

A System Development Methodology Framework for Development of Rural Community Based Information Systems in South Africa.

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ABSTRACT

For more than a decade researchers, development agencies and government have focussed on the use of Information and Communication Technologies to improve the socio-economic status of people in underdeveloped rural communities. In the past few years there has been remarkable recognition of the importance of developing systems that address specific needs of rural communities. Education, Health, Commerce, Government and Agriculture are amongst rural community needs that could be addressed by these systems.

System development is a complex process and studies have shown that if poorly conducted, the process could lead to failure of the system being developed. Due to differences in context and application, the processes followed in the development of the rural community systems need to differ from those of commercial applications. One such difference is the choice of the Information System Development Methodology [ISDM] used.

Following a methodological approach to Information Systems development is important as it improves discipline, standardization and monitoring towards a quality system. There are hundreds of Information System Development Methodologies available for use during development and choosing the wrong ISDM has been linked to problems such as systems being delivered late, over budget or not meeting the needs of the users. To improve success during the development of rural community systems, this paper proposes an Information System Development Methodology framework that could be adopted distinctively for rural community systems. This framework takes into account the social attributes of people in rural communities, the nature of the systems being developed and the role of the users in the systems being developed.

Keywords

Information and Communication Technology, Rural Community Information Systems, System Development Methodologies, Socio-economic Development.

1 INTRODUCTION

The past two decades have seen an increasing focus on Information and Communication Technologies for Development (ICT4D). Institutions like NGOs (Non Governmental Organisations), Aid Agencies and some private companies continue committing funds to ICT4D. This interest in ICT4D was brought about by the realisation of the vital role that Information and Communication Technologies (ICTs) can play in accelerating rural social and economic development (Migiro & Wayi, 2007; Madon, Nicolau, Roode, & Walsham, 2009). A number of ICT initiatives have been implemented, not only as a means of curbing the digital divide but also to address various needs in rural communities. ICT initiatives provide resources and tools that serve individuals and communities by delivering access and empowerment in areas such as local economic development, cultural affairs, civic activism and community based health and environmental initiatives (Harris, Songan, Khoo, & Bala, 2000; Donner, Gandhi, Javid, Madhi, Ratan, & Toyama, 2008). In South Africa, Education, Telecommunication, Agriculture, Commerce and Crime- fighting are some of the areas where implementation of ICT initiatives could be instrumental in improving community living conditions.

ICT4D initiatives have evolved, with the initial focus being on reducing the digital divide by ensuring that people from rural communities have access to technology (Benjamin, 2001). The past few years have seen a change in focus in the recognition of the role of ICT in addressing the specific needs of communities through Community Information Systems (Community IS). This focus has led to the growth of a fresh discipline commonly known as Community Informatics, aimed at designing and implementing ICT based projects for communities. Due to the complexity of communities and a scarcity of off-the-shelf applications, most community systems have to be developed individually as an experiment for successive systems (Harrison & Zappen, 2005).

The nature of users of rural based Community IS necessitates that a development process different from the normal organisational processes has to be undertaken. Blake (2010) recommends broadening of the field of application development away from the traditional mathematical and engineering approach to consideration of social and human issues. This paper recommends a general ISDM framework to be used in developing Community IS.

Section 2 of this paper discusses Community IS, with examples of rural based Community Initiatives in South Africa. Section 3 outlines Information System Development Methodologies and section 4 presents the proposed framework for development of rural community systems.

2 COMMUNITY IS

Soanes, Sara, and Elliot (2009) define a community as body of people living in one place or united by one origin, interest, etc. As this paper's focus is on rural communities, the definition of 'community' will be adapted to mean a group of people belonging to a rural area, with ongoing interactions and common interests.

In general, South African rural communities are characterised by:

- Very low income per capita as compared to the general population, with high levels of unemployment (Akinsola, Herselman, & Jacobs, 2005): Most rural areas are characterised by massive reliance on social grants as the main source of income. The South African rate of poverty is 45%, but in rural areas this figure rises to more than 50% (Fourie, 2008).
- Dependence on natural goods: This leads to poor quality of life because of scarcity of essential goods and services. The lifestyle of the community often depends mainly on agriculture and livestock farming (Fourie, 2008), as there is no direct linkage to formal markets.
- Poor education: The majority of people in rural communities are illiterate and some have never had formal education (Rao, 2004). In some instances schools are far and learners are forced to walk a number of kilometres to reach their school.
- Poor infrastructure: Lack of roads, electricity, telecommunication infrastructure (Wayi, 2006; Akinsola, Herselman, & Jacobs, 2005). There is also a greater majority of people who listen to radio compared to those who watch television (Fourie, 2008).
- Information Systems illiteracy: There is limited knowledge about Information Systems and the role it can play in a rural community (Rao, 2004).
- Traditional Leadership: In South Africa specifically, traditional leadership is one of the attributes of a rural area.

Rural community based information systems have an important role to play in improving conditions faced by people in rural communities. The Siyabuswa Educational Improvement and Development Trust (SEIDET) project in Mpumalanga is an example of a prominent community based ICT project that has made inroads into the education field for rural communities (Phahlamohlaka, Braun, Romijn, & Roode, 2008).

Community IS is the umbrella term that refers to ICT applications implemented to address the social, economic, political or cultural goals of a community (Stillman & Henry, 2009). Rural communities in South Africa are still lagging behind in terms of participation in global activities. Relevant ICT systems, if well implemented, could offer a platform from which these communities would benefit.

Progress towards a more articulate theory is still very much deficient in the area of rural Community IS development (de Moor, 2007). This deficiency could be attributed to complexity and diversity of the Community IS area. Over the years it has been possible to introduce ICT into rural communities through community centres, as the focus was mainly to ensure access to computers. Development of specific systems is, however, more challenging as the system should be linked to community problems and be usable by the people faced with the problems. One of challenges with the development processes for Community IS is difficulty in ensuring availability of the same individual stakeholders and beneficiaries throughout the process (Vercon, 2009). Involving community stakeholders will improve continuity thus ensuring

computers leave behind their definition as community technical tools to being tools used to emancipate rural communities.

2.1 EXAMPLES OF RURAL COMMUNITY IS INITIATIVES IN SOUTH AFRICA.

South Africa has implemented a number of ICT4D initiatives with community specific systems. Living labs around the country offer potential in terms of systems developed with the needs of the community in mind. Below is an outline of some living labs and some Community IS initiatives already in existence in South Africa.

2.1.1 Living Labs

European Network of Living Labs (ENOLL) defines a Living Lab as an open innovation environment in real-life settings in which user-driven innovation is the co-creation process for new services, products and societal infrastructures (European Network of Living Labs, 2010) . Living Labs started as pilot projects aimed at involving users in developing simple systems to be used to improve the social and economic conditions in rural communities.

A Living Lab approach to community development takes advantage of the diverse creativity of the participants and end-users to bring relevant solutions to rural communities. In South Africa universities, the Meraka Institute (division of the Centre for Scientific and Industrial Research), SAP consulting, the public sectors and some Telkom Centres of Excellence are some of the participants in the development of community systems (Chaffers, Guzman, & Merz, 2009; Herselman, Marais, & Roux, 2009). The systems that have been developed through living labs include enterprise based, logistics, agricultural and health based systems for rural communities.

Table 1 depicts some living labs that are found in rural communities around South Africa. Each system developed serves a distinct need of a particular community.

Table 1: Some Living Labs found in rural South African rural communities (Herselman, Marais, & Roux, 2009)

LIVING LAB	INFORMATION
Limpopo	This living lab was planned by the Provincial Government. A feasibility report completed in 2007 proposed four focus areas for the Limpopo living lab namely, community projects (in technology and innovation), innovation solutions, business development and incubation of Technology and innovation enterprises as well as training and development which are also part of the Limpopo ICT Institute.
Siyakhula	This came about through a partnership in the Eastern Cape between Universities of Rhodes and Fort Hare, established March 2006. Rural ICTs focussed on software applications, e-Services, Web 2.0, empowerment and community

	engagement.
Moutse	Partnership between the Ndlovu Medical Centre, Elandsdoorn Development Trust, INTEL and Meraka. Education, telemedicine and rural Connectivity.
Sekhukhune	Partnership between the Meraka Institute and SAP Research. Rural Micro-Service Enterprise creation and the development of ICT enabled collaborative work environments (e.g. collaborative procurement and logistics, collaborative stock management).
Soshanguve	Planned by Tshwane University of Technology (ICT Faculty); focussing on Education, Research, Community Development, and Job Creation.
Bushbuck Ridge	Partnership between SAP Research and Wits University. This system is Electronic Patient Health System for chronically ill patients in rural areas.

2.1.2 Other Initiatives

2.1.2.1 *Public Information Terminals*

Public information terminals (PiTs) are an initiative of the Department of Communications and the South African Post Office. PiTs are standalone units through which the public can access information from the government and business via the Internet (Snyman, 2008). These terminals are placed in post offices and Internet labs. Internet labs were later incorporated into what became known as Inter-net kiosks or citizen's post offices for previously disadvantaged areas (Snyman, 2008).

2.1.2.2 *Tsilitwa- Qumbu, Eastern Cape*

This is a Telehealth system in Tsilitwa, a rural village situated 50km north of Umtata. It is an initiative by the University of Cape Town to help nurses in clinics to communicate with the doctors who are in a hospital 20km away from the village. Through this system the clinic sister is thus able to interact with the doctor at the hospital through data, voice and video communication via a wireless system. This facilitates cost-effective healthcare for patients who would have had to travel long distances (Turker, *et al.*, 2007).

2.2 BENEFITS OF COMMUNITY IS

There are various socio-economic benefits associated with the introduction of Community IS in rural areas. McIver (2005) identifies the following potential benefits of a rural Community IS:

- *Poverty and hunger eradication:* through improved local access to information that impacts on local food production or other sectors of local economy such as tourism.
- *Education and literacy:* The supplementation or improvement of primary education might also be facilitated by Community based systems.
- *Reversing major diseases and improving health care:* The delivery of life-critical health information might also be facilitated and improved through Community based systems.

- *Gender equality*: opportunities will be afforded to women and girls to learn information technology (IT) skills in many parts of the world.

3 INFORMATION SYSTEMS DEVELOPMENT METHODOLOGIES

Avison and Fitzgerald (2006) define Information System Development as a way of conceiving, analysing, designing and implementing information systems. A system development project is initiated when a need for a particular system is identified and this need is preceded by a desire to solve a problem, create a new product or extend features of an existing system. ISDMs are used by developers to structure the Information System Development process (de Vries, 2004) and there are hundreds of ISDMs in use today (Harris *et.al*, 2000).

The dictionary definition of a methodology is that it is a system of methods used in a particular area of study and a method is defined as a particular form of procedure for achieving something in a systematic way (Soanes, Sara, & Elliot, 2009). Another definition states that an ISDM is a combination of a system development approach, a system development method, a system development process model and a system development technique (Huisman & Iivari, 2006).

Further discussions on ISDM are presented below.

3.1 HISTORY OF INFORMATION SYSTEMS DEVELOPMENT METHODOLOGIES

System development is as old as the history of computing. There are vast differences in how systems were developed in the early stages of computing compared to how development is conducted today. The difficulties with software development could thus be attributed to the complex nature of software relative to hardware and an awareness of differences in system context (Jayaswal & Patton, 2006; Pressman, 2005). Over the years designers (or development teams) and users have changed the way they look at their information systems and realised the importance of collaboration towards bringing about a desired solution.

According to Avison and Fitzgerald (2006) ISDMs have undergone the following stages:

- *The Pre- methodology era*: This is the era from the beginning of computing to the early 1970s. Programming and solving technical problems was the emphasis with less understanding of business needs (Avison & Fitzgerald, 2006).
- *Early- Methodology Era*: The early methodology era was characterised by a growing need to build computers through phases and stages (Avison & Fitzgerald, 2006).
- *Methodology Era*: The rigid nature of the System Development Lifecycle (SDLC) stages and some limitations including too much emphasis on documentation and technological focus leading to the continued proliferation of ‘new’ ISDM. Avison and Fitzgerald (2006) state that from the 1980s through the 1990s, practice and theory paved the way for the spread of methodologies in almost any software being developed.
- *Era of Methodology Reassessment*: The last stage is what they (Avison & Fitzgerald, 2006) regard as the review of methodologies by organisations from the 1990s. The review

was a response to failure in software projects attributed to the choice of a bad methodology or ‘inappropriate’ use of a particular methodology. Object orientation, agility and context engineering paved the way for growing research on social and technical considerations when choosing an ISDM (Bieber, McFall, Rice, & Gurstein, 2007).

These changes in methodologies are in response to the rapid evolution of information systems. User satisfaction, however, still is the measure of success of an information system (Schach, 2005).

3.2 SOCIO-TECHNICAL SYSTEMS APPROACH TO INFORMATION SYSTEMS DEVELOPMENT

The process of establishing a system involves more than constructing a solution to a defined problem. There are several activities and people involved in the process. A system is a collection of complementary and interacting components characterised by properties, capabilities, behaviour and a boundary which separates it from the environment (Mihailescu & Mihailescu, 2010). An Information system as a product of the system development process emanates from a desire to bring about a working solution to a complex set of organisational, human, or in this case, community problems. These problems call for an intensive process aimed at developing a suitable solution within organisational and environmental boundaries. The dilemma facing information systems developers is creating a system that responds to community needs, and is fit for use by the users (Schach, 2005).

The concern on social aspects responds to the recognition of the two pillars of an information system, the social pillar and the technical pillar. According to Patnayakuni and Ruppel (2008), the social pillar is made up of system developers, system users, the environment, the context and the social attributes of the system being developed. In agreement, Harrison and Zappen (2005) argue that the involvement of a significant number of a regular mass of community users is crucial to the design and development process. Users have a clear knowledge and understanding of community needs, environment, norms and boundaries. The technical pillar is made up of tools, techniques, devices, artefacts, methods, configurations, procedures and knowledge used by participants to acquire inputs, and transform them into a working system (Harris *et.al*, 2000). Acknowledgement and nurturing these pillars are important in improving performance during the system development process and as part of a holistic systems approach to system development to ensure user satisfaction.

Adopting a socio-technical systems approach in an ISDM would accentuate holistic consideration of the system development environment. Boahene (1999) and Avison and Fitzgerald (2006) agree on the significance of the environmental context of the intended information system. Harris *et.al* (2000) recommends the following list of aspects that make up an ISDM, which have to work together to produce the desired system:

- *Staff*: Skills, background knowledge, experience

- *Stakeholders*: Problems, interests, expectations
- *Power/ authority*: Organisational structure, influence
- *Procedure/ Process*: Sequence of steps, tasks, deliverables
- *Technology*: Computer language, hardware platforms, tools
- *Requirements*: Stated, implied, anticipated and non- stated needs

3.3 SYSTEM DEVELOPMENT PROCESS

Information system problems are diverse and require different approaches to a solution and thus it would be impossible to have one methodology used in solving Information System Development needs of various system or organisations. Distinction in approach is important and could lead to a shift of thinking amongst various software categories.

Various methodological perspectives have been identified by various authors (Harris, *et.al*, 2000; Avison & Fitzgerald, 2006). Differences in problem context, scope and system size are some of the reasons behind the use of a variety of ISDMs by organisations. Although different, most ISDM are based on the traditional waterfall model. A system development team using this methodology (as per picture below) applies a linear process from problem identification to the delivery of implementation of the system (Hitchins, 2007). During the Requirements stage users and developers engage in discussions in order to have a common understanding of the system requirements (Schach, 2005). These requirements are then translated to a design which is then used to implement a system, after which the system is verified to check if it meets the initial requirements. Maintenance happens at the end of the chain to fix any problems or upgrade the system, when necessary.

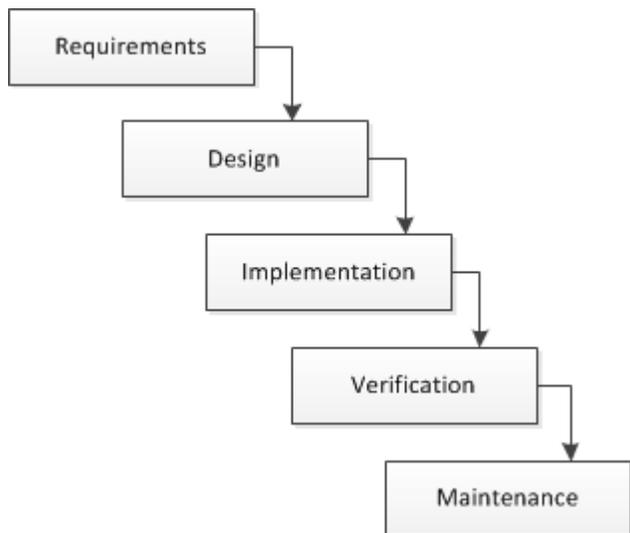


Figure 1 SDLC model (waterfall) (Schach, 2005)

4 A SYSTEM DEVELOPMENT METHODOLOGY FRAMEWORK FOR RURAL COMMUNITY IS

A general problem in Information System Development has been too much focus on technical issues when solving business problems. For a long time the need to engage stakeholders in developing a mutually-beneficial system has often been overlooked, as most traditional innovation support programmes take the form of infrastructure investment and the setting up of formal platforms – often under the premise of ‘build it and they will come’ (James, 2010). Failures of most Community IS initiatives can be linked to this mentality because the resultant system does not reflect on the needs of the communities but rather the aspirations of the designers.

The need for a development methodology for community systems arises from the differences in nature between organisations and communities. By their nature, rural communities are more complex than structured organisations. An organisation has well formulated policies, defined boundaries, usually with a single role of maximising shareholders’ wealth. The social dynamics of rural communities cover a far wider spectrum compared to the limited structured social interaction found in organisations (Stillman & Henry, 2009). Unlike in an organisation setting, a rural community system is usually conceived from the identification of the need by the developers, not the users (community) as is usually the case in organisations (Donner, *et.al*, 2008). One of the attributes of a rural community is that there is limited knowledge about Information Systems and how it can be used to improve living standards. For a system to work, interplay between social and technical pillars of development is crucial. This means that the system developers have to spend more time trying to find the relevant stakeholders for the system and explaining the system to the community users (Harrison & Zappen, 2005).

Various elements of the framework are presented below, followed by a diagrammatic presentation.

4.1 RURAL COMMUNITY IS DEVELOPMENT: THE ENVIRONMENT

Based on discussions from this paper, the following table is an adaptation of socio-technical environmental issues facing development as introduced by Boahene (1999). These factors must be considered during the development of the rural community system.

Table 2: Environmental Factors Affecting Development, adapted from Boahene (1999)

ELEMENTS	CHARACTERISTICS
<i>Staff</i>	Staff members include the people working in the centres where the rural community IS will be housed, the development team and the administrators.
<i>Stakeholders</i>	The facilitators, the developers, the users and community leadership are stakeholders in a rural community. Sensitivity to experience, language and social characteristics of the community stakeholders should be respected.

<i>Power/ authority</i>	Securing a buy-in from top management of funding institutions and community leaders like the chiefs is vital to the success of the development process. Developers must be familiar with procedures and protocol followed to access community leadership. Culture and norms of the rural community could also be a hindrance to the success of the development process.
<i>Procedure/ Process</i>	The recommended process is presented in the following section.
<i>Technology</i>	Includes computer language, hardware platforms, networks, tools, notes that will be used during development.
<i>User's Needs</i>	Emphasis on holistic user participation throughout the process to ensure better understanding of stated, implied, anticipated and non- stated needs.

4.2 COMMUNITY ISDM SELECTION

In selecting an ISDM, the attributes of a rural community and the above socio-technical issues of system development must be considered. Taking these into account, a rural Community IS development methodology in South Africa should:

- *Be simple:* As stated in Section 2 of this paper, on average, people from rural areas are illiterate and have a limited understanding of Information Systems. Meraka Institute, Universities and SAP are some of the main drivers of the Living Labs initiative. This means that initiators do not emanate from the community. The whole software lifecycle management and user interface must be simplified (Merz, De Louw, & Ulrich, 2007).
- *Be flexible:* The chosen methodology should be flexible in many respects. Rural communities are ruled by a traditional leader who may demand some changes to one or more aspects of the system development and that could affect the pre-defined processes. Obtaining commitment from community leaders is important; it was instrumental in the case of Connected Kids System in Troy, New York (Harrison & Zappen, 2005). Another issue that needs flexibility is the fact that one system could be used to address various problems from different users, i.e. health, agriculture and rural businesses.
- *Involve Users.* It is crucial that a wide range of stakeholders are involved during development (Bieber, *et.al*, 2007). The level of user knowledge of community dynamics, the proposed system and the system development process is as important.
- *Accommodate the social context:* The importance of taking into account the socio-economic conditions of the community could never be over-emphasised. Methodology must embed the needs of the community, as they may emerge before or after the technology is installed (Harris, *et.al*, 2000). The chosen system development methodology must aim to address the social, economic and technical needs of the community.

4.3 RURAL COMMUNITY ISDM PROCESS

A generic software development methodology process consists of sequential stages from *Requirements, Design, Implementation, Verification and Maintenance*. Requirements and Design

are the most challenging stages when developing a community based Information Systems (Donner, *et.al*, 2008; Bourgeois & Horan, 2007; Bieber, *et.al*, 2007). Challenges in these stages are due to the extent of ground work that has to be undertaken in building awareness and acceptance amongst the users, given problems of illiteracy and other social factors. It then becomes impossible to apply a linear process when developing a system for a rural community. Continuous user participation and process iteration are unavoidable.

4.3.1 Requirements

Language and technology are important factors during requirements stages in a community based Information System. An Iterative process should be followed from needs identification to requirements analysis (Bourgeois & Horan, 2007). It is always advisable to include amongst the developers someone who has an in-depth understanding of the community language and community culture and circumstances. During requirements there is a need for understanding of the current state of the community's components (people, structures or governance, groups and communication, other systems) (Bieber, *et.al*, 2007).

4.3.2 Design

Design includes a series of meetings between the user and the developer to identify various system features and needs and convert them into a design for a system. The purpose is to ensure that the system is developed according to the user's needs. Various tools are used during design (Schach, 2005) but must be simple and explained using the local language. A series of iterative designs using simple tools is necessary in order to be easily understood by the community users (Donner, *et.al*, 2008).

4.3.3 Implementation and Verification

The developers are the most active people during this stage but constant communication with the users is necessary to ensure that there is a mutual understanding of the system functionality. A prototype approach is necessary with constant tests and feedback from the users (Bourgeois & Horan, 2007). Continuous *Iteration* and *Testing* are vital as part of implementation to ensure that users fully understand the functionality of the system.

4.3.4 Operation and Maintenance

Community emancipation through Community IS can only be achieved when the developed system is working, as per the context and the needs of the community (Donner, *et.al*, 2008). Rural communities are characterised by a lack of technological infrastructure and thus it might be difficult for the community users to contact the developers in case of a need for system maintenance or upgrade. Communication lines should be well established and strong relations with the community leaders (Harrison & Zappen, 2005) would be instrumental in ensuring that system errors are reported.

4.4 FRAMEWORK PRESENTATION

As per the above discussions, this framework (as portrayed in Figure 2 below) starts with the identification of the problem or opportunity, which necessitates development of a Community IS. This is one aspect that differentiates a Community ISDM from a traditional System development methodology. When developing a system for a particular organisation, the background information about that particular organisation can easily be accessed from available documents, unlike in a rural community setting where a developer is expected to draw information from various community members. Social and technical issues are then analysed in order to gain a thorough understanding of the environment. This is followed by a system development lifecycle process, leading to a working and well maintained system.

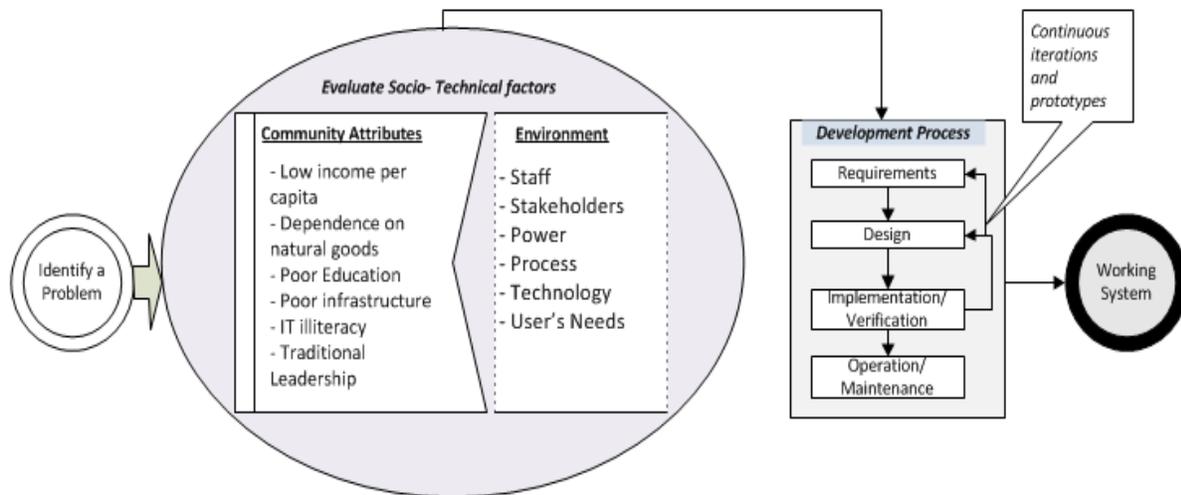


Figure 2. A rural community ISDM framework.

5 RESEARCH METHODOLOGY

Desktop research was used in writing this paper. Most references used are from journal papers and conference proceedings in the areas of Community IS and System Development Methodologies. On the basis of the scoping exercise, a more in-depth search and analysis of published academic and scholarly articles, practitioner reports and documented case studies was undertaken. These sources helped to craft an informed analysis of a community ISDM aimed at improving success and sustainability of ICT based socio-economic development initiatives for rural communities.

6 CONCLUSION

This paper recommends a framework for system development methodologies for community based systems. The framework took into account the social and technical pillars of system development, characteristics of a rural community and some examples of community systems

already available in some South African rural communities. User participation, process iteration and the understanding of a rural community environment are identified as important ingredients contributing towards a successful rural community system.

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