THE DEVELOPMENT, USE AND POTENTIAL CONTRIBUTION OF APPROPRIATE ICT-BASED SERVICE SYSTEMS TO ADDRESS RURAL TRANSPORT RELATED ACCESSIBILITY CONSTRAINTS - Emerging lessons from case studies in South Africa.

JOHAN MARITZ[1] and **GOODHOPE MAPONYA**[2]

Built Environment Unit, Council for Scientific and Industrial Research
Pretoria, 0001
Tel: (012) 841-2928, Fax (012) 841-4054
[1] jmaritz@csir.co.za, [2] gmaponya@csir.co.za

ABSTRACT

Rural environments suffer a number of constraints including high transport cost, irregular or unpredictable transport services, transport of low passenger and freight volumes, and low logistics service demand and supply. Rural residents, especially those residing in South Africa's ex-homeland territories are spatially removed from employment and service centers and as a result experience the abovementioned constraints. To address specific rural transport and logistical problems, researchers at the CSIR's Built Environment Unit have turned to a service system approach – where ICT systems are developed to target and address a specific transport related problems. The use of such systems holds the potential to overcome such constraints, and could improve the general accessibility of rural households and enterprises (e.g. to services, peers and markets). During 2008-10 the Council for Scientific and Industrial Research's (CSIR) Built Environment unit initiated a two (related) research projects: one focused on the development of a logistics brokering system that could address rural transport challenges facing local residents. The second, a healthcare application, dealt with supporting local home-based care workers that provide care for patients at home, whilst supplying vital health care statistics to health care professionals at the local clinic/hospital thus avoiding the need to travel frequently.

Both these systems use a session-oriented service technology known as Unstructured Supplementary Services Data (USSD), to deliver the services between users, service brokers or facilitators and the end users. A service system framework was applied within a living labs context which positively affected the outcomes of the projects. These systems, and others like it, hold much potential to address transport related rural accessibility challenges.

1. INTRODUCTION

When Nelson Mandela took the oath as president of South Africa 16 years ago, this ushered in a time of hope for change and the betterment of many lives - especially the poorest of society i.e. those most affected by past policies. Pre-1994 the colonial and apartheid governments undertook an ambitious experiment in racial segregation (known as apartheid) which resulted in the ordering of space to benefit the white minority population (King, 2007).

The spatial consequences of ‘grand apartheid’ are most evident in the creation of Bantustans (later referred to as the Homelands). Although the political boundaries of these areas have been erased as a result of the new dispensation, and incorporated into South Africa, the spatial remnants of these apartheid creations still remain. The result is often high density scattered settlements in a rural setting.

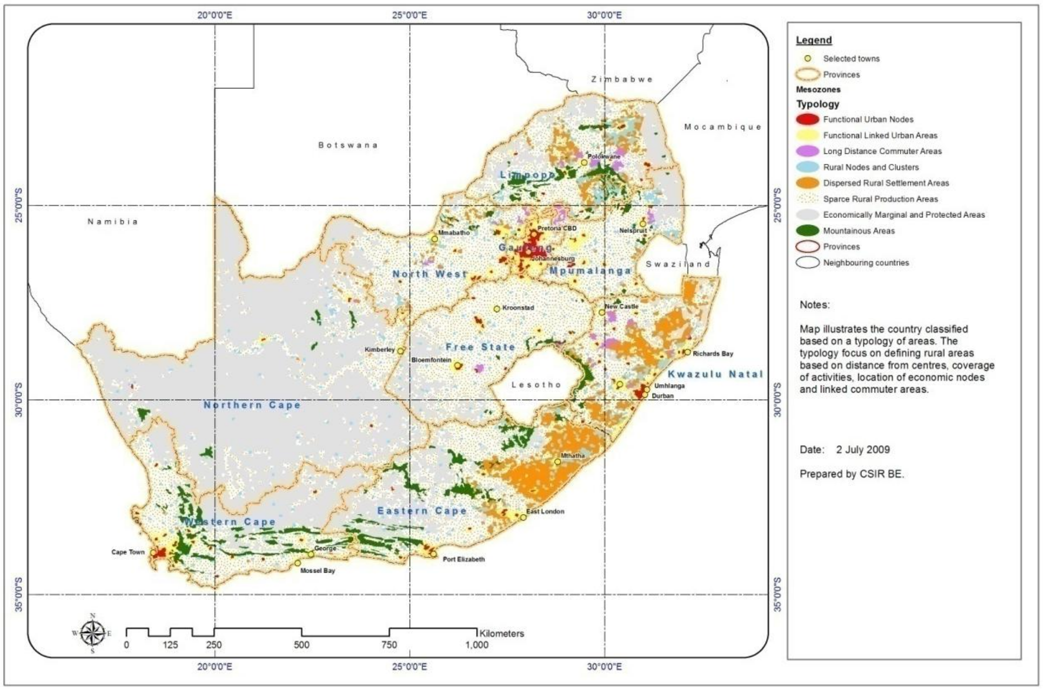

Figure 1: Rural-urban typology.

A typology of functional rural and urban areas, developed by researchers at the Council for Scientific and Industrial Research (CSIR), helps to categorise and better represent the different types of rural areas, and allows for more detailed analysis of a range of rural settlement types (see figure 1). This indicated that there are large numbers of households that still reside within the boundaries of the old homeland territories (nearly 20.1 million residents representing almost 43 per cent of the total population - Calculated from the 2005 Geospatial Analysis Platform developed by the CSIR Built Environment with the demographic adjusted data for 2004) and these residents are often far from towns and service centres as well as the main employment areas within South Africa. Some areas are even known for long distance commuting, where residents travel every day between employment in the main cities and areas previously part of the Bantustans. Due to the extent of ***spatial ‘disconnectedness’***, these areas are also described as ‘displaced rural areas’. Many settlements would probably not have developed as is, was it not for the apartheid policies that often forced people to settle and live within these areas (Maritz, 2006). Residents of these displaced rural areas are also often the poorest in society, and many are mostly dependant on the financial support of family members working in cities, social grant payments, running an informal business and or subsistence agricultural practices to sustain their livelihoods. For most people in these displaced rural areas, access to services, information and markets have become a fundamental requirement for securing a decent livelihood. This applies to economic services, such as agricultural knowledge and credit, as well as to social services such as basic health care and education. Rural road infrastructure is often in a poor condition, which creates a reluctance of those with motorised vehicles to use the roads, or to provide regular and widespread transport services. Transport services are infrequent in places which further constrains the accessibility of local residents: these conditions severely limit the ability of residents to access basic services, social infrastructure and support, attain higher education, or have regular social interaction (social networks) to name a few.

2. BACKLOGS AND THE USE OF TECHNOLOGY

The reality is that the extent of services and infrastructure needed (including roads) in rural areas is still large and it is unlikely that many areas will be improved for many years to come. According to the South African Road Federation the rural and municipal road network is failing, both in condition and its ability to cope with increased demand (SARF, 2008). Internationally, as in South Africa, the pressure on governments to overcome the service backlogs has also forced them to look at other, more innovative means, to improve people's access to services (Oyedemi, 2009). One technology that holds much potential for reaching and servicing such rural communities is Information and Communication Technologies (ICTs).

Information and Communication Technologies (ICTs) have proven extremely valuable in the developed world and has had a revolutionary impact on the way we do business, live and learn (Morales-Gómez & Melesse, 1998) - it has in many respects replaced the need for travel to access some services or facilities than would otherwise be the case (Douma et al., 2004). During the 1990's two new mediums of communication were developed that has resulted in a revolution in communication; they are wireless communication (particularly the mobile phone) and the Internet. In the developing world not all has benefitted from such ICTs – a major factor has been the costs of access, thus fewer of the poor are able to invest in ICTs. Apart from costs, other problems such as illiteracy and awareness also hamper its uptake. South Africa is much more developed, and its ICT infrastructure is far more advanced than in most Sub-Saharan African countries, but it still has many displaced (and remote) rural areas with poor populations experiencing similar difficulties than other African countries with respect to education, unemployment, ICT infrastructure and role of the small business sector.

It has been proven in many instances around the world that ICTs can help alleviate poverty, improve the delivery of education and health care, and make government services more accessible to citizens (Wondie, 2007). Many countries, including South Africa, have therefore turned to ICTs to overcome some service backlogs, especially in the more remote communities. South Africa's government has placed a strong emphasis on ICT sector development through the implementation of its National ICT strategy. It advocates ICT penetration, particularly for disadvantaged segments of the society. The South African government has, through legislation, created the Universal Service and Access Agency (USAASA) to promote the goals of universal access and universal service in the under serviced areas of South Africa. Universal access indicates a situation where every person has a reasonable means of access to publicly available telecommunication services. Several local examples of ICT implementations exist including multi-purpose community centres equipped with computers, and the internet allowing residents to source information without the need to travel vast distances. Most are however merely placing ICT in communities. Most do not effectively harness ICTs to provide solutions though targeted systems.

A more recent development is to involve the communities in the research and development of ICT-based solutions and service systems that address or overcome some of the accessibility constraints they are experiencing. Previously, a large percentage of applications or systems developed for rural communities have failed, either through improper design methods or through insufficient involvement of the communities (Heeks, 2002; Maritz, 2009). New approaches, such as setting up ‘Rural Living Labs’ (RLL), have been initiated to improve the way in which systems are developed and deployed thereby attempting to improve the success rate of rural ICT-based systems. In South Africa the most prominent RLL is located in the Sekhukhune district (previously part of the Lebowa Homeland). Two current projects are examples of using ICT-based systems to overcome accessibility constraints:

1) A **Logistics brokering system** was developed for the Kgautwane area of the Sekhukhune district, to overcome rural transport challenges facing local residents through providing a mechanism to capture demand for transport, which could then be organized and be matched with the existing supply of transport.
2) A **Home-based health care support system** was developed for the Leroro Communities in the Ehlanzeni district of the Mpumalanga province. The system facilitates and speeds up health care status information flows between care workers and health care practitioners at the local clinic and hospital.

The development of rural service systems, such as these, requires several approaches that are aimed at developing ICT-based systems that are appropriate and sustainable. The following section will briefly elaborate on useful approaches for developing rural (ICT) service systems.

3. APPROACHES

Several approaches were applied in the development of the two ICT-based systems to ensure that they are appropriate to the needs of users, and sustainable in the long term. Each approach deals with a particular challenge or constraint related to either the rural context or system development itself. Table 1 summarises the approaches and indicates its focus, benefits and list relevant related literature.

Table 1: Approaches applied.

Approach:	Focus	Benefits/purpose	Related Literature
Living Labs approach	Establishing long term relationship with real world context participants	• Involvement of users in development/ co-creation of system • Establish affordable service • Overcomes sustainability challenges	(Fourie, 2007), (Maritz et al., 2007), (Lynne Markus et al., 2002)
Design Science	Develop appropriate system in organizational setting	• To fulfil the user requirements – to determine the real business relevance	(Stefik, 1984), (Denning, 1997), (Tsichritzis, 1997)
Service System	To ensure complete system design	• Takes wider environment into account • Set boundaries for development	(Kotler, 1997), (Van de Kar & Verbraeck, 2007), (Maritz, 2009)

Rural service broker	Serves as bridge between developers and community	• Enables easier access and interaction with local stakeholders • Ensures bottom-up participation	(Muniafu, 2007)

Prior to developing any system in the case study areas, research was first conducted to understand the local problems and constraints. The complexities of these environments obliged the CSIR researchers to first establish rural **living labs** (RLLs). RLLs are defined as user-centric, real-life research and development contexts, involving people, businesses and public players in the co-creation of services to enhance rural development. According to Mulder (2008) the main advantage of a Living Lab approach over more traditional user-centric methodologies, is its multi-contextual sphere in which the co-creation of ICT product- and service development takes place. It is also about research and technology development institutions setting up long-term relationships with the inhabitants of the real-world context in a way that will ensure active participation by the latter in the research and development process (Maritz et al., 2007).

In order to create appropriate service systems the **design science paradigm** was followed, which is used to conduct research in information systems and organizational settings. Design science strives to create innovative and valuable artefacts, whereby the researcher attempts to create products that serve a human purpose, and the outputs are assessed against criteria of value or utility (Stefik, 1984). It is fundamentally a problem solving paradigm. This paradigm is used to create and evaluate the two systems (also referred to here as the artefacts) in facilitating and improving rural passenger logistics and health care information flow in rural areas. To understand the general characteristics of each use case, action research was applied. Apart from improving efficiencies in the flow of information, the more general goal was to improve the extent of accessibility of users. Design science guidelines were used to design the systems to fulfil the user requirements identified, and to determine the real business issues (problem relevance) to be solved by the systems. In both cases, interviews, questionnaires, and observations were used to obtain both qualitative and quantitative data from the stakeholders.

It is not the development of systems that is a concern, of concern is the sustainability of systems. Past experience has indicated that systems often fail due to incomplete design – or simply not taking local realities sufficiently into account. According to Kotler (1997) **service systems** are 'any activity or benefit that one party can offer to another that is essentially intangible and does not result in the ownership of anything'. The design object is a combination of the service concept itself, the organisational structure, and the information technology architecture (Van de Kar & Verbraeck, 2007). Focusing on only one of these is ineffective and the boundaries between these are also not clear (yet mutually interdependent). The service system framework, as described by Van Der Kar and Verbraeck (2007), was applied to develop both systems.

From research conducted during the preceding two years and contributions from the work of Muniafu (2007), it was clear that automated systems would be less likely to work from the start – rural areas such as Kgautswane and Leroro relies more on personal relationships. Locals are sceptical of new 'solutions'. People in such areas prefer to work with people that are familiar to them. Also the type of application/system can be complicated and the use of a

broker or intermediary would add an element of flexibility to the system. Therefore as part of the living labs service brokers are present. They operate at community centres and have intimate knowledge of the system as well as all the stakeholders in the area. They also serve to bridge the cultural and communication gaps that often affect research and development in these contexts.

4. CASE STUDIES

The following briefly describes two case studies where service systems were developed. Each system dealt with a particular pain point, but both systems (either directly on indirectly) also address poor accessibility/mobility.

4.1 Case study 1 - Kgautswane logistics brokering system

Kgautswane, located on the eastern edge of the Sekhukhune district, consists of a string of villages located in a valley with an approximate population of more than 100000 residents. Almost no formal/substantial economic activities are found within the valley, and main employment and service centres are located outside Kgautswane. The isolation of location creates a pressure to access facilities and services. The villages in Kgautswane are served by both bus and taxi transport services. These services mainly operate in the morning and evening peak periods when transport demand is high and more ‘predictable’. During the day however there is no certainty about the demand for transport. Surveys conducted and interactions with local groups established a real need for transport during this late morning /early afternoon period. Often people walk when transport does not arrive or alternatively return home to travel another time or another day. A review of available technologies revealed that mobile phones were used widely in these communities. The aim of the proposed service system was to address the high level of information lop-sidedness between demand and supply in the public transport market to mitigate some of the mismatch between supply and demand: Taxi operators do not know the extent of demand during the off-peak periods and end up over or under providing services. The intended logistics brokering system had to be simple to use, affordable, and based (largely) on existing ways of doing things, it had to coordinate local logistics service processes to capture and manage travel demand to cost-effectively schedule viable trips (for the service providers, namely the taxi association) within Kgautswane’s geographically dispersed settlements. During the technology review, it became apparent that mobile phones had to be the communication instrument (medium) for users. Although the Short Message Service (SMS) is a widely used data application in South Africa, it has cost implications and was <u>not seen</u> as an affordable system to use within the impoverished rural communities of Kgautswane. Several other communication options were considered including the use of human language technologies and Unstructured Supplementary Services Data (USSD). Eventually it was decided that USSD was suitable given the type of mobile phones used – it is also an established technology with several local service providers to support and assist in development. USSD allows for the transmission of information via a Global System for Mobile communications (GSM) network. In contrast to SMS, it offers real time connection during a session. USSD is a session oriented service, and can support a sequence of exchange of information (TelecomSpace, 2008). USSD messages are simple to form and easy to send. User can directly enter the USSD string and press ‘call’ to send the message. In terms of costs it is also cheaper than SMS; an SMS cost 30 cent during off-peak (75 cent during peak) on average whereas USSD cost (depending on the service provicer) 5 cent or less per session.

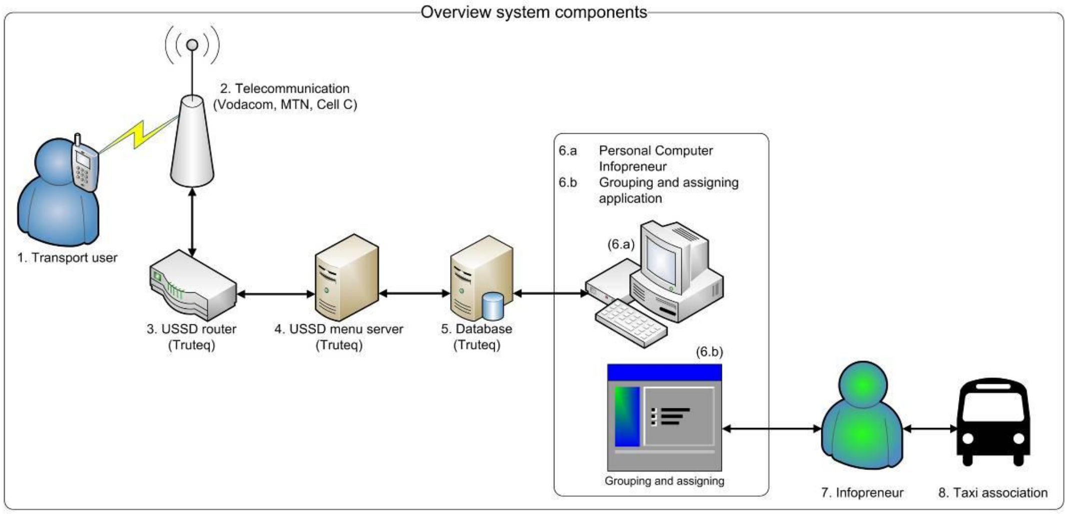

Figure 2: Technical overview of the system and it's components.

Figure 2 illustrates the components of the eventual system. The service concept as conceptualised was simple but relies on key relationships between the various stakeholders. The transport user is the main client and the need for transport originates here. Through the USSD system the user would communicate his/her need for transport using a mobile phone in advance of the trip. The information would be accessed by the service broker via a website, who would undertake the clustering and scheduling a number of days in advance of the trip. The broker would see if a trip already exists at the time and with matching destinations to that of the user. After finalising a trip the broker would send the trip document, noting trip details such as route, passengers and arrival times, to the local taxi association. The taxi association then arranges for a taxi to make that trip using their normal work procedures through the queue marshal. Return trips can also be scheduled but would often be part of the afternoon peak trip. For a trip to be viable a passenger load of five people is required – this is a measure indicated by the taxi association and has been implemented in the initial booking on the system to avoid trips for only one or two passengers. This requirement reduces empty kilometres and thus also the trip cost risk for the taxi driver. The booking cost is recovered from the booking transaction, and a portion of the USSD cost can also be used to pay the broker. The user pays the taxi driver when undertaking the trip, and is not different from the current operating process.

4.2 Case study 2 - Leroro home-based health care system

The second example deals with the health service within rural communities; unlike the developed environment where health services and after care is well institutionalised, the situation is vastly different in South Africa's rural areas. Poverty and distant health services make health care expensive and less accessible to many. The sick often remain at home rather than go to health centres due to the effort and cost involved. In this context the voluntary care by members of the local community is extremely valuable. These individuals, mostly woman volunteers known as home-based care workers, regularly visit the sick within their local areas. The site of this case is the Leroro communities, located in the Ehlanzeni district in northern Mpumalanga bordering the Blyderiver Canyon. It consists of four clustered communities each with approx 9000 inhabitants (Wouters et al., 2009). The settlements are serviced by one hospital and three clinics. Patients are normally assigned to these care workers by the local clinic or hospital, and it is then up to the care workers to monitor their progress and report back to the clinic or hospital. Due the scattered nature of settlements it is not easy for care workers to provide reports to the formal health care facilities regularly. As they are also often unemployed themselves, even sending an SMS is a cost they cannot afford. Regular trips to the health facility to hand over such information are also too costly for care workers. Researchers form the CSIR's Built Environment Unit involved with separate communities in Leroro (previously part of the Lebowa homeland) recently developed an ICT service system that care workers can use to submit the vital sign data for each assigned patient to a central site when information is collected on each patient.

Figure 3: Caregiver equipment

Caregivers were equipped with medical equipment that could enable them to collect five vital signs (i.e. Body Temperature, Body Weight, Blood Pressure, Pulse and Blood Sugar Level) – see figure 3. All equipment was carefully chosen to make the daily activities of caregivers simple and reliable. A USSD system was built to serve as a medium of information transfer between the three stakeholders involved in the system (i.e. Caregivers, Clinic Sisters and Information Officer). After measuring the vital signs from the patients, caregivers send these to the clinic via a USSD technology (see figure 4 below). The role of the information officer is to monitor information flow between caregivers and clinic sisters and manage the database of both caregivers and patients on the system.

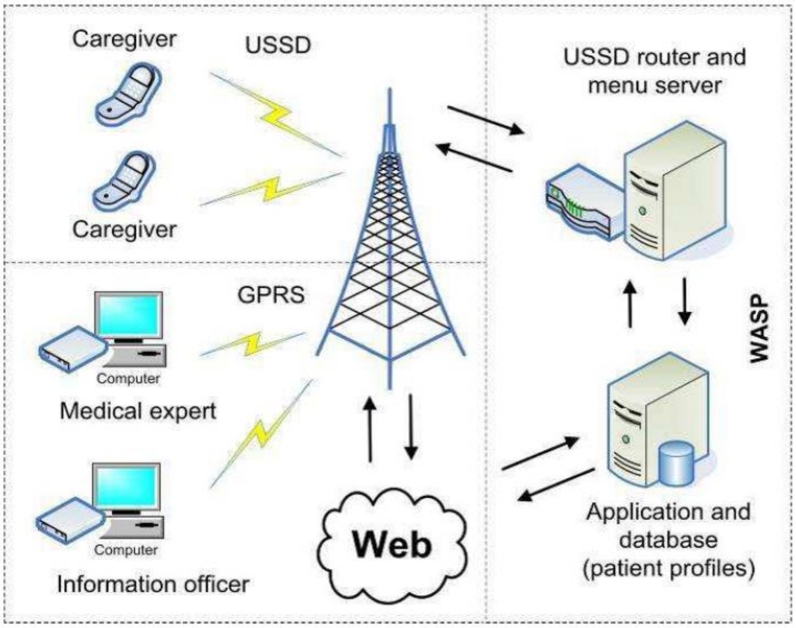

Figure 4: Technical architecture of the Home Based Care (HBC) system

Care workers trained in the basics of recording vital signs such as blood pressure, heartbeat and temperature, submit this information using a mobile phone and a standardised (USSD-based) menu system (see figure 5).

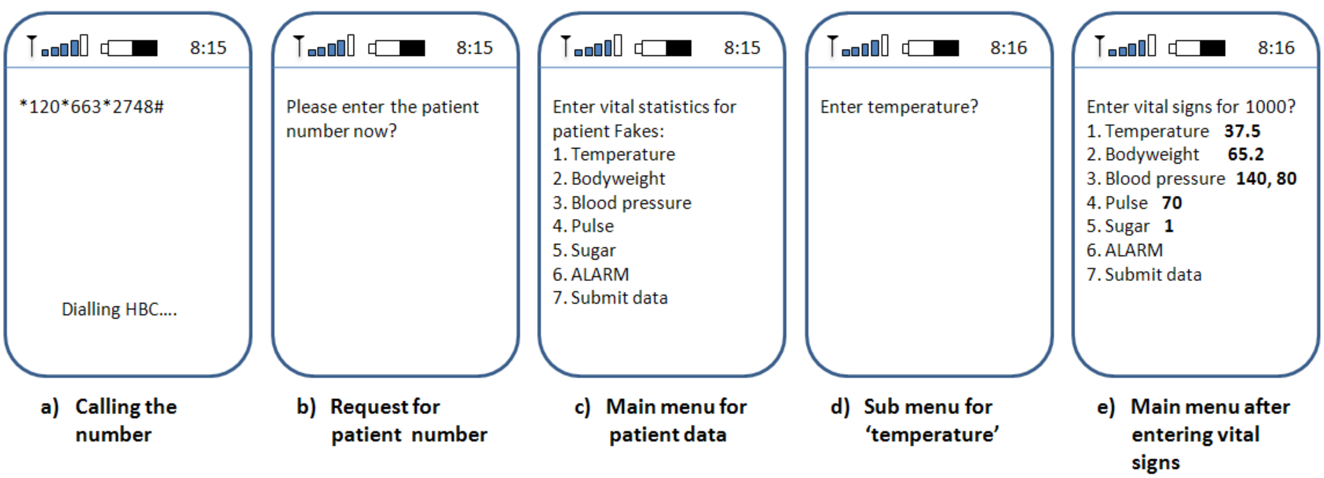

Figure 5: Some screens of the HBC USSD interface (Wouters et al., 2009)

This system significantly speeds up information collection on patients and reduces the need for care workers to physically travel to the home-based care centres or the clinics to submit this data. Care workers can, using the system, also quickly request an ambulance service in the event of an emergency. Medical professionals examine the measurements on their personal computer and are thus also more aware of the current condition of their patients and target the patients specifically that need to go to a clinic or hospital for treatment. Overall this reduces the need to travel in an already accessibility-stressed environment.

5. IMPLICATIONS FOR ACCESSIBILITY

It is not the intention of this paper to explore the details of each system but rather to focus on the potential implications for accessibility. Both systems deal with a specific reality and pain point experienced in the respective areas. It is undeniable that residents of both areas are experiencing low levels of accessibility as well as mobility constraints. The Logistics brokering system contributes to giving certainty to users on a trip and reduced the period of time spent waiting for transport. Although still in the experimental phase it is hoped that the usage of the brokering system will grow as more users are convinced of the benefits. During 2009 the University of Pretoria, in cooperation with the Institute of Rural Management in India, undertook a project to apply and model mode choice behavior in constrained rural environments. The research utilized stated preference and logit modelling techniques (explained in a paper by Venter and Venkatesh (2010) in this conference). The results indicated that an increase in trips would result through the use of a pre-booked brokering service. A brokering service would reduce the current transport captivity and improve overall access. The brokering system is currently being monitored to establish the usage and a follow-up impact study is planned for late 2010.

In 2008, a project was run in Leroro to establish the travel behavior of home-based care workers – see (Maritz, 2008). This was done though the use of GPS tracking devises carried by the Home-based care workers. This was applied as a form on simplistic travel diary where participants were not required to have a detailed travel log. Using tracking allowed researchers to establish the role travel plays in delivering home-based care services. The findings indicated that care workers spent a fair amount of time traveling (almost 3 hours per day), and mostly traveling on foot. They also had to physically travel to report on the conditions of patients. Using a service system to report the condition of patients visited enabled a more rapid and up-to-date flow of patient data. The system did not remove the need to travel but it did reduce the need to frequently travel to report on patients and to transfer medical condition information. This in itself allows care workers to spend more time with patients and saves transport costs for those activities replaced though the tele-monitoring service system.

6. CONCLUSIONS AND RECOMMENDATIONS

Rural service systems have the potential to contribute significantly to address rural pain points, but only when such systems have been developed through using a proper design process. Such a design process must preferably include the involvement of communities in solution development especially in view of the long term sustainability (continued use). Using a service system approach linked with the rural living labs approach has proven to be more effective when it comes to system development for displaced rural communities – even the smallest issues can make a difference, and through involving the users in the development process, these issues were addressed.

Rural service systems can impact on the way things are done – thus behavior of users is affected: rural logistics brokering will only work if some measure of pre-planning can take place. The weak point in these particular rural service systems is the human element: the broker must regularly process the bookings – failure to do this in time will result in the users losing faith in the system. Failure of a stakeholder such as the taxi driver to do the trip on time will also result in users losing trust in it. The testing, use and monitoring of these systems are vital to ensure that all issues are identified and addressed. Close participation of the key stakeholders is therefore crucial. There are still much too learn when it comes to service systems for rural communities, and applying a living-lab approach has proven valuable in the case of these two systems. The use of design science and service systems approaches has been valuable in identifying the pain points, understanding the operational and contextual constraints and developing suitable technical solutions (based on workable technologies).

In the absence of major improvements in transport, infrastructure or the socio-economic situation of rural residents, these service systems has the potential to overcome some accessibility and mobility constraints by avoiding unnecessary wait times, or by removing the need to travel altogether where electronic transport of information (as is the case with the home-based care system) means less trips. The experienced gained thus far through the development of these two systems has indicated that - ICT service systems could potentially contribute substantially to overcome similar problems experienced elsewhere and in applications not yet available or researched. The relevance and sustainability of such systems remains a challenge, and it is recommended that approaches discussed in this paper be considered in such ventures.

7. REFERENCES

Denning, PJ, 1997. A new social contract for research. Communications of the ACM, 40(2), pp. 132-134

Douma, F, Wells, K, Horan, TA and Krizek, KJ, 2004. ICT and travel in the twin cities metropolitan area: enacted patterns between internet use and working and shopping trips, Paper presented at the 83rd Annual Meeting of Transportation Research Board, pp. 11-15 January 2004

Fourie, L, 2007. Enhancing the livelihoods of the rural poor: The role of information and communication technologies. Pretoria: Global Image

Heeks, R, 2002. Failure, success and improvisation of information systems projects in developing countries. Report nr 11. Manchester, UK: Institute for Development Policy and Management

King, BH, 2007. Developing KaNgwane: geographies of segregation and integration in the new South Africa. The Geographical Journal, 173(1), pp. 13-25

Kotler, P, ed, 1997. Marketing management; analysis, planning, implementation and control. 9th Edn. Prentice Hall

Lynne Markus, M, Majchrzak, A and Gasser, L, 2002. A Design theory for systems that support emergent knowledge processes. MIS Quarterly, 26(3), pp. 197-212

Maritz, J, 2009. Development of a logistics brokering system for South Africa's displaced rural residents, Scientific Committee, ed. In: Proceedings - International Conference on r-ICT 2009, 17-18 June 2009 2009, Research Center for Information and Communication Technology, Institut Teknologi Bandung, pp. 300-310

Maritz, J, 2008. Using GPS data loggers to measure rural accessibility in South Africa, Scientific Committee, ed. In: Geoinformation challenges, September 8-12, 2008, University of Selisia.

Maritz, J, 2006. PhD Proposal: Impact of use of virtual communication on physical communication via changing accessibility patters in the rural developing area context (South Africa). Utrecht: Utrecht University: Faculty of Geographical Sciences

Maritz, J, Veldsan, A and De Louw, R, 2007, 2007-last update, breaking the barriers of rural development [Homepage of CSIR], [Online]. Available: www.csir.co.za (2 Dec 2009)

Morales-Gomez, D and Melesse, M, 1998. Utilizing Information and Communication Technologies for Development: The Social Dimensions. Journal of Information Technology for Development, 8 pp. 3-13

Muniafu, SM, 2007. Developing ICT-enabled services in transition countries - a studio-based approach for logistics brokering, Delft University of Technology, The Netterlands.

Oyedemi, TD, 2009. Social inequalities and the South African ICT access policy agendas. International Journal of Communication, 3 p. 151

SARF, 2008. Roads go downhill. http://www.servicepublication.co.za/index.php/breaking-news/77-roads-go-downhill edn. Cape Media Corporation

Stefik, M, 1984. The sciences of the artificial: HA Simon, second edition (The MIT Press, Cambridge, Massachusetts, 1981); 247 pages, Artificial Intelligence, 22(1), pp. 95-97

Telecomspace, 2008. Unstructured supplementary services data (USSD). [Homepage of Telecomspace], [Online]. Available: http://www.telecomspace.com (2008)

Tsichritzis, D, 1997. The dynamics of innovation. In: P.J. DENNING and R.M. METCALFE, eds, "Beyond Calculation: the next fifty years of computing". First edn. New York: Copernicus, pp. 259-265

Van De Kar, EAM and Verbraeck, A, 2007. Designing mobile service systems. Volume 2 edn. Delft University of Technology: Faculty of Technology, Policy and Management

Venter, C. & Venkatesh, A. 2010. Test and application of stated preference and mixed logit modelling techniques for travel behaviour research in a rural context. Conference paper (submitted) edn. Pretoria: SATC

Wondie, E, 2007. The role of information and communication technology in decentralized governance: The Role of Information and Communication Technology in Enhancing

Participatory Governance: The Case of Ethiopia. Municipal Development Partnership and The World Bank Institute

Wouters, B, Barjis, J, Maponya, G, Maritz, J and Mashiri, MAM, 2009. Supporting home based health care in South African rural communities using USSD technology, 15th Americas conference on Information Systems, San Francisco, California, United States of America, 6-9 August, Association for Information Systems