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Coordinating divided Structure for data frameworks: Case of animal data frameworks

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Abstract

Information System (IS) is used for information communication. But the problem with the existing Agro-ISs is that they are not integrated. To integrate it, we need to have an integration framework. Generally, much has been done on the designing framework for IS integration. However, there are credible things which can be added to improve these frameworks. A framework can be designed in such a way that it guides users on technologies to be used, skills needed for the task, goals, outcome and output of integration. This is what this study focused to contribute. To design the framework, guiding factors were established. These factors were the one which surround farmers and in one way or another hinder or support accessibility of information from integrated ISs. The factors were discussed and presented in the mapping matrix. Under each factor, viability of technology on the ground was established and compared against the available technology. From the mapping matrix, scenarios on possible applications were established. Guides on Technologies, skills, goals, output and outcome of integration were established to form a framework for integrating applications and ISs. Then the framework was demonstrated empirically and compared with the existing frameworks. Results show that the proposed framework is more comprehensive in terms of guides it provides, than the existing frameworks.

Keywords: Information System (IS)**,** applications, framework, fragment, fragmented IS.

INTRODUCTION

Information System (IS) is used to communicate information. It is among the key tools used for information accessibility and dissemination. The problem with the existing ISs is that they are not integrated but are living in isolation mode (Liu et al., 2000; Lu et al., 2012). These ISs should be integrated so as to solve the problem of isolation and enhance information access. Livestock ISs are among ISs which live in isolation mode (Frost, 1997). There is a need for more efforts to be directed to these systems so as to enable integration and accessibility of of information which will generally boost development of the livestock sector.

In Tanzania, Livestock Sector is among the mainstay of the country's economy (Rutasitara, 2001; Engida et al., 2015). Paradoxically, this sector is held back by a combination of factors which include unreliable markets, poor transport infrastructure, effects of climate change, poor policies and lack of extension officers (Covarrubias et al., 2012; Mlote, 2013). The effects of these factors are aggravated by poor access to information

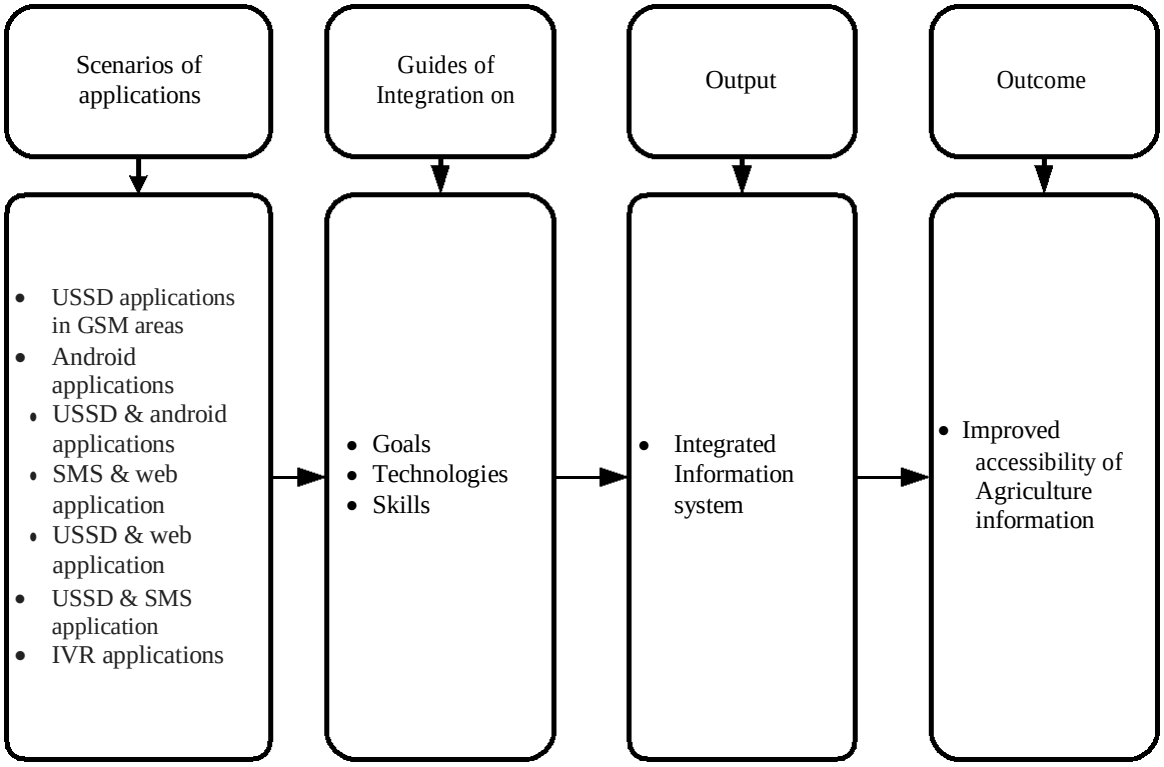

Figure 1. Conceptual framework of a proposed framework.

despite the facts that in Tanzania there are numerous agricultural ISs such as TigoKilimo and Kariakoo Market Corporation. One stock centre of Agro-information can be used to improve access to information. However, the ISs presented by literature are not integrated.

There are number of works done by different scholars on this framework for integrating ISs, but do not focus on the integrating of livestock ISs. Some of these works are the study by (Kuang and Gao, 2007), where these scholars developed a framework for integrating manufacturing ISs. This framework didn't specify skills and technologies needed for integrating manufacturing ISs. Study by (Jain et al., 2009) developed a framework for end-to-end system integration but do not specify the skills needed for the task of information integration. Another study done by (Sekgweleo et al., 2015), developed a framework which guides organisations in a successful integration of separate ISs. This study mentioned categories of actions which should be performed, to accomplish system integration (Magara, 2006). They left behind important components of IS integration like skills, outcome, output and nature of ISs. This framework leaves a huge task to users by finding the missed components.

Generally, much has been done to facilitate integration of ISs. Scholars worked hard to contribute much in this field. But there are credible things which can be added to improve these frameworks. Framework can be designed in such a way that it guides users on technologies to be used, skills needed for the task, goals, outcome and output of integration. This is what this study focused to contribute.

Conceptual frameworks

Conceptual framework of a proposed framework

The conceptual framework comprises a list of possible scenarios of applications or ISs and guides its integration in terms of technologies which will be used, skills required for the task and possible goals of that integration. Also conceptual shows guide the possible output and outcome.

The framework of Figure 1 concept is assumed that it will improve guides towards integrating separate ISs. This framework targets to minimize the generic of existing frameworks by identifying types of ISs plus its guides on integration.

Conceptual view of factors guided the proposed framework

The process of designing a framework was guided by factors which influence information accessibility in rural

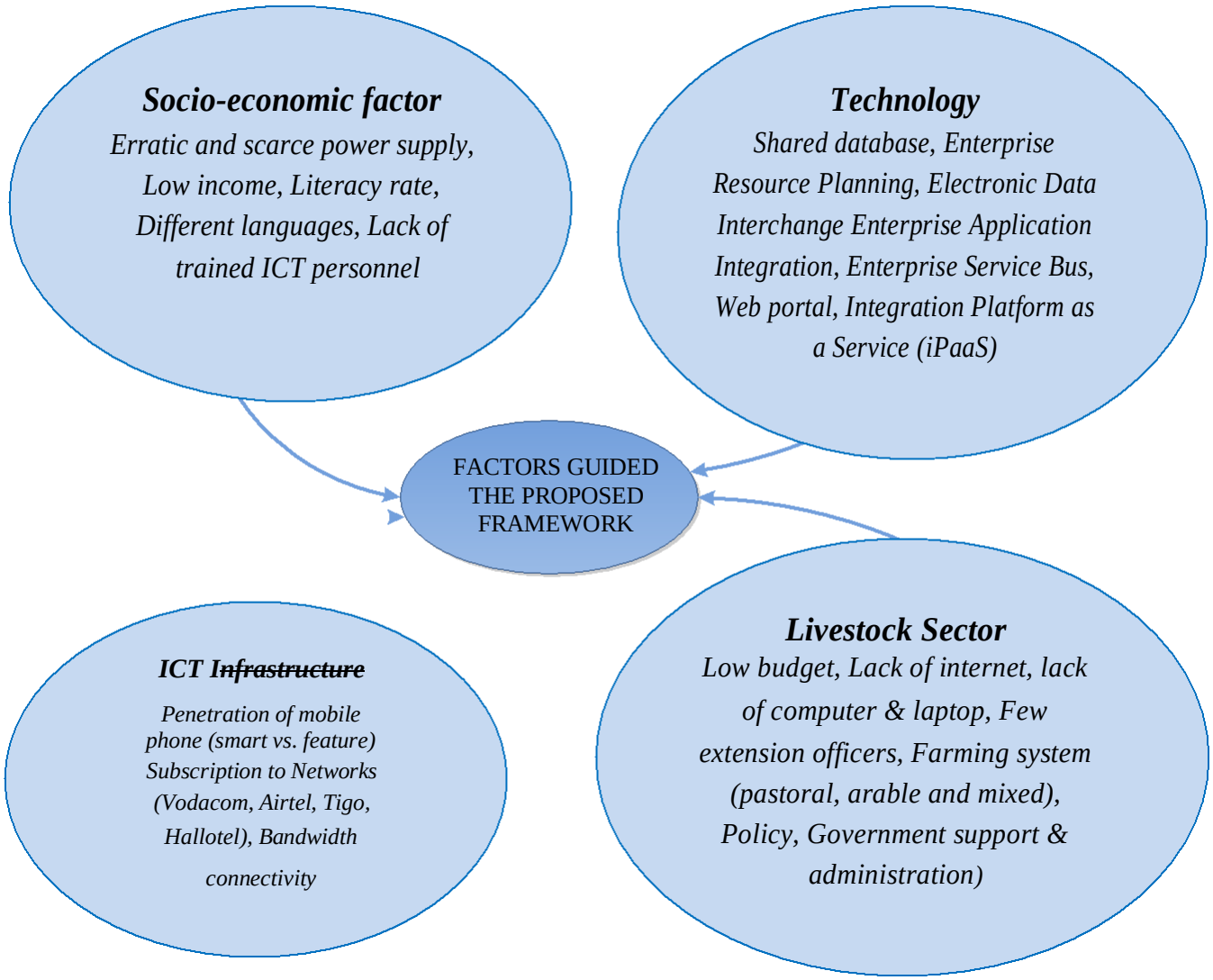

Figure 2. Conceptual view of factors guided a proposed framework.

areas. Some of these factors are those which fall under technology, socio-economic, Information and Communication Technology (ICT) infrastructure and livestocksector. These factors are shown in Figure 2.

MATERIAL AND METHODS

The whole process of designing a framework for integrating ISs were guided by factors which surround farmers and influence accessibility of information in the rural community. To accomplish this process, factors which surround farmers were established, discussed and presented in the mapping matrix. The established factors were those which fall under socio-economic factors, available technologies, ICT infrastructures and livestock sector. Under each factor, viability of technology on the ground was established and compared against the available technology in the mapping matrix.

Scenarios on possible applications were deduced from mapping matrix. After having scenarios, guides on goals, skills, technologies, output and outcome of integration was established to form a framework for integrating fragmented applications and ISs. Then the framework was demonstrated empirically whereby three web based systems were integrated by using guide of the new proposed framework. Finally the proposed framework was compared with the existing frameworks, to see which one is more comprehensive than other.

Factors which guide the proposed framework

Livestock sector

Factors included here are those which fall under the livestock sector and at the same time support or hinder viability of a certain technology. Also, the included factors have a direct effect on the accessibility of integrated ISs in rural areas. The framework was designed with a clear view that it is going to integrate applications and ISs for the community, which is surrounded by the factors like low budget, lack of internet, lack of computer and few extension officers.

Table 1. Viability of technology against factors on the ground.

Guide for viability of Technology against reality on the ground		Technologies						
		Shared DB	ESB	ERP	Web Portal	iPaaS	EAI	EDI
ICT infrastructure	High penetration of feature phones	•	X	X	X	X	X	•
	High penetration of Smart phones	✓	✓	✓	✓	✓	✓	✓
	Subscription to a certain network	•	•	•	•	•	•	•
	GSM/3G/4G with Feature phone	•	X	X	X	X	X	•
	GSM/3G/4G with Smart phone	✓	✓	✓	✓	✓	✓	✓
Socio-economic	No electricity at all	X	X	X	X	X	X	X
	Lack of electricity	•	•	•	•	•	•	•
	Presence of ICT trained personnel	✓	✓	✓	✓	✓	✓	✓
	Low income	•	•	•	•	•	•	•
	High Literacy rate	✓	✓	✓	✓	✓	✓	✓
	Low Literacy rate	•	•	•	•	•	•	•
	Different languages	•	•	•	•	•	•	•
Livestock sector	High budget	✓	✓	✓	✓	✓	✓	✓
	Low budget	X	X	X	X	X	X	X
	Presence extension officers	X	X	X	X	X	X	X
	Good government support	✓	✓	✓	✓	✓	✓	✓
	Bad government support	•	•	•	•	•	•	•
	Supportive policy	✓	✓	✓	✓	✓	✓	✓
	Unsupportive policy	X	X	X	X	X	X	X

Key: X= Not Viable, ✓ = Viable,• =Subjected to

Mixed farming, arable farming and pastoral farming are the farming which dominated the rural community area. Other factors which surround the rural community are good government support and supportive policy (JICA, 2014; Absawidi and Khamis, 2017).

According to Elifadhili et al. (2013 and Nchemba (2016), the government had not set aside a specific amount in its budget for agro-information sector. In connection to that, lack of internet limits ways through which integrated applications can be accessed. Good government support and supportive policy favour innovation towards enhancement of information accessibility.

ICT Infrastructure

ICT infrastructures which surround the rural community can either support or hinder agro-information accessibility. This framework was developed with the view that it is going to integrate applications and ISs which are found in area with higher penetration of feature phone, higher subscription to Vodacom Network (Khamis, 2017). The other factor which surrounds this area is low bandwidth connection (TCRA, 2016).

Higher penetration of feature phone imply that larger number of farmers in rural areas have no ability to accesses information via web interface. Many farmers have ability to access integrated ISs via three ways which are Unstructured Supplementary Service Data (USSD), Interactive Voice Response (IVR) and SMS. Only few farmers and stakeholders who possess smart phone are free to browse online and use USSD, IVR and SMS to get required information when there is no internet. Higher subscription to Vodacom network implies that in case were accessibility of information via USSD is needed, IVR and SMS application have to host server at the Vodacom network.

Technology

The framework for integrating IS was designed with the view that, the existing technologies for its integration are Enterprise Resource Planning (ERP), Enterprise Application Integration (EAI), Enterprise Service Bus (ESB), shared database, Electronic Data Interchange (EDI), Web portal and iPaaS. ERP is a business process management technology, which allows an organization to use a system of integrated applications to manage businesses (Liaquat and Rashid, 2002). EDI is an electronic interchange of business information (Shahzad and Heindel, 2012). IPaaS technology enables software engineers to integrate applications externally (Potočnik and Juric, 2012). EAI is the use of software and computer systems architectural to integrate a set of enterprise computer applications (Bussler, 2009). Web portal is a special designed website that brings information together from diverse sources in a uniform way (Kumar and Telang). Shared database technology allows isolated applications to share the same data (Pham et al., 2015).

Factors surrounding farmers were mapped against technologies to determine their viability. The aim here was to determine which technologies are viable under a given factors. Table 1 show mapping matrix for viability of factors against technologies.

Socio-economic factor

Factors surrounding the rural community, which falls under socio-economic factor were considered to ensure that we come up with a holistic framework. Considerations of these factors in designing a framework were expected to result into a framework which fits to all environments around the rural community. Factors which were

considered during proposing a framework were power supply, literacy rate, languages among community members, income and number of ICT trained personnel. This framework was developed with a view that systems which will be integrated, will be accessed by users, most of whom are low income earners (Mashindano et al., 2011; Aikaeli, 2010), Swahili language users (Absawidi and Khamis, 2017) and non ICT trained. Also, this can be accessed by users who mostly acquired primary education and those living in areas which have scarce power supply (Msyani, 2013; Absawidi and Khamis, 2017).

Low income earners cannot afford to pay higher cost to access information. In areas with scarce supply of electricity, farmers cannot use computer and laptops for accessing information. Smart phones can't be frequently used due to the fact that they have short standby time than feature phones. So, smart phones need more power than feature phones. Low level of education and uses of local language bring difficulties in understanding and analysing information. So information must be detailed to enable users to understand and use it.

Mapping matrix

Table 1 show mapping matrix. It presents viability of existing technologies against factors which influence accessibility of information in rural communities of Tanzania. From the mapping matrix (Table 1), "⎫" shows that technology is viable under a given factor, "**X"** shows that technology is not viable under a given factor while "•" shows that technology can be viable or not viable under a given factors after being subjected to something.

Entries in mapping matrix

ICT infrastructure: Under ICT infrastructure, the factors which aremapped under existing technologies have a higher penetration of feature phone, penetration of smart phone, subscription to networks and GSM/3G/ 4G with smart phone.

In the area with higher penetration of feature phones, the shared database is applicable depending on the type of applications involved. If USSD, SMS and IRV are introduced in such an area, it will work. EDI is applicable since feature phones use SMS which is among the electronic data interchange. All technologies are applicable in areas with higher penetration of smart phones. Subscription to networks allows applications of technologies which depend on the type of mobile phones (feature or smart) and network in which they are subscribed to. For example, if a USSD server is hosted at Vodacom Network, then those who are subscribed to other networks will not be able to access services offered by the USSD application.

Applicability of technologies is subjected to a condition because the type of mobile phone to be used is not mentioned. GSM/3G/4G with feature phones is subjected to be applicable under shared database and EDI depending on type of application involved. All technologies are applicable to smart phones.

Socio-economic factors: Under socio-economic, factors mappedin the mapping matrix are power (electricity) supply, ICT trained personnel, low income, literacy rate and different languages. Technologies are not applicable in areas which have no electricity at all. But areas with scarce electricity supply, applicability of technologies is subjected to some conditions since in some areas electricity will be available at a certain time. The presence of ICT trained and higher literacy rate favours all technologies to be applicable since their customers are aware of technologies.

Applicability of technology under environment with low income, low literacy rate and different languages are subjected to a certain condition. Introduction of technology depends on its price, so it works under low income earners. If technology needs users who know only how to read and write, then this technology can be introduced in communities with low literacy rate. In area with customers who use different languages, technology can be introduced basing on the common language if majority will be able to cope with it.

Livestock sector: Low budget, high budget, government support,policy and the presence of extension officers are mapped on the mapping matrix. It is possible to apply technologies in areas with higher budget, good government support and supportive policy. Unsupportive policy and low budget hinder introduction of technologies in rural areas.

The presence of extension officers in the area has no effect on technologies. Where there is bad government support, introduction of technology and its applicability is subjected to conditions since private organizations can come up with technologies.

Integration Matrix

Scenarios of possible applications were deduced from the integration matrix to form set of facts (framework) which have guides on technologies, skills required, goal, output, outcome as shown in Table 2.

Description of the proposed framework

This section deals with description on how the proposed framework can be used to guide different integrators to integrate different applications easily. The proposed framework contains scenarios of applications in the first column at the left hand side. These scenarios are collections of possible applications or types of ISs in which integrators may come across in task of integration. These proposed framework guides the integrators in the following ways:

(a) In selecting technology for integrating a given applications, proposed framework contains a special column for technologies which are appropriate for the given applications. This reduced the problem of looking for appropriate technology from experts, when the integrator comes across a task of integrating applications.

(b) In selecting skills for integrating a given applications, there is a list of skills which are needed for integrating certain applications. In case the owner of applications wants to integrate it, he/she will be required to look for a certain skills rather than looking for consultation on what skills will be needed.

(c) Goals for integrating any applications were depicted in the framework. This helps integrators to know exactly the aim of integrating certain scenarios of applications before integrating it.

(d) In determining the output and outcome of integrating a given applications, the proposed framework contains columns for output and outcome of different applications integration. The questions of what will be the output and outcome of integrating two or more scenarios of applications are answered in this framework. An integrator can easily see the proposed output and outcome of integrating certain applications.

The proposed framework is of a great importance as it will solve the problems of looking for technologies, skills, aims, outputs and outcomes of integrating diverse applications and ISs.

Empirical demonstration of the proposed framework

Demonstration was carried out due to few number of system integrators who could be used in evaluation of this framework. Three website based ISs were developed and used as a case study

Table 2. Proposed framework.

Scenarios/Guides	Technologies	Skills required	Goal	Output	Outcome
USSD applications for use in GSM areas only	Shared DB	PHP, USSD gateway configuration,	To integrate information from different USSD applications and to provide their unified view to farmers	Integrated IS from different USSD applications which can be accessed by using single USSD access code.	Increased number of information which can be accessed by farmers through single USSD access code Reduced time for searching and accessing multiple applications Increased number of farmers with access to information by using USSD codes and Internet Increased options of accessing shared database i.e. through internet and USSD codes Reduce cost of accessing information from multiple applications
Android applications in poor connectivity areas	Web portal, JSON, REST	Java, Android SDK, XML, APIs, HTML 5, CSS	To present a unified view of applications to farmers	A new dashboard of an android applications for farmers	
USSD and android applications	Web portal, Shared DB	PHP , USSD gateway configuration, Java, Android SDK, XML	To integrate information from android and USSD applications to provide their unified view to farmers	Shared database from USSD and Android applications	
USSD and android applications in good connected areas	Shared DB Web portal	PHP , USSD gateway configuration, Java, Android SDK, XML	To increase number of options of accessing shared database from USSD and android applications	Shared database from USSD and Android applications	
SMS and web application	Shared DB	Java, C#, PHP, Java script, Ajax, Action Script, HTML,SQL,MYSQL	To integrate information from web and SMS applications	Shared database from web and SMS applications	
USSD and web application	Shared DB Web portal	Java, SQL,MYSQL, HTML, CSS, JavaScript, PHP, MySQL, SQLite, PostgreSQL, MongoDB	To integrate information from USSD and web based applications and presents unified access to it	Shared database which can be accessed through USSD codes or web browser	Reliable methods for accessing shared database in poor and good internet connection.
USSD and SMS application	Shared DB	PHP, SS7, XML, HTTP, REST VB.NET, AJAX , C#, Java, JSON,	To present a unified view of application to farmers	A new dashboard	Increased number of farmers with access to integrated information in rural and urban area
IVR applications	Shared DB	C#, IVR ecosystem (speech recognition, TTS, VXML) Java, Telephone tech(Call routing, SMS, VOIP) IVR development environment (Avaya AOD, Voice Object)	To integrate information from different IVR applications and enable farmers to have wide range of choice on which information to access	A new dashboard	Increased number of information to be accessed by farmers by increased number of options from which information can be accessed.

which include; Kilimanjaro Auction Mart, Moshi Meat Market and Arusha Eggs Market. These systems were hosted online at sub domain of domain www.livemarketstz.com.

The sub domains used were www.egg.livemarketstz.com for Arusha Eggs Market, www.meat.livemarketstz.com for Moshi Meat Market and www.livestock.livemarketstz.com for Kilimanjaro Auction Mart and were integrated using the proposed framework as an empirical demonstration.

View of the developed systems

The view of the developed systems can be seen in Figure 3, 4 and 5.

Integration of three developed systems

From the proposed framework, researcher checked the scenario to see if web based systems are included in the framework. Web based system was found in the framework and its guides was used to integrated the three developed systems. This guide shows that the skills required for its integration are HTML, CSS, JavaScript, PHP and databases which can either be MySQL, SQLite, PostgreSQL or MongoDB. Technology which fits the integration is web portal. The goal of the framework is to guide the integrator in integrating web based system to present a unified view of systems to users. The output of integration will be a new dashboard of web based systems for users and the outcome will be to reduced time in searching and accessing multiple systems.

Integration of these systems used the advantage of having android applications in the field. The three web based applications were integrated with android applications to facilitate having one access centre for all systems. The applications were integrated in such a way that it will be available via android application.

Accessing databases: To retrieve information which isstored in databases of integrated systems, a simple web service special for passing the request to the database and returning the result from the database, back to the android was developed. This web service returns the results in a format that android understand. The android were

Figure 3. Kilimanjaro livestock auction mark view.

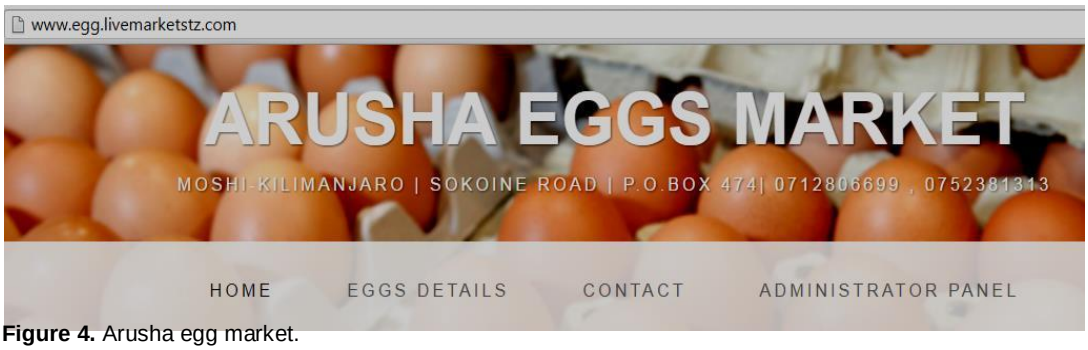

Figure 4. Arusha egg market.

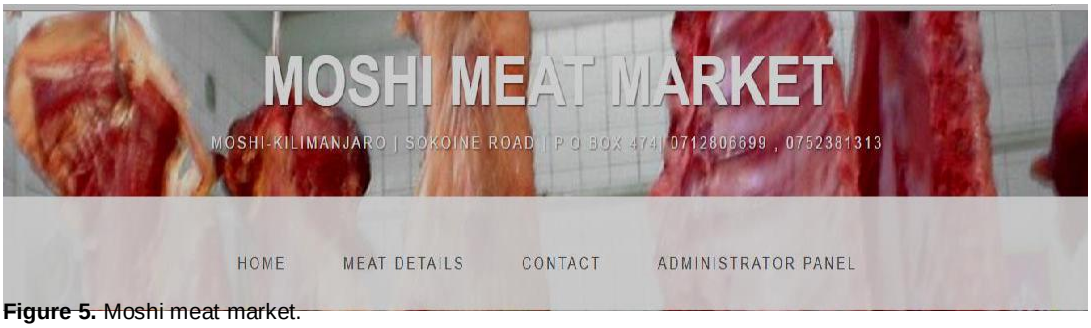

Figure 5. Moshi meat market.

designed in a way that it send request in REST or POST form to the systems and returns result in JSON format.

Connection of android applications to databases of systems: This connection was achieved through the use web service at the middle between database and android. Since database used was MySQL, then the PHP codes were used to solve this. POST was used to send request to PHP script which is hosted at server. Then the script returns result in JSON format which is easy to be parsed by Android into the desired result.

Below is the PHP script which takes the request from the POST data and submit it to the database via web service. The result is then returned in a JSON format as shown by arrow in Figure 6.

Installation of integrated mobile application which carries integrated systems: Figures (A), (B), (C), (D) and (E) shows thepicture of mobile application installation in five steps. Application was installed in smart phone before its use and can be downloaded and installed in any android device (Figure 7).

After installation, this integrated application stay in the list of mobile applications (D) which groups all mobile applications. After running the mobile application, this takes the user to list of integrated systems (E) where user can send a request to the selected applications (Figure 8).

Figure 9 shows integrated mobile application with their functions. To view several detailed we have to use view details, while the add detail add any new details which administrator wants to add. Other functions are profile and logout.

Comparisons of guides provided by frameworks

The comparisons of guides provided by frameworks can be seen in Table 3.

RESULTS AND DISCUSSION

The new proposed framework provides easiest guide to integrators during integration of ISs and applications. The framework is tabular in such a way that the integrator is

```php
<? php

$databasehost = "localhost";
$databasename = "livestock";
$databaseusername ="Abswaidi";
$databasepassword = "Mfanga";

$con = mysql_connect($databasehost,$databaseusername,$databasepassword) or die(mysql_error());
mysql_select_db($databasename) or die(mysql_error());
mysql_query("SET CHARACTER SET utf8");
$query = file_get_contents("php://input");
$sth = mysql_query($query);

if (mysql_errno()) {
    header("HTTP/1.1 500 Internal Server Error");
    echo $query.'\n';
    echo mysql_error();
}
else
{
    $rows = array();
    while($r = mysql_fetch_assoc($sth)) {
        $rows[] = $r;
    }
    print json_encode($rows);
}
?>
```

Figure 6. Android applications to databases of systems.

(A) (B) (C)

Figure 7. Installation of integrated application.

required to find the scenario of systems he/she want to integrate from. Afterward, all guides will be available from the table.

This is different from the existing frameworks which provide steps that can be followed during integration. The existing framework does not provide guides on skills and

Figure 8. View of installed integrated application.

Figure 9. Integrated mobile application.

technology which can be used for integration. It leaves the burden to integrators to find it out. Table 3 show comparisons of existing frameworks with a proposed framework. The result show that the new proposed framework is more comprehensive as it provides more guides to users than the existing frameworks.

Conclusion

In this study we designed a framework used for integrating fragmented ISs. The process of designing this framework was guided by factors which are identified and established by the researcher. These factors were among

Table 3. Improvements of new proposed framework.

S/N	Guides on Integration	Existing frameworks	New framework
I	Technology to be used for integration	X	✓
Ii	Skills required for integration	X	✓
Iii	Goals of integration	X	✓
iv	Outcome of integration	X	✓
v	Output of integration	X	✓

Key: X= Absence, ✓ = Presence

the factors which influence accessibility of information in the rural community of Tanzania. Effects of these factors hinder or support integration and accessibility of information from integrated ISs. The factors involved were livestock sector, socio-economic factors, available technologies and ICT infrastructures. These factors were discussed and presented in the mapping matrix.

Under each factor, viability of technology on ground was established and compared against the available technology in the mapping matrix. From the mapping matrix, scenarios on possible applications were established. After having scenarios, guides on technologies, skills, goals, output and outcome on integration were established to form a framework used for integrating fragmented applications and ISs. The proposed framework was then demonstrated empirically by using it to integrate three web based ISs. After that, the proposed framework was compared with the existing frameworks to see which one is more comprehensive than other. The results show that the proposed framework is more comprehensive than the existing framework.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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