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Understanding Crowdsourcing of Agricultural Market Information in a Pilot Study:
Promises, Problems and Possibilities (3Ps)

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ABSTRACT

Access to agricultural markets and marketing information are essential factors in promoting competitive markets and improving agricultural sector development. The agricultural sector employs majorities in developing countries and contributes greatly to its development. Unluckily, majorities of the farmers are smallholders living in rural areas and thus, lack appropriate access to markets for their products and also, they are deprived of agricultural market information. As results, farmers are exploited by middlemen who offer low prices for their agricultural produce. This study presents the best way for the agricultural stakeholders to obtain easily agricultural market information service. This study presents a novel agricultural market information system which was implemented using some concepts of crowdsourcing. Crowdsourcing allows sellers to broadcast whatever produce they want to sell and customers are allowed to submit their requests using either SMS or web.

KEYWORDS

Agricultural, Crowdsourcing, Customers, Farmers, Information, Market, System

INTRODUCTION

Agricultural information interacts with and influences agricultural productivity in a variety of ways. It can help to inform decisions regarding land use, labour, capital investment and farm management. Agricultural productivity can arguably be improved by relevant, reliable and useful information and knowledge (Barakabitze et al., 2015). Hence, the creation of agricultural information (by extension services, research, education programs and others) is essential to organizations that facilitate the collection and dissemination of such information to farmers who in-turn can exploit the market potentials, thereby managing the continuous changes in the agricultural production system. Therefore, there is a need to understand the functions and use of agricultural information systems (particularly agricultural market information systems) in order to improve these systems using emerging

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technologies as well as techniques for sourcing and advertising agricultural produce in markets (Demiryurek et al., 2008). Crowdsourcing for marketing information is one of the novel techniques in marketing. Gatautis and Vitkauskaite (2014) define marketing as "a process dedicated to relations with customers' establishment, facilitating exchanges and leading to both sides satisfaction". According to Lui (2007), different ways of marketing products include face-to-face marketing, virtual world, online marketing and crowdsourcing. Each of the mentioned approaches in marketing has its own advantages and disadvantages. Crowdsourcing platform in marketing is more advantageous since it can be integrated into all functions of the marketing. It can be used to involve customers from product design, product development, product advertisement, promotion and marketing (Lui, 2007; Whitla, 2009). Thus, crowdsourcing can change the market configurations as well as change how end users (i.e. customers) are involved during the development of a product or good to be sold in markets.

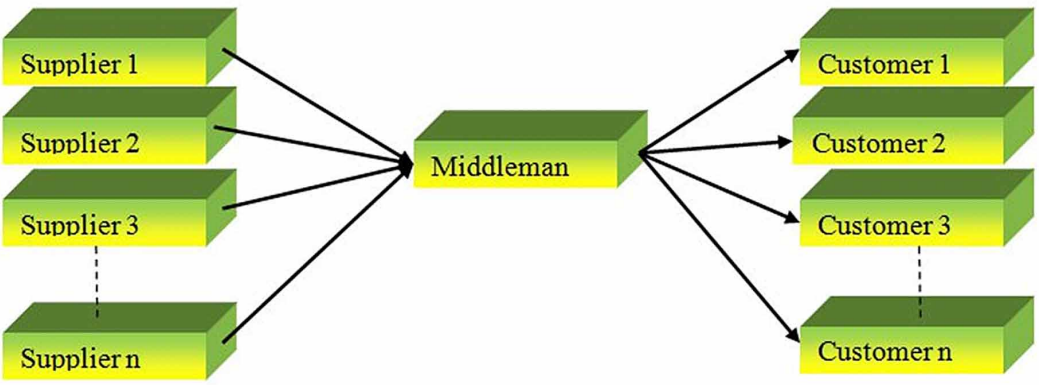
Gatautis and Vitkauskaite (2014) and Whitla (2009) present different functions which can be provided by crowdsourcing platform during the marketing of activities, namely: product management, pricing, distribution management, communications management, Marketing planning and Marketing research. In his seminal article on examples of crowdsourcing as an approach for problem solving, Brabham (2008) concludes that crowdsourcing platform provides a model capable for aggregating talents/wisdom, leveraging creativity or innovation while reducing the costs and time needed to solve different marketing problems. Market problems that are related to product management, pricing, distribution, communication, planning and research could be addressed through effective engagement of people in the crowds (Gatautis and Vitkauskaite, 2014; Whitla, 2009). This is the reason Britton et al., (2013) define Crowdsourcing as "a distributed problem-solving technique leveraging the efforts of a group, known as "the crowd". Further, Britton et al., (2013) explain that crowdsourcing allows a project to be defined and volunteers to be invited so as to contribute to problem solving in form of micro-tasks. The volunteers involved in micro-tasks solving are dispersed and may not necessarily be members of the organization owning a project. In order to solve such a problem, an organization needs to have a specific approach or framework to use while addressing the problem in participatory manner. According to Erickson et al., (2012), there are different approaches or frameworks for crowdsourcing that are grouped according to functional themes, namely: 1) common tasks performed by the crowd, 2) crowd serving as a think tank, 3) crowd assuming unique roles in specific locations, crowd serving as a platform to address organizational challenge, and 5) engaging the crowd to add value to organizations

In agricultural marketing activities, middlemen or intermediaries are introduced to facilitate matching of agricultural products with buyers. These middlemen are better equipped with marketing information and conditions they use in promoting their roles (Figure 1). Middlemen play key roles of trading, distributing and delivering agricultural products to markets. They also act as guarantors of quality in markets when there is uncertainty with respect to the good being traded (Biglaiser 1993; Biglaiser and Friedman, 1994; Li, 1998; Van Driel, 2003; Rao, 2008). Furthermore, these middlemen also known as dealers or brokers can help to reduce the cost of market search. Johri and Leach (2002) demonstrate how market-dealers can improve market efficiency by increasing the quality of the match between buyers and sellers in a heterogeneous market. Rubinstein and Wolinsky (1985) claim that market dealers shortens the time between transactions because they have a higher possibility of matching buyers and sellers.

Description of the Problem

The roles of intermediaries in providing marketing services particularly to smallholder farmers have not been received positively by many (e.g. Enete, 2009; Keys, 2005; Scheuermeier, 2007). Some perceived them as parasites who exploit farmers by taking away a large share of the benefit accrued from the sale of crops by taking advantage of farmers' unawareness of market prices. Intermediaries could cheat farmers by taking advantage of their lack of knowledge of market prices, poverty and weak bargaining power arising from illiteracy and low social status, on the one side, and monopsony

Figure 1. Supplier - middleman - customer relationship (Moi University, 2017)



or oligopsony types of marketing system, on the other (Lightfoot and Scheuermeier, 2007). Roy (2012) noted that intermediaries often flout market norms and their pricing lacks transparency and thus their presence reduces the returns of farmers substantially.

Existing literatures reveal that the issue of exploitation of famers by middlemen is not new, and it has been observed for years (Bauer and Yamey, 1968; Enete, 2009; Keys, 2005; Scheuermeier, 2007). Keys (2005) noted that middlemen constitute a "real face" in the otherwise "hidden hand" of the market. Poor access to markets by farmers is an outcome of lack of market information, poor or lack of road infrastructure connecting markets, and lack of means of transportation. Lack of market information has some consequences to farmers selling their agricultural produces: farmers may fail understand the real market price of farm produce, know whom to sell their produce to and, identify alternative markets for their produce. All these factors encourage the existence and operations of middlemen in agricultural marketing. Existence of middlemen in agricultural marketing and poor access to agricultural markets and market information have some related effects to farmers: poor returns after selling their farm produces, low farm productivity, discouragement to engage in agriculture, poor investment in agriculture, hunger in rural areas, and poverty.

Problems of poor access to agricultural markets and market information are prevalent in developing countries including Tanzania. Majorities of farmers in Tanzania are smallholders living in isolated rural areas characterized by poor road infrastructures; lack of electricity and safe water; poor or lack of transportation means; poor or lack of communication networks; and poverty. Due to these factors, smallholder farmers tend to rely on nearby markets as sole markets for their farm produce or sell the produce at their homes. Also, agricultural traders and middlemen visit rural areas to collect and purchase farm produces and transport such produce to town markets (district, regional and zonal) or export to other countries (Magesa *et al.,* 2014).

Cases where farmers are exploited by greedy traders and middlemen have been cited by many scholars. In Mozambique, Rodrick et al. (2002) report that cashew nut growers only receive 40 to 50 percent of the border price, even after border taxes are allowed for. They go on to note:

It is clear that the marketing channels for raw cashew nuts remain imperfectly competitive. Farmers' incomes are depressed not only by transport and marketing costs, but also by the market power exercised by the traders. (Rodrick et al., 2002: p.120).

It has been argued that, the greedy market dealers contribute to poverty in developing countries (Magesa et al., 2014). Chau and Goto (2009) claim that in rural areas, middlemen make excessive profits because of their market power. These dealers take products from farmers at a relatively low price,

exaggerate prices, and increase the financial burden to the final consumers. The more the middlemen and commission agents in the supply chain are the higher the price of the product (Oguoma et al., 2010). In this kind of exploitation, only the middlemen are the ones benefiting, leaving producers and consumers in a poor state. From another perspective, market brokers are considered as a threat to food security, Oguoma et al. (2010) assert that middlemen discourage genuine investors in agriculture because they hardly get fair pricing from them. It is argued that the real profit goes to the middlemen who buy agricultural products at very low prices and sell at high prices to buyers.

Several investigations have been undertaken to identify whether having access to appropriate market price information can give more power to smallholder producers in developing countries. Findings real varied outcomes: According to Svensson and Yanagizawa (2009), Uganda experienced 15% increase while in Rwanda no effects was observed. In Tanzania, farmers have strong relationships with particular middlemen that they cannot even change and choose a different one if dissatisfied; therefore, for them having being informed about market prices does not help the situation (Molony, 2008).

Some of the challenges which hinder farmers towards adopting ICTs in agricultural activities include: Lack of relevant technology, poor infrastructure and language constraints, limited access to updated agricultural information, economic hardship, inappropriate input and output prices, unconducive policy environment to support the adoption of appropriate agricultural ICTs, lack of appropriate incentives, poor access to credit and limited capacity to monitor agricultural activities (Barakabitze et ., 2016)..

The identified drawbacks pertaining to poor access to agricultural markets and market information require an integrated approach combining conventional ways of communicating agricultural market information and ICT based solutions. Therefore, in this study agricultural market information system (AMIS) is proposed and implemented. AMIS provides the easiest way where farmers are able to enter and add their products to the system. Since the proposed approach is a web based system, sellers can therefore advertise the products so that they can be easily viewed by different people from different places. When new products are in the market, all the registered users of the system are notified automatically through their e-mail address about the presence of new product. This enables both AMIS users to get the updates of the products. This process of notifying users (i.e. crowds) and getting their views is called crowdsourcing. Also, farmers can use text messages (SMS) as a tool to submit their products into the AMIS for sale. This makes the products available to all parties while allowing the traders to see the information using the web or via SMS.

RELATED WORKS

According to Murugesan (2013), crowdsourcing application in East Africa ranges from those in web, social media, Internet based applications / portal / platform to mobile based system. The crowdsourcing applications in East Africa have been implemented in different sectors such as education, agriculture, health, environment and social. According to Murugesan (2013) paper, the most notably crowdsourcing platform in East Africa are:

1. M-Farm—which provides up to-date market information to link farmers and buyers through a marketplace and to report on current agricultural trends (mfarm.co.ke).
2. iCow—a mobile app that helps dairy farmers manage their cows more sustainably in Kenya (icow.co.ke).
3. Ushahidi platform, which is a tool that allows users to crowdsource information using multiple channels, including SMS, email, Twitter, and the Web.
4. Ushaurikilimo – a crowdsourcing platform for e-extension (Sanga et al., 2016).

The crowdsourcing applications are becoming common not only in East Africa but also, in other countries in Africa such as Zambia, Congo, and Ghana (USAID, 2013). Literature review presents reasons why few sellers and buyers are attracted to adopt and use crowdsourcing platform (Hossain, 2012). For example, Cui (2013) presents the weakness of the crowdsourcing platform which was developed. From Cui's study, even though there are user generated contents for markets / market information but in many applications involving crowdsourcing platform, the location of user is not known. Thus, there is a need to incorporate WebGIS in crowdsourcing platform. Thus, such crowdsourcing platforms which allow user to supply the information can be geo-referenced with Global Positioning System (GPS). Thus, there is a need for more studies to be conducted on this emerging field in computer science.

PROPOSED SOLUTION

AMIS provides a simple interface for maintenance of agricultural product information. It can be used by agricultural institutions or agricultural firms selling agricultural products to maintain the records pertaining agricultural products.

The creation and management of accurate, up-to-date information regarding agricultural products is critically important in different aspects. AMIS deals with all kind of product details, buyers' and sellers' details and related market reports. It tracks all the details related to the purchase of products on a daily basis. The software developers of AMIS embedded fundamental principles of marketing (Röling, 1988).

AMIS is then integrated to the instant market access system (mAMIS) that utilize the SMS capability of the system. They connect using database matching. wAMIS and mAMIS share database using web service connection (Figure 2).

Figure 2 present a context diagram of AMIS which includes both wAMIS and mAMIS. Since mAMIS works separately but integrated to wAMIS then this paper will discuss the wAMIS in detail and leaving out the mAMIS for now. The mAMIS was just used to obtain data from the mobile based SMS from the customers and farmers only.

Research Method

This study adopted a mix of qualitative research and quantitative research methods. Qualitative researchers aim at gathering an in-depth understanding of human behavior and the reasons that govern such behavior. The discipline investigates the "why" and "how" of decision making. Besides this, the researcher also examines the phenomenon through observations in numerical representations and through statistical analysis. Along with questionnaires that were administered to respondents for the statistical representation of the findings in the study. interviews with the respondents and a few experts in this field was also conducted.

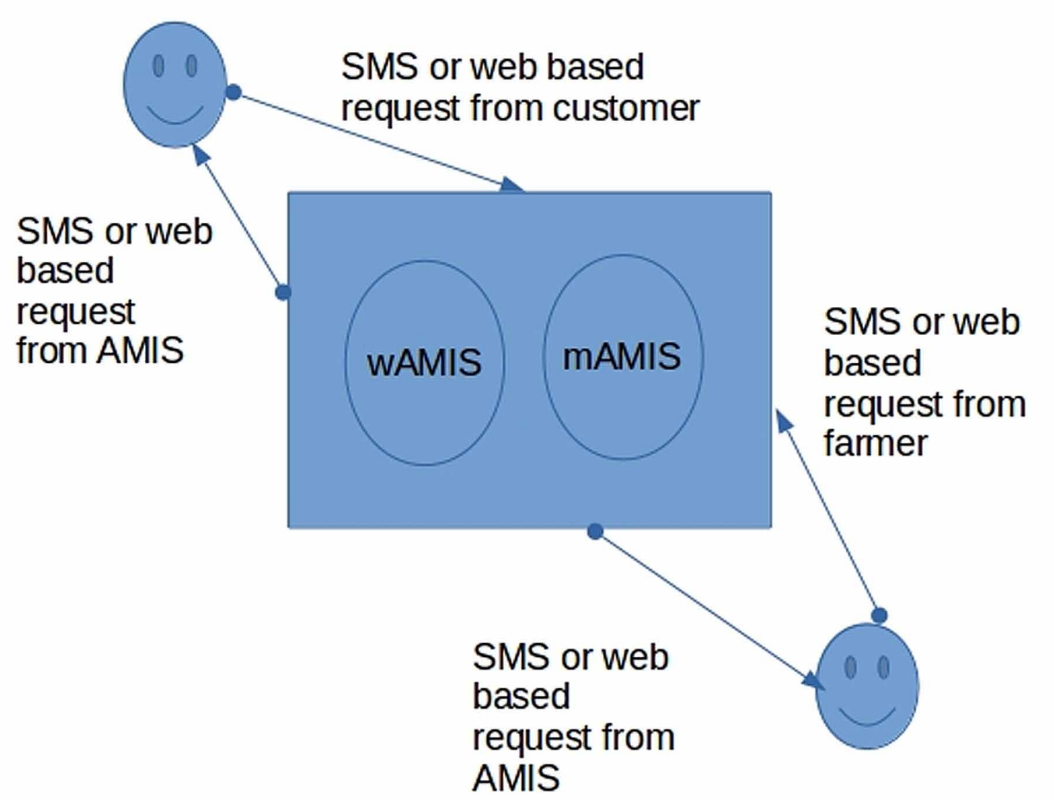
Sample and Sampling Method

he simple random sampling approach was adopted to obtain a more scientific result that could be used to represent the entire population. Farmers and buyers were randomly selected to reduce the potential for human bias in the selection of cases to be included in the sample. As a result, the simple random sampling provided us with a sample that was highly representative of the population being studied. The respondents were interviewed using questionnaires that were structured to solicit relevant information from each category of the respoindents.

Participants

Participants were 100 farmers, most of them from farms around SUA. 150 buyers mostly from Morogoro area near SUA. A majority of the participants were male (60%) and 40% were female. Also, a majority of the participants were Tanzanian (85.8%) as a minority were farmers of foreign origin.

Figure 2. Conceptual diagram of AMIS



Design

The purpose of system design was to plan for a solution to the problem specified by the requirements document. It comprises of a detailed description of how the implementation would be organized. It was considered the most vital section of software development as any bad or good design would result to a bad or good system. The design stage included architectural design, detailed design, interface design, security design and database design.

Architectural design aimed to identify the modules that should be in the system, the specifications of these modules, and the interaction between the modules in order to produce the desired results. The specifications were carefully analyzed and a module structure that has the desired functionality was produced (see Figure 3).

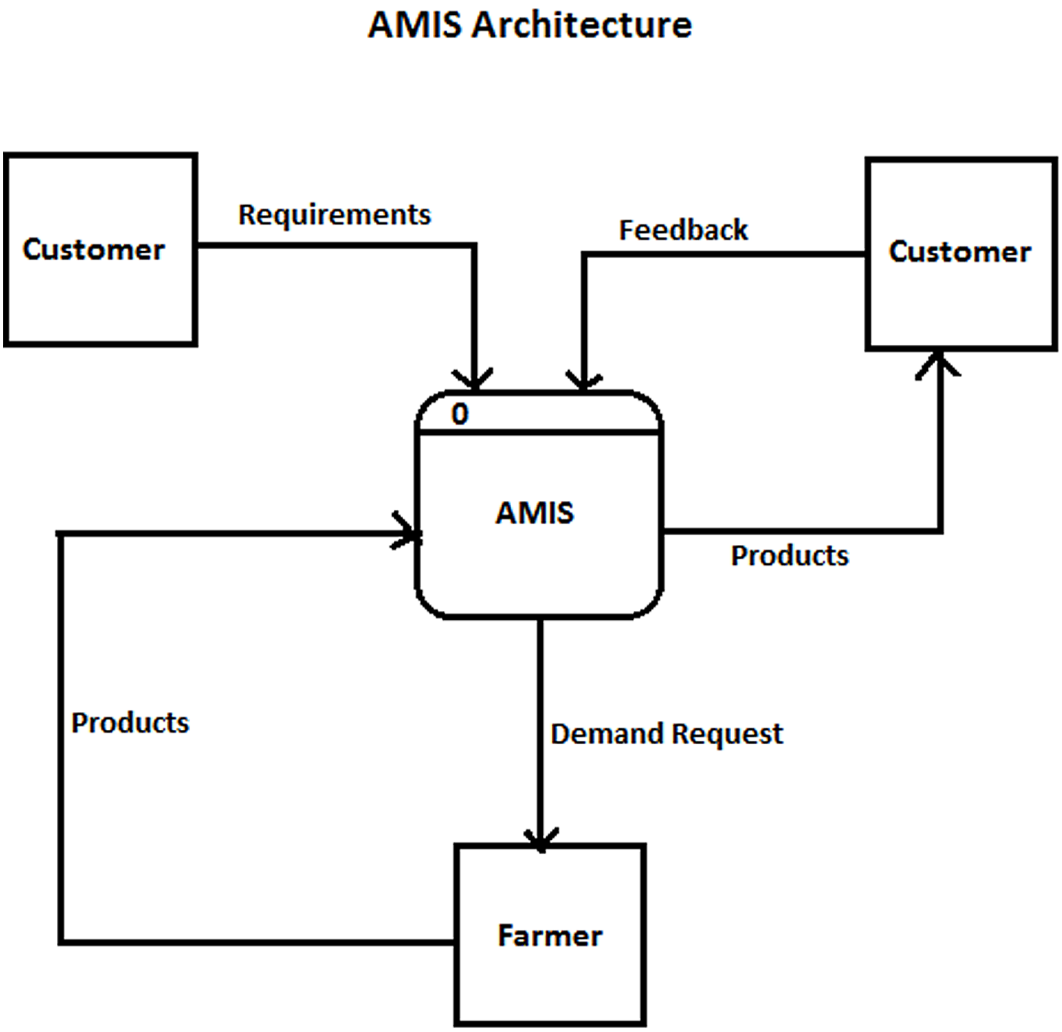
See Figure 3. AMIS includes the connection and view of the farmer and the customer (Agricultural products' traders). The design allows the farmer to submit products and a customer to see the product. A customer can request for products and farmer can see the products too. The integration with wAMIS is not seen in this architecture as it works inside the AMIS system as one system.

Detailed design was broken down into 3 major modules as follows:

Front-End Design **c**omprised of the user interface which links users and the system. Users could interact with the AMIS by using the series of interactive web pages as displayed through the web browser.

Application Tier Design for providing communication between the client and the server. PHP scripting language was used to fetch user queries from the browser into the database and retrieve the relevant materials back to the user on the web page. In order for the PHP to work Apache web server with PHP scripting language was installed.

Figure 3. Context diagram of AMIS



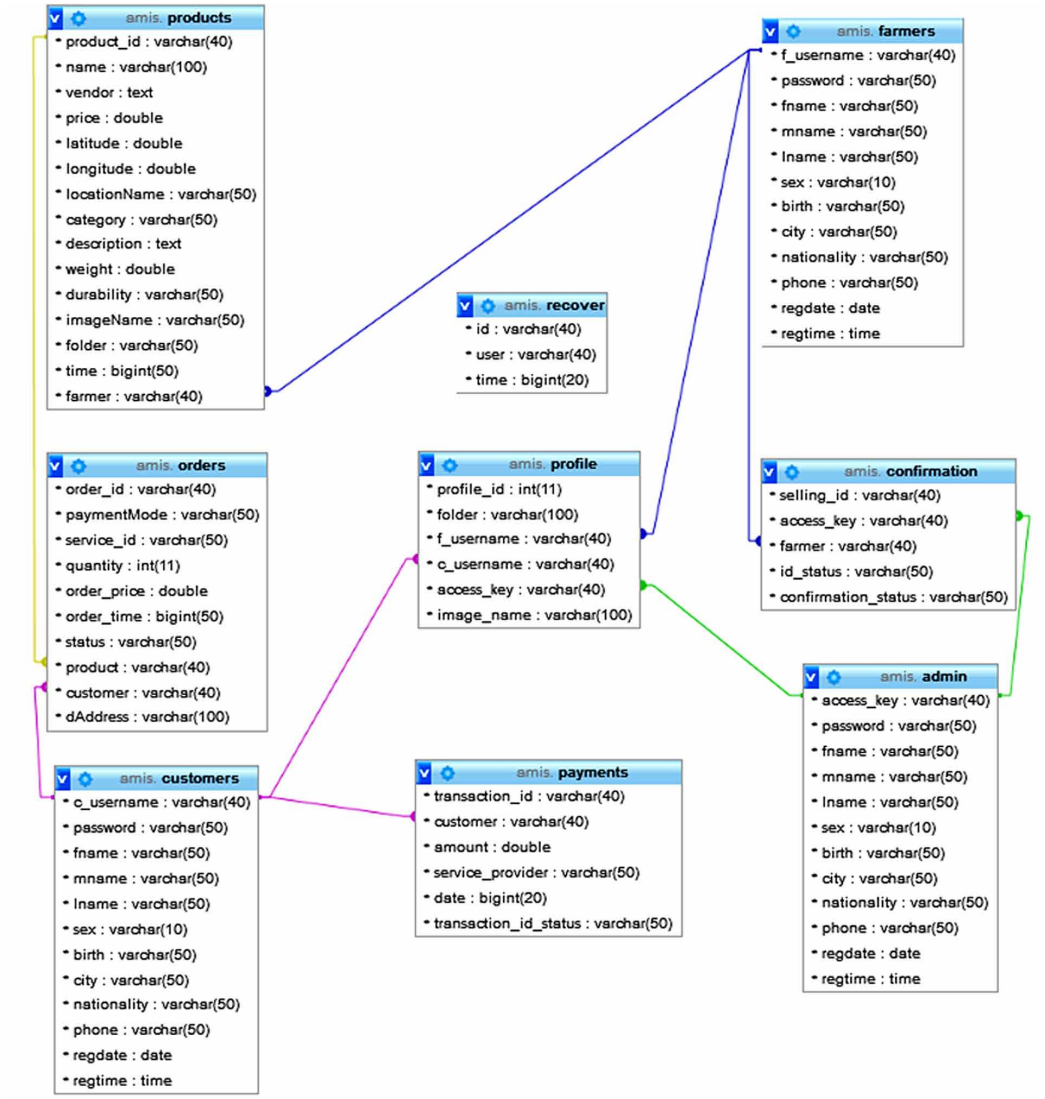
Back–End Design comprise of the Database. In the database is where information about users and products is stored so that users can access them through front-end's user interface. MySQL as the database server was used.

AMIS has mAMIS which provide alternative access to AMIS information using SMS. They share the architecture but wAMIS has web based view while mAMIS provide SMS capability access to AMIS (Table 3).

AMIS Entity Relationships

Figure 4 shows the Entity Relationship Diagram (ERD) which indicates the actual relationships existing in AMIS database. The proposed system has 8 entities that store information of the users, products and orders.

Figure 4. AMIS entity relationship diagram



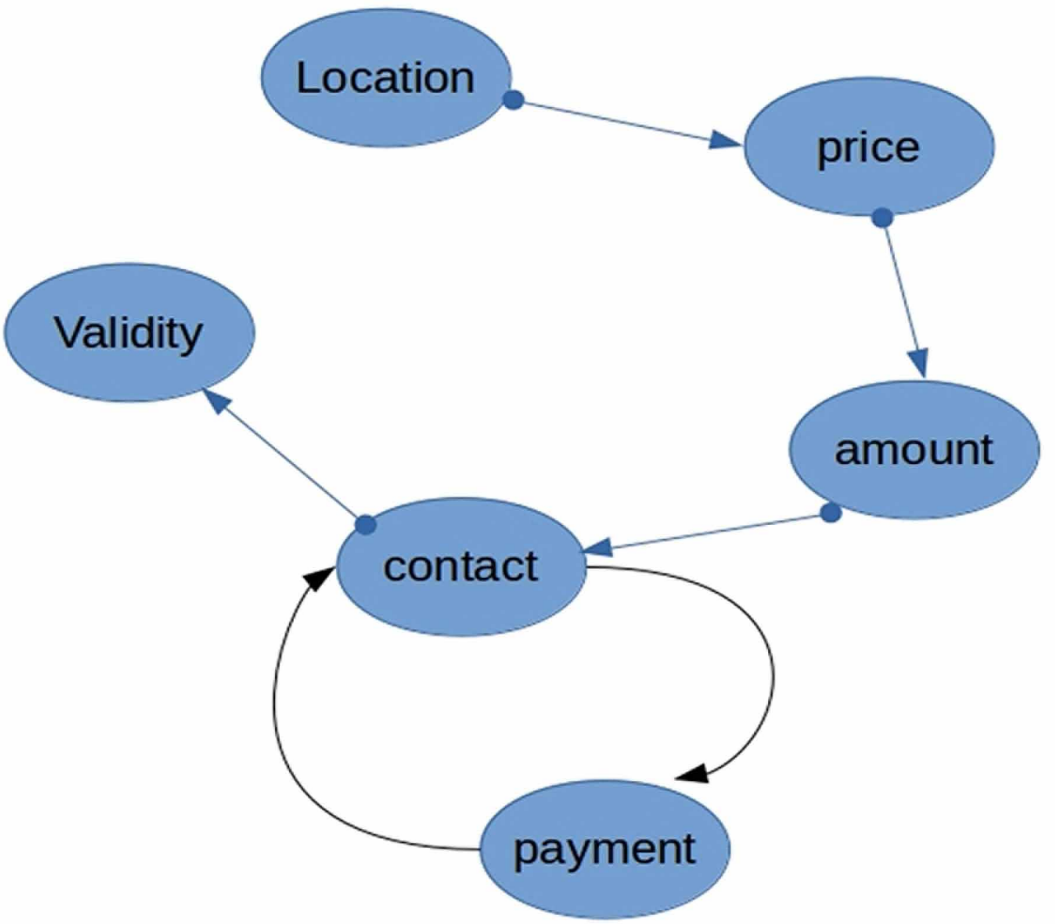
AMIS Cloud Source Information Collected

The farmers and customers were required to submit online or via SMS different types of the information. This information includes: location of product, price, amount, validity and contact information (Figure 5). mAMIS provides capability to submit payment methods too.

Field User Satisfaction Research Data Collection

Participants were given a sheet of paper consisting of a list of questions to be answered. Farmers were given a list of fourteen open ended questions related to farming and selling activities. Buyers/ customers were given a list of ten open ended questions related to their activities with system together with products of interest. After this process, answers for both questionnaires were collected and analyzed in order to identify user requirements.

Figure 5. AMIS cloud source information collection



RESULTS AND DISCUSSION

During the study, it was found that 80.3% of users who participated in the sample preferred a web based system where users could register themselves and perform different functions within the developed system. Among users who responded to questionnaire,45.0% were farmers selected from different areas, 50.7% were customers and buyers of the agricultural products from different areas and 4.3% were other users who had adequate knowledge of web systems and database.

The above information is summarized in the following Table 1.

Development of database that would be used to store and manage end-user data was done with the aid of Software Requirements Specifications (SRS) and ERD in Figure 3. The basic building blocks of all data models are entities, attributes relationships and constraints. The database proposed consists of six tables which are used to store information about users and products. The first table stores particulars of farmers where different personal details are recorded such as names, date of birth, contacts etc. The second table stores similar information of buyers. The third table stores particulars of products where product name, vendor, price, location (latitudes and longitudes), weight, durability and product descriptions are recorded. The forth table stores details of system administrator of the system which include access key that will allow admin to login in to the system. The fifth table stores payment details of the products when purchased by the customer whereas the sixth table stores orders

Table 1. Summary of users who prefer web based system

Category	Male	Female	Percent
Farmer	27	18	45.0%
Customers	36	40	50.7%
Others	15	17	4.3%

of the product as made by the customers. Other extra tables are proposed by the database admin including the one for recovering passwords, another one for confirmation of sellers in the system and the other for storing profile details of the user.

Development of different graphical user interfaces that would be used by the user to input information to the system and receive feedback from the system was also done. Interfaces for the developed system are as detailed in subsequent sections.

Index Page

This is the first interface (available in amis.esy.es/) in which every user interacts when visiting the system (Figure 6). This interface consists of the lists of the available products for sale which are being advertised by the sellers. It consists of products with their pictures at the center and list of products' category on the left column where a user can click to the product of interest in order to view the product in detail.

Product Purchasing Interface

This interface is where customer will be required to enter some information in order to purchase. This information includes quantity of product to order, payment mode, service address and delivery address (Table 7). All this information is required for proper and quick delivery of the products. See Figure 6.

User Interface

This interface allows the users (customers and farmers) to register to the system. At the first time, users should register themselves by providing their personal details as well as the system details which are required during the registration process. Also, the users will be required to provide the email address and password. It also contains a drop-down list where users should provide their login category that is either customer (buyer) or seller.

Other interfaces that was also proposed are Add new product interface, View products interface, View orders interface, Order confirmation interface, Deleting account interface, User profile interface, and System Administrator interfaces.

Development of security design of the system for securing the sensitive information stored in the database e.g. usernames and passwords was also done. Information stored in the database, was hashed using MD5 hashing algorithm.

Cloud-Source Knowledge Base

This system collects all the information from the users (customers and farmers) and matches the information so as to enable interactions and transactions between the farmers and customers. This allows the farmers to obtain good deals from the customers directly. Most of the information is stored in a cloud database allowing farmers to make easy reference of the past history of the best customers and give them opportunities to get new customers too.

The system allows researchers to monitor market information and develop best ways that will allow farmers and government to maximize the agricultural production with open systems.

Figure 6. Homepage of AMIS

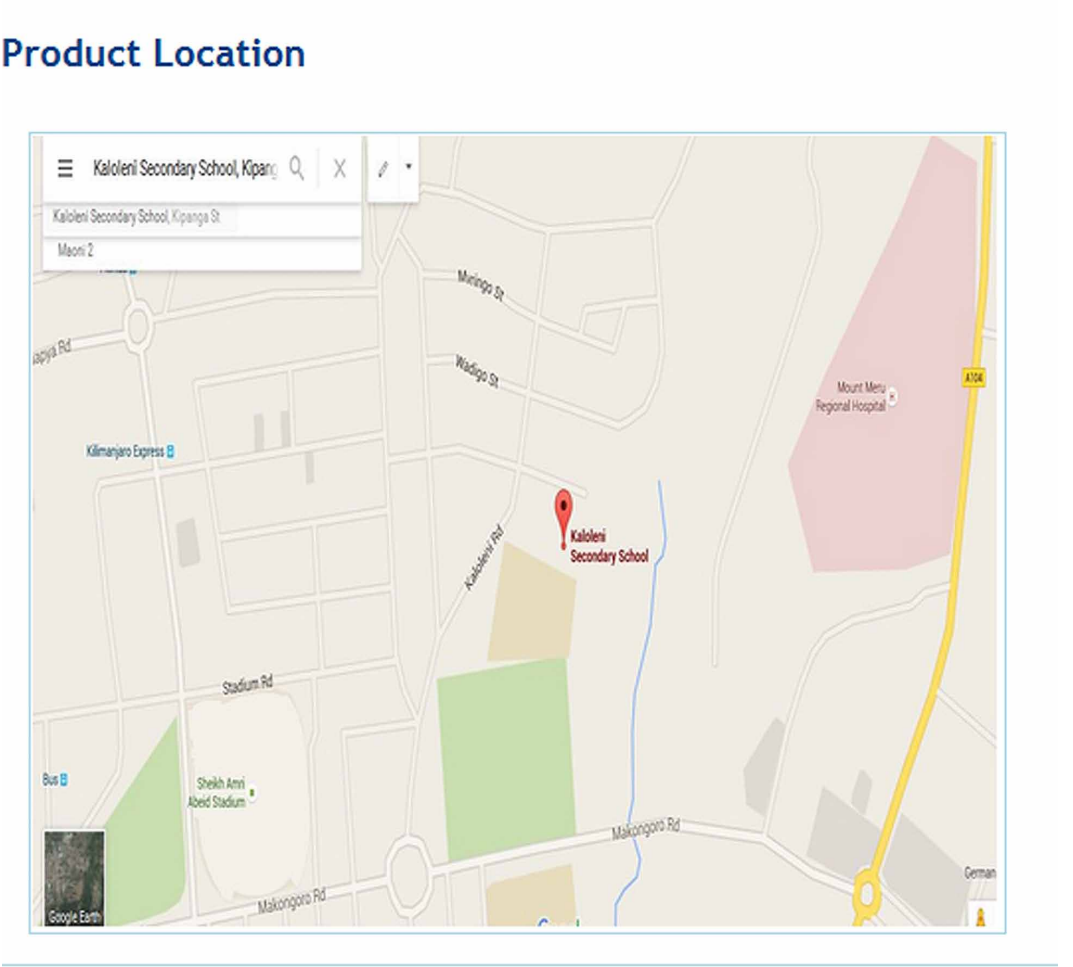
CONCLUSION

The method used in the development of AMIS was the rapid prototype approach because it enables the developer to design a system which is user friendly and interactive. The prototype was first developed and users made some changes as per their requirements.

Some of users tested its usability and it was followed by the collection of more user requirements that were included in subsequent version of the system. This process was done repeatedly until the users were satisfied with the developed system.

Finally, in order for the users to interact with the developed system, dynamic web pages were created to make communication with the database easily by registering their information and viewing the information stored in the database.

Figure 7. Map of market for information displayed on AMIS



A more comprehensive study to exploit the full benefits of the new technology in this field of market information system is highly recommended. This may be able to identify deficiencies in the design and content and therefore improve upon the existing system. The university should tap into the developed system so as to maximize the potential benefits of crowdsourcing agricultural marketing information.

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