the basic concepts of knowledge, types of knowledge, definition of KM, and models of KM from the literature. Indian agriculture section starts with agriculture in Indian scenario, present status of Indian agriculture, types of organization in Indian agriculture and definition of agriculture knowledge management (AKM). The ICT section starts with definition of ICT, importance of ICT in KM, and ICT initiatives in Indian agriculture.

Review of literature assists in understanding the problem area, formulating the empirical nature of the study and also provides a basis for interpreting the empirically obtained results. It helps in providing basic knowledge and understanding of the research trends in KM, and ICT in AKM. With this fact in mind, a sincere effort has been made to review the literature from researches, survey reports, books, journals, magazines, popular articles and other sources of information relevant to the study.

2.2 Knowledge management (KM)

Knowledge Management (KM) has become one of the foremost agendas in many organizations, research institutions and academics [29] [30]. It is a dynamic and

continuous set of the processes which enables enhancement in the organization and expands their innovation processes. The objective of KM is to manage knowledge which is important to enhance and expand the innovation processes in the organizations [4] [3]. It also ensures that people have access to right knowledge, in the right place and at the right time. KM typically focuses on the organizational objectives such as to improve performance, to establish an environment in which people are encouraged to create, learn, share and use knowledge together for the benefit of their organization.

This section aims at providing review of knowledge and KM concepts and provide conceptual background that helps to develop and understand the research KM model. The section commences with reviewing various definition of knowledge, and describes KM in the literature, stressing the difference of knowledge with data, information and wisdom, types of knowledge, and the concept of KM.

2.2.1 Concept of knowledge

Knowledge is one of the most valuable asset in the organization[31]. The concept of knowledge has been actively discussed since the time of the ancient Greeks. Knowledge is a concept with multi-layered meaning which incorporates many disciplines such as philosophy, economics, management, information technology, human resource and artificial intelligence [32]. "Knowledge is consider as a broad and abstract notion that has defined epistemological debate in western philosophy" [29]. Knowledge is defined as a "justified true belief" that increase an individual's capacity to take effective action, performance and adoption [29][32][33].

Some scholars argue that knowledge resides in the minds. For example, Alavi and Leidner (2001) define knowledge as "information that is processed in the mind of the individual" [29]. Similarly, Robert M Grant (1996) says that knowledge resides in the heads of individuals and which is known [34].

Many scholars agree that knowledge is more than data or information. It involves the application of the expertise of individuals to use and capitalize on information. Wickramasinghe and Von Lubitz (2007), argue that "knowledge, information, and data have always been significant,whether in the agrarian age,

industrial age, or information age" [35]. Knowledge is defined as "the facts, skills and understanding that one has gained especially through learning or experience, which enhance ones ability of evaluating context, making decision and taking actions" [36]. Many definitions have been developed in the literature to help in understanding the knowledge and distinguish it from other forms of contents such as data and information. Table 2.1 gives some definitions of knowledge

Table 2.1: Definitions of knowledge in the literature

Reference	Definition
Davenport *et al* [37]	"Knowledge is information combined with experience, context, interpretation, and reflection. It is a high-value form of information that is ready to apply to decisions and actions."
Alavi and Leidner [38]	"Knowledge is a justified personal belief that increases an individual's capacity to take effective action."
Van der Spek and Spijkevert [39]	"Knowledge is defined as the whole set of insights, experience and procedures which are considered correct and true, and which therefore guide people's thoughts, behaviour and communication."
Bennet and Bennet [40]	"Knowledge is the capacity (potential or actual) to take effective action in varied and uncertain situations."
Nonaka and Takechi [41]	"Knowledge is dynamic human process of justifying personal beliefs towards the truth."

Data, information and knowledge

The field of Information Science (IS) defines of knowledge by distinguishing it from information and data. It is therefore important to understand difference between data, information, and knowledge. According to Debons (1988), data, information, knowledge and wisdom can be viewed as part of a continuum, one leading into another, each the result of action on the preceding, with no clear boundaries between them [42].

Data is a representation of observations or facts out of context, and therefore, they are not directly meaningful [43]. Data also refers to unorganized and unprocessed facts [36]. Davenport and Prusak (1998), viewed data as the raw material for creating information that by itself carries no judgment or interpretation, and

no meaning [6].

Awad and Ghaziri (2004) defined information as "an aggregation of data that makes decision making easier" [36]. It is the result of placing data within some meaningful content, often in the form of a message [43]. Data under contextualized, categorized, calculated and condensed to become information [6].

Davenport and Prusak (1998), described knowledge as "a fluid mix of experience, values, context, information and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers" [6]. Knowledge also refers to an understanding gained through experience. It is "know-how" or familiarity with how to do something that enables a person to perform specialized tasks [36]. Wiig (1999), defined knowledge as a "set of truths and beliefs, perspectives and concepts, judgments and expectations, methodologies and know-how" [44]. Therefore, knowledge is more than data and information.

As given in Figure 2.1, data, information, and knowledge can be differentiated by representing them in a hierarchy where knowledge is represented at the top as the most valuable and meaningful entity for the end-users, and data is represented at the bottom with the least value and meaning to the end-users but with the at most availability and programmability in the organization [36] [45].

2.2.2 Classification of knowledge

Knowledge may be classified in a number of ways. The classification of knowledge helps the KM developer to know how to manage each type of knowledge during knowledge capture processes [36]. An understanding of the concept of knowledge taxonomy is important because it helps in knowing how the contribution of knowledge can improve the organization's performance.

Knowledge can be classified in different ways. A common distinction is that between tacit and explicit knowledge. Tacit knowledge is defined as non-verbalized, intuitive and unarticulated [46]. Polanyi (1962), stated that it resides in people's minds, behavior and perception and evolves from social interactions [46] [47]. It is deeply rooted in action, procedures, routines, commitments, ideals,

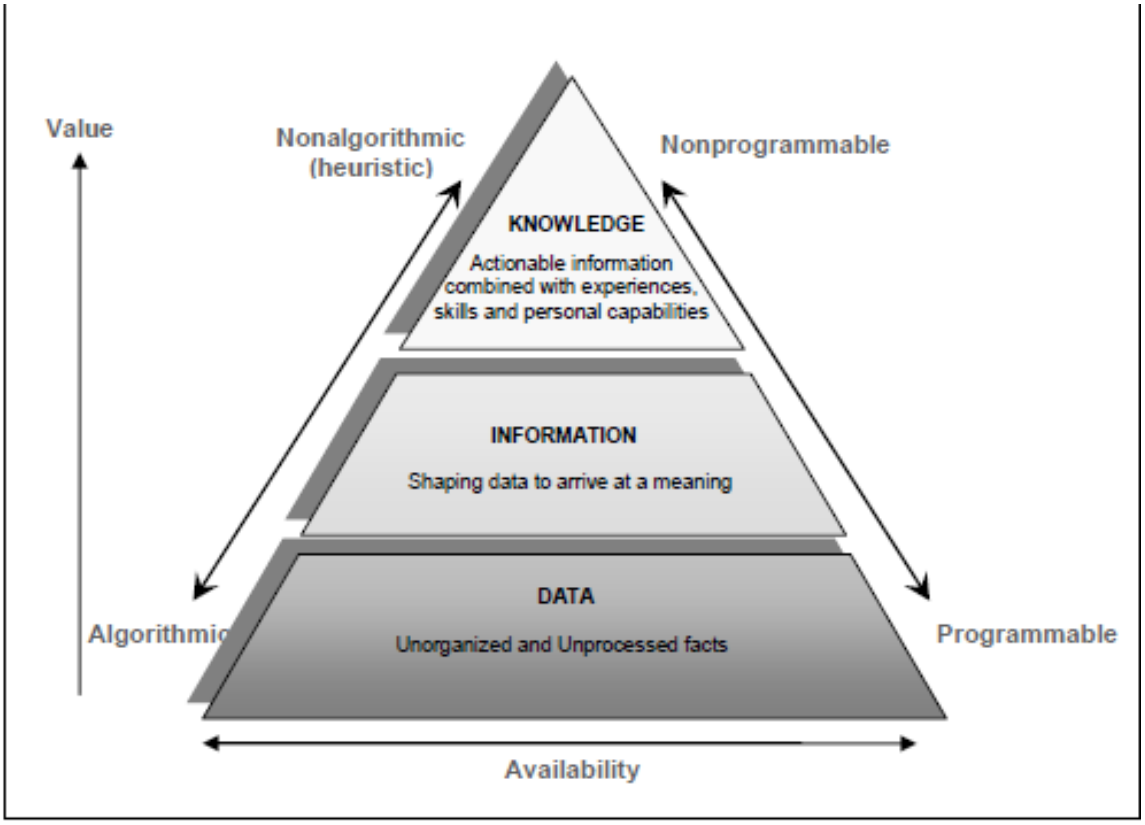

Figure 2.1: Data, Information and Knowledge (Source: Hesham Saleh Ahmad,2010)

values, and emotions. In most organizations, tacit knowledge is rarely shared or communicated. Therefore, it is often lost when the individual possessing it leaves the organization [48].

Explicit knowledge can be expressed in formal and systematic language and shared in the form of data, scientific formula, specifications and manuals [49]. Explicit knowledge can be processed, transmitted and stored relatively easily. Therefore, it is easier for organizations to capture this knowledge in repositories, systems, or operating technologies and make it available to all the members of the organization.

The categorization of knowledge into tacit and explicit dimension was popularized by Ikujiro Nonaka *el al*, in explaining the theory of organizational knowledge creation [47] [32]. They argue that knowledge is created through conversion between tacit and explicit knowledge through the process of socialization (tacit to tacit), externalization (tacit to explicit), internalization (explicit to tacit) and com-

bination (explicit to explicit).

In 2000, Nonaka, Toyama and Konno (2000) further developed the model of knowledge creation to consist of three elements: (i) the SECI process, the process of knowledge creation through conversion between tacit and explicit knowledge; (ii) ba, the shared context for knowledge creation; and (iii) knowledge assets - the inputs, outputs, and moderator of the knowledge-creating process. The three elements of knowledge creation interact with each other to form the knowledge spiral that creates knowledge as shown in Figure 2.2

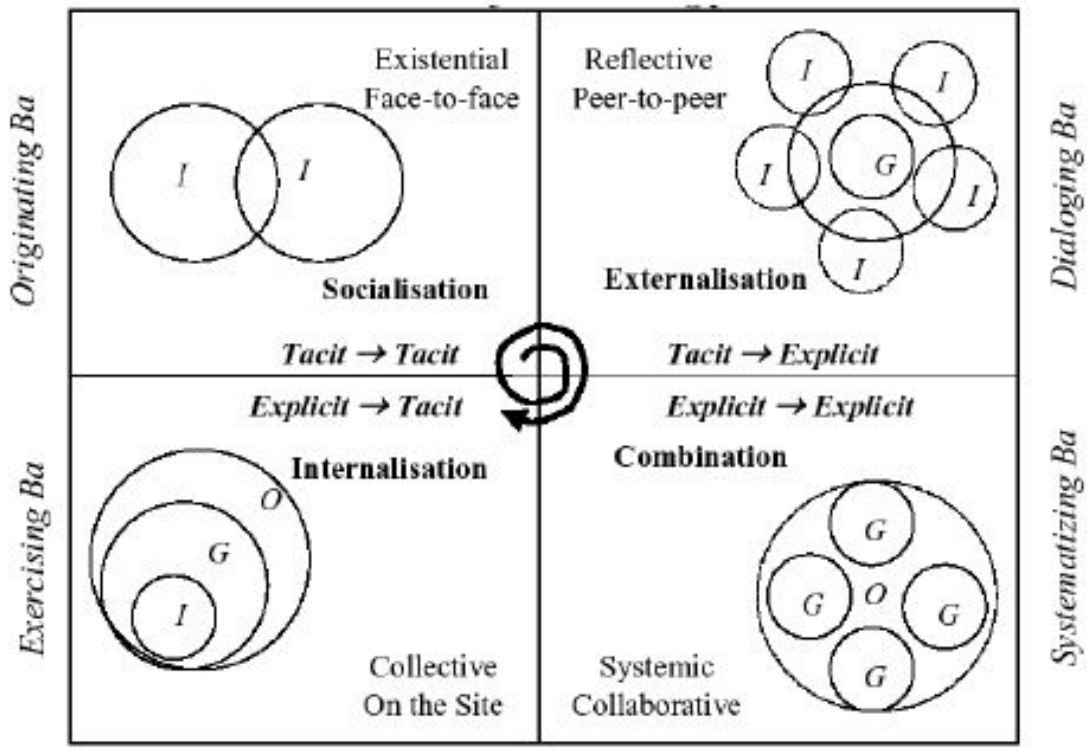

Figure 2.2: SECI as a self transcending process

The SECI model assumes that knowledge is created in a four-way taxonomy and it is transferred and converted based on socialization (from tacit-to-tacit knowledge through shared experiences), externalization (from tacit-to-explicit knowledge with the help of metaphors, models and analogies, for example printed materials, rock paintings), combination (from explicit-to-explicit knowledge through ICTs) and internalization (from explicit-to-tacit knowledge through learning by doing or translating theory into practice). It also assumes that the knowledge creation process in turn, depends on three different kinds of learning

relationships that are set up between the individual (I), group (G) and organization (O).

According to Nickols (2000), knowledge falls into three categories: explicit, implicit and tacit which characterizes by its ability to be articulated (see Figure 2.3). If knowledge has been articulated, it is explicit. If knowledge can be articulated but has not been articulated, it is implicit. If knowledge has not been articulated then it is tacit [50].

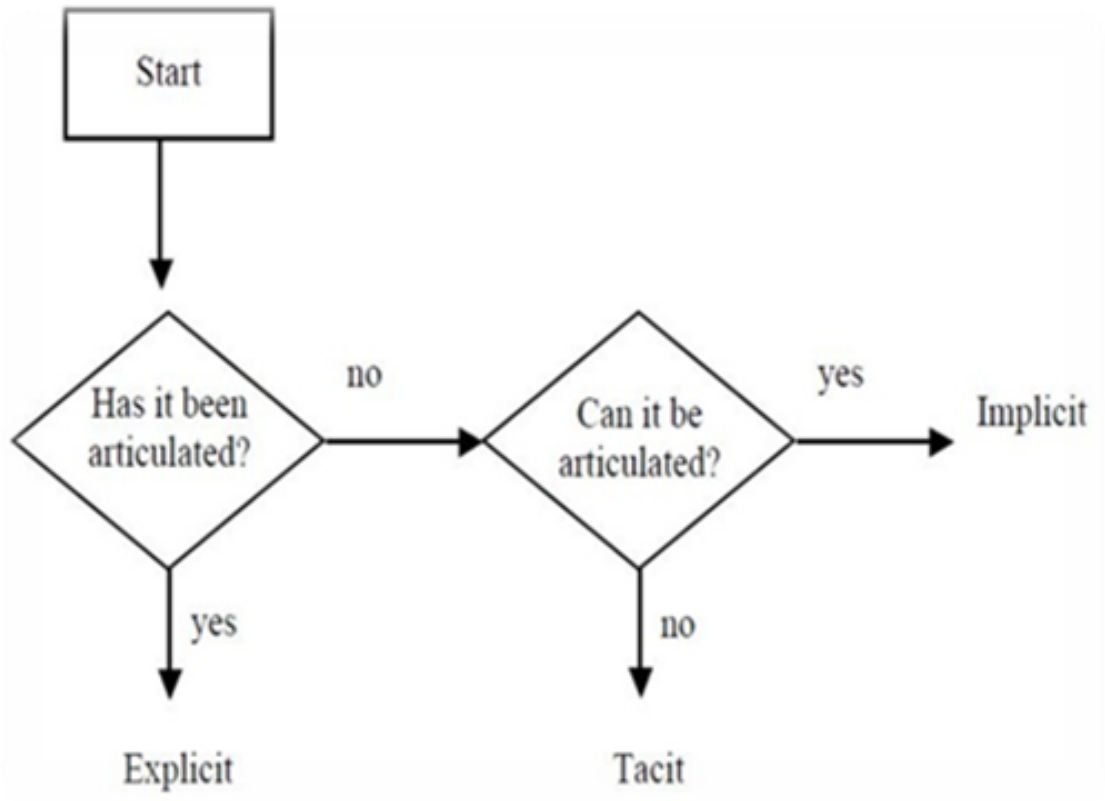

Figure 2.3: Explicit, Tacit and Implicit

The terms 'tacit' and 'implicit' knowledge are often treated as synonymous in the literature [51]. But some authors [50] suggest that implicit knowledge is a third type of knowledge that lies in the middle ground between tacit and explicit knowledge. Implicit knowledge is defined as "knowledge that a person can articulate, but is unwilling to do so because of specific reasons under certain settings, such as cultural custom or organizational style" [52][53].

Many methods for categorizing knowledge have emerged and been used

within the KM literature as growing interest and awareness of its usefulness and importance. For example, David W De and Liam Fahey (2000), proposed three different kinds of knowledge, i.e. human knowledge, social knowledge, and structured knowledge [54]. Collins (1993), classified by distinguishing between codified and non-codified knowledge, and proposed five categories of knowledge, namely: embrained, embodied, encultured, embedded and encoded [55]. It is evident that there are various types of knowledge described in the literature. However, the distinction between explicit and tacit knowledge seems to be accepted by the majority of academics and practitioners.

2.2.3 Knowledge management (KM)

Knowledge management (KM) is rooted in many disciplines that include business, economics, psychology, information management etc. There are many definitions and interpretations of the term "KM" that have been used in the literature. Some of the important definitions of KM given in the literature are provided in Table 2.2

KM is defined as a process that creates or locates knowledge and manages the dissemination and use of knowledge within and between organizations [63]. It is a formal process that engages an organization's people, processes and technology to find a solution that captures knowledge and delivers it to the right people at the right time [64]. KM allows an organization to exploit its intangible assets to create value through improved organization performance [6]. According to Alavi and Leider (1999), KM refers to a systemic and organizationally specified process for acquiring, organizing and communicating both tacit and explicit knowledge of employees so that other employees may make use of it to be more effective and productive in their work [38]. Lakshman (2007), defined KM as "an organizational capability that allows people in organizations, working as individuals, or in teams, projects, or other such communities of interest, to create, capture, share, and leverage their collective knowledge to improve performance" [65]. American Productivity and Quality Center (APQC) defines KM as "an emerging set of strategies and approaches to create, safeguard, and use knowledge assets (includ-

Table 2.2: Definitions of knowledge management

Reference	Definition
Jashapara (2004) [56]	"The effective learning processes associated with exploration, exploitation and sharing of human knowledge (tacit and explicit) that use appropriate technology and cultural environments to enhance an organization's intellectual capital and performance."
Wiig (1997) [57]	"It is a set of distinct and well-defined approaches and processes. The overall purpose of knowledge management is to maximize the enterprise's knowledge related effectiveness and returns from its knowledge assets and to renew them constantly."
Carlucci *et al.* (2004) [58]	"The KM is a managerial paradigm which considers knowledge as a resource at the basis of a company's competitiveness. It identifies the capabilities to generate value for a company's stakeholders with the explicit and systematic implementation of approaches, techniques and tools for the assessment and management of intellectual capital."
Ruggles (1998) [59]	"It is an approach to adding or creating value by more actively leveraging the know-how, experience, and judgment resident within and in many cases, outside of an organization."
Lee and Yang (2000) [60]	"It is an emerging set of organizational design and operational principles, processes, organizational structures, applications and technologies that helps knowledge workers dramatically leverage their creativity and ability to deliver business value."
Quintas *et al.* (1997) [61]	"It is the process of continually managing knowledge of all kinds to meet existing and emerging needs, to identify and exploit and acquire knowledge assets and to develop new opportunities"
Beijerse (2000) [62]	"It is the management of information within an organization by steering the strategy, structure, culture and systems and the capacities and attitudes of people with regard to their knowledge. It is the achievement of the organization's goals by making the factor knowledge productive."

ing people and information), which allows knowledge to flow to the right people at the right time so that they can apply these assets to create more value for the enterprise" [66].

Robertson (2003), defined KM as "a conscious strategy of harnessing tacit and explicit knowledge into action by creating context, infrastructure and learning cycles that facilitate finding and using the collective intelligence of society" [67]. According to Suresh and Mahesh (2010), KM is a strategic management of people, knowledge representation along with associated content, information in an organization and using technology, so as to improve knowledge sharing and utilization, by transferring relevant knowledge to people directly or indirectly so that people derive overall benefits in all aspects of the functioning of the organization [68]. Lai, described KM as a system of actions upon knowledge, which includes the establishment of strategies and procedures, with proper utilization of technologies, so that the acquisition, storage, conversion, sharing, application and generation of knowledge can be effectively performed, with the aim of effectively using the available knowledge for problem solving and decision making [69].

Having highlighted these definitions, it was concluded that all these KM definitions provided a framework that builds on past experiences and create new approaches for managing knowledge within a community or an organization. It was also concluded that most of these definitions emphasized the processes of creating, discovering, capturing, sharing, preserving and utilizing the available knowledge for the organizational achievements over its competitors.

2.3 Agriculture sector in India

India is primarily an agrarian economy, where agriculture and its allied fields act as main source of livelihood for more than 60 per cent population of rural India. Despite the fact that contribution of agriculture to the Gross Domestic Product (GDP) of the country has fallen from about 30 per cent in 1990-1991 to 13.9 per cent in 2013-2014, it still forms the backbone of development in terms of employment and livelihood with more than half of India's workforce engaged in this primary

sector [10]. India continues to have widespread hunger forcing it to be ranked a lowly 97 among 118 developing countries for which the Global Hunger Index (GHI) was calculated in 2016. [1]

India's population has been increasing progressively and it is likely to reach 1.44 billion in 2020 and 1.64 - 1.74 billion by 2050 [70], and the per capita availability of agriculture land for cultivation has fallen radically from 0.91 hectors in 1951 to about 0.32 hectors in 2001 . Furthermore, it is projected to decline to 0.09 hectors by 2050 [10]. The availability of land is expected to emerge as a major constraint on agricultural growth. Due to increasing demand of land for housing, rising level of urbanization and industrialization, increasingly larger quantity of agricultural land is being shifted to non-agricultural uses. In the past, loss of agricultural land was being compensated by converting forest land into agricultural land.

Present Indian agriculture faces various challenges like climate change, declining water availability, degradation of land, shrinking land availability, high cost of cultivation, environmental degradation, poverty and inaccessibility to modern technology, diminishing availability of agricultural labor and farmers' reduced interest in agriculture [71]. The National Commission on Farmers has drawn attention to the knowledge deficit that constrains the agricultural productivity which highlights the failure of public extension system and inability of extension workers to enrich the farmers with knowledge of new technologies [10] that can enable them to be more productive.

If India is to respond successfully to these challenges and also to achieve accelerated growth, there is a need to have greater use of modern information and communication technology (ICT), and management of knowledge (tacit and explicit) among, researchers, extension personnel, farmers and other stakeholders. Further, the agricultural extension requires paradigm shift from top-down to bottom-up approach [72].

"Agricultural and food security policy makers had clearly seen the need for knowledge connectivity from academic or research institutes to villages. There

[1] http://www.thehindubusinessline.com/opinion/global-hunger-index-and-indias-dismal-ranking/article9215932.ece?homepage=true

is a national agenda for creating knowledge centres in every village. There is also a need to create a national agricultural knowledge repository in digital form which is alive and is nurtured daily feeding, weeding and pruning or enriched by interactive usage" [73]. A report by planning commission[2] on "India as Knowledge Superpower (2001)" emphasized the need for developing the capacity: to generate, absorb, disseminate and protect knowledge, to exploit knowledge as a powerful tool to derive societal transformation. The National Knowledge Commission (NKC) which is an advisory body to the Prime Minister of India, had observed that more than 60 per cent of Indian population depends on agriculture for their means of livelihood. It believes that appropriate application of knowledge in agriculture will boost the agrarian economy and give the Indian farmer a competitive edge in the global market. NKC has stressed that knowledge applications in agriculture should be community-driven and farmer-led and should work towards providing range of services [3].

2.3.1 Difference between Indian agriculture and Western agriculture

The Indian model of agriculture can be described as an intensive subsistence model whereby the cultivation is mainly focused on consumption by the family. Mentioned below are some the difference between Indian and Western agriculture sector

- Indian agriculture is labor intensive whereas in Western it is capital intensive.
- As mentioned early 60 per cent of population in India dependent on farming, whereas in Western it is practiced for commercial.
- Most of the Indian farming methods are still traditional, farmers don't use modern technology and possess family farms. In western, farming is done

[2] http://http://planningcommission.nic.in/aboutus/taskforce/tk_know.pdf
[3] http://knowledgecommission.gov.in/

for business purpose and modern technologies are employed to increase the yield of the crop.

- In India farming is largely dependent on rainfall and irrigation techniques are not advanced. In Western farming is well irrigated and use modern methods of irrigation.
- Both countries provide subsidies to its farmers but Western govt provides larger subsidies to its farmers.
- The land available for farmers in Western countries is more than India due to varying population density.

2.3.2 Public, private, and NGOs in Indian agricultural extension

Indian agriculture research and extension activities have been dominated by the public-sector for the last 60 years. The Indian Council for Agricultural Research (ICAR) is one of the largest national agricultural research organizations (NAROs) in the world. In addition, there are non-agriculture universities and research organization working in agriculture. Private sectors are involved in agriculture and research since 1960's. They work in the areas of production of seed, fertilizer, pesticides, export and import of crops produced and research and development in these areas. Non-government organizations (NGOs) also play a significant role in Indian agriculture by involving in activities like research, co-operatives formations, and helping set up farmers' organizations [74]. Table 2.3 lists the activities of the different types of organizations in Indian agriculture.

2.3.3 Agriculture knowledge management (AKM)

Agriculture knowledge management involves different players such as farmers, extension personnel, researchers, inputs suppliers etc. Management of agricultural knowledge takes place at three different levels. First, at individual of farmers, extension officers and researchers. Second, at the level of network of individuals, and groups, and third within organizations or institutions [75].

Table 2.3: Activities of organizations

Public sector
• Increase the productivity of agriculture crops • Research and development • Education • Focus on training, demonstration and extension services • Creation and dissemination of agriculture knowledge • Transfer of technology through KVKs, ATMA etc • Organizing training programs for farm communities
Private sector
• Increase the productivity of processing varieties • Research and development • Input supply and market intervention • Creation and dissemination of agriculture knowledge • Commercial objectives • Partial specific crop extension
Non-government organizations (NGOs)
• Involve in community development • Holistic approach including human resource development and environment • Research and development • Involve in community development • Focus on extension, farmer groups, self-employment, self-help group • Disseminating knowledge, generating local knowledge • Developing local self-help organizations/groups, empowerment of farm women

In agriculture, like any other domain, knowledge exists in two forms, viz. explicit and tacit knowledge (see Table 2.4). The main sources of knowledge for farmer are local (neighbors, family, markets and community based organizations). Farmers also get information from extension officers of government agencies, NGO's and private companies

To have an effective knowledge management in the agriculture sector, it requires a systematic and continuous interaction of stakeholders that include farm-

Table 2.4: Agricultural knowledge types and storage

Owner	Knowledge description	Type	Storage
Scientist	Experts create knowledge through experiment	Explicit/ scientific	Database, research papers, webportal, news articles, books
Farmer	Local knowledge created through experience	Tacit / local	Hard to store, mainly store in individual mind

ers, farmer organizations/groups, research institutes, scientists, policy makers, extension officers, non-government organizations and the private sector among others. Knowledge management can play a pivot role in enhancing agriculture and will also help in addressing the problem of food security. It helps in creating knowledge repositories, improving knowledge access, its sharing and transfer and enhancing the knowledge environment in farm communities especially in the rural context [16]. AKM is defined as "the process of generation, processing and creation of database, dissemination and effective utilization to meet current and emerging challenges in agricultural development" [10][16].

According to Paul G (1990), an effective agricultural knowledge and information system (AKIS) will help in making continuous innovation and development in agriculture and the performance of AKIS could be measured in terms of its contribution to sustainable agricultural adaptation and innovation [75]. Providing access to relevant knowledge to the farming community will help to improve their production, productivity and brings higher returns to them. If the agricultural sector is not backed up by modern agricultural knowledge and information, farming community in the developing countries are likely to remain trapped in low productivity, food insecurity and poverty [10]. Moreover agricultural organizations in India started realizing the importance of managing the agriculture knowledge (tacit and explicit; internal and external) for the dissemination [22] to small and marginal farmers with support of modern technology. Therefore agriculture knowledge management (AKM) has a vast scope for managing agricultural knowledge through public, private and non-government organizations in India [13].

2.4 ICT in Indian agriculture

ICT include a range of technologies that integrate information technology devices like personal computers with communication technologies such as telephones and telecommunication networks. It is an umbrella term that includes computer hardware and software, digital broadcasting and communication technologies,

digital information repositories and internet, television, radio, mobile phones and the policies and laws that govern the use of these devices and media [16][76]. ICT has transformed the face of agriculture in many developed countries. Most agricultural activities in these countries are now based on the use of web-linked interactive databases for obtaining information on weather, natural resources, quantities of products demanded, credit, and government programmes, as well as technical knowledge [19].

There has been a growing use of ICT in developing countries mainly due to both demand-side factors, such as the increasing popularity of mobile phones and the Internet, and by supply-side factors, such as regulatory reforms, falling costs and prices, and technological innovation [77]. India has rich experience in implementing large number of ICT-based AKM projects that attempt to bridge the digital divide. These projects provide a range of services i.e. from weather information to market price and to make a difference in the quality of rural life. ICT in Indian AKM aims to increase the competitiveness of Indian agriculture by providing affordable, relevant, searchable and up-to-date agro-information services [16] and make it a significant factor in the future competitiveness in the global economy. It supports farmers to access timely and relevant information, as well as empower the creation and sharing of agricultural knowledge among themselves [78]. The use of ICT in AKM includes community radio, short message service (SMS) and voice-based cellular telephony, information through tele-centers, Internet kiosks, village knowledge centers etc. that are used to transform/support the traditional agriculture extension system [79] [80].

The importance of ICT in AKM has encouraged various player (Government, co-operative sectors, private entities, NGOs etc) to take initiatives to disseminate agricultural knowledge using different ICT components. Some of the ICT initiatives taken by these player in Indian agriculture are described in Table 2.5. These ICT projects have been broadly classified into three categories viz. web-based technology, knowledge worker with ICT support, and mobile technology.

Table 2.5: Categorization of ICT initiatives in Indian agriculture

Delivery mechanism	Project Names	Organization
Web technology	Agropedia	Govt
	RKMP	Govt
	AgriTech	Govt
	KISSAN Kerala	Govt
	AGRISNET	Govt
	AGMARKNET	Govt
	eKirshi	Govt
	aAQUA	Govt
	e-Arik	Govt
	iKisan	Private
	e-SAP	Govt and Private
Knowledge worker	e-Sagu	Govt
with ICT support	e-Choupal	Private
	Tata Kisan Sansar	Private
	Digital Green	NGO
	MSSRF-VKC	NGO
Mobile technology	Kissan Call Center	Govt
	IFFCO-IKSL	Govt and Private
	RML	Private
	mKrishi	Private
	Nokia Life Tool	Private
	Spoken Web	Private and NGO
	Fisher Friend Project,	NGO
	Lifelines	NGO

Various ICT tools have been deployed for agriculture knowledge management which includes organizational web portals created for specific commodities, sectors, and enterprise and for e-commerce activities [80]. A careful analysis of these websites and portals indicates that these are mostly used for disseminat-

ing generic information. These websites and portals have poor quality and do not encourage two-way communication between the farm communities and subject experts [83][21].

An electronic database that includes audio and video recordings are widely used for disseminating knowledge in the farm communities. E-mails and discussion forums are commonly used to share knowledge among subject experts, research group and professionals in organizations [80]. These have little or no presence of the farmers and the farm communities.

Analysis of various ICT projects (Table 2.5) in Indian AKM reveals that they primarily focus on the transfer of knowledge from experts to farm communities, following a one-way flow of knowledge without much interaction. Many ICT projects are pushing external content towards local people based on what experts think the community needs [84]. Researchers and subject experts are still following this pattern of transfer-of-technology, based on assumption that knowledge is created by them and spread by extension officers and to be adopted by farm communities [85][86].

Hence, for effective AKM, there is a need to focus on how ICT affects all the knowledge management processes (viz. acquiring, creating, storing, organizing, and sharing or disseminating) at the organization level.

2.5 Chapter summary

This chapter aimed at providing required background of knowledge,classification of knowledge, knowledge management, Indian agriculture, types of organizations in Indian agriculture and ICT in Indian agriculture related to the objective of the research to develop a model of KM for Indian agricultural organization.

The chapter started with discussing the importance of KM to the organization. Then, the chapter reviewed knowledge definitions in the literature and showed how knowledge is different from data and information. The chapter reviewed importance of classification of knowledge. The review of knowledge classification highlights two important types of knowledge, i.e tacit and explicit knowledge.

Furthermore the chapter reviewed various definitions of KM and its importance to organization from the literature were reviewed

We discuss about the present status of Indian agriculture and various challenges it facing. This chapter reviewed types of organization that are working in agriculture extension. In the review we found that there are three major organization in Indian agriculture. They are public sector, private sector and NGOs. Moreover the chapter reviewed various ICT initiated project in Indian agriculture from literature. A deep analysis of these project reveal that ICT in AKM has been mostly used to support traditional agriculture extension system, i.e. dissemination of knowledge to farm communities thinking that farmers are consumer and not producer of the knowledge.

CHAPTER 3

A Theoretical Framework for Agriculture Knowledge Management Process

3.1 Introduction

This chapter outlines the various KM models presented in the literature. It presents the requirements of the KM model needed for agricultural organizations. The chapter then presents a proposed model for implementing of AKM in agricultural organizations and describes its various elements.

3.2 Knowledge management (KM) models

Many organization are exploring and adopting KM to build their strength and achieve a sustainable growth in the global economy. The American Productivity and Quality Center has defined KM to be a "conscious strategy of getting the right knowledge to the right people at the right time and of helping people to share and put information into action in ways that strive to improve organizational performance" [87].

This study reviewed different KM models to provide the theoretical guidance for research in developing the AKM model. There are many KM approachers in the literature for managing organizational knowledge. Each approach has its characteristics and limitations. Developing suitable approach for AKM practices requires an understanding of available KM approaches [88]. Therefore the theoretical framework of this study was guided by the KM models reported in litera-

ture. Table 3.1 lists the relevant literature that provided the theoretical framework for this study.

Ruggles (1997), suggested three categories in KM model, which represents the primary knowledge activities of most organizations. They are *Knowledge Generation*: the development of new process and creation of new ideas; *Knowledge Codification*: categorization and codification of knowledge and *Knowledge Transfer*: exchange of the knowledge between individual, department and organizations [89].

Davenport and Prusak (1998), divide the KM model into three stages: *Knowledge generation, Knowledge codification & coordination, and Knowledge transfer*. Knowledge generation is further classified into five modes: acquisition, dedicated resources, fusion, adaptation and networking. The aim of the codification is to organize the knowledge so that it can be easily accessible to those who need it. Knowledge transfer occurs at many levels. The authors discuss knowledge transfer in both formal and informal modes of exchange of knowledge [6].

Probst *et al* (2000), KM building blocks includes: *knowledge identification, Knowledge acquisition, knowledge development, knowledge sharing and distribution, knowledge utilization and knowledge retention*. Knowledge identification: analyzes and describes the company's knowledge from both internal and external environment. Knowledge acquisition: imports a substantial part of knowledge from outside sources. Knowledge development: focuses on generating new skills, new products, better ideas and more efficient processes. Knowledge sharing and distribution: distributing the right knowledge to the right place at the right time. Knowledge utilization: ensures that the present knowledge is applied productively for the benefit of that organization. Knowledge retention: selects, stores and regularly updates knowledge for potential future use [88].

Lai and Chu (2000) divided KM model in to six stages: *Knowledge initiation, Knowledge generation, Knowledge modeling, Knowledge repository, Knowledge distribution & transfer, and Knowledge use & retrospect*. The initiation stage involves creating awareness and identifying the knowledge requirement. Generation refers to generation of knowledge by identifying what kind knowledge exists in the organiza-

Table 3.1: KM models

Authors and Year, KM process/model stages
Ruggles, (1997) Knowledge generation, Knowledge codification and Knowledge transfer
Marc Demarest, (1997) Knowledge construction, Knowledge embodiment, Knowledge dissemination and Knowledge use
Davenport, (1998) Knowledge generation, Knowledge codification & coordination and Knowledge transfer
Lai, (2000) Knowledge initiation, Knowledge generation,Knowledge modeling, Knowledge repository, Knowledge distribution and transfer, Knowledge use and Knowledge retrospect
Tynadale, (2000) Knowledge creation, Knowledge organization, Knowledge distribution, and Knowledge application
Alavi and Leidner, (2001) Knowledge creation, Knowledge storage/retrieval, Knowledge transfer and Knowledge application
Ganesh D Bhat, (2001) Knowledge creation, Knowledge validation, Knowledge formatting Knowledge distribution and Knowledge application
Mihir Parikh, (2001) Knowledge acquisition,Knowledge organization, Knowledge dissemination and Knowledge application
Hall and Casey, (2005) Knowledge creation, Knowledge storage and retrieval, Knowledge transfer Knowledge application and Knowledge roles and skills
Supyuenyong and Islam, (2006) Knowledge creation and acquisition, Knowledge organization and retention Knowledge dissemination and Knowledge utilization
Mustafa, (2006) Knowledge creating, Knowledge sharing, Knowledge structuring Knowledge using and Knowledge auditing
Karadsheh, (2009) Knowledge infrastructure, Knowledge combination, Knowledge evaluation Knowledge evaluation, Knowledge filtering, Knowledge repository Knowledge sharing, Knowledge application and Knowledge performance

tion, who own it and identifying the creator, collecting and importing knowledge and technology from outside or learning from existing knowledge. Modeling stage deals with justifying, structuring and organizing the produced knowledge to represent effective in the repository for future use. Repository maintains the existing knowledge and facilitates further sharing. Distribution and transfer stage is concerned about how the knowledge is distributed or shared with others. The Use stage deals with utilized of knowledge to produce commercial value. Retrospect stage deals with reviewing the process, performance, impact for its effectiveness and finding if any new knowledge was created [90].

According to Tyndale (2000), knowledge development life cycle comprises of four parts: *Knowledge creation, Knowledge organization, Knowledge distribution and Knowledge application*. Knowledge creation includes discovery, capture and generation of knowledge. Knowledge organization refers to the codification and cataloging the knowledge so it can be easily accessed and re-used. Knowledge distribution is concerned about transferring knowledge from one person to other person or group, and the absorption of that knowledge. Application relate to the processing, application and synthesizing of knowledge [91].

According to Alavi and Leidner (2001), KM process consists of four stages: *Knowledge creation, Knowledge storage/retrieval, Knowledge transfer and Knowledge application*. Knowledge creation involves developing new content or replacing existing content with new/updated knowledge within organization. Knowledge Storage/retrieval refers to accessing knowledge from the organizational memory. This storage may be in various forms like documentation, electronic database, and codified human knowledge. Knowledge transfer is concerned about the communication channel that helps to transfer knowledge between individual, from individual to group, between groups and from groups to organizations. Finally Knowledge application refers to applying knowledge in different location as define in the organizational work flow [29].

Bhatt (2001), categorized KM process into five stages: *Knowledge creation, Knowledge validation, Knowledge presentation, Knowledge distribution and Knowledge application*. Creation refers to the ability of organization to develop novel and use-

ful ideas and solution. Knowledge Validation concern to evaluation of knowledge and its effectiveness in existing organizational environment. Knowledge Presentation is a way to present and display the valid knowledge to the relevant organizational members. Knowledge Distribution is concerned about the distribution and sharing of knowledge throughout the organization. Knowledge Application means making knowledge more active and relevant [92].

According Parikh (2001), KM cycle contains four processes. They are *Knowledge acquisition, Knowledge organization, Knowledge dissemination and Knowledge application*. Knowledge acquisition is an activity which deals with finding and acquiring knowledge in knowledge-based resources. Knowledge organization is the phase where knowledge is refined, organized and stored. Knowledge dissemination is aimed to ensure that the relevant people gets the required knowledge (personalized) and suggest ways in which how distribution can take place. Not all collected information and knowledge is useful for everybody. It depends upon the needs and roles of the users. Knowledge application involves applying knowledge to newer scenarios and learning from it [4].

According to Oluic-Vukovic (2001), the major KM processes are: *gathering, organization, refining,representation and dissemination*. Knowledge gathering involves multiple processes of knowledge discovery, capture and creation. It includes activities of data mining, text mining, and gathering information from various sources. Knowledge organization refers to classification and structuring the knowledge. It involves of cataloging, indexing, filtering and clustering the knowledge. Knowledge refining is the process where knowledge is analyzed for improvement. Knowledge representation implies rules for indicating and mapping the data. The knowledge representations using semantic network, frame, decision trees and predicate logic are activities involved in representing the knowledge. Knowledge dissemination involves the use of channels and formats necessary to communicate the knowledge with others. It provides access to the knowledge by using different communication channels like web pages, videos and so on [93].

Bouthillier and Shearer (2002), proposed KM process with six steps. They are *Knowledge discovery, Knowledge acquisition, Knowledge creation, Knowledge storage*

and organization, Knowledge sharing and Knowledge use and application. Discovery involves tracing internal knowledge available within the organization. This will help a department of the organization to become aware of the knowledge which is existing in another department. Acquisition will help in getting knowledge from other external sources into the organization. Creation step involves creation of new knowledge from different sources with combining internal knowledge with other internal knowledge. Storage and organization of knowledge concerned about organizing knowledge for better access. Knowledge sharing involves the transfer of knowledge from one (or more) person to another one (or more). At the end using and applying knowledge indicates the effective use of knowledge and is indicate the success of KM cycle [94].

Stollberg *et al* (2004), describe the process of KM as *Knowledge identification, Knowledge acquisition, Knowledge preparation, Knowledge allocation, Knowledge dissemination, Knowledge usage and maintenance*. Knowledge identification helps in finding attributes of the required knowledge and assigning them to the knowledge assets. Acquisition process concentrates on discovering the required knowledge through consulting, researching buying and self-creation. Knowledge preparation focuses on how to present the knowledge to the users. Knowledge allocation is concerned about the ease of access to the knowledge. Dissemination ensures that effective distribution of knowledge among the users. Knowledge usage ensures that people use knowledge in KM system. Finally Knowledge maintenance is to keep the system up-to-date [95].

Peachey and Hall (2005) says that, KM process take place in five phases: *Knowledge creation, Knowledge storage and retrieval, Knowledge transfer, Knowledge application and Knowledge roles and skills*. Creation involves the methods for generation of new knowledge within the organization and from outside. Storage and retrieval focuses on storing, organizing and retrieving the organizational knowledge. Data mining and advance computer storage can be used as effective tools for enhancing the access to the organizational memory. Knowledge transfer occurs at many levels. It can be between individuals, from individuals to group and between groups and between groups and the organizations. Knowledge application describes the

integration of knowledge into organizational practices by using technology for effective use of organizational knowledge [96].

Supyuenyong and Islam (2006), classified KM process in to four sub-processes. They are: *Knowledge creation and acquisition, Knowledge organization and retention, Knowledge dissemination and Knowledge utilization*. Knowledge creation and acquisition includes capturing, searching, gathering and synthesis. Knowledge creation or acquisition happen only when enterprises understand and identify the organizational requirements. In Knowledge organization and retention, knowledge is categorized by filtering and indexing and then kept in the organizational storage or repositories. It is then used effectively for reducing cost and achieving quality improvement. Knowledge dissemination will transfer the knowledge in both horizontal (knowledge transfer among employee in the organization) and vertical (knowledge transfer between company's partners, suppliers, customers or collaboration institutes) directions. Knowledge utilization process is to generate value to the knowledge or to make knowledge work such that the organization incorporates the knowledge for their products and services [97].

Sagsan (2006), proposed KM life cycle with five stages: *Creating, Sharing, Structuring, Using and Auditing*. In knowledge creating stage organization will process the all forms of knowledge. The author called it as knowledge kitchen. Knowledge is created in the organization by focusing on individuals, groups and departments. If knowledge is not created in the organization, neither sharing nor auditing can be carried out. Knowledge sharing emphasizes the ways and tools for effective sharing. Knowledge structuring categorizes (mapping, storing and retrieving) knowledge by using classification tools and enables for timely retrieval of the knowledge. Knowledge auditing refers to determining what amount of knowledge is being used in organization's product, services and process [98].

The KM model proposed by Karadsheh (2009) includes eight steps. They are *Knowledge infrastructure, Knowledge combination, Knowledge evaluation, Knowledge filtering, Knowledge repository, Knowledge sharing, Knowledge application and Knowledge performance*. Knowledge infrastructure includes sub-process: *Discovery, Capture and Creation*. In this knowledge infrastructure the first stage is discovery. It is

the method for developing new tacit or explicit knowledge from data or information or mixture of previous knowledge. Discovery phase involves finding internal knowledge within organization or from external sources. The second stage in knowledge infrastructure is knowledge capture or acquisition. It is defined as the process of reclaiming either explicit or tacit knowledge residing inside people or organizations. The final stage in knowledge infrastructure is knowledge creation. Knowledge creation is a process of creating new knowledge by combining internal knowledge with other internal knowledge. These three stages in knowledge infrastructure will help in finding the knowledge which is relevant to the organization's goals and objectives. Knowledge Combination is a phase of collecting the information discovered, captured and created into a single portfolio. In this phase the collected information goes through the process of evaluation, filtering and is then stored in a temporary repository for sharing and application. Knowledge Evaluation is the process of evaluating the knowledge to ensure that knowledge is accurate and valuable before it can be shared. Knowledge Filtering involves classification, categorization and organization of the knowledge. Knowledge filtering structures the information with indices, links and catalog for storage. Knowledge Repository is used for storing filtered knowledge. It is viewed as organizational memory. Knowledge sharing will transfer the knowledge among individuals and others within and outside the organization. Intranets and extranets are used as suitable platform for knowledge sharing. The purpose of knowledge application is to apply and represent information to knowledge seekers in appropriate matter. And the final stage is knowledge performance, it will evaluate performance of knowledge management system in achieving goals and objectives of organization. [3].

3.2.1 Review of related studies of KM models in Indian organizations

Despite a substantial increase in the size of the customer base in India, there are not many success stories from the public and private sector organizations which have effectively used KM for improving business performance [99].

Pandey has studied KM implementation in two public sector companies, National Thermal Power Corporation (NTPC) and Power Grid Corporation of India Limited (PowerGrid). Knowledge sharing, use, reuse and capitalization have not still formed a part of the culture in these organizations. NTPC and POWERGRID both did not undertake process of knowledge management formally. The author had developed KM process framework with the following stages: creation and acquisition, collation, storage and use, dissemination, sharing, reuse and capitalization. KM technology in the form of portals, repositories, electronic databases, libraries and communities of practice have been used to enable KM process [99] [100].

Bhusry and Ranjan (2011) proposed a framework to study KM in higher educational institutes. The framework comprises of the following stages: knowledge creation, encapsulation and storage, structuring, dissemination, employment, audit and measurement [101]. A study by Singh and Soltani (2010) in 10 Indian IT companies in North India was conducted looking at various phases of knowledge management viz. knowledge generation, knowledge codification, and knowledge transfer and knowledge application. It was reported that KM process was the fundamental activity of managing and transferring knowledge in organization. Periodic KM quests should be conducted to assess the knowledge gap in terms of searching for the best practices in this area [102].

3.2.2 Lesson learned from the review of KM models

From the discussion of all these KM process frameworks, it can be argued that all of these frameworks focus on the business or organizational settings. It is also evident that these models emphasize the implementation of KM processes for the effective management of knowledge in organizations. These are mostly based on experiences and studies in Western industrialized countries that are already becoming knowledge economies. Moreover, it shows that KM process primarily relates to the developed countries in the world with emphasis on the organizations from the sectors like the IT industry, automobile manufacturing industry and pharmaceutical industry.

It is evident that the KM models reported in the literature emphasize the implementation of KM processes for effective management of knowledge in organizations [88][94][103]. These models used different labels to show their KM processes, but they all emphasized the following process: knowledge acquiring, knowledge creating, knowledge storing, knowledge organizing, knowledge sharing, knowledge disseminating, and knowledge applying. In the context of Indian agricultural organizations, implementation of these KM process would enable the organizations and farm communities to acquire, create, organize, store, share and apply the knowledge in order to improve the farm activities.

There are very few research studies conducted on the KM process in the agricultural sector, especially the Indian agricultural sector. Hence, this study sought to assess the application of KM models in managing knowledge (both tacit and explicit) in this sector viz. Indian agricultural organization. The study therefore adapted ideas from all the models proposed in literature in order to provide the theoretical base for the application of KM model in managing both tacit and explicit knowledge in the agricultural organizations in India.

3.3 Need of KM in Indian agricultural organizations

There are increasing evidences of the benefits of KM for organizations. They include helping in being more competitive, achieving higher efficiency and increased output [104][105]. KM is the thriving strategy in the corporate world to improve the performance of the organization. When one talks about KM, one sees that applications of KM are predominantly restricted to the corporate world. There are few studies that practically analyze its application in agricultural orgnaizations [65]. Hence KM practices in agricultural organizations are believed to enhance their competency and productivity. KM in agricultural organizations or institutes can provide opportunities to encourage collaboration, sharing of knowledge and improve the extension communication which in turn can lead to increase in agricultural productivity [105]. Enhancing KM will assist the various stakeholders like the agricultural organizations or institutions, subject

experts, policy makers and farmers, to overcome the challenges faced by them like climate change, dependence on rainwater for agriculture, etc.

KM in agriculture of developing countries like India has been reported to be in an infant stage in the year 2012 [13]. It was found that most investments in agriculture and extension were based on the assumption that agricultural knowledge is generated by the subject experts or scientists, which is transferred to the farmers with the help of extension officers, thus ignoring local knowledge creation and sharing, as well as the relevance of articulating demands by farmers and promoting their self-confidence and empowerment [106][107].

It has also been established that creation of related knowledge is done collectively, in groups, through mechanisms of networking and communication between organizations [108][109]. Agriculture knowledge management (AKM) cannot be merely achieved by simple means, it can achieve through processes that involve various stakeholders like research institutes, universities, policy makers, private sectors, NGOs, subject experts, knowledge workers, farm communities, etc.

It is necessary to study the role of KM in Indian agricultural organizations in helping them meet the challenges of scarcity of natural resources, address the issue of climate change, improve the productivity, provide easy access to all kinds of traditional and modern knowledge to farm communities and experts, provide access to the different levels of expertise in agriculture for the benefit of whole agricultural community

3.4 Methodology used for developing framework

The study builds up a framework based on the investigations and observations from the case studies. This kind of study can be categorized as theory creating or building [110]. Even though KM is not a new phenomenon, little is known about it in agricultural organizations in India. Thus, initially this study is exploratory, and considers the past and then investigates the present circumstances.

According to Myers and Avison (2002), there are two dominant groups of re-

search methods in information systems (IS): quantitative and qualitative [111]. Quantitative methods have been applied in social sciences through laboratory experiments, formal, survey, and numerical methods. While qualitative methods were developed in the social sciences to enable researchers in understanding people and the social and cultural contexts. It includes action research, case study, and ethnography. Each of these methods have different ontological, epistemological, axiological, rhetorical and methodological characteristics [112]. The most appropriate one for this study is the case study method, which is the most common one used in qualitative research in information systems (IS).

3.4.1 Case study

There are several definitions for the case study methodology. Yin (2003), defined case study methodology as " an empirical enquiry that investigates a contemporary phenomenon and context that are not clearly evident" [113]. According to Benbasat *et al.*, case study is defined as " a research approach that examines a phenomenon in its natural settings, employing multiple methods of data collection to gather information from one or few entities (individuals, groups or organizations) on a phenomenon that is not clearly evident at the outset" [114]. The case study methodology has been increasingly used in social sciences and is often promoted as a suitable method for research in organizational and management studies [113]. As research objective of the study is to understand the flow and management of knowledge in organization and develop framework, the case study can serve as valuable tool to for the current study.

Case study is also good for research where no experimental control or manipulations of variables are involved when compared to other approaches (laboratory and field experiments). It does not necessarily require step-by-step data analysis, and this allows of various interpretations of research data. Case study method allows use of multiple methods of data collection such as interviews, documentary reviews, archival records, direct and indirect participant observations [113].

Yin (2003), suggests that a single case study is appropriate in a situation previously inaccessible to scientific investigation, an extreme or unique case, or for

theory testing purposes, while multiple case study provides general explanations that are applicable to individual cases in spite of differences in each individual case [113]. Multiple cases also support the development of abstraction across cases and make the result more generalizable and reduce any possible bias [115]. Herriott and Firestone, suggest that the evidence from multiple cases is often considered more compelling, and overall study is therefore regarded as being more robust [116].

3.4.2 Case selection

The case selection process is an important aspect. It should be done very carefully before empirical data is collected [113]. The case organizations for this research study were selected through a purposive sampling. This is done to achieve a fine diversity in the responses and improve the quality of the data for facilitate generalization of the observed. The organizations are selected for this study on the basis of the following characteristics:

1. The case organizations should exhibit a strong desire for mobilization and dissemination of knowledge to the farm communities

2. The case organizations and the employee should be involved in knowledge intensive work

3. The employee should be actively involved in knowledge management programs

Based on the above characteristics, four organizations (two milk co-operatives and two non-government organizations) were chosen for the study. To achieve a rich mixture of responses, interviews were conducted in distinctive geographical location. After careful selection of the organizations, we followed the usual method of gaining access to organizations by requesting permission from those in-charge. All the initial contacts were made by e-mail and phone calls. The following sub-section provide brief description of the case organizations selected for this study

Case A: Mulukanoor Women's Cooperative Dairy (MWCD)

Mulukanoor Women's Cooperative Dairy (MWCD) is located in Karimnagar district of Telangana state, where marginal and small mixed crop-livestock farmers account for 89 per cent of the households with less than 2 hectare of land. MWCD, India's first women's cooperative dairy has an inspirational background story, which is based on the co-operative spirit articulated by two local and one national level development organizations viz. Cooperative Development Foundation (CDF), Mulukanoor Cooperative Rural Bank and Marketing Society, and National Dairy Development Board (NDDB). The MWCD federation comprises of women's dairy cooperative societies at each village level. Each women dairy cooperative (WDC) society maintains the procurement details of each member in the society; provide various services like supply of feed and fodder, animal health care, livestock management, veterinary services, insurance, community development, etc. MWCD, as on date, has over 110 member cooperatives which have a membership of over 21000 marginal and small mixed crop-livestock farmers. The initial target was to establish and promote 72 cooperatives and with a target membership of 11000 (eleven thousand) livestock farmers in five years, within a radius of 30 km around Mulkanoor.

Case B: Mehsana District Cooperative Milk Producer's Union Ltd (MDCMPUL)

The Mehsana District Cooperative Milk Producer's Union Ltd (Dudhsagar Dairy), the largest milk processing unit in India, is located at Mehsana city in Gujarat. It was established in 1960. It is a district level apex body of milk cooperative societies in Mehsana. It aims to provide remunerative returns to milk producers and also intends to serve the interest of consumers by providing quality and safe milk products that give good value for money. The intention was that the dairy would play an ever increasing role in the rural economy, providing gainful employment to large numbers of producers in the district and would raise producers' awareness so that they could manage their own affairs through co-operatives. MDCMPUL provides different services like co-operative services which include organising milk day programs, conducting cleanliness drives, organising lead-

ership programs, cooperative development programs, programs on cooperative principles and practices, etc. It also provides Animal husbandry services which include animal health service, veterinary services, feed and fodder services, etc.

Case C: Dharampur Utthan Vahini (DHRUVA)

DHRUVA is an associate organization of BAIF Development Research Foundation, registered in 1995 under the Societies Registration Act 1860 and Bombay Public Trust Act, 1950. The activities are spread over three predominantly tribal districts of South Gujarat, namely Navsari, Valsad and Dangs. DHRUVA came up with the novel idea of establishing wadis (orchards) for enhancing the livelihood opportunities of rural and tribal poor in this part of the country. After successful implementation of wadi program, DHRUVA started working in different areas with tribal people for their development. The organisation provides livelihood generation through farming system improvement, watershed development, livestock management, women's development, health, sanitation and nutrition, micro-financing, agri-produce processing and marketing and strengthening of local communities and user groups through the formation of People's Organizations. Backward and forward linkages with the application of appropriate technological advances are the backbone of all the development programs implemented by DHRUVA. These programs are based with the intent of providing Anna (livelihood), Akshar (literacy), Aarogya (health) and Aacharana (moral values) to the people of these communities.

Case D: Digital Green (DG)

Digital Green is an independent non-governmental organization that focuses on training farmers to make and share (show to others) short videos where they record their problems, share solutions and highlight success stories. Its approach is primarily to use a technology-enabled means of communication for bringing about a behavior change. The means of communication is cost-effective, scalable, and brings together researchers, development practitioners, and rural communities to produce and share locally relevant information through videos. It part-

ners with local public, private and civil society organizations to share knowledge on improved agricultural practices, livelihood, health and nutrition using locally produced videos. At present it has been implementing projects in collaboration with over 20 partner organization across 9 states in India and parts of countries like Ethiopia, Afghanistan, Ghana, Niger and Tanzania. Till date, 439 videos have been produced in different categories like agriculture, animal husbandry, health, etc.

3.4.3 Data collection

The study used several methods of data gathering: semi-structured interviews were complemented with short time on-site observations and surveys with quantified responses. Organizational documentation and presentations by senior management about their KM-related initiatives were collected and analyzed. Visits were made to all these organizations for about two weeks each, to interview and to administer questionnaires and to collect other relevant information.

Individual interviews were conducted with the regional managers, senior and middle level managers, project coordinator, program officer, cluster in-charge, field officer. These people play a key role in managing knowledge and were positioned at the intersection of both vertical and horizontal flow of knowledge in their respective organizations. A series of open-ended questions were used in the interview process. The questions were focused on their knowledge management processes and the use of information and communication technology (ICT) for the same. The employees were stratified according to their position and were selected randomly for interviews. Direct observations were used in this study during the organization visit. Observations were made on the use of ICT tools and the different processes of knowledge management followed in the respective organizations

3.4.4 Findings, analysis and discussion

The acquisition of knowledge in the four organizations that are a part of this study were found to take benefit of their networking with project partners, research institutes, state agriculture universities and farm communities. DHRUVA acquires

knowledge (good agriculture practices) from state and national agriculture research institutes for growing cashew nuts orchards. MWCD acquires knowledge from National Dairy Development Board (NDDB) on clean milk production techniques, livestock management, rational balance etc. MDCMPUL acquires dairy related knowledge from its own research and development department and also from their partners like state agriculture universities, NDDB, state veterinary universities etc .

In DG, the generation or creation of knowledge takes place with support of NGO partners, national and international partners. DG takes the existing practices identified by the NGO, and capture them through videos which feature local early adopter farmers or farmer groups describing a technology or practice. The community service provider will identify farmers who are practicing and adopting good agriculture practices (GAP) to record their knowledge in the form of a video.

The storing and organizing of knowledge in DG is being done on online repositories, databases and electronic devices. Once the videos are recorded, they are checked by the subject matter specialist, who also reviews the videos to ensure the knowledge's accuracy and clarity before storing in the organizational repository. DG uses technologies like indexing and mapping which helps in easy retrieval of the knowledge from the repository.

DHURVA has documented various success stories and case studies from their projects, which they had implemented in tribal areas. These are stored in the form annual reports, user manuals, books and videos. MDCMPL and MWCD store and organize the knowledge in the form annual reports, user manuals, books and in the soft form on web portal form.

DHRUVA organizes field visit trips, training programs and capacity building sessions for the farmers to help them to learn new technologies. Training and capacity building has become an integral part of the organization's operation. The experts provide training and conduct meetings with farmers. During the meetings and trainings, the farmers share their experience with the experts. This has resulted in the exchange of knowledge between the two parties i.e. it has pro-

vided the farmers access to the scientific knowledge present in the horticulture research institutes and the experts access to the tacit knowledge present in the farm communities. The findings from the study shows that farmers rely more on face-to-face communication than the use of ICT tools for sharing knowledge.

The sharing of knowledge in MDCMPL is taking place through their field officer, cluster in-charge and veterinary doctors. They provide community development program, capacity building and training program on recent technologies. Similarly in MWCD, knowledge sharing is taking place through cluster in-charge, field supervisor, project officer and agriculture extension. They organize weekly and monthly meetings at village and cluster level to disseminate knowledge related to livestock management to farm communities. The Field supervisors make personal visit to farmers' house to check cattle and provide personalized information and knowledge to them. Digital videos that are locally generated are shown to farmers with support of NGOs partners of DG. The community service provides a local mediator who will screen the locally generated digital videos to farmers in each village during suitable evening hours at a location chosen by the NGO field staff. During video presentations, farmers' feedback, questions and concerns are transcribed and entered in database. This information is then used in the production of new videos.

3.5 Proposed theoretical framework of AKM process

The proposed theoretical framework was developed based on the outcomes of case studies (four organizations) and secondary source data (literature review of various KM models proposed by different researchers).

3.5.1 Knowledge acquiring and creating (KAC)

Knowledge acquiring and creating is the first stage of this conceptual framework [29][4][91][94]. In terms of processes, knowledge acquiring and creating is where members in the organization gain, collect, create and obtain required and useful knowledge to perform their job-related activities. It is a complex, multidimen-

sional and dynamic process. KAC involves developing new content and updating existing content with the organization's tacit and explicit knowledge [117]. Knowledge creation is recognized as the process where new ideas, best practices are generated [80]. It is about obtaining knowledge from external/internal sources or the recovery of the knowledge (explicit or tacit) that resides with the people working in the organization [97][118].

Feedback related existing practices that are used by farm communities based on their experiences on the existing practices is an important mechanism of incooperating the tacit knowledge in KM system and converting it into explicit knowledge.

For creating new knowledge, it requires everyone in the organization to work in teams and be involved in a non-stop process of personal and organizational self-renewal [119]. Creation of knowledge in an organization involves a continuous interplay between tacit and explicit knowledge and it develops into the spiral flow as knowledge moves through individuals and groups at different organizational levels [29]. According to Nonaka, knowledge creation takes place in four modes within an organization: socialization (tacit to tacit), externalization (tacit to explicit), combination (explicit to explicit) and internalization (explicit to tacit) [32]. Training programs, workshops or seminars are some of the other means for employees/members of the organization to acquire and create new knowledge [120][121]. Members or employees of organization rely on technologies like the INTERNET for acquiring work-related knowledge to perform their daily work [121].

3.5.2 Knowledge organizing and storing (KOS)

The second stage of this framework is knowledge organizing and storing. This process consists of codifying, storing, refining, indexing, evaluating, updating and storing the codified knowledge in an organization's repository [94][122]. In knowledge organizing process, knowledge is evaluated or validated to ensure that knowledge is accurate and valuable before it can be used [30]. Once it is evaluated, it is categorized and represented in a structured manner with indexing or

mapping to facilitate for efficient storage and usage in the organization repository at a later point [4][47][122]. Tools like indexing and catalogs will help to locate the knowledge within and between organizations repository [91].

Organizations have to continually review and validate their knowledge so that they can update knowledge in repository [92]. Updating the existing stored knowledge will reduce redundancy, improve quality and minimizes obsolescence [6]. The repository can contain knowledge represented in various forms like documentation, electronic database and codified human knowledge. The repository serves as storage for the knowledge which is organized and also facilitates its ease of sharing and disseminating. It is viewed as the organizational memory. The repository should be built and maintained to achieve cost reduction and quality improvement [97]. Therefore for efficient storage in the repository, it should be archived periodically to provide backup that can be used in case of failure or crash of the machines/servers [103].

3.5.3 Knowledge sharing and disseminating (KSD)

Knowledge sharing/disseminating is the fourth stage of this framework. It is the process by which sharing of knowledge take place among individuals and/or groups in the organization, thereby promoting learning and creation of new knowledge. Knowledge sharing is where tacit and explicit knowledge is disseminated throughout the entire organization [30]. It is considered as a core process of KM since one of the main goals and objectives of KM is to promote sharing of knowledge among individuals, groups and organizations [3] [117]. Transfer of knowledge can be in the horizontal and/or vertical directions. Horizontal knowledge transfer takes place between the employees in the organizations and vertical knowledge transfer takes place between organizations. Knowledge sharing process can be driven by formal, informal and personal approaches such as meetings, discussions, social networking, collaboration, focus group meetings, face-to-face interaction, etc. [30][123].

Knowledge in the organization is transferred through social networks, collaboration, and daily interaction that include informal and formal chatting and

conversation [6]. The combination of incentives and the co-operative form of behavior of the employees will support knowledge dissemination in the organization [97]. This creates a congenial environment within organization for sharing knowledge, and during this process, a new knowledge can be created by combing the shared knowledge and the existing knowledge. According to Choo, in organizations, members combine their explicit knowledge by sharing/exchanging reports, memos and a variety of other documents [124]. To achieve the objectives of the KM, the organization need to provide an environment where employees or members can freely share, retrieve and contribute to the organizational knowledge repository.

3.5.4 Knowledge applying (KAP)

Knowledge applying is to make good use of knowledge by the members/employees of an organization to apply and adopt the best practices in their daily work [125]. This process also means to put knowledge into practice, where employee should apply lessons learnt from previous experience or mistake [126]. According to Davenport and Klahr, the effective application of knowledge can assist the organization to improve efficiency and reduce cost [6]. Knowledge application includes the application of decision-making protection, action and problem solving which finally lead to knowledge creation [127].

Figure 3.1 is the proposed theoretical framework of AKM process. The framework indicates that the potential of using knowledge for agricultural development should be conceptualized within the targeted community. The KM model provides guidelines for agricultural organization to manage knowledge at various levels by integrating both tacit and explicit knowledge. The KM model identifies four major stages of managing knowledge: acquiring and creating, organizing and storing, sharing and disseminating and applying. It is cyclical process through which each knowledge item goes through right from creating to applying the knowledge item and in the process new knowledge items may be created and the process continues.

At each stage, it has provision to include both tacit and explicit knowledge.

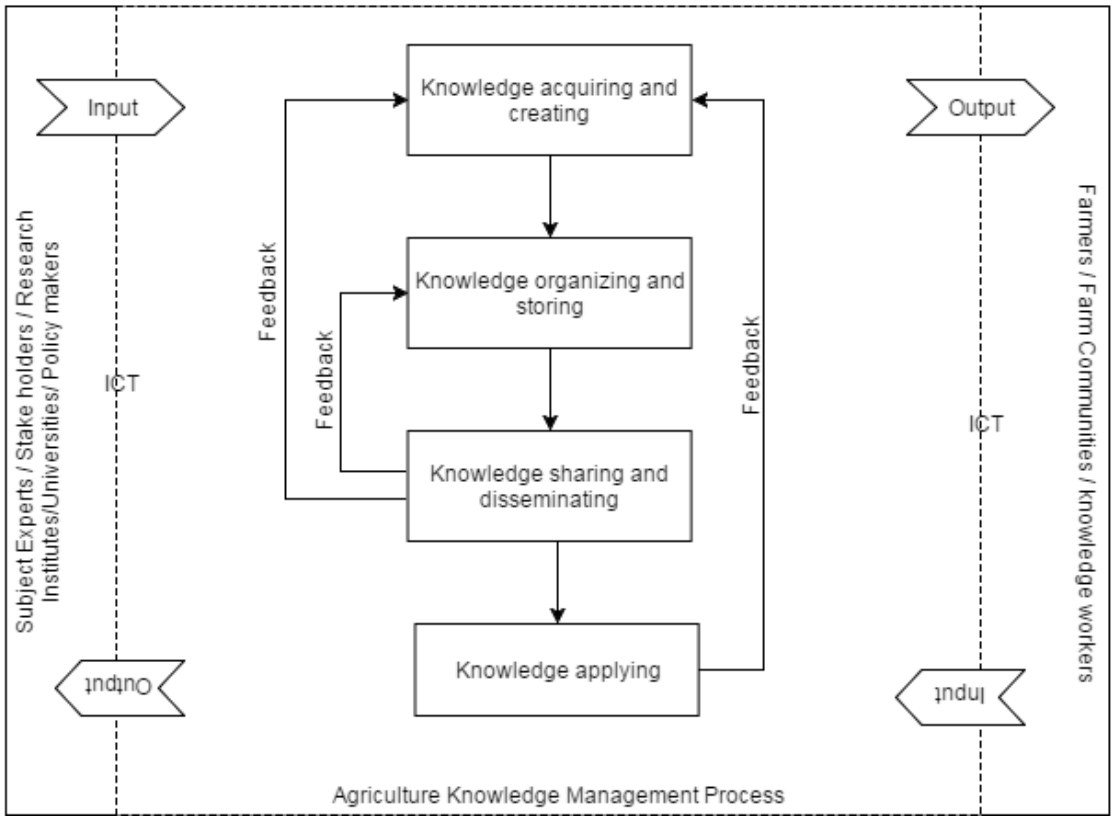

Figure 3.1: Proposed theoretical framework of AKM process

Members of the organizations from top management to field workers, policy makers of the organization to farmers and farm communities are included in the process of KM to enable integration of tacit (individual/groups at local level) and explicit (scientific knowledge) that exists at various levels. This would provide a better linkage for information and knowledge to flow in both the lab-to-land and land-to-lab directions. The framework will help in integrating the combination of multiple perspectives and engagement with multiple knowledges.

All aspects of KM were subsumed in this four major stages of proposed framework. Feedback mechanism in the framework provide a means of evaluating and updating the knowledge at various levels for the proposed framework of AKM.

3.6 Chapter summary

In this chapter, we elaborately discuss about the various KM models presented in the literature. These are mostly based on experiences and studies in Western in-

dustrialized countries that are already becoming knowledge economies. We highlight the need of KM for Indian agricultural organizations. Case study methodology has been opted for data collection i.e. to understand how organization in Indian agriculture manage knowledge. Last section we proposed a novel theoretical framework for agriculture knowledge management process in Indian agricultural organizations. In next chapter we present metrics that can help in evaluating the effectiveness of AKM in different Indian agricultural organizations using the proposed framework.

CHAPTER 4

Metrics for measuring AKM performance in agricultural organizations

4.1 Introduction

This chapter outlines the importances and objective of the KM metrics for an organization. It presents the various performance measurement models for KM illustrated in the literature, and lessons learned from them. The chapter then presents the proposed metrics for agriculture knowledge management process.

Organizations are attempting to use KM to improve organizational performance, however commonly accepted KM principles are yet to be developed [128]. Stankosky and Baldanza (2001) stated that, "although the thrust behind KM is to improve efficiency, effectiveness, and innovation, there are still no organized, commonly accepted KM principle or references to rely upon" [129].

Performance measurement is required by managers to know how well the KM system is performing in the organization and also helps in making important decisions on KM strategies and investments [130]. The main objective of performance measurement is "to improve KM effectiveness, efficiency and adaptability in order to add more value to the overall performance of an organization" [131]. According to Pervaiz *et al*, measurement enables an organization to evaluate, control and improve its KM processes [132]. KM measurement program can improve the identification, mapping, monitoring of knowledge flow patterns, critical knowledge issues and best practices in an organization [133].

Metrics are used by managers to identifying if their organizations are "better

than yesterday and if they are better or worse or doing just as well as their competitors" [134]. But Klug *et al* argue that, it is not easy to measure KM performance because it is an intangible characteristic that includes subjectivity, transferability, embeddedness, self-reinforcement, spontaneity, and perishability [135]. Similarly Glazer (1998), argue that KM metrics are distinct from other metrics due to the intangible nature of the knowledge resource [136].

The term "metrics", "criteria" and "performance measurements" are used recognized in the literature. This study uses the terms "metrics" and "performance measurement" interchangeably to describe how they could be used in assessing AKM process in agricultural organizations. The IEEE standard glossary of software engineering provides the following definitions of measures and metrics. A *measure* is "a standard, unit, or result of measurement" and a *metric* is "a quantitative measure of the degree to which a system, entity, or process possesses a given attribute" [137].

Organizations need to measure the KM process in order to verify if the desired results are being achieved. The main purpose of the KM metrics is to evaluate the performance of KM in the organization, and ability to explain and suggest future strategic actions that organizations could take to further improve them. Considering the importance of metrics of AKM process has in agricultural organizations, this research aims to develop or propose metrics for the different phases of the AKM process.

4.2 Literature review

Some of the relevant performance measurement models found in the literature for KM process are discussed in this section.

Balanced scorecard (BSC) is a managerial tool developed by Kaplan and Norton (1996). It measures an organization in four key areas: financial performance, internal business processes, customer, and learning and growth within the organization [138]. It is suitable for KM performance measurement as it links learning components and other intangible assets to organizational performance. For ex-

ample Gooijer (2000), describes an approach for measuring the performance of KM strategies for a public sector agency by expanding BSC into a performance scorecard that is used to map KM objectives across the four BSC key areas [139]. Minonne and Turner (2009) applied BSC to measure and monitor the performance of KM maturity by focusing on four forms of integrations, viz. cultural, organizational, procedural, and methodical [140].

Alea M. Fairchild (2002) proposed KM metrics using BSC methodology. She proposed a measurement model for KM metrics and examined their sustainability and soundness in assessing knowledge utilization and retention for generating revenue. She used of a BSC approach to determine a business-oriented relationship between strategic KM usage and IT strategy and implementation [141]. Yan Mi (2008), analyze the relationship between enterprise's core competency and KM. He introduced the theory of BSC and evaluated the performance of enterprise KM from the four perspective of BSC [142].

Tariq *et al* (2011) used a BSC for measuring indigenous knowledge management (IKM) system in indigenous communities, which can help the researchers to realize the communities-based structure of knowledge management. They explore a process-oriented KM model for indigenous communities and proposed third-generation BSC approach in the design of a holistic approach for KM system of communities. [143].

Teruya (2004) categorized the KM performance measurements into different types such as: internal measurement, external measurement, organization-orientated analysis, project orientated analysis, and success case study method [144]. Ahn and Chang (2003), measured the contribution of knowledge to business performance. They developed KP3 (product, process and performance) methodology to measure the contribution of knowledge to business performance by employing product and process as intermediaries [145]. To explore integrated performance measurement system that evaluates the financial and non-financial performance of KM system, Hsiao and Wen (2011) has proposed Knowledge Performance (KP) methodology by integrating KM system with BSC [146].

KPMG Consulting (2000), had surveyed 423 organizations in the Europe and

United States and identified 14 criteria for measuring KM performance. They are: better decision making; better customer handling; faster response to key business issues; improved employed skills; improved productivity; increased profits; sharing of best practices; reduction in costs; new or better ways of working; increased market share; creation of new business opportunities; improved new product development; better staff attraction/retention and increase in share price [147].

According to Allee (1997), there are six benefits of KM implementation: sharing best practices; new or better ways of working; improved communication and improved learning/capability to adapt, increased innovation and enhanced intellectual capital [148]. Choy (2006), identified 38 items for measuring KM performance and grouped them into five dimensions: systematic knowledge activities; employee development; customer satisfaction; good external relationship; and organizational success [149].

Lee *et al*, (2005) proposed the KM performance index (KMPI) to assess KM performance. This is one of the pioneering initiatives that evaluate KM based on its processes. KM process consists of five components, viz. knowledge creation, accumulation, sharing, utilization, and internalization. There are used to define the knowledge circulation process. KMPI is able to improve the quality of decision-making by investing in information system resources and establishing and evaluating the knowledge circulation process. The limitation of this method is that it involves too many subjective opinions which is not desirable when used for benchmark analysis [150]. Similarly, Goldoni and Oliveria (2006) proposed metrics with KM process phases. Based on a bibliography research, they suggested metrics for KM process phases that do not follow a linear sequence [134].

Indian organizations too developed KM metrics to measure KM performance in their organizations. For example Tata Steel Limited developed Knowledge Manthan Index to measure the effectiveness of KM by capturing aspects like involvement of people, sharing of ideas, quality of implementation etc [151]. Wipro Technologies Limited developed a KM engagement and effectiveness (KMEE) index. The information published on KMEE dashboard gives the top management a clear view of engagement and effectiveness of KM at the organizational level

as well as at each of the business unit level [152]. Similarly Infosys Technologies Limited has created an internal metric known as the Knowledge Maturity Model (KMM) for tracking its progression on KM initiatives within the organization [153]. Tata Consultancy Services Limited has developed a Knowledge Management Maturity Model which include five stages, viz. initial, intent, initiative, intelligent and innovative. The author called it as '5iKM3' to access and harness the organizations ability to manage knowledge [154] [7].

Lesson learned

The models discussed above were mostly developed based on industrial profit-making organizations like the IT sector, Automobile etc, where as KM performance measurement tools for agricultural organizations (public and nonprofit-making organizations) are very limited. Moreover most of models are not evaluated based on KM processes. Since the focus of agricultural organizations can be very different from profit-making ones, AKM performance measurement models can be developed to fill the gap. The models above are mainly for evaluating KM in a single organization. A performance measurement model which can benchmark KM performances across a specific industry is missing.

4.3 Developing metrics for AKM performance measurement

In this section, we propose metrics for AKM process based on the systematic review the literature on KM performance outcomes. Here we AKM process consists of four components, viz. knowledge acquiring and creating (KAC), knowledge organizing and storing (KOS), knowledge sharing and disseminating (KSD), and knowledge applying (KAP). These components are briefly explained in the section 3.6 of Chapter 3. In this research, the processes are treated as interrelated parallel activities instead of a series of activities. This is because these processes actually happen concurrently in an organization rather than consecutively. AKM will be evaluated as a multi-input and multi-output system, shown in Figure 3.1.

AKM will be evaluated as a whole system taking into consideration all inputs and outputs, and the four AKM processes. In this way, the overall AKM performance along with the individual AKM process performances can be obtained.

KM performance is measured using both qualitative and quantitative methodology [120]. Qualitative measures assess the 'human' side of KM, such as culture, behaviour, practice, perception, and experience, while quantitative measures assess the 'tangible' side of KM, such as the number of knowledge workers and number of research and development projects etc [130]. Based on a review, the measures for the proposed AKM performance measurement have been selectively adopted from the literature. These measuring metrics were associated with four phases of AKM process. After careful analysis of literature, we have proposed 16 items that will be used to measure AKM performance for the agricultural organizations. The proposed measuring items are described below:

1. ***Number of Knowledge workers or field supervisor***: Knowledge workers or field supervisor are the important elements of the AKM process. They are responsible for generating or creating new knowledge, ideas and solutions. They document and store knowledge in databases and retrieve it from organization's repository when needed. The major activity of knowledge workers is to disseminate knowledge to farm communities through personal interactions or focus group discussions. In addition, they also utilize their knowledge and expertise in solving problems and improving the organization in various ways like help in achieving organizational goals, helps in disseminating right information to right person at right time etc [120].

2. ***ICT infrastructure and tools***: ICT infrastructure and tools are important for AKM process. They enable members within and outside the organization to effectively/easily access, store, search, retrieve, and share the required knowledge. These tools helps in collaborating and communicating among the stake holders and enable virtual communities of practice (CoPs) [29][6] [120].

3. ***Number of group discussions and meetings***: Group discussions and meet-

ings between various stake holders provide an opportunity for generating new knowledge or innovation or acquire knowledge [134][143].

4. ***Knowledge network or Enhance collaboration with farm communities, partners or other organizations***:By collaboration with research institutions,organizations and farmers will help in getting or knowing advance technology [143] [155]. These networks enable farmers to exchange knowledge between their communities, research institutions etc.

5. ***Number of new knowledge, ideas, and solutions created***: New knowledge, ideas, and solutions are created by the experts group, knowledge workers, and farmers via the process of knowledge creation. By acquiring knowledge from external resource, new ideas and solutions may be added into organization repository [130].

6. ***Number of documents (in all formats) stored and added in the organization repository***: Information in different formats like videos, audios, soft and hard copies of case studies, annual report etc. are stored in the organization repository. This can be an indication on how effective knowledge is being converted from tacit to explicit [134][130][67].

7. ***Number of registered users who access and/or downloaded from knowledge repository***: The number of documents downloaded or accessed, indicates the extent to which the member within and outside of the organization, farm communities are using AKM system to retrieve required information and knowledge [134][130].

8. ***Rate of update of knowledge repository***: This show how frequently organization update its knowledge repository [143][134].

9. ***Frequency of evaluation of knowledge by subject experts***: How frequently knowledge is being evaluated by the subject experts or update the knowledge in repository so that it can be use by various stake holders [67].

10. ***Trainings, capacity building, fields visits, community of practices (CoP) etc. conducted***: Experts group, farmers group share their experience with each

other. This communication can be help in improving their knowledge. The number of such meetings is used as a proxy to measure the performance of KSD [134][143][130][155].

11. ***Expenditure on trainings, discussion sessions, fields visits etc.***: Training programs, field visits, capacity buildings are means to transfer up-to-date knowledge to the field worker, and farmers. New knowledge or ideas would be generated by the farmers and field workers after digesting the obtained knowledge [130].

12. ***Promoting or encouraging knowledge sharing with peer groups***: Organization motivates by giving reward to members of the organization and farmers to share their experience with each other [156] [157].

13. ***Acknowledgment of individual or group contribution in knowledge creation***: By providing rewards, acknowledge to individual or group will encourage farm communities and members in the organization in creating new knowledge [143].

14. ***Number of problems solved and new ideas implemented***: Farmers apply and utilize the knowledge provided by the organization for production improvement. The number of problems solved server as a good estimation on how well the knowledge in an organization is being utilized by farm communities [130].

15. ***Reduced input cost***: Farmers are able to reduce input cost by apply the knowledge provided by the organization [155].

16. ***Number of feedback from users***: Field worker or knowledge worker need collect feedback from the farmers. This will help in regenerating or recreating knowledge [67].

The Table 4.1 list the proposed measurement metrics for AKM process (KAC, KOS, KSD and KAP). The measurement phase withhold process metrics in both qualitative or quantitative. The metrics in the KAC phase it is perceivable that the

Table 4.1: Proposed metric for measuring AKM process performance

Measuring items	**AKM process**				**Method to measure**	
	KAC	*KOS*	*KSD*	*KAP*	*Quantitative*	*Qualitative*
Number of Knowledge workers or field supervisor	x	x	x	x	x	x
ICT infrastructure and tools	x	x	x	x	x	
Number of group discussions, meetings on processing new knowledge or innovation or acquiring knowledge	x		x		x	x
Knowledge network or collaboration with partners or other organizations	x		x		x	x
Number of new knowledge, ideas, and solutions created	x				x	
Number of documents (in all format) stored in organization repository		x			x	x
Number of register user who are access and downloaded from knowledge repository	x	x			x	
Frequency of updating knowledge repository		x			x	x
Evaluation of knowledge by subject experts		x				x
Number of meetings, discussion sessions, trainings, capacity building, fields visits, community of practices (CoP) etc. conducted			x		x	
Expenditure spent on trainings, discussion sessions, fields visits etc.			x		x	
Promoting or encouraging knowledge sharing with peer groups			x		x	
Acknowledgement of individual or group contribution in knowledge creation	x				x	x
Number of problems solved and ideas implemented				x	x	
Reduced input cost				x	x	
Number of feedback from users				x	x	

proposed indicators are all quantitative as it aims to measure KAC in the organization. To measure the KOS phase, it is necessary to apply the statistic method that stores the organizations knowledge. According Robertson (2003), the above

indicators in KOS phase should be used with careful, as the present existing or availability of the system need to be analyzed [67]. It has been observed in the KSD phase, the indicators are both quantitative and qualitative measures. Besides that, the organization must measure the amount spent in knowledge dissemination. In metrics in KAP phase are with quantitative indicators.

4.4 Chapter summary

This chapter began with the discussion on importance of the measuring the KM process. In the next section the review of various KM measuring performance were discussed. In the final section we proposed the measuring metric for AKM process which can measured using both qualitative or quantitative methods

CHAPTER 5

Linkage between ICT and AKM Process

5.1 Introduction

This chapter brings out the relationship between Information and Communication Technology (ICT) and Agriculture Knowledge Management process (AKM process). We discuss the hypothesis, research framework and followed by methodology. The data analysis and results are presented, subsequently supported by the relevant discussions and summary.

In recent years, knowledge management (KM) has become a critical subject of discussion in the business literature. Both business and academic communities believe that by leveraging knowledge, an organization can sustain its long-term competitive advantage [92]. It has been discussed in the Chapter 2 that, researchers, industries and academics have taken different perspectives on KM, ranging from technological solutions to communities of practices (CoPs) and the use of best practices. Majority of managers in various organizations and industries believe in the power of information and communication technologies (ICT) in facilitating KM, and also believe that ICT can provide an edge in harvesting the knowledge [9]. Most recent research suggest that successful implementation of KM evolves integrating knowledge enablers like organizational structure, organizational culture, ICT etc. which are important for the success of KM in organizations [158][127][159]. In this chapter we explore one of the important knowledge enabler ICT and its key issues that affect the AKM process in agricultural organizations.

5.2 Research framework and hypothesis development

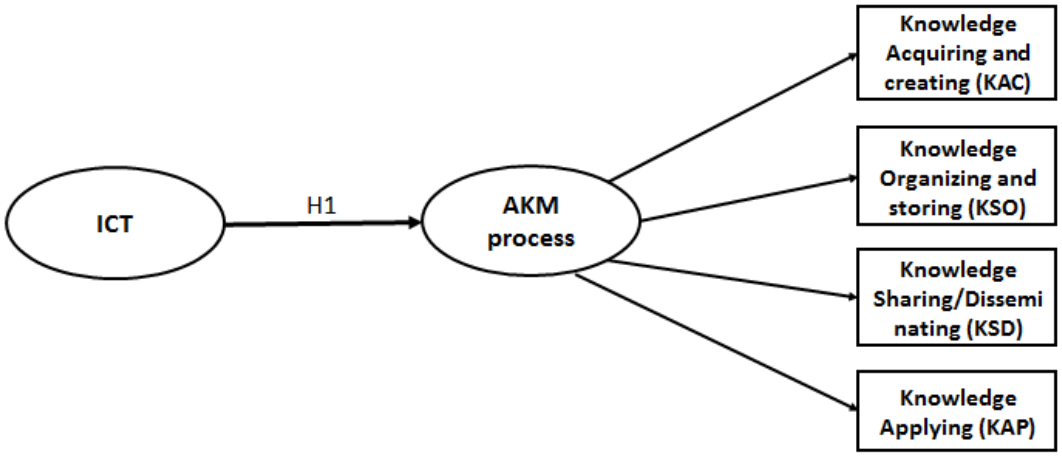

Figure 5.1: Research framework

As mentioned earlier in chapter 2, few studies have analyzed/focused on the relationship between knowledge management process and ICT in Indian agricultural organizations. Therefore, this research aims to discover the linkage between these two aspects. The main objective of this study is to understand the relationship between knowledge enablers like ICT and the agriculture knowledge management process. In this study, ICT has been assumed to be the independent variable (IV) and agricultural knowledge management (AKM) process has been taken as the dependent variable (DV). Figure 5.1 shows proposed research framework.

5.2.1 Agriculture knowledge management process (AKM process)

AKM process includes activities of acquiring, creating, storing, sharing, diffusing, developing and deploying knowledge by individuals and groups [160]. According to Davenport and Prusak (1998), KM has three processes that have received most consensus viz. knowledge generation, sharing and utilization [6]. On other hand, Alavi and Leidner (1999), proposed four processes of knowledge manage-

ment viz. creation, storage, transfer and application [161].The present study examines the following four processes: acquiring and creating, organizing and storing, sharing or disseminating and applying as proposed by Vanagla *et al*, for the agricultural organization [162][163]. The details of these processes are given in section 3.6 of chapter 3

1. **Knowledge Acquiring and Creating (KAC):** In this process members in the organization gain, collect, create and obtain required and useful knowledge to perform their job functions. It involves updating existing content or developing new content by using organization's tacit and explicit knowledge [117]. KAC is about obtaining knowledge from external and/or internal sources or capturing of the knowledge (explicit or tacit) that resides inside the people working in the organization [118].

2. **Knowledge Organizing and Storing (KOS):** This process involves structuring, indexing, evaluating and storing the knowledge in organization's repository. Knowledge is validated, codified (to represent a useful format) before it can be used [30]. Once knowledge is evaluated, it is categorized and represented in a structured manner with indexing or mapping to enable efficient storage in the organization's repository and for effective usage at a later point [122].

3. **Knowledge Sharing and Disseminating (KSD):** It is the process in which sharing of knowledge take place among individuals and/or groups within and outside the organization. Knowledge sharing is considered as a core process of knowledge management because one of the main goals and objectives of knowledge management is to promote sharing of knowledge among individuals, groups and organizations [164][3]. Knowledge in the organization is transferred through social networks, collaboration, and daily interaction like chatting, face-to-face, formal and informal conversations [6].

4. **Knowledge Applying (KAP):** Knowledge applying is to put the knowledge to good use. The members or employees of the organizations can apply and adopt the best practices in their daily work [5]. According to Davenport and

Klahr (1998), the effective application of knowledge can assist the organization to improve efficiency and reduce cost [37]. This process also implies putting knowledge into practice, where the employee should use lessons learnt from previous experience or mistakes made in the past [126].

5.2.2 Information and Communication Technology (ICT)

ICT plays an important role in facilitating communication between different parts of the organization that often inhibits through normal channels of communication [127]. Many researchers have found that ICT plays important role in supporting knowledge management process in the organizations [165][166]. ICT tools help in capturing the knowledge created by knowledge worker and making it available to the large community [167]. ICT has been widely used in an organization, and thus qualifies as a natural medium for the flow and KM process in the organization [127]. Thus, we hypothesize:

H1: ICT has significant and direct effect on Knowledge Management process.

5.3 Research methodology

In this section, we will cover the major areas of research methodology, which it includes the research design developed to examine the research hypothesis. In particular, it encompasses three major parts namely: (1) research design (2) survey instrument and operationalized research constructs and (3) methods of statistical analysis.

5.3.1 Research design

It is a part of the elementary plan for research which covers main ideas like sample, approach and the measure taken to gather and assess data [168]. From the literature we found that number of research studies have been carried out in the developed countries which focused on kowledge enabler of knowledge management. The approaches adopted by these studies are empirical in nature and followed the similar approach i.e., each study has taken the success factors from

the literature and then tested hypothesis. In this study we also adopted similar approach by identifying critical success factors through the literature review and discussions with subject experts and managers in organizations.

Most studies tend to use either quantitative or qualitative approach to explore the unexplained phenomena [169]. However, it is argued that use of only quantitative or qualitative approach falls short of major approaches being used in the social and human sciences. It is suggested that mixed methods approach should also be considered when planning for the research design [169]. This study used mixed methods approach, with both quantitative and qualitative methods.

A difference between qualitative and quantitative approaches

Qualitative research is used to find and confirm the presence and absence of element, while quantitative methods are used to measure the degree of an element already present [170][171]. Furthermore, qualitative approach is referred as the interpretative, constructivist approach whereas quantitative method referred as the traditional, experimental or positivist, post-positivist approach [172].

In a qualitative study, the intent is to learn from participants, the questions are open-ended, allowing participants to provide information from their perspectives whereas in quantitative approach, the intent and the literature point towards focused closed-ended that relate variables to each other [173]. In qualitative studies research procedures are particular and replication is very rare while in quantitative studies research procedures are standard and replication is frequent [174]. Quantitative approach focus on variables and qualitative approach focus on interactive processes and events [169][174]. In a quantitative study, it usually ends with the validation or invalidation of the hypotheses that were tested whereas, qualitative study is more likely to end with tentative answers or hypotheses about what was observed. These tentative hypotheses may form the basis for future research studies [172]. Overall, both qualitative and quantitative approaches differ in their strengths and weaknesses.

Mixed methods approach

Mixed methods research is the type of research in which a researcher focuses on collecting, analyzing, and mixing both quantitative and qualitative data within a single study or series of studies [175]. The central premise is that the use of quantitative and qualitative approaches, in combination, provides a better understanding of research problems than either approach alone. When we use in combination, quantitative and qualitative methods complement each other and provide more complete picture of the research problem [176][177]. According to Johnson and Onwuegbuzie (2004), mixed methods research defined as the class of research where the researcher mixes or combines both qualitative and quantitative research techniques, methods, approaches, concepts or language into a single study [178]. The main approach of mixed methods is the use of multiple approaches in answering research question, rather than restricting or constraining researchers' choices [178]. Moreover it address both exploratory and confirmatory questions by gathering information that results conclusion [177].

The mixed methods research designs can be broadly classified into two categories: *mixed-model* (mixing qualitative and quantitative approaches within or across the stages of the research process) and *mixed-method* (the inclusion of a quantitative phase and a qualitative phase in an overall research study) [178]. An example of mixed-model design would be the use of questionnaire that includes rating scale (quantitative data collection) and one or more open-ended questions (qualitative data collection). To construct a mixed-method design, the researcher must make two primary decision: (a) whether one wants to operate largely within a dominant paradigm or not (also know as dominant-less-dominant model) and (b) whether one wants to conduct the phases concurrently or sequentially.

Justification for a mixed methods approach

This study used mixed methods approach, where quantitative method is used to collect the data by designing questionnaires and qualitative method is used for conducting semi-structured interview with one or more open ended questions. Quantitative data was embedded in the qualitative to enrich the description of

the sample participants. Both quantitative and qualitative data were used to provide the complete analysis of the research problem in order to answer the research questions [177]. By deploying qualitative approach, data was obtained based on the participation of various levels of people in the organization, to describe complex phenomena, such as knowledge management and ICT; to understand people's personal experiences and the way organization manage both tacit and explicit knowledge. On the other hand, quantitative research was employed in the study in order to obtain data that allowed the quantitative predictions to be made. By deploying both qualitative and quantitative approaches, the research objective was measured and able to explain scientifically. Since there is no personal or formal relationship between researchers and interviewees or the organization as a whole, this allowed for triangulation and also helped to validate data interpretation and findings [179].

5.3.2 Questionnaire Development

After development of research framework, a series of personal interviews with professionals and academicians were conducted to validate the model. Since the proposed model for agriculture organization is not same as any previous models in the literature, items in the constructs were adapted with modification to suit the agriculture context. For tapping the response, the Likert scale rating method has been adopted in the study. This method is more appropriate when the items consist of statements that give respondents an option to response by selecting numerical score. Therefore, in this study, five point Likert scale rating from "strongly agree" to "strongly disagree" was adopted for each items of independent variables and dependent variables. The questions are well-structured, understandable and were developed in four languages namely English, Hindi, Gujarati and Telugu because the composition of people working and geographical location of milk cooperatives and NGOs that were the part of the study.

The questionnaire was split into two main sections. The first section has the general information of the respondent such as name, gender, position, education and number of years of experience in the organization. The second section in-

vestigates the critical metrics for measuring ICT and KM processes (acquiring and creating, organizing and storing, sharing/disseminating and applying). The questionnaire consists of 45 items, out which 13 items cover demographic data, 7 items are related to independent variable (IV), and 35 items cover dependent variable (DV). These items were explained briefly in following subsection.

5.3.3 Items measuring variables

The main objective of this study is to test the relationship among the variables in the research framework (Figure.5.1) through measurement process. It consists of three major steps: (1) definition of concepts, (2) operational definition that gives meaning to a concept by identifying the activities or operations that are important to measure it, and (3) empirical measures that describe how people concretely measure specific item [174]. According to Neuman (2005), a researcher first conceptualizes a variable, giving it a clear conceptual definition, next developing set of indicators and finally, applies or use these indicators for studying in the empirical world [174]. Figure 5.2 illustrates the three levels of the above mentioned measurement process through an example in this research-the measurement of agriculture knowledge process (dependent variable). In this, the major concept is (agriculture knowledge management process) is personalized into four constructs, then each construct is operationalized and measured using different numbers of scaled items.

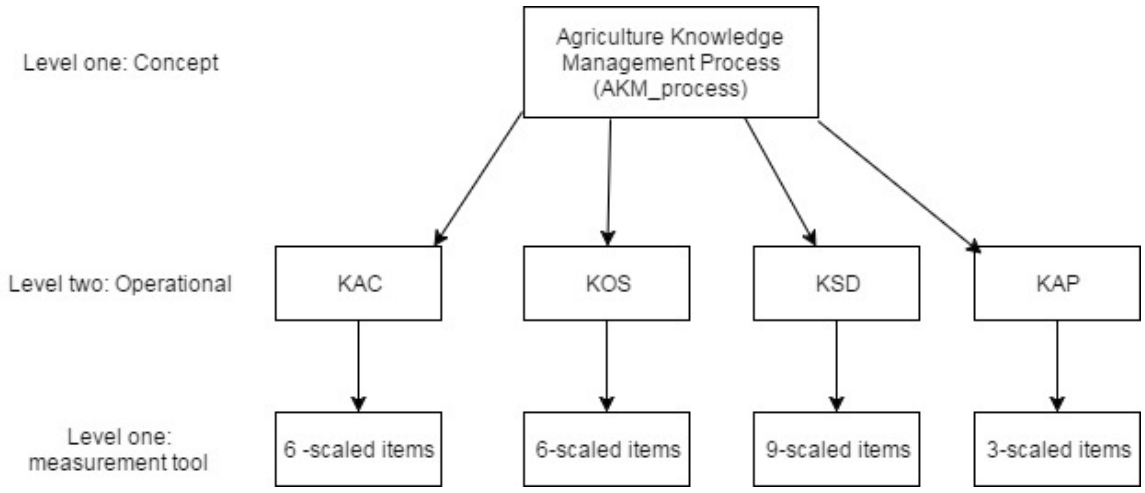

Figure 5.2: Abstract construct to concrete measure of AKM process

The items related to the independent variable (IV) and dependent variable (DV) are mentioned below:

Information and Communication Technology (ICT)

For the success of AKM, the role of ICT is critical. To make AKM more effective, ICT needs to be carefully aligned with AKM and also required to motivate the organizations' members/farmers to adopt and use it in their work process. For measuring ICT, seven items have been developed or constructed based on operationalization process with required modification from literature. The following are items:

1. Our organization has ICT infrastructure (like computer, networks) for managing all kind of documents on agriculture knowledge [180].
2. ICT infrastructure (like computers, software, networks) is easy to use for uploading, searching and retrieving agriculture knowledge [181].
3. We use ICT tools (like computers, emails, telephones, mobile) to communicate within organization.
4. I/We routinely utilize ICT tools (like computers, emails, and telephones, mobile) to access agriculture knowledge from outside organizations.
5. I/We use ICT tools (like computers, emails, telephones, mobile, audio conference, video conference) for sharing agriculture knowledge with farm communities [170]
6. We use computers for storing agriculture knowledge [170].
7. We use internet and/or intranet to access the agricultural knowledge repository [180].

Knowledge acquiring and creating (KAC)

Six items were constructed to based on the literature to measure KAC. The following are items:

1. Organization has processes of acquiring agriculture knowledge by collaborating with research institutes, business partners, and farm communities [182][183].

2. Organization gives importance's on creating new agriculture knowledge [182][158].

3. Organization creates manuals and documents on best practices, and success stories in agriculture [158].

4. Organization encourages employee, and farm communities to exchanges new ideas between individuals and groups [183][158].

5. Organization rewards farmers for generating new knowledge in agricultural practices [183].

6. Organization rewards employee for generating new knowledge in agricultural practices [183].

Knowledge organizing and storing (KOS)

Six items were constructed based on the literature to measure KOS. These items are:

1. The organization utilizes various print material (such as newsletters, handbooks, annual reports, manuals etc.) to store agriculture knowledge [183][184].

2. Organization use audios, videos formate to store agriculture knowledge.

3. Databases that store the gathered agriculture knowledge (from farm communities and expert group) are available in the organization's repository [184].

4. Organization has good ICT infrastructure to store the agriculture knowledge

5. Organization uses advanced ICT tools for filtering, listing, indexing the agriculture knowledge to facilitate effective and efficient retrieval [183].

6. Knowledge repository (library) are frequently updated [184].

Knowledge sharing and disseminating (KSD)

Nine items were constructed based on the literature. The following are items used to measure KSD:

1. Periodical annual reports/success stories are created to share with all organization members [184].
2. Periodical meetings/workshops/seminars are held to share about best practices, and new technology in agriculture [184].
3. Farm communities are willing to share their experience and knowledge with each other.
4. Farm communities are willing to share their experience and knowledge with experts group.
5. We share our field experience with peer group in the organization.
6. We use ICT tools like mobile, audio and video conferencing, internet for sharing agriculture knowledge [185].
7. Organization encourages employee to share their knowledge with peer groups and others.
8. Organization has resources centers, community halls and forums for sharing agriculture knowledge.
9. I believe that sharing agriculture knowledge across groups will yield high benefit [185].

Knowledge applying (KAP)

Three items were constructed based on the literature to measure KAP. The following are items:

1. Farmers apply agriculture knowledge to improve their productivity [182].

2. Farmers take the advantage of new technology to improve their efficiency [182].

3. Farmers use the agriculture knowledge to solve the problems in agriculture [182].

5.3.4 Data collection

Unit of analysis in this study are the middle-level managers, veterinary doctors, agriculture extension officers, project coordinators, cluster in-charge or supervisors and field workers/operators. These people are surveyed because they play a key role in managing knowledge. These people are positioned at the intersection of both vertical and horizontal flow of knowledge. Therefore they can synthesize the tacit knowledge of both top (scientist group) and bottom (farmer group) level, convert them explicit knowledge, and incorporate it into the organizational knowledge repository. Before running an actual survey, the questionnaire has gone through the pilot test, to ensure the objectives of the questionnaire are clear. A total of 283 responses were collected from the four organizations (see section 3.4 cases study details). Some of these respondents were also interviewed (by semi-structure and group) to get a deeper understanding of the flow and management of knowledge and challenges faced by the members/employees in their knowledge mobilization activities. Data was collected during their weekly and monthly meetings in the organization. During the meetings, the participants were asked to fill the questionnaires. The objectives of the research and questionnaire were explained to them, before filling the form.

5.3.5 Methods of statistical analysis

Data is analyzed seeking answers to the research questions and test the hypotheses in the study range from correlation analysis to performing an advanced analysis using Structural Equation Modeling (SEM). The initial statistical analysis was carried out using the IBM- SPSS (version 20) to examine the reliability and validity of the scales used in this study. Eventually, SEM via the Analysis of Moment

Structures (AMOS version 20.0) software was used to examine and test the proposed hypotheses.

Data screening and cleaning

Data screening is the process of ensuring that the data collected is clean and ready to go before one conducts further statistical analyzes. Data must be screened in order to ensure the data is usable, reliable, and valid for being subjected to further statistical analysis. The data screening is done to check for any missing data in rows, unengaged responses, and outliers. By using SPSS software, data were screened by checking each variable to see whether any values were out of range.

Reliability and validity

This study deals primarily with constructs and variables. The objective is to develop clear definitions and to create measures that yield precise and accurate findings. The concept of reliability and validity are used to assess how well a question or group of questions are addressed. These two concepts are interrelated and reliability is a precondition for validity and has been addressed in this study [186].

The term reliability refers to "the consistency of a research study" or "the degree to which an assessment tool produces stable and consistent results". For testing of reliability, internal consistency method has been used in this study. Internal consistency refers to "the degree to which the items on a test jointly measure the same concept or construct" [187]. It is connected to the inter-relatedness of the items within the test [188]. Cronbach's alpha, one of the most commonly used coefficient methods has been used to assess the internal consistency of the items [189]. It used to measure the how closely related as a group is a set of items as a group as per the research feedback. A high value of alpha is often used as evidence that the items measure an underlying construct. The theoretical range of Cronbach's alpha is from 0 to 1. Suggested guidelines for interpretation are < 0.60 unacceptable, $0.60 - 0.65$ undesirable, $0.65 - 0.70$ minimally acceptable, $0.70 - 0.80$ respectable, $0.80 - 0.90$ very good, and > 0.90 consider shortening the scale by reducing the number of items [190]. A cut-off point of 0.60 in the alpha's value

indicates an acceptable degree of reliability of the construct [191][192]. Hence internal consistency method was used in assessing the reliability of the survey instruments in this study.

Validity refers to "the degree to which an instrument measures what it is supposed or intended to measure." Construct validity is the "degree to which the measurement scale represents and acts like the concept being measured, where multiple indicators are consistent." Convergent and discriminant validity are both considered subcategories or sub-types of construct validity. Both convergent and discriminant validity were checked for each construct in this study to test construct validity. Convergent validity refers to "the degree to which items that should be related are actually related", while discriminant validity signifies "the degree to which items that should not be related are in fact not related" [30].

To test convergent validity, the composite reliability (CR) and average variance extracted (AVE) were used in this study. Composite reliability is "a measure of the overall reliability of a collection of heterogeneous but similar items". Average variance extracted (AVE) is defined as amount of variance that captured by the construct in association with the amount of variance due to the measurement error [193]. For convergent validity, CR value must be greater than or equal to 0.7 and AVE value must be greater than or equal to 0.5 [191] [194]. Discriminant validity is "theoretical base way of thinking about the ability of a measure to estimate the underlying truth in a given area" [195]. It is used because each variable was measured by multiple items. In this study factor analysis is used to check discriminant validity.

Two types of factor analysis were used to verify construct validity: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). EFA is used to identify a set of latent constructs underlying measured variables, and CFA specifies how well the observed variables are related to a set of latent variables. Steps involved in conducting EFA were assessment of the suitability of the data, factor extraction, and factor rotation. The suitability of the data for factor analysis was assessed by using the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's test of sphericity [196]. In most academic and business stud-

ies, KMO and Bartlett's test play an important role for accepting the sample adequacy. KMO value ranges from 0 to 1. The minimum recommended value for KMO is 0.60 [196]. The Bartlett's test of sphericity should be statistically significant at $p < 0.05$, suggesting a sufficient sample size [196]. For factor extraction, the principle component method (PCM) with varimax rotation was chosen as it is the most popular type of rotation and is commonly used in operation management researches for simplifying factors rather than variables [158].

CFA provides an appropriate means of assessing the efficacy of measurement among the items [182]. In this study, CFA was conducted to evaluate the unidimensionality of the latent variables, convergent validity as well as the discriminant validity [191]. AVE from a CFA is also used to assess convergent and discriminant validity. When all the AVE values are greater than 0.5, convergent validity is satisfied. When an AVE for each construct is greater than squared correlation coefficients for corresponding inter-constructs, discriminant validity is confirmed [197][193].

Structural equation modeling (SEM)

Structural equation modeling (SEM) has been widely adopted in social science research for quantitative studies [197]. It is very useful in examining the interdependent relationship between latent variables [191]. SEM is a multivariate statistical analysis technique that is used to analyze structural relationships. It is the combination of factor analysis and multiple regression analysis. This method is preferred because it estimates the multiple and interrelated dependence in a single analysis. SEM has been designed to assess how good a proposed conceptual model can fit the data collected and also to establish the structural relationships between the sets of latent variables [198]. According to Anderson and Gerbing (2010), this structural test involves a two-stage process. The initial stage is to ascertain good measurement of the constructs and the latter stage requires an evaluation of the structural relationships [199]. In this study, the measurement and structural models were generated and estimated using Statistical Package for the Social Sciences (SPSS 20.0) and Analysis of Moment Structures (AMOS 20.0).

Goodness-of-fit

To ensure the goodness-of-fit of the structural model, i.e., how well the data set fits the research model, there are several indices which are computed by using AMOS. According to Hair*et al.*, there is no single statistical test that best describes the predictive power of a structural model [191]. Byrne (2010), noted that determination of which indices are acceptable to assess goodness-of-fit is quite complex because "particular indices have been shown to operate somewhat differently given the sample size, estimation procedure, model complexity and/or violation of the underlying assumptions of multivariate normality and variable independence" [198]. Therefore, assessment of goodness-of-fit remains on individual where each researcher can decide with an understanding of the various indices, the model, and the data. In this study the following indicators are used to test the goodness-of-fit of the structural model:

1. **Likelihood-ratio chi-square statistics (χ^2):** According to Hair *et al.*, likelihood-ratio Chi-square statistics is the most fundamental measure of overall fit and is the only statistically based measure of goodness-of-fit available in SEM [191]. As suggested by Bagozzi and Yi (1988), a p-value exceeding 0.05 and a normed chi-square value (χ^2/df) that is below 3, are normally considered as acceptable [200].

2. **Goodness-of-fit (GFI):** Along with likelihood-ratio Chi-square statistics, fitness of the structural model can be studied by using the Goodness-of-fit index (GFI). GFI was created by Joreskog and Sorbom (2008) as an alternative to the Chi-Square test. It calculates the proportion of variance that is accounted for by the estimated population covariance [201]. The index ranges from 0 to 1. It is a universal consensus that a minimum value of 0.90 is required to indicate a good fit [191].

3. **Adjusted goodness-of-fit statistic (AGFI):** AGFI is extended from GFI by adjusting the "degrees of freedom for the null model". AGFI tends to increase with sample size. As with the GFI, values for the AGFI also range

between 0 and 1 and it is generally accepted that values of 0.90 or greater indicate well fitting models [201][191].

4. **Root mean squared error of approximation (RMSEA):** The RMSEA tells us how well the model, with unknown but optimally chosen parameter estimates would fit the populations' covariance matrix [198]. RMSEA in the range of 0.08 to 0.10 provides a mediocre fit and below 0.08 shows a good fit [202].

5. **Normed Fit Index (NFI):** The NFI is also known as the Bentler-Bonett normed fit index. It varies from 0 to 1. The NFI equals to the difference between the Chi-square of the null model and the Chi-square of target model, divided by the Chi-square of the null model. A model is regarded as acceptable if NFI greater than or equal to 0.90 [198] [203].

6. **Comparative fit index (CFI):** The CFI represents comparisons between the estimated model and a null or independence model. The value lies between 0 and 1, and larger values indicate higher levels of goodness-of-fit. CFI must be greater than or equal to 0.9 [204].

5.4 Pilot study

A pilot study is performed before collecting of primary data. The procedure for data collection is conducted in the similar way to the main study with the author as data collector. The details of data gathering procedures are outlined in the section 5.4.4. Green *et al* (1988) have recommended that the sample size for this phase should be small [205]. Therefore a sample of 30 respondents were selected, who would be the potential participants for main study. The collected data were entered in SPSS (20.0) for statistical analysis. For the testing of the reliability, internal consistency method is used, which is tested through finding the value of Cronbach's alpha [189]. Table 5.1 shows the Cronbach's alpha values for all constructs, which range were ranged from 0.64 to 0.85, suggesting that the measure is reliable as recommended by Nunnally [206].

Table 5.1: Internal reliability

Constructs	Cronbach's Alpha
ICT	0.81
KAC	0.78
KOS	0.79
KSD	0.85
KAP	0.72

5.5 Data analysis and results

This section presents the results of data analysis including the demographic characteristics of the respondents, bias checks, testing the measurement model and testing the structural model. Summaries of the respondent characteristics for gender, education, working position and work experience are presented. Analysis of data starts with data screening whereby result of the survey for every item was extracted from the survey program into the SPSS for data cleaning and further analysis.The measurement model testing is based on the output of the SPSS-AMOS applied to the survey data. The analysis involves checking item reliability, checking internal consistency reliability of the construct measures, and checking convergent and discriminant validity. The structural model analysis is also based on the output of the SPSS- AMOS. The resutls for the hypothesis in the model are presented and interpreted in view of the literature and qualitative data.

5.5.1 Sample respondent characteristics

A sample of 283 respondents was collected from four different organizations. Out of 283 responses, 8 responses were invalid as the complete questionnaire was not answered by the respondents. Remaining 275 responses were found usable. The characteristics of the respondents are reported in terms of frequencies and percentages. Table 5.1 summarizes the profile of the respondents.

Table 5.2: Profile of the respondents

Sample characteristics	Frequency (n=275)	Percent (%)
Gender		
Male	184	67
Female	91	33
Education		
High school	97	35.3
Bachelor Degree	137	49.8
Master Degree	41	14.9
Working position of respondents		
Managers	8	3
Project in-charge / Program managers	40	14.5
Veterinary doctors / Agricultural Officers	47	17.1
Field in-charge/Supervisor	180	65.4
Experiences of respondents		
$0-5$ years	101	36.7
$6-10$ years	96	35
$11-20$ years	55	20
Above 20 years	23	8.3

5.5.2 Assessment of reliability and validity

Choi (2010) has highlighted the importance of both reliability and validity in the data collection and instrument development stage. He also opined that reliability is "the degree to which the construct is free from random error, and it can be measured as the ratio of true component of the score to the total score" [207]. The reliability in this study is measured by Cronbach's alpha, one of the most commonly used coefficient methods to assess the internal consistency within the items. Hair *et al*., suggests that as a rule of thumb, the cut-off value of Cronbach's alpha is 0.60 while a value of 0.80 is considered to be good [191].

Validity is defined as " the degree to which a measurement assess what it is supposed to measure." In this study we examine construct validity (convergent and discriminant validity). To ensure construct validity in this study, EFA was conducted on the AKM process (KAC, KSO, KSD, and KAP) and ICT to confirm the underlying latent variables. As recommended by several researchers and practitioners [191][158][30], items with factor loading below 0.50 are dropped. After EFA performance, the measurement constructs were further verified using

CFA to examine whether the indicators are loaded on the chosen latent variables.

Table 5.2 displays the results of uni-dimensionality, reliability, convergent validity and discriminant validity. Cronbach's alpha value for ICT, KAC, KOS, KSD and KAP are 0.791, 0.700, 0.771, 0.810 and 0.703 respectively. The alpha for all constructs lies between 0.7-0.8 which shows that the items are reliable for further analysis.

Basically, there are two major form of factor analysis, namely EFA and CFA. In the previous sections, we explained about these two approaches. It was stated that most of the researcher have considered factor analysis as exploratory and is effective in studying the structure of set of variables [208]. EFA was used to examine the uni-dimensionality of the constructs and CFA was also carried out in order to provide greater support of the reliability and validity of the factors. Hair *et al*., mentioned that priniciple component analysis (PCA) with Varimax rotation is commonly preferred for minimum number of constructs needed to describe the maximum portion of variance indicated in the the original set of items [191]. As a result PCA with Varimax rotation was conducted chosen to perform factor analysis.

EFA was performed on seven items of ICT. To justify the factor, only factor loading of greater than or equal to 0.5 was considered. In the validation process, two items (i.e. ICT2, ICT4) with poor factor loadings of less than 0.5 were dropped. Similarly EFA was performed on 24 items of AKM process using the PCA with Varimax rotation to examine their uni-dimensionality. In the validation process of EFA, 5 items (i.e. KAC5, KAC6, KOS1, KOS2, KSD9) in the AKM process construct were dropped due to poor factor loadings of less than 0.50 on their respective latent variable [191]. The results of EFA of ICT and AKM process are presented in Table 5.2.

Besides that, The Kaiser-Meyer-Olkin (KMO) and Bartlett's measure of sampling adequacy [196] was computed for comparing the magnitudes of the observed correlation coefficients to the magnitudes of the partial correlation coefficients. Higher values of KMO measure indicated that a factor analysis of the variables was good [167]. For ICT, KMO equals to 0.728 at significance level of

0.01 showed that the degree of common variance among the items was quite high; therefore factor analysis could be conduct for ICT. Similarly for KAC, KOS, KSD and KAP, the KMO and Bartlett's (Chi-square) values are adequate and significant at $p = 0.001$ levels and therefore support the appropriateness of factor analysis. As show in Table 5.2, all constructs have fulfilled the KMO and Bartlett's requirement.

For convergent validity, the composite reliability (CR) for the constructs are greater than 0.7 and also average variance extracted (AVE) for the constructs are greater than 0.5 [191]. As shown in Table 5.2, all the constructs have fulfilled these two requirement. Hence all the constructs satisfy the convergent validity [191][194].

Table 5.3: Exploratory Factor Analysis for ICT and AKM process

First order Constructs	No. of Items	Indicators	Factor loadings	KMO Bartlett's	CR ($\geq$0.7)	AVE ($\geq$0.5)	Cronbach's alpha
Information Communication Technology (ICT)	5	ICT6	0.849	0.728	0.836	0.561	0.791
		ICT3	0.749				
		ICT1	0.755				
		ICT5	0.691				
		ICT7	0.64				
Knowledge acquiring and creating (KAC)	4	KAC3	0.789	0.810	0.854	0.532	0.725
		KAC4	0.759				
		KAC2	0.723				
		KAC1	0.637				
Knowledge organizing and storing (KOS)	4	KOS4	0.823	0.744	0.845	0.610	0.771
		KOS6	0.790				
		KOS5	0.772				
		KOS3	0.694				
Knowledge sharing and disseminating (KSD)	8	KSD8	0.812	0.821	0.941	0.551	0.81
		KSD7	0.779				
		KSD2	0.771				
		KSD1	0.728				
		KSD4	0.721				
		KSD3	0.720				
		KSD5	0.696				
		KSD6	0.694				
Knowledge Applying (KAP)	3	KAP2	0.779	0.761	0.888	0.594	0.703
		KAP3	0.777				
		KAP1	0.756				

Discriminant validity is achieved when the square root of AVE for each construct is higher than the correlation coefficients among the constructs [191]. Refer-

ring to Table 5.3, this condition has been satisfied.

Table 5.4: Results of discriminant validity analysis

Contructs	ICT	KAC	KOS	KSD	KAP
ICT	**0.748**				
KAC	0.676	**0.729**			
KOS	0.478	0.388	**0.782**		
KSD	0.478	0.591	0.298	**0.744**	
KAP	0.178	0.509	0.191	0.61	**0.77**

Note: The square root of AVE value for each construct is printed along the diagonal, while the correlation coefficient between each pair of construct is presented as the off-diagonal element

Next, the second-order CFA was conducted for the first-order constructs of the study. It was used to confirm that the underlying measurement constructs are loaded into their respective theorized construct (AKM process) [30]. In this respect, the factor loadings between first-order constructs and second-order constructs must be greater than or equal to 0.5 [191]. The result of the second-order CFA are displayed in Table 5.4 and the finalized model of KM process construct are illustrated in figure 5.3. The goodness-of-fit indices for this second-order CFA of AKM process are as follows: normed Chi-square (χ^2/df) value of 1.355, GFI = 0.977, AGFI = 0.926, NFI = 0.968, CFI = 0.991, and RMSEA = 0.042.

Table 5.5: Second-order CFA of AKM process

Second order construct	First order constructs	Factor loadings ($\geq$0.5)
AKM process	KAC	0.798
	KOS	0.765
	KSD	0.945
	KAP	0.807

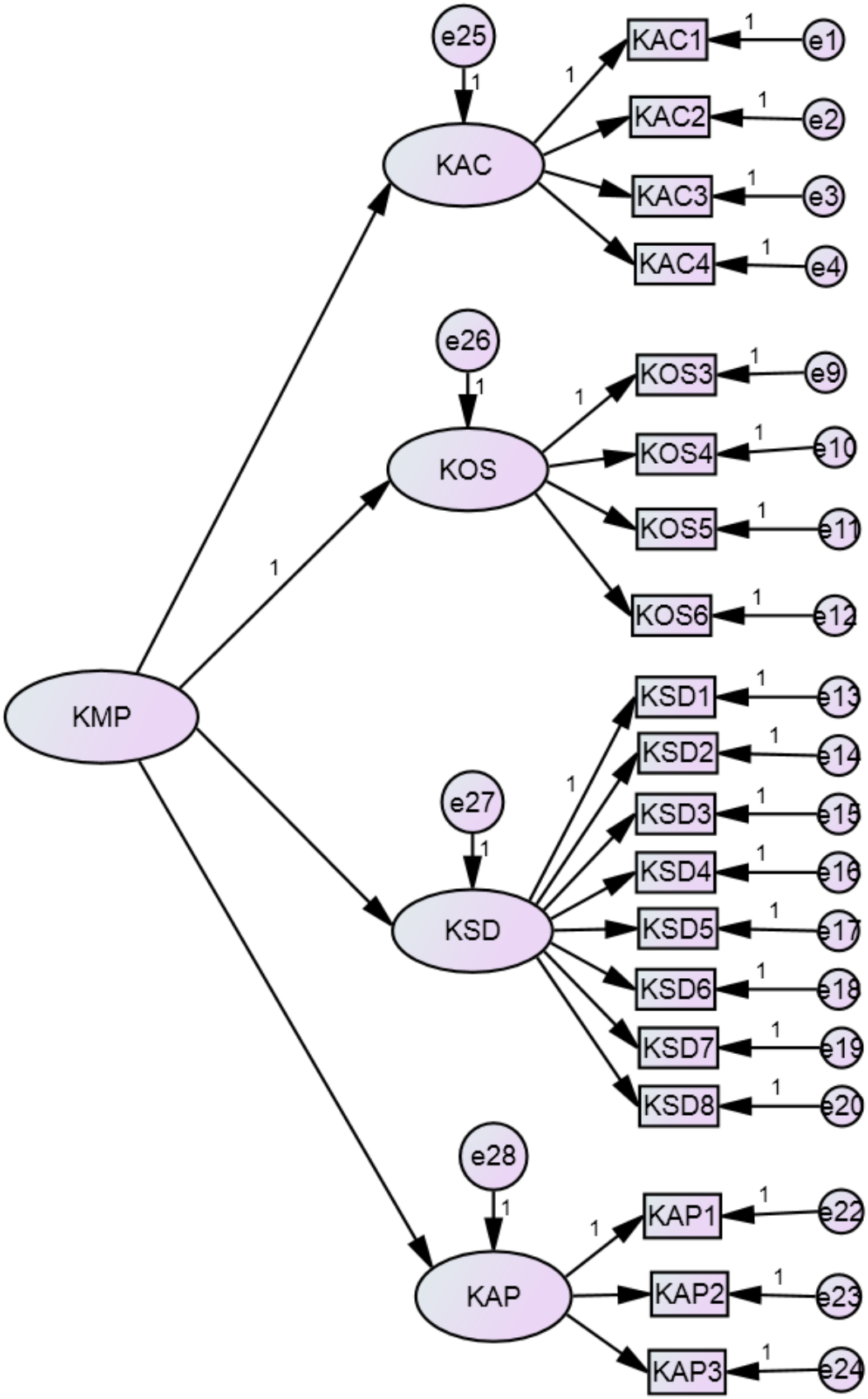

Figure 5.3: Second-order CFA model of AKM process

5.5.3 Structural equation modeling (SEM)

The relationship between ICT an AKM process (i.e. testing the hypothesis) and the SEM analysis for the model testing are described in this section. The SEM was conducted by using the maximum likelihood estimation (MLE) procedure. MLE is one of the most popular methods and is effective when the multivariate normality assumption has been fulfilled [207] [191]. The advantage of SEM are: (1) it provides a direct approach to manage relationships simultaneously, hence it is able to provide statistical efficiency concurrently; (2) it is able to examine comprehensively the relationship between the observed and latent variables and (3) it is one of the most appropriate technique for modeling hierarchical latent constructs and is effective in removing the biasing effects of measurement error [209] [210] [211] [212]. Moreover, SEM approach will provide full information on the extent to which the research model is assisted by the data beyond the regression approach.

Before analyzing SEM, the size of the sample is very should be checked [213]. Hair *et al.*, stated that a sample size between 100 and 200 observations is considered adequate and satisfactory [191]. The sample size of this study (N=275) is within the acceptable range and hence can be considered as sufficient and adequate. The structural model analysis is based on the output of the AMOS 20.0. The final model of the study is illustrated in Figure 5.4 . The curved bi-directional arrow represents the covariance or correlation between the indicated pair of measurement errors of the respective items due to redundancy. Therefore, the correlated errors were set to be "free parameter estimates" using the double-headed arrow.

Overall model fit

The major issue is to examine how good is the research model (Figure 5.1) in fitting the dataset. There are several indicators which are computed by AMOS 20.0, that can be utilized to examine the goodness of the model fit. As suggested by [198] [191], there are six major measures to determine the goodness-of-fit. These include Chi-square statistic, GFI, AGFI, RMSEA, NFI, and CFI.

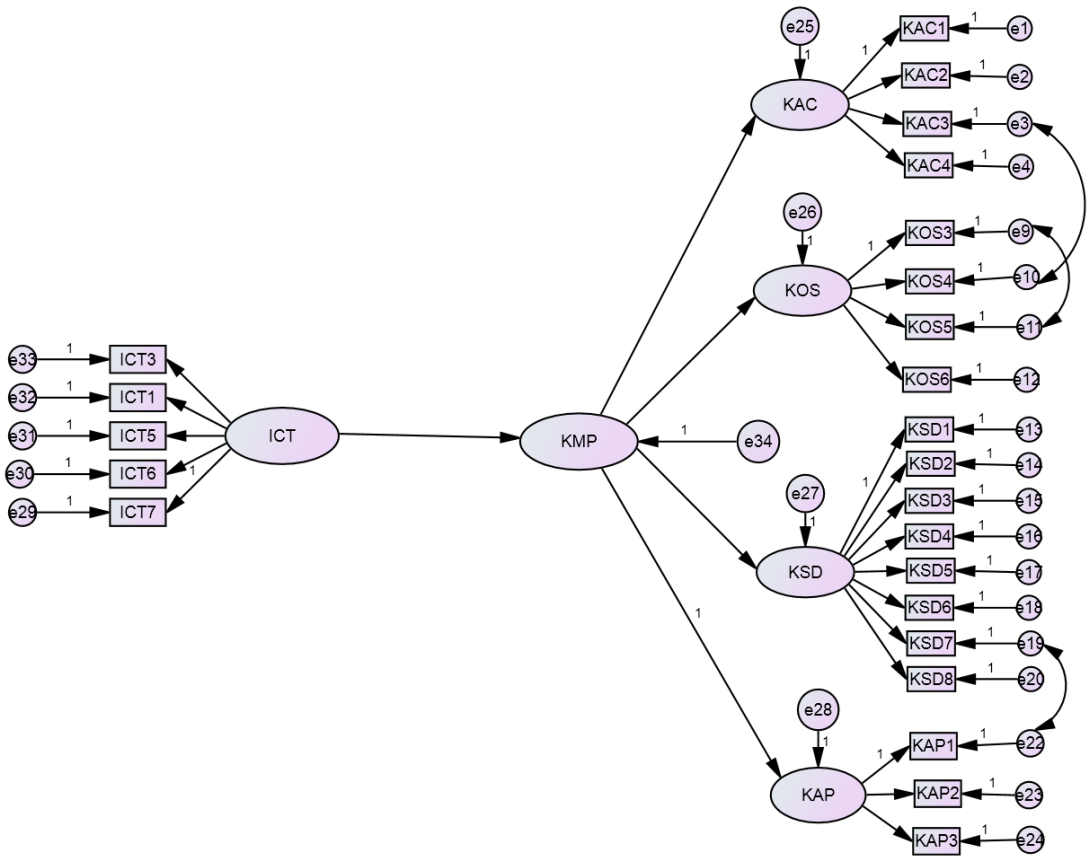

Figure 5.4: Finalized model

The most fundamental measure of overall fit in SEM is likelihood-ratio Chi-square statistics. As suggested by Bagozzi and Yi (1988), a p-value exceeding 0.05 and a normed Chi-square value (χ^2/df) that is below 3, are normally considered as acceptable [200]. They further asserted that goodness-of-fit indices such as GFI, AGFI, CFI and NFI should be at least 0.90 to be considered as acceptable and to indicate a good fit while RMSEA values between 0.05 to 0.08 indicate a fair fit.

Table 5.5, shows the overall result of the structural model study. Based on the Chi-square ratio (χ^2/df = 2.738) that is less than 3.0 as recommended by [200] and other fit indices (GFI= 0.917; AGFI= 0.907; CFI= 0.931; NFI=0.921), the recommended cut-off value of 0.90 has been exceeded. Moreover, the RMSEA =0.081 is below 0.08 as suggested by [191][198]. This indicates that the model has a good fit to the dataset. Since all fit indices have met their individual common acceptable values, this verifies an acceptable fit of the structural model with the dataset [200][214][191].

Table 5.6: Measures of the Model Fit

Name of the index	Value obtained	Level of Accepted Fit	Results
chi-square value (χ^2/df) (Chi-square = 662.7 Degrees of freedom = 242)	2.738	Below 3 and p=0.001	Acceptable
GFI	0.917	$\geq$0.90	Acceptable
AGFI	0.907	$\geq$0.90	Acceptable
CFI	0.931	$\geq$0.90	Acceptable
NFI	0.921	$\geq$0.90	Acceptable
RMSEA	0.081	$\leq$ 0.08	Acceptable

Testing hypothesis

Table 5.6, presents the hypothesis testing result for the causal effect of ICT on AKM process. Based on the result, it was verified that ICT was found to be significant and positively associated to AKM process. Hence *H1* was accepted.

Table 5.7: Hypothesis testing result

Hypothesis	Beta value	p-value	Comment
H1:ICT KM process	0.44	***	Significant
Note: *** significant at 0.001			

5.6 Discussion

The majority of the respondents were field in-charges and supervisors, who are actively involved in knowledge management process between farm communities and organizations. Most of the respondents under the sample of the study used cell phone for accessing agriculture knowledge from neighbors, friends, families and subject experts in the organizations. Most of the respondents in the sample were using various ICT tools for AKM practices. Still there are challenges which need to be considered for effective AKM practices in the agricultural organizations. The digital divide between various locations and between the individuals still exists in the surveyed organizations.

In this study, the SEM approach was applied to examine the relationship between ICT and KM process in Indian agricultural organizations. As is evident from the analysis conducted above, ICT was found to have a significant effect on

KM process in the respondent organizations in India. This is in agreement with the proposition of Alavi and Leider (2001) that information technology can lead to a greater breadth and depth of knowledge creation, storage, transfer and application in organizations [29]. The result is also consistent with the findings from past studies. For instance, Chadha *et al.*, found that ICT enhances the visibility of knowledge and facilitate the process of acquiring, creating, storing and disseminating [167]. Allahawiah et al. also verified that there is the positive impact of information technology on knowledge management processes [215].

In four of the case organizations, there were clear indications that staffs at various levels and experts have been using Internet, emails for acquiring, storing and sharing knowledge from state and national research institutes. This is substantiated by the statements obtained from various respondents with whom we have interacted during our study. Given below are some excerpts from the interaction we had with them.

Program coordinator [MWCD]: "Under National Dairy Plan, National Dairy Development Board (NDDB) has provided laptops and the internet connectively for uploading the information of each and every cattle in the village to keep track of ration balance of the cattle".

Veterinary doctor [MDCM]: "Under project Ration Balance Program and Productivity Enhance Program, information about all cattle's of the co-operatives were stored in the online database. By assessing this database we can know which village is a shortfall of ration balance, about the Artificial Insemination (AI) requirement and so on. According to that, our doctors prepare their daily route map to visit the villages."

Program manager [DG]: "We use the internet to acquire knowledge from experts within and outside the organization."

Mobile technology is also being widely used for communication and sharing of knowledge with farm communities in all four organizations. Milk cooperatives are using short message services (SMS) for sending alerts on milk procurement, veterinary camps etc. While Digital Green initiated to use interactive voice response (IVR) systems to overcome barriers of literacy. The above is also

substantiated by the statements obtained from field supervisors and program coordinators with whom we have interacted during our study. Given below are some excerpts are what they have to say in this regard.

Field supervisor [MDCM]: "We send SMS to the farmers' mobile once milk is procured from them at village collection center. The SMS contain the details of the fat percent, Solid Not Fat (SNF) content and the quantity in liters."

Program coordinator [MWCD]: "Mobile phones have enabled us to quickly contact people in the organization that we think have specific knowledge/information in specified areas to answer specific queries. This, in turn, helps in providing quicker response to farmer query special in the case where I don't have an answer to query."

Field supervisor [DHRU]: "Farmers call on my mobile phone to know about pest management for his crop. I use to reply to their quires on the phone itself."

In Digital Green, digital videos were developed or created on local relevant agriculture and livelihood practices by using ICT tools like video cameras. Then these videos are disseminated by screening for farm communities using battery-operated Pico projectors. All these developed videos are organized and stored in organization repository. These videos can be accessed both offline and online. The above is also substantiated by the statements obtained from field supervisor with whom we have interacted during our study. Given below are some excerpts are what they have to say in this regard.

Field Supervisor [DG]: "I have been trained by Digital Green in using ICT tools to film/record the best agriculture practices in farm communities. And I disseminate/show this recorded videos to my fellow farmers using Pico projector in village community hall."

Field Supervisor [DG]: "We use Pico projects for disseminating agriculture videos to farm communities in offline mode. After screening we collect feedbacks from the farmers, respond to the questions raised by the farmers."

From the observations and discussions with members or employee, we understand there is a limit of using ICT in organizations. For instance, we observed that only top and senior management in DHRUVA have access to laptops and internet

facilities. The field supervisors use a mobile phone to communicate with peer and farm communities. The above is substantiated by the statement obtained from field supervisor with whom we have interacted during our study. Given below are

Field Supervisor [DHRU]: "We don't have the internet and desktops or laptops with us. Our senior persons have with them. We use mobile phones to disseminate knowledge regarding plant protection, pest management, group meetings, etc., to farm communities. In our daily job we visit farmers' fields personally and interact with them and also attend the calls from them."

The findings through the analysis of data are consistent with the statements made by various people we interacted during the study and indicate a significant relationship between ICT and KM process.

5.7 Chapter summary

This chapter elaborated research methodology and strategies adopted in the study. It explain both quantitative and qualitative research which consists of unit of analysis, sample size, and procedures for data collection. It also explain about the design of survey instrument which explained the questionnaire scaling and its structure as well as the operationalization. The methods of statistical analysis in this chapter include the data purification process, reliability and validation procedures, statistical techniques such as EFA, CFA, SEM and goodness-of-fit measures were discussed in this chapter

In the last section of this chapter present the results of the data analysis and research findings of the relationship between ICT and AKM process. Multivariate analyses such as EFA, CFA and SEM analysis were performed in order to answer the hypothesis. The findings revealed that ICT has a strong and significant positive impact on AKM process.

CHAPTER 6

Conclusion

The research work was started with the intent of addressing the lack of evidence about knowledge management process in Indian agricultural organization. The intent was to contribute to the domain of agriculture through a comprehensive review of various knowledge management processes or models and the effect of the use of ICT on the knowledge management process in the organization from the existing literature. This eventually led to the idea of developing a framework for managing knowledge (both explicit and tacit) in the agricultural organization, which encompasses all the aspects of knowledge management.

Although KM practice and research are at initial stages in Indian agriculture, this study will provide insights into the state of knowledge management process, help in understanding the flow and management of knowledge in the organizations. Prior to this, there were very few published sources that considered the effect of ICT on AKM process in Indian agricultural organizations. Along with this, metrics for measuring AKM performance have been proposed that can be used to indicate the goodness of the AKM process in agriculture organizations.

The framework proposed by this research work could be used by any agricultural organization irrespective of size, location, and economic background. This framework could guide agricultural organizations in their knowledge management initiatives, in order to analyze their environmental factors like technology. The top management officials and others like knowledge workers could use this framework and establish KM teams and justify the decision to the organization. The agricultural organization can use knowledge management metrics to evaluate and understand the flow and management of knowledge in their organization.

This will help them take necessary steps to improve the KM process and fine tune it to enable them to achieve their objectives.

Conclusions about each research objective are presented in the following sections.

6.1 Conclusion on the proposed agriculture knowledge management (AKM) process framework

The study findings showed that the western based KM models were developed in the context of organizational environment and thus fail to address the needs of rural communities, where both tacit and explicit knowledge are acquired and shared in different manners. The study found that tacit knowledge was acquired and shared within a local, small and network of communities, thus knowledge loss as prevalent. On the other hand explicit knowledge was shared in wide using documents, reading materials and etc. Most of farmers willing to share their knowledge with experts groups in order to strengthen their knowledge system, since their knowledge was not sufficient to solve their farming problems. There is thus a need to determine an AKM model that will manage and integrate both tacit and explicit knowledge to improve farming activities.

In recent times, there has been increased interest in research on knowledge management in Indian agriculture. Only large organizations operating in developing countries are able to adapt KM practices, due to the economic challenges and their limited capabilities. The framework produced by this research could be used by any agricultural organization, irrespective of size, location and economic background. The only prerequisite is the willingness of the organization to be competitive and to participate in the knowledge economy. The framework would guide organizations in their AKM initiatives; in order to analyze their environmental factors need to be addressed. Managers or knowledge worker could use the framework to establish a AKM team to achieve the objectives of the organization. The framework can be used as a holistic approach that requires interaction of ICT, people and KM process.

6.2 Conclusion on Metrics for measuring AKM performance in agricultural organizations

The objective is establishing metrics to measure agriculture knowledge management process. This research associated the metrics identified with the agriculture knowledge management process phases of acquiring and creating, organizing and storing, sharing or disseminating and applying. The list of metrics was generated through secondary resources.

The proposed metrics can be used by agricultural organizations that are in their initial stage of implementing AKM. Organizations can visualize in choosing an approach for implementing AKM process and also being prepared to face difficulties

6.3 Conclusion on Linkage between ICT and Agriculture Knowledge Management Process

The availability of ICT has a significant effect on knowledge management process in the case organizations. ICT was found to assist in the process of getting required knowledge and enabling easy communication among the farm communities and organizations. The availability of ICT is seen to enhance dissemination of explicit and tacit knowledge and sharing of best practices effectively among the farm communities and expert groups in the organizations. The rapid developments in the field of ICT for example rapid mobile penetration, availability of the internet, web technologies and mode of communications like emails, video conference etc. helps faster creation, storing, sharing of knowledge within organization. In organizations where face-to-face meetings take very frequently, technology can play a supportive role in recording such meetings for further use.

The results of this study contributed in several ways to the knowledge management theory and practice specific to Indian agriculture. No research of this nature has been conducted in Indian agricultural organizations to assess the rela-

tionship between ICT and KM process in agricultural organizations. This study will guide the various levels of managers in selecting of the kinds of tools and technologies to be acquired, with the understanding that lack of support is a major hindrance in the application of technology in KM process in agricultural organizations. The proposed set of metrics could be used as common tools to measure the performance of ICT on KM process in agriculture organizations and for future research.

6.4 Contribution to research

This thesis contributes in a number of ways to KM and ICTD researchers and practitioner, as discussed in the following.

- The use of AKM in the development agriculture has frequently been advised by the various authors and development agencies [18][16][21]. However, there is so far no systematic as well as comprehensive evaluation of AKM in Indian agriculture. It would be difficult to implement something successfully without prior knowledge of either those factors that are critical to success or factors that lead to a failure. My study contributes by offering a comprehensive review of AKM in Indian agriculture, with an emphasis on the systematic analysis scope and challenges. While Paper I and II provide a comprehensive views of the challenges of AKM in Indian agricultural organizations and proposed AKM framework.

- The metrics for measuring the performance of knowledge management process is very important for any organization. Various measuring metrics for KM performance which were discussed in the Chapter 4 were mostly developed based on industries profit making organizations like Tata steel, Infosys Technologies etc, where as KM performance measurement tools for agricultural organizations are very limited. To address this gap, my study contributes by proposing metrics for measuring agriculture knowledge management process in agricultural organizations.

- This thesis offers an increase understanding towards the use of information and communication technology in managing agriculture knowledge management in agricultural organizations. As mentioned in the chapter 2, very few studies have analyzed/focused on the usage of ICT in agriculture knowledge management process remains unexplained, which should be an important direction for future research. The study will help managers at different levels in selecting tools and technologies that can be used to support AKM process in their organizations. The proposed set of items/variables used in this study may also be used in future as basic tools to measuring the effectiveness of ICT on AKM process in agriculture organizations. Paper III and Paper IV will provide details about development of items/variables used for measuring the relationship between ICT and AKM process, methodology for data collection and data analysis.

6.5 Limitation and future work

Based on the literature availability on KM in Indian agriculture, this work might form a basis and entry point to others who are interested in researching in KM in agriculture. An attempt of KM in Indian agriculture has been made, there are, nevertheless, some limitations of this research.

The main limitation of this study is the number of organizations that have been used as a part of the study and the generalization. Although an attempt to improve the ability to generalization the results of the study as been made by carefully selecting the four organization that were the part of the study to be as diverse as possible. However the diversity capture by these four may not adequate to cover the different types of agricultural organizations in India. The emphasis has been on the context of each organization, flow and managing of knowledge, and their operating environment, which does not necessarily seek generalization for the setting to a population. It helps in deeper understanding of organization's structure and operation, which later helps in setting up in other agricultural organizations.

Non-profit organizations, cooperatives have been included in the work, with the intent to study the contribution of various level of knowledge workers in the organization contribute and disseminate knowledge to farm communities, within and outside the organization. Tweaking this framework while applying to other types of organizations like public, private working in the domain of agriculture is something that can be tried in future and presented as set of case studies. Though it has been in the central of Indian agriculture, thus the framework can be applied to other non-agricultural organizations.

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Appendix 1

Table 1: General Information

Name of Respondent
Name of Organization
Gender
Male
Female
Education Qualification
High school
Bachelor Degree
Master Degree
Position/Designation in Organization
Managers
Project in-charge / Program managers
Veterinary doctors
Field in-charge/ Supervisor
Work Experience
0-5 years
6-10 years
11-15 years
Above 15 years

Table 2: Information and Communication Technology

ICT measuring items		Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
ICT1	Our organization have IT infrastructure (like computer, networks) for managing all kind documents on agriculture knowledge					
ICT2	IT infrastructure (like computers, software, networks) are easy to use for uploading, searching and retrieving agriculture knowledge					
ICT3	I use ICT tools (like computers, emails, telephones, mobile) to communicate within organization					
ICT4	I routinely utilize ICT tools (like computers, emails, telephones, mobile) to access agriculture knowledge from outside organizations					
ICT5	We use ICT tools (like computers, emails, telephones, mobile) for sharing agriculture knowledge with farm communities					
ICT6	We use computers for storing agriculture knowledge					
ICT7	We use internet, intranet to access agriculture knowledge repository					

Table 3: Agriculture Knowledge management process

Measuring items		Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
KAC1	Organization had processes of acquiring agriculture knowledge by collaborating with research institutes, business partners, farm communities					
KAC2	Organization give importance's on creating new agriculture knowledge					
KAC3	Organization creates manuals and documents on best practices, success stories in agriculture					
KAC4	Organization encourages employee, farm communities to exchanges new ideas between individual and group					
KAC5	Organization rewards farmers for generating new knowledge in agriculture practices					
KAC6	Organization rewards employee for generating new knowledge in agriculture practices					
KOS7	Organization utilizes various print material (such as newsletters, handbooks, annual reports, manuals and etc) to store agriculture knowledge					
KOS8	Organization utilize audios, videos to store agriculture knowledge					
KOS9	Database that gathered agriculture knowledge are available in the organization's repository					
KOS10	Organization has good IT infrastructure to store the agriculture knowledge					
KOS11	Organization use advance IT tools for filtering, listing, indexing the agriculture knowledge to retrieve					
KOS12	Knowledge repository (library) are frequently updated					

Measuring items		Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
KSD13	Periodical annual reports/success stories are made to share with all organization members					
KSD14	Periodical meetings/workshops/seminars are held to share about best practices, new technology in agriculture					
KSD15	Farm communities are willing to share their experience and knowledge with each other					
KSD16	Farm communities are willing to share their experience and knowledge with experts group					
KSD17	We share our field experience with peer group in the organization					
KSD18	We use ICT tools like mobile, audio and video conference, internet for sharing agriculture knowledge organization rewards employee for generating					
KSD19	Organization encourages employee to share their knowledge with peer groups and others					
KSD20	Organization has resources centers, community hall and forums for sharing agriculture knowledge organization utilize audios, videos to store agriculture knowledge					
KSD21	I/We believe that sharing agriculture knowledge across groups will yield high benefit					
KAP22	Farmers apply agriculture knowledge to improve their productivity					
KAP23	Farmers take the advantage of new technology to improve their work efficiency					
KAP24	Farmers use the knowledge to solve the problems in agriculture					

List of Publications

International Conference Proceedings

1. Ram Naresh Kumar Vangala, B.N Hiremath, Asim Banerjee (2014) " A Theoretical Framework for Knowledge Management in Indian Agricultural Organizations" Proceedings of the 2014 International Conference on Information and Communication Technology for Competitive Strategies. Udaipur, Rajasthan, India, November 14 - 16, 2014. ACM New York, NY, USA. ISBN: 978-1-4503-3216-3 DOI: 10.1145/2677855.2677861.

2. Ram Naresh Kumar Vangala, Maitrayee Mukerji, B. N. Hiremath (2015) "ICTs for agriculture knowledge management: insights from DHRUVA, India". Proceedings of the Seventh International Conference on Information and Communication Technologies and Development Singapore, Singapore âĂŤ May 15 - 18, 2015. ACM, New York, NY, USA. ISBN: 978-1-4503-3163-0. doi>10.1145/2737856.2737863.

3. Ram Naresh Kumar Vangala, Asim Banerjee, B. N. Hiremath (2016) "Effect of ICT on Knowledge Management Process in Indian Milk Co-operatives: A Structural Equation Modeling Approach" Proceeding of 2016 IEEE Region 10 Humanitarian Technology Conference (R10-HTC), Agra, India, 2016, pp. 1-6. DOI: 10.1109/R10-HTC.2016.7906777.

4. Ram Naresh Kumar Vangala, Asim Banerjee, B. N. Hiremath (2017) "Linkage between ICT and Agriculture Knowledge Management process: A case study from Non-Government Organizations (NGOs), India". IFIP International Federation for Information Processing 2017, Published by Springer