Designing Information Architecture

for a mobile interface

How to design and integrate information architecture into an information ecology

By Grace Selah Penuel

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Abstract

My academic background in agricultural sciences, combined with information technology and the innate desire to contribute to the improvement of the lives of people living below the poverty line in Africa, have influenced the direction of this work.

In this thesis, the problem was how to design and integrate interactive information architecture into an information ecology. This is because without integrating technology carefully into the context for which it was designed, the most frequent consequence is that it would fail to be put into use. Nardi and O'day have clearly recognised the magnitude of this problem, in working with the metaphor of information ecology and suggesting the involvement of mediators. Mediators who are keystone species can adapt the tool to fit the local circumstances for which it is designed.

Davenport and Prusak stress that information architecture that serves to guide the user to the location of information enhances the findability and usability of such information. This is because you cannot use what you cannot find.

Interestingly, new technology might create a sensational entry into the information ecology through extensive marketing, but is soon lost without being integrated due to the fact that it has not been shaped to fit the use situation. For instance, it could be too complicated for the human subjects to learn to use, too expensive for them to maintain, or could just be a poor repetition of what they already have. Moville and Rosenfeld stress the notion of a holistic information architecture which results to a solution that is workable within the information ecology given.

The methods used to find out how to design the information architecture known as ”M-MKulima” in this master thesis were interview, benchmarking, background research, a heuristic evaluation, persona, use cases, and prototype testing. The interview gathered information and data that helped establish the current information practice, barriers in the current practice, who the provider of information was and the keystone species. Benchmarking supported the adoption of good ideas that were working successfully from similar information architectures while a background research was used for a technology assessment to establish what kind of technological tools and functions could be creatively built upon. A heuristic evaluation was suitable for identification of the existing structures in the ecology in order to build on what was already working, while persona and use case methods were used to help focus design decisions around meeting user needs as best as possible and for specifying system requirements. Finally, a prototype testing was to pinpoint the weak and strong usability and information architecture features of M-Mkulima. The results enabled the weak features to be improved upon so that M-Mkulima could function more effectively, saving the cost and time of finding information.

M-Mkulima is an emergency system to help farmers manage an endemic plant disease known as Maize Streak Virus. In its integration, it was established that the agricultural officer was actually a key stone species, and thus a human mediator. In line with Nardi and O'day's explanation, and the Schema theory, this meant that he could facilitate the integration of the information architecture successfully into the ecology, because he had a specific role within the organisational environment. This role meant that he possessed some very necessary skills and resources.

Consequently, the problem formulated, which had been how to design and integrate information architecture into an ecology was answered. This was through the information architecture

development process of M-Mkulima and the identification of a mediator through whom careful integration into the ecology could be facilitated.

This work therefore supported and expanded on Nardi and O'days work, which augments the use of a mediator in integrating new technological tools into an ecology.

In order to improve the proposed concept of integration and design and get fresh perspectives, I have included formative evaluation and test of concept outcomes of qualified professionals within the agricultural sciences field as well as information technology in Kenyan and Denmark. I have also attached a research paper where ”Saidia Mtoto,” a mobile emergency system prototype whose concept was the basis for working with M-Mkulima, was reviewed and accepted by experts at the 3rd Workshop on Innovative Mobile Technology and Services for Developing Countries (IMTS-DC'10). The workshop was in conjunction with the International Conference on Computing and ICT Research. (ICCIR10), Makerere University, Kampala, Uganda.

Acknowledgements

My heartily gratitude goes to my Lord and Saviour Jesus Christ for loving me so much that He gave His own life so that I may live.(Galatians 2:20).

I am also grateful to my supervisor, Professor Ellen Christiansen, for the insightful supervision and professional support that she gave me throughout the design and writing of this thesis. A note of gratitude also goes to all others who were involved in the successful coordination of the information architecture course at Aalborg University, and to all participants in user tests during the development process of M-Mkulima.

Lastly, my gratitude goes to my husband Jan, and daughter for their understanding support as I dedicated more of my time to ensure a successful completion of this master thesis; and to my dear parents in Kenya, who have always believed in my ability and encouraged me in my educational pursuits.

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Prologue

The objective of this master thesis was to demonstrate the design of an information architecture in a given information ecology. Here I aimed to show and generalize good practice for an information architect, when confronted with the task of designing mobile applications for users in rural remote areas, characterised by low technology and low income.

A mobile phone provided a design challenge due to its size and variability in make, but suited the task maximally because it is the technology most currently used in the given design context in Kenya. The result was a prototype named M-Mkulima. M stands for mobile while “Mkulima” is a Swahili word for farmer. This unique naming and design of M-Mkulima was based on my experience from a previous project, “Saidia Mtoto,” which has been accepted in the ICCIR10 Conference and included with this report here as an attachment. It was described by the reviewing committee for the Conference as addressing a practical problem and reflecting an innovative use of the mobile phone, an ICT.(Information and Communication Technology)

Saidia Mtoto experimented with how to involve end users in the development of a mobile based information architecture. It was a health emergency system for infants. While developing it, I interviewed via telephone some parents who had lost their children at infancy, simply because they did not have access to information about what to do during an emergency. In its design process, I collected data and information from; the interview, benchmarking of a similar emergency medical system namely the Heart Defilibrator for which I had designed an Information Architecture poster in my 9th semester, and a poster with First Aid Information for infants that was designed for parents at Hvidøvre hospital in Denmark. This was because I wanted to build on ideas from similar systems that were already working successfully in Europe, instead of trying to invent a whole new emergency system for a Kenyan context.

In the study, it became apparent that the information architecture solution arrived at for Saidia Mtoto involved end users. It was also an effective and efficient solution that could possibly be integrated in the ecology for which it was designed because ”as people become more involved in their own information ecologies, they would be able to articulate more clearly and precisely what works and what doesn't, what they value, and what they need and want.” (Nardi, O'day ,1999) Consequently, they would creatively be able to adapt the ICT to meet their own needs.

Using the successful ideas developed in Saidia Mtoto as a benchmark, another similar emergency system at www.mydokta.com, and other research methodologies expounded on later in my thesis, I researched and designed M-Mkulima. One goal of the research was to find out the information practice and structures that existed in the ecology in order to build upon them carefully.

Consequently, this thesis encompasses my theoretical and practical work and depicts an indepth understanding of the four information architecture fields included in the curriculum.These fields are:

- Rhetorics
- Categorisation
- Knowledge organisation
- Information ecology

Inspiration

At the beginning of this project, I found an insightful source of inspiration by reading about the challenges experienced by a missionary who worked to introduce modern medicine amongst a once primitive tribe of Motilone Indians. See the extract below:

“Then I looked up, and my heart almost stopped. I was encircled by dark-skinned naked men, with huge bows drawn taut. Nine dots of arrowheads pointed right at me. I forgot all about my leg.”Don't shoot! Don't!” I said in Yuko, pleading also with my eyes. Their eyes, like little black chunks of coals, made no response. Their arms did not relax at their bows.(Olson, 1999), pg. 82-83

The above extract is a true account taken from the book *Bruchko.* It describes a true narrative account of a reknown Christian missionary, lying down on the ground with an arrow sticking out from his thigh, as he pleads for his dear life!

His name is Bruce Olson, and in this extract, he represents a man with modern medical knowledge of tropical medicine, and good news about the gospel of Jesus Christ. Yet he is received with the brutality similar to that given a dangerous predating animal. Why was this? This was because Olson tried to penetrate the Motilone Bari Indian ecology without considering the social setting which was already in place.

In the 60's, after several badly failed attempts, he managed to penetrate and introduce very valuable change to the society of the then deadly fierce tribe with a penchance for killing and destroying intruders with new ideas. How did he manage to do this without being beheaded like his predecessors? Look at what happened to those who tried to enter the Motilone territory before him:

"The primary contact between the Motilones and civilisation came in the form of arrows," Nieto told me. " No one had ever learned any of the Motilone language, nor had he ever been close enough to describe their physical culture. The Motilones lived in a wild jungle area on the border between Venezuela and Columbia," he said.

Only the big American oil companines seemed to be interested in the area. Everytime their employees entered Motilone territory however, they were shot at. Great numbers had been wounded by Motilone arrows; Many had been killed.(Olson, 1999)Pg. 67

In understanding this story, it is noteworthy to learn that the animousity to the oil company employees existed despite the fact that the very employees sometimes discovered the Motilones great need for modern tropical medicine. A revealing instance is when an employee had discovered more than twenty dead and deserted from an epidemic of measles. The employee had described a detailed chilling description of their rotting bodies, exposing the fact that despite their extreme animousity, these people were just humans in dire need of information and modern medicine.

Olson's work later was described as the fastest example of development that has ever occured in a primitive tribe, meaning that later he succeeded.In his autobiographical book, *Bruchko,*Olson describes his successful strategy very simply as built on two reasons: The first reason being that the Motilone Bari Indians were not asked to give up their own culture and become ”white men,” but everything introduced was based on what they already knew.

An instance is when there was a severe case of pink eye disease amongst the Indians. During that incidence, Olson did not insult the Motilone people's customs by telling them that their witchdoctor's methods of administering portions and singing incantations to her god, in hope that the god would drive away the evil spirits from her people, were primitive and not working. Instead he did something very wise. He discovered the existing curing structure and gave the witchdoctor responsible for curing the people a tube of terramycin, an antibiotic that is effective against that bacterial eye infection. This empowered the witchdoctor and increased her status as an effective

healer, while allowing Olson to introduce modern medicine. The existence of the curing system among the Motilones depended on the witchdoctor, who could be identified as a keystone species for that ecology.

During the outbreak of a deadly disease, which the witchdoctor attributed to evil spirits visiting evil on the people because of their rebellion, Olson took a sample of dirt and human excrement that littered the front doors of the Motilone homes. His goal was to perform an experiment under a microscope in order to let the witchdoctor see the "evil spirits" (bacteria) dancing under the microscope before the disinfectant was applied. He then asked her to apply disinfectant and see the ”evil” spirits dead. With conviction that the Olson's portion (disinfectant) had killed evil spirits that caused disease and death, the witchdoctor was able to accept and introduce sanitational methods. Consequently vaccination against preventable diseases like measles was integrated into the Motilone curing system.

The people quickly accepted the new health changes in their existing curing system. They knew the witchdoctor well and trusted her working methods. Consequently, valuable changes in medicine were accepted and spread quickly amongst the tribe, while her stature increased because she was seen to have good portions and very effective healing methods.

This method of using the witchdoctor as an important mediator eliminated unnecessary competition between the missionary Olson, and the indian woman witchdoctor. Following this successful integration of medicine, she acted as a very safe avenue for introducing other health measures. (Olson, 1995), Pg 124-129

Olson factfully describes the second reason for his successful strategy as the Holy Spirit, with whom the community became baptised when they accepted Jesus Christ as a personal Saviour and Lord. Olson stresses that without the Holy Spirit; there would have been no real or lasting development because the people were naturally egoistic and uncaring even to members of their own community.

He describes instances of extreme egoism where a starving family would not benefit from the excess food of the next door neighbours. Instead the food would be thrown away and wasted. A sick neighbour's animal would be left to die, as everyone went about their duties without caring about the starving animal. Yet after conversion, their hearts changed and softened such that they were no longer egoistic, but developing constantly in godly love towards Jesus and their neighbours.

I noticed a guiding pattern that Bruce Olson used to successfully introduce modern medicine to the Motilone Bari Indians. I have outlined this inspiring pattern in Figure 01. As I designed and integrated M-Mkulima, there were challenging instances where I shifted focus from trying to figure out how to proceed in the course's stipulated theory, to drawing inspiration from a real life, action packed account of how Olson did it. The results were very fruitful as demonstrated here.

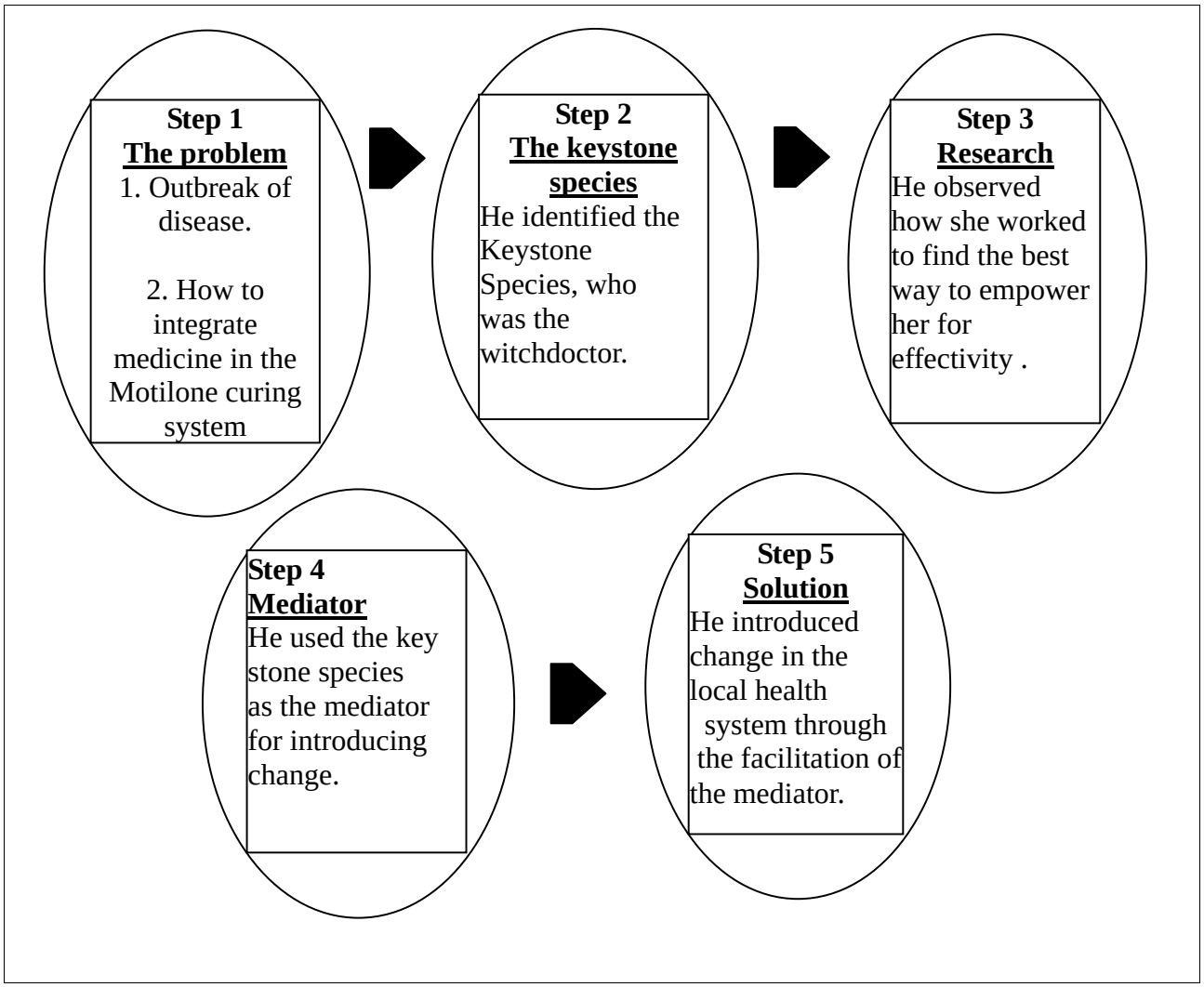

Figure 01: The steps that took Olson took from the problem to the solution

My role's similarity to Olson's role

Unlike Bruce Olson, I was not"handing medical vaccinations to the witchdoctors whom "the people trust," but was working within the ethical boundaries of an information architect.

My role was similar to Bruce Olson because in the ecology of my design, I represented an information architect and an agricultural professional working strategically to integrate change from a distance more than 4000 miles away. The fact that I hold a Bachelor of Science degree in agriculture from Nairobi university in Kenya, did not mean that I could anyhowly design and dump new technology in the Kenyan agricultural market! I have lived abroad for more than 9 years, and things did not remain static in my absence. Therefore just like Olson, I had to take a careful consideration of the local circumstances by finding the current existing structures in the given ecology.

The success of Olson's strategy in introducing structural changes in agriculture, medicine, spiritual matters, education and various other sectors, unlike in the beginning where he met strong resistance, is best captured in the next paragraph:

"Over a period of time, she (the witchdoctor) introduced disinfectants into the normal ceremonies of the Motilones. For instance, there was a cleansing ceremony when a new communal home was built. All the Motilones who are going to live in that home gather sing chants and strike the walls with sticks to make any evil spirits leave. At my suggestion, the witchdoctor had them use disinfectants with the ceremony, and people noticed that health measurably improved. She also had the midwives use disinfectants when mothers gave birth, and the mortality rate declined."(Olson, 1999) p. 128

A contribution to the millennium goals

My research work in this thesis, is also an information architecture contribution to the concerted efforts by the Food and Agricultural Organisation to fight hunger and poverty in developing nations like Kenya.

Combating hunger and poverty is part of the millenial goals of the Food and Agricultural Organisation, as described in a document called the Eradication of poverty and hunger (ERP). It was jointly produced by FAO, the International Fund for Agricultural Development (IFAD) and the World Food Programme (WFP) and circulated at a world summit meeting. [1]In the document is detailed some concise evidence of how hunger impedes effectively the efforts by individuals and societies to exit out of poverty. It affects negatively peoples' health, their ability to do productive work and learning capacity.

Knowledge of the detrimental impact of hunger and the essential role of agricultural growth in fighting hunger and poverty constituted the basis of a "twin-track approach to poverty and hunger reduction."What does this approach detail? The strategy simply advocates enhanced access to food through various approved methods. Investment in development, particularly in support of agriculture and rural development is one of them. In the ERP document is evidenced that, investment in agriculture and rural development is a powerful means for reducing poverty and hunger. This is due to the fact that the vast majority of poor and hungry people live in rural areas, and practice small hold agriculture as a means of livelihood. Consequently, growth in small holder agriculture turns out to be the most important engine for the creation of employment and incomes for the poor.

In general, 70% of the poor live in rural areas of developing countries. They also depend on agriculture for their livelihood, either directly or indirectly. This fact explains why M-Mkulima, is designed to improve agriculture for a target group in a rural area of Kenya. (http://www.fao.org/newsroom/en/news/2008/1000923/) 24.2.10

The Kenyan government has also coupled its vision of reducing hunger and poverty to the millennium goals. It has implemented various agricultural projects to support the vision[2]. A screen shot of the government vision statement reflects this goal very clearly.(Figure 02)

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1 The ERP document is available at: http://www.fao.org/docrep/008/a0056e/a0056e00.htm

2 "The Njaa Marufuku Kenya (NMK) programme was started in 2005 by Agriculture Sector Ministries with support from FAO and the MDG center, to provide an overall strategic framework for a 10-year action plan for hunger eradication in Kenya. It was formulated to fast track the fulfillment of MDG 1 – reduce by half the number of extremely poor and hungry people in the country by the year 2015. The Ministry of Agriculture is the focal point in NMK implementation."

http://www.kilimo.go.ke/index.php

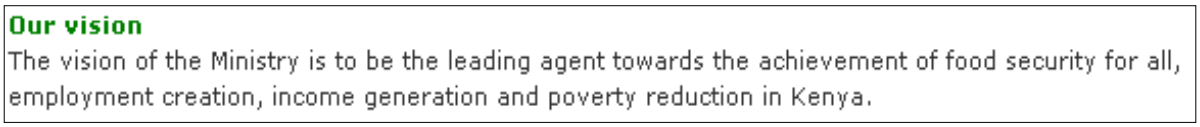


Figure 02: A screen shot of the Kenyan government's vision.

Section 1: Introduction

1.1 Research output and economic growth

Kenya's research output was ranked sixth in Africa behind South Africa, Egypt, Nigeria, Tunisia, and Algeria. This was very significant because research output was directly linked to economic development, meaning that the first four countries also lead in Gross Domestic Product. What does this mean for the Kenyan government? It means that if it wants increased economic growth, then it must pursue a marked increase in research output!

The Global Research Report from Thomson Reuters released a report in april 2010 indicating that although Kenya was among the leaders in research, it only produced 6,500 papers compared to South Africa's 47,000 between 1999 and 2008. Egypt and Nigeria generated 30,000 and 10,000 papers respectively.

The report further stated that the whole of Africa produces an average 27,000 papers per year. This is shockingly the same output produced by the Netherlands alone and calls for a reaction! How would it not call for a reaction, knowing that no country wants to stagnate economically?

In the study, it was reported that countries in the north of Africa, also located in the region most economically progressive in the continent, actually had the highest output of reasearch papers in recent years. Even though this region has only six countries, it had more than 10,500 in 2008. (http://www.nation.co.ke/News/Kenya%20lags%20in%20research%20papers%20/-/1056/898966/-/5kc7lgz/-/index.html) 5.07.2010

There is clear evidence that the Kenyan government must prioritise research. As if to stress the need to accelerate economic growth, the March 2010 Short Rains Assessment issued by the World Food Program estimates that 1.6 million people in Kenya are still in need of food assistance. In this group are pastoralists, agro-pastoralists and the target group for M-Mkulima who are people in marginal agricultural areas.[3]

To increase research output, Kenya can harness more of the research potential in its diaspora. Who are the diaspora? The African Union defined the African diaspora as "[consisting] of people of African origin living outside the continent, irrespective of their citizenship and nationality and who are willing to contribute to the development of the continent and the building of the African Union." The union has a constitutive act. In it is a declaration that it shall "invite and encourage the full participation of the African Diaspora as an important part of our continent, in the building of the African Union."(http://en.wikipedia.org/wiki/African_diaspora) 6.7.2010

Why is this focus on the diaspora important? Kenya has many highly qualified professionals who have settled in the diaspora category for various reasons, including joblessness at home. This

3 Kenya is a low-income food-deficit country with a GDP per capita of around US$1,240 (2007 World Bank). The 2007 UNDP Human Development Report ranked Kenya among the "medium human development" countries of the world, placing it 148th out of 177 countries.The Human Development Index combines three basic aspects of human development: health, knowledge, and standard of living. (http://www.wfp.org/countries/kenya) 28.07.2010

challenge facing Kenya is not unique. China, India, and South Africa, also developing countries, have creatively initiated new approaches to tap into the expertise and other valuable resources of their respective Diasporas in order to meet development goals and progress towards competition at the global level. Instead of despairing and bemoaning the brain drain, they have embraced brain exchange, thus leading the way in finding a viable solution to the once serious problem. (http://www.migrationinformation.org/feature/display.cfm?ID=150)5.07.2010

There are many advantages of exploiting the Diaspora for a country in dire need of accelerated economic growth like Kenya. A research carried out in the United States of America outlined some major advantages as:

a) International partnerships: Immigrants often do not severe all ties with their countries of origin. Those who left home, with an academic background, communicate with their families and relatives due to the considerably low cost of communication and the advanced ICTs in the developed world. They also have contact with their former colleagues at work and in the academic institutions they attended. They are thus well positioned to build strong international working partnerships. These international partnerships can be used by the Kenyan government to foster research, which accelerates economic development.

In addition to building personal and professional relationships with their home country, the Kenyans in the Diaspora foster similar relationships in the countries where they have migrated to, thus opening further avenues for international working partnerships. This is through exchange and bringing together of potential working partners from both places. This partnership leads to increased research activities that foster economic growth, and knowledge sharing.

b) Better understanding of the home environment: The Diaspora have a better understanding of the cultural, linguistic, political, educational and ecological contexts that exists in their countries of origin. As a result, Kenyan Diaspora can act as very valuable bridge builders, or mediators of research between countries where they live and their home country. These augers well for research partnerships and economic development for all involved.

c) Committed advocates for research: Many Kenyans in the Diaspora often know the details of information and other serious economic needs at home. This propels them to be morally committed advocates for research and collaboration in projects that promote development in both countries. Besides, policy makers and potential scientific collaborators often trust a person that shares their culture. Why do they? Since these collaborations involve negotiations, and communication, different cultural norms can influence conversational volume and intensity. An Arab raising his voice, repeating points and even pounding the table, thinks he is being sincere, while a westerner overhearing such a conversation thinks that the Arab is arguing. The beckoning “come here” palm gesture used in Kenya can signal “go away” to most North Americans. These inaccurate decoding can create intercultural misunderstanding and strife, thus spoiling chances of research collaboration. (Ting-Toomey, 1999) p. 123-126

I am a Diaspora academic from Kenyan who wants my research work to be valuable to my people in rural remote villages of Kenya and eventually other African countries. Consequently, throughout the 7, 8, 9th and 10th semesters, I purposely chose projects that would enable me to interact with users in these contexts. These are users located in contexts that are often characterised by low technology, low income and other special design and communication hurdles. Consequently, in this thesis, I have focused on the appropriation of technology to these environments.

In order to add value to the human lives involved in the technological development, my work processes involved gathering data as a Diaspora information architect located more than 4000 miles away. From planning and conducting interviews with young sincere and bereaved mothers that had lost their infants at birth, to emailing over 10 agricultural officers who seemed too busy to have time

for email and mobile telephone interviews. The unanswered emails and telephone to agricultural officers in Kenya demonstrate some of the challenges involved in working more than 4000 miles away from the target users and context. Yet there was a sure way to get things done. I am delighted at the prospect of continuing to do valuable research work amongst such vulnerable user groups.

1.2. The overall learning goals of the information architecture course

My main sources of theoretical background here were Nardi and O'day's Information Ecologies-Using technology with the Heart, Davenport and Prusak's work in the book Information Ecology and Moville and Rosenfeld's book, Information Architecture for the World Wide Web. These works were part of the study material in this course, and provided a detailed and rich background of theory for the topic I chose as will be seen throughout this work.

The overall learning goals for the course were demonstrations of my competence in various areas of Information Architecture. I am confident that these goals have successfully been met through this thesis work. Categorization and classification was one of the intellectual goals for the course. This gave me a challenge in the information architecture development process of M-Mkulima, where I had to design and facilitate the navigation and finding of information. An example is the global navigation for M-Mkulima where I have used categories like “information” to group content about diseases. Besides, an observation of ethical guidelines while categorising information was paramount because terminology can have political or destructive communicative consequences.

I had to facilitate intercultural communication at both professional and non professional levels. This was through the involvement of end users who were a low technology, non professional target group in Kenya, and the stakeholders at different levels with different technological, cultural and professional backgrounds. A professional researcher from Kenya could for instance understand what an “ecology” means, but a semi-literate rural farmer using technology in a village in Siaya could not. Here I had to creatively use language that could be understood.

My work involved practical reflections aimed at improving processes and products. While this was necessary, practical competence goals were also an essential part of this thesis in order to meet the requirements stipulated in the study regulations. The design process of M-Mkulima involved the practical application of knowledge acquired during throughout the course, which had a user driven innovation focus. This implied that I had to design M-Mkulima with the end user in mind. Consequently, its main design goal was to solve problems experienced by the end users in the current information practice.

The end users were part of a culture with its own values. Knowledge about cultural sensitivity and project management was applicable in my work of finding how to integrate the designed M-Mkulima in the Siaya ecology. This meant that I had to carefully consider the cultural implications of decisions made. Many of the local semi-literate people in the Siaya ecology speak Luo for instance. Luo is a language with its own cultural values that impacted the design and integration decisions. These decisions became an integral part of a project management that involved planning, working and executing the goals of my work.

Knowledge of project management guidelines in the design of culturally sensitive multimediated information architecture was vital in my work, because it involved interviewing users gathering data, enlisting the support of test users in the agricultural universities of Denmark, planning multimediated test of concept presentations and creating design strategies amongst others.

Evaluation and benchmarking were part of my research tools and methodologies for making important decisions about the content, context and users of M-Mkulima. There were ideas that were already working in similar emergency systems, and these could be adopted, instead of inventing new ones that cost more time and money.

I developed communication strategies for M-Mkulima, based on the design's ecological context. By asking questions like, whether the information distribution method should be push or pull, I was able to provide answers within the work process of M-Mkulima, by including both push and pull methods to meet user needs.

My competence in conceptualising the design of interactive information architecture within the relevant information ecology has been demonstrated, whereby I have placed an emphasis on information practice and interaction design. This is due to the nature of the case I worked with, that ethically built upon similar cases where the designed product could not be integrated successfully in the ecology. They could not be integrated because in my earnest quest to help meet user needs, I had overseen the appropriation process of the new technology in the context of use.

The work I present here is a concept of interactive information architecture on a mobile interface. Where as information architecture means defining information structures to answer the user's question of how to find the information they need, interaction design defines the behaviour of a system to answer the question "how does the user perform the action they want?."

My conceptual design has three main components. The human computer interface, where interaction between the end user and the mobile interface take place, the digital resource, which is the actual information structure facilitating support of content and information finding and the technological requirements (ICTs) for implementing M-Mkulima. Technological requirements means the implementation solutions and technologies used in the design of M-Mkulima. This concept is illustrated in Figure 1.

Interaction, information architecture and ICTs

There is a relation between the human computer interaction, information architecture and information and communications technologies.

The human computer interface: This depicts interaction between the computer or mobile interface and the user. The user interacts with the interface to either pull information or push information in M-Mkulima, thus meeting their needs and goals.

The digital resources: M-Mkulima should ideally provide informational content and support services in the form of learning objects. These are resources usually digital and web based that used and can be reused to enhance and support the learning process, e.g. learning modules conveyed through a convenient information architecture, informing about disease, symptoms, prevention etc.

Technologies (ICTs): These are the technological solutions like the database management system, Web 2.0, which are used to create the information architecture of M-Mkulima to enable access and use of information.

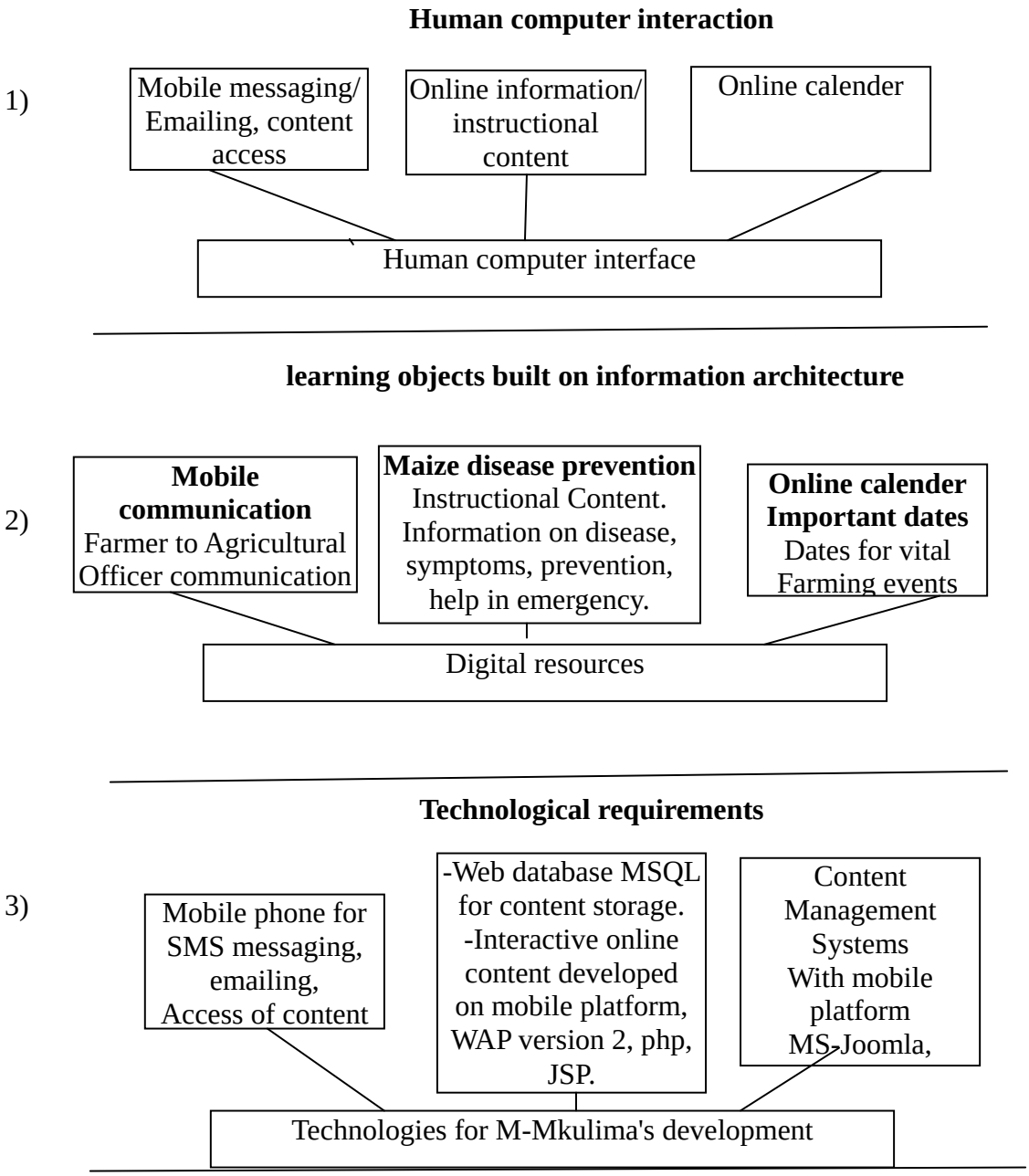


Figure 1: Conceptual design framework for M-Mkulima

In this thesis, section one begins with a brief explanation of what to expect in the seven major sections. It includes a presentation of the concept, how my work meets the study goals, the definitions of information architecture, and information ecology. Section two consists of the problem formulation, where the problem statement is drawn from a generalisation of the fact that integration of technology is a problem faced by designers of technological tools.

Section three consists of the relevant literature reviewed, the information architecture development process, user tests and reflections made during the design process. In the fourth section is the concept of design, the practical integration of technology in the given ecology, the results a formative evaluation of the concept and my reflection.

Section five underscores the advantages of appropriating technology through a mediator. Section six underpins the general relevance of this research experience to Information Architects working in similar situations and how it supports and expands on Nardi and O'day's research work, while section seven is a summary and conclusion of the work.

1.3. What is information architecture?

Information architecture, in this thesis is defined as the structural design of information spaces in a manner that supports completion of tasks by users and facilitates the use of perceptive insight to access the content. [4]The definition sets in focus two man areas which are the completion of tasks by users and intuitive access to content.

An illustrative example drawn from daily life is a building. The door represents the entrance point. What if there was no visible door and you could hear laughter and happy human voices inside, could you insightfully perceive that the door is on the roof? Through practice, we all know that doors are not located on the roofs of buildings; therefore the most likely intuitive reaction would be to keep going round and round the building looking for the door. This could be until you give up ever finding it, or somebody pears through the window and tells you that the door is on the roof. By that time you would be frustrated, wondering how strange this building with a door on the roof is built and how to get to that entrance.

The architecture of a building is designed to enable intuitive access to the rooms inside. In the same way, the architecture of information must be designed to support content finding.

Moville and Rosenfeld further define information architecture as the art and science of shaping information products and experiences to support usability and findability. (Moville and Rosenfeld, 2006) p. 4. This definition was also very relevant to the design of M-Mkulima in this project because if the product is difficult to use, the end users will have a good excuse to reject it. The product will then have failed inspite of having consumed reasonable time and money during the information architectecture development process.

A major usability website gives some of the main characteristics of usability that are considered during the design of M-Mkulima.(http://www.webnauts.net/usability.html) 3.05.2010. It should be quick and easy to learn, efficient to use, allows rapid recovery from errors and easy to remember

Information architecture design does not take place in an isolated space on the moon. Users, who are part of a social setting, are involved. These are the human subjects that use technological tools to communicate and complete tasks. Every social setting is information ecology. It is structured by some information architecture. Architectural changes in the social setting are systemic. When one element is changed, the effects ripple like waves through out the system. (Nardi, O'day, 1999)p. 51.This means that changing the information architecture, will change the information ecology and consequently have an overall impact on the social setting.

Consequently, technology must be carefully integrated into the existing habits and information practices according to the values of the information ecology. Values are the core that regulates the functions of an ecology. Therefore, with the design of M-Mkulima, I had to not only deal with the information architecture development, but also the social setting and the information ecology. What then, is information ecology? See the next sub-heading for a definition of this terminology.

1.4. Information Ecology

The term ecology in information architecture is derived from the use of the same word in a biological environment. This is because the word ecology conotates key characteristics that must be considered where technology is used. In nature, ecology refers to the study of the interdependence between plants and animals in a physical environment. It is a sub-discipline of Biology that focuses

4 This definition is found at http://www.informationsarkitektur.aau.dk/

on the study of life.

The term ecology when used in conjunction with information focuses on human activities within a given context. Information ecology is thus defined as “a system of people, practices, values and technologies in a particular local environment.” (Nardi, O'day, 2000) p.49. The focus is on the human subjects and how they use technology, than on the technology itself.

Davenport and Prusak use an illustration to paint the broader picture of information ecology. This is because every information ecology is rooted within a broader ecological environment. Thus successful integration and broader planning for large scale integration requires knowledge of the different elements of the interconnected web of the broader environment, because changes in one environment can affect all the 3 ecological environments. (Davenport, Prusak1997)p. 40

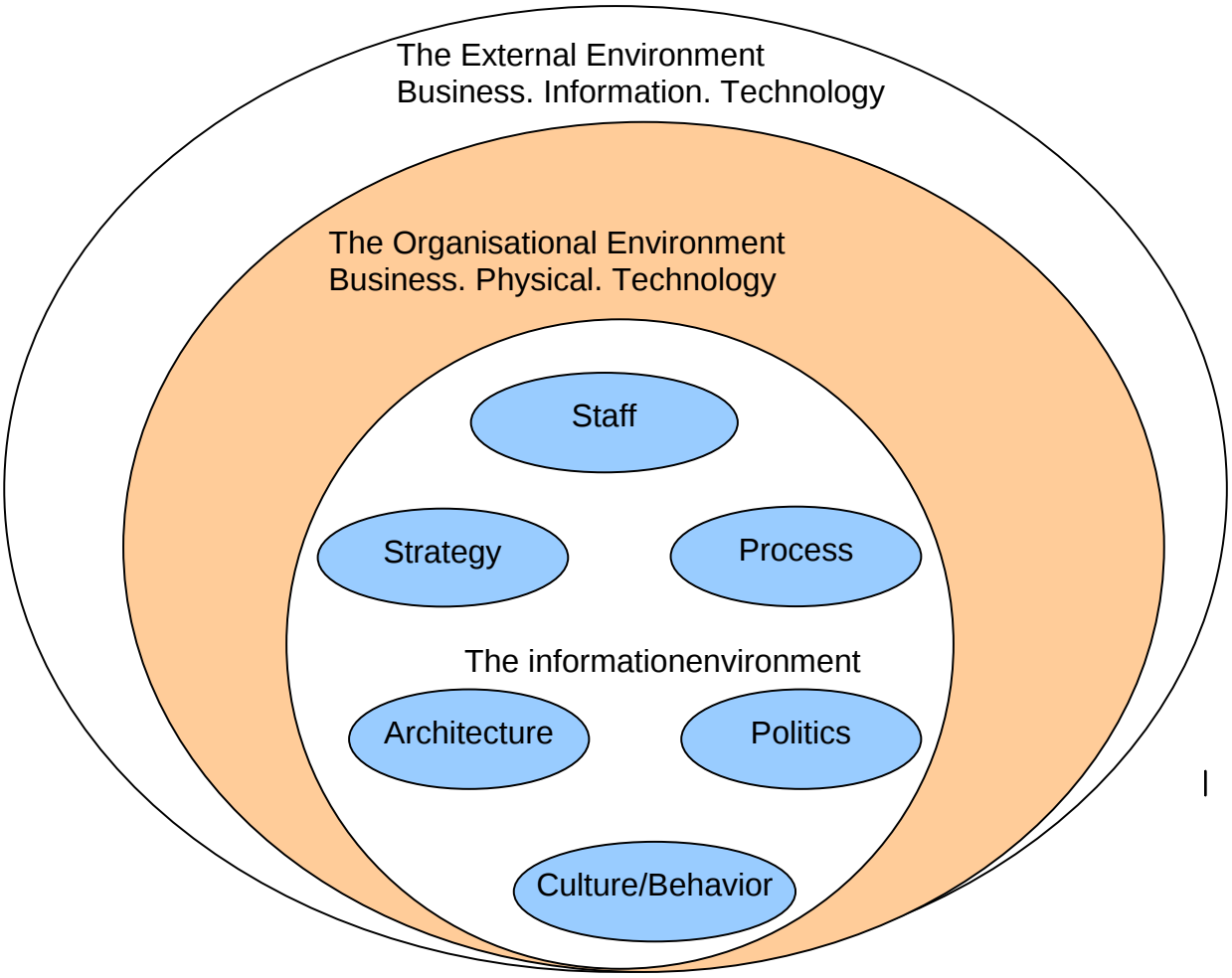


Figure 1.1: The three ecological environments of an information ecology

An information ecology has special characteristics. Knowing these characteristics is important when trying to integrate new technology into the social setting. An example is when a building architect repairing a storey house knows that each repair he makes on the foundation of one storey, must be compartible with the whole building and ecological environment. Otherwise a storey house repaired with sand would collapse in a storm!

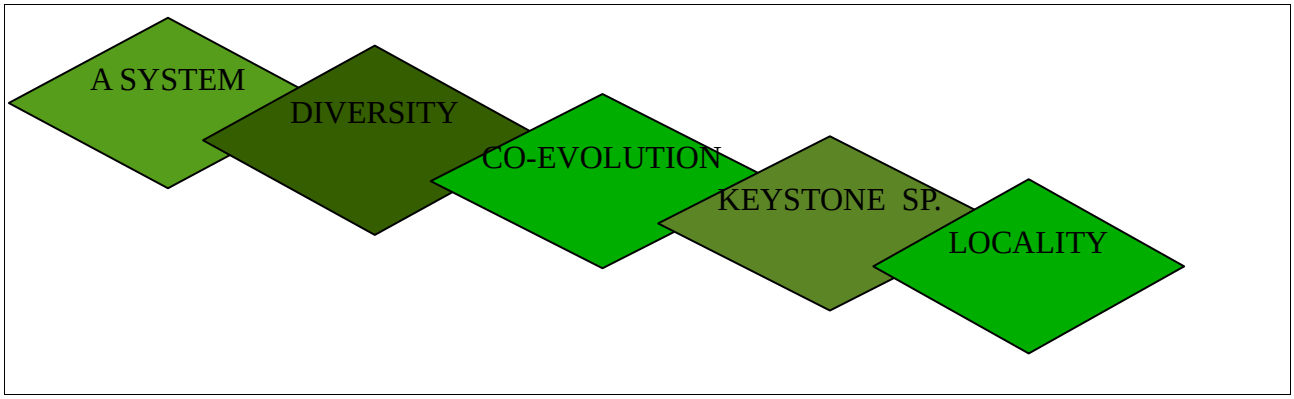


Figure 2: The 5 Characteristics of an Information Ecology

These 5 characteristics as argued by Nardi and O'day are:

a) It's a system
As a system, its different parts though as different as sunlight, whales and salt-water in a marine ecology, interrelate and depend on each other. This means that local changes can disappear without a trace, if they are not compatible with the rest of the system. In a system, change in the structure has a ripple effect, in that its effect can be felt through out the whole system.

b) Diversity
In a biological ecology, different species complement each other, each with their distinguishing roles and functions. Diversity exists in information ecology as expressed through different kinds of people, with different kinds of tools working together in a complimentary relation to meet goals and needs. (Nardi, O'day, 2000).

c) Co-evolution
Co-evolution is the process through which a natural environment offers many toe holds for life of various forms. (Nardi, O'day, 2000) p. 52. This is important for its continual existence. On the Lake Victoria, the water Hyacinth has been an ecological problem. Due to this aquatic weed's ability to spread rapidly and colonise hitherto uninfested areas, its populations may expand rapidly over a short time disrupting the whole ecological environment. Its expansion is so fast that it chokes the other aquatic plants.

In information ecology, people and tools evolve continuously in an attempt to have a perfect fit. This means that people learn new ways of using tools, adapt to and create new technology in order to evolve interdependently. Even when the evolution of tools are static, the human subjects evolve in creativity and skills thus finding new ways to use tools and shape them to their information practice.

d) Keystone species
In the biological environment, a keystone species is a species that is identified to have a major influence on the structure of a particular ecosystem. The very fact that it is present, impacts many other members of the ecosystem. If its population reduces or totally disappears, there can be far-reaching or even deadly consequences for the ecosystem. Yet, how do biological ecologists identify the key stone species in an ecosystem?

Many ecologists agree that there is no single stable method by which a keystone species in a biological environment can be identified. An important pattern that emerged from several studies

showed that the concept of a keystone species depends on the context[5]. A key stone species in one context may not be the same in a different context. These contexts constitute ecosystems, which is defined as a community composed of organisms. People are part of ecosystems. The ecosystem acts as a resource of services that support the health and wellbeing of human populations.

In a healthy ecosystem are four kinds of keystone species based on their functional role as key stones. (http://www.conservation.co.nz/upload/documents/science-and-technical/sfc203.pdf) 21.04.2010

- **Organisms controlling potential dominants:** The functional role of such organisms is to keep check or control the population of a potentially dominating species. Through its role, it promotes co-existence by reducing competition amongst other species for the limited space.
- **Mutualists:** Mutualism depicts a situation where two species are mutually dependent. As a result, the elimination of one will result in the death of the other.
- **Resource providers:** These species provides vital resources to other organisms in a time of scarcity. By this provision, they bridge a major gap in supplies. The organisms that depend on it for survival in a given ecology cannot survive if it is eliminated.
- **Ecosystem engineers:** These species modify the physical environment in a way that releases resources for other organisms. They often disturb the physical habitat exposing and providing new habitats that would otherwise not be available.

e) Locality

Only the participants of an information ecology can establish the identity and place of the technologies that are found there. (Nardi and O'day, 2000) p.53. The name given that technology only means something to the human beings who put it to use. An example is when Saidia Mtoto is mentioned, a person residing in an ecological context located in Australia will not know what it means, but one in Kenya who uses the technology knows exactly what it means.

How can this characteristic be expounded on in this thesis? Consider the mobile phone as the ICT tool on whose interface the interactive design proceeds.

i) It has a local place and identity

The mobile phone has a place and identity in the ecology under study. Kenya has seen impressive growth in mobile phone ownership in a short span of time. In the year 2000, there were just 200,000 users. This number has sky-rocketed to more than 17.5 million people with mobile phones currently, out of a population of 38.5 million. This growth can partly be attributed to tariffs by mobile operators like Safaricom, which give many Kenyans the opportunity to select the most convenient operator depending on one’s requirement. It is no wonder that this acquired place and identity for the technology makes it the choice technology for this thesis. (http://www.nowpublic.com/tech-biz/kenyan-mobile-phone-innovations) 21.04.2010.

ii) The infrastructure supports its widespread use

The infrastructure enables mobile networks to be used in very remote areas, even where there is no electricity for computer based internet services. The Siaya ecology, where this research study is taking place has no electricity supply. Only about 1.3 million of Kenya's 37 million people are connected to the national electrical grid according to a spokesman for Kenya Power and Lighting Company. Yet the introduction of the solar phone, which uses solar energy, now makes it even

5 This links shows more information on keystone species in a biological environment. http://www.doc.govt.nz/upload/documents/science-and-technical/SFC203.pdf

easier for mobile phones to be used in very remote and infrastructurally underdeveloped areas. See figure 2.1.

Figure 2.1: A solar cell phone (http://edition.cnn.com/2009/TECH/08/21/solar.cellphone/index.html) 21.04.2010)

I have defined two important key words in this thesis. These are information ecology, and information architecture. Next, I intend to discuss the general problem of integrating technology into an information ecology, and use the specifics of some information architecture cases that I worked with for the purpose of arriving at a suitable problem formulation.

Section 2: Problem formulation

2.1 A general problem of integrating Information Architecture into an information ecology

A problem arises when the functional and successfully designed information architecture is introduced to a social setting, without regard to the core values. Every information ecology has values, policies as well as tools and human activities that should fit together. They are refered to as the core values, and a system that fails to uphold these core values of the people involved is prone to be subject to enomous unwaranted stress.

In real life, a stranger does not just arrive in a certain family's home and decide that he wants to live there without a name, a history, a role and regard for the family's values! There are certain values, rules and roles that govern human behaviour in such situations. Roles, which we basically draw reference to in social relations, make it possible for man to navigate in society.(Bekkers, Homburg,2005) p. 108

Working without an understanding of the core values of the ecological environment is a general problem in the need based consumer market, where technology designers overcrowd the market place with as many new ideas and tools as possible. They do this in the hope that the best will survive, and the rest will die out in a natural selection process. Does this always auger well for integration of new functional technology?(Davenport, Prusak, 1997), p. 32

My cases given in subheadings 2.2, 2.3, and 2.4 show that information architects sometimes try to apply their creativity to design new technology, that effectively meets end user needs without researching the existing ecological environment. This kind of research would find current

information practises and if something can be learnt from them or if they could be built upon. It would also locate, for instance categories and knowledge organisation structures that could be built upon.

2.2. Case one: Saidia Mtoto

”At the onset of the design, it was clear that there were real user needs. An information architecture product known as”Saidia Mtoto” was designed and tested using personas in possible scenerios, and a user task analysis. The results showed that these needs were met. The problem that remained unsolved was how to integrate the product into the ecology.”

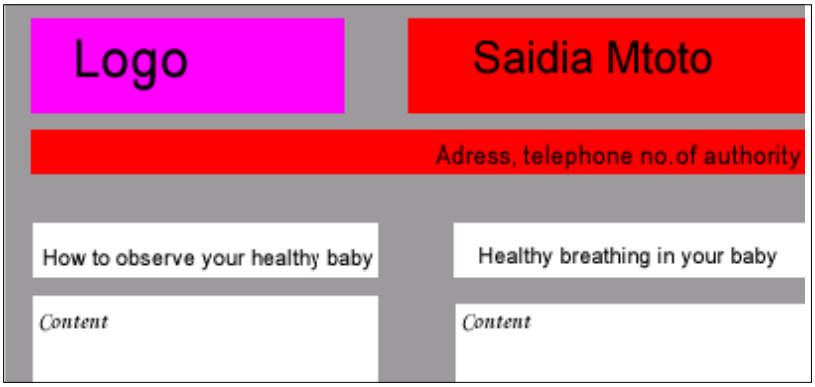
Saidia Mtoto is an information architecture prototype that I designed in my 9th semester work. The framework for design was the”Schema theory,” which consists of 3 beliefs that affect learning acceptance of new technology. These are that; there is logic and order to individual structures known as schema, the associative nature of the human mind connecting schema to other schema in the learning and recognition process, and the networking nature of the mind that draws information out of one schema to interprete another. (Norman, 2002)p. 115-116

I developed it as a response to real information needs amongst end users, and was to be used in emergency situations in low income target groups in Kenya. These end users were mothers who had lost their newborn infants due to inaccessibility to information on how to handle emergencies of a medical nature.

Losing one's infant through death sudden death is tragic, and any human being in a position to help prevent such a tragedy from recurring would want to help. Consequently, empathy was also a strong propelling force in my decision to design a possible solution to help such mothers.

The two strategical questions asked at the beginning of the design in order to guide the communicative consequences of the finished product were answered. These two questions had been, what major user problem the information architecture designed helped solve and how the design involved the end users.

The major user problem solved was the provision of a bridge that helped mothers access and find information that could be used before an emergency occurred, and also during an emergency. See the organisation of the Information Architecture in Table I that follows.

User information needs and goals	**Features on Saidia Mtoto to meet user information needs**
Before an emergency occured, end users needed to continue learning and be empowered with information on what to do. They could find this information on Saidia Mtoto.	

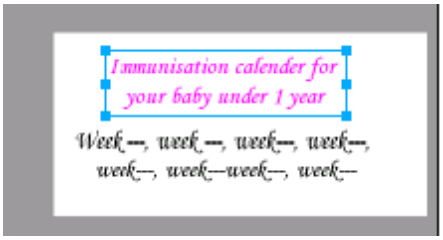
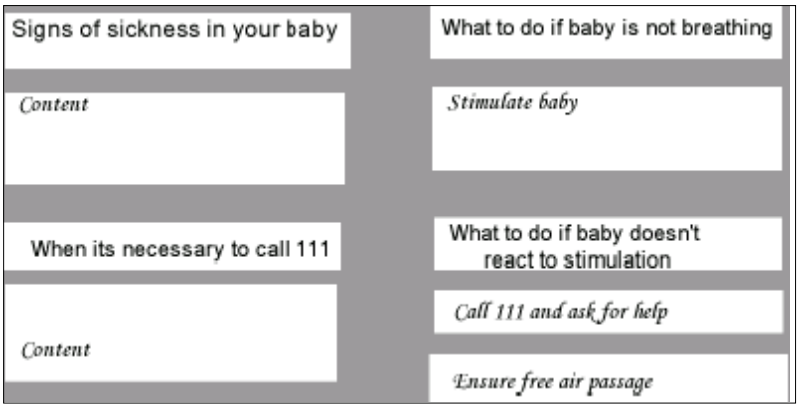
Users needed to continue learning.A calender on Saidia Mtoto ensured that they kept returning to check important dates on Saidia Mtoto. Consequently, they could continue using the information poster and learn from it.	
During an emergency, the end users needed to find information on what to do to help save their helpless infant's lives. Saidia Mtoto met this information needs effectively by linking users to specific information under each label.	

Table I: How Saidia Mtoto's met user needs.

The successful design of Saidia Mtoto meant that the end users would now know what to do during an emergency, instead of watching their babies die because of lack of information.

End users were also well involved in the design process. The data obtained from interviewing them helped determine the folowing:

- **The name of the Information architecture:** Saidia Mtoto meant help a child, which 50% of the end users found easier to remember in comparison to two other names.
- **The emergency telephone number to call:** 75% of the respondents found 111 easiest to recall. This was chosen as the possible free toll number for the emergency system.
- **The image to be put on the poster with instructions about how to use the system:** In comparison to the image of a doctor with stethoscopes, which received 0%, 50% of respondents wanted to see an image of a mother and a child, because they believed that mothers in Kenya shoulder the burden of child bearing.
- **The placement of the A4 poster in the medicine cupboard:** 75% wanted it placed in the medicine cupboard, which is a place they normally place other medicines.
- **To some extent the content to be provided under each label:** The content labels had to reflect their information needs for instance, ”when it's necessary to call 111”, was a reflection of their need to access help during an emergency system.
- **The inclusion of cultural features like the scripture on the top of the poster:** The end users in Kenya are very spiritual, with most belonging to some Christian community. Thus the scripture would adhere them to the information on Saidia Mtoto, in contrast to some few lines telling sexully inclined jokes. God has a central role in the African culture. (Ting-Toomey,

1999)p.64

- **A free emergency system:** Disclosure of their low income also ensured that the Saidia Mtoto system would be free for these typical end users to find and use. 75% earned under 600 Danish kroners per month.

The result was a visual A4 information architecture. Given a scenario where an infant suddenly fell ill in the night, the mother would effectively determine if the nature of the emergency required her to react by using her mobile phone to call the free emergency number for advice, or simply help stimulate the newborn to breathe and recover. Outside the boundaries of the emergency, the mother also had time to learn important health signs and use the poster to check vaccination dates, as in a calendar. Its effectiveness could be measured in terms of lives saved, its low cost and time saved besides other IA values.

The A4 poster architecture, like notes, helped avoid overloading of information, except that which is very necessary into the mobile phone. Notes acted as mental aids (Norman, 2002), p192. Mental aids are important because they help the memory. A person does not have to remember more than 5 unrelated items at a time during an emergency.

Based on how far it solved the problem of information needs, Saidia Mtoto was successful, and subsequent tests revealed its potential as a low cost, low technology emergency system. Yet inspite of the success in designing Saidia Mtoto, some vital gap was evidently present because the information ecology had to be studied before carefully integrating it into the given context. Examples of unanswered questions resulting from this gap were: Who, apart from the nurse responsible for receiving emergency calls, would be best placed to administer the system in the long run? Was this nurse a reliable channel, or would money be wasted on implementing the system, only for the product to end up lying unused in some dark forgotten hospital room due to an ineffective administration policy?

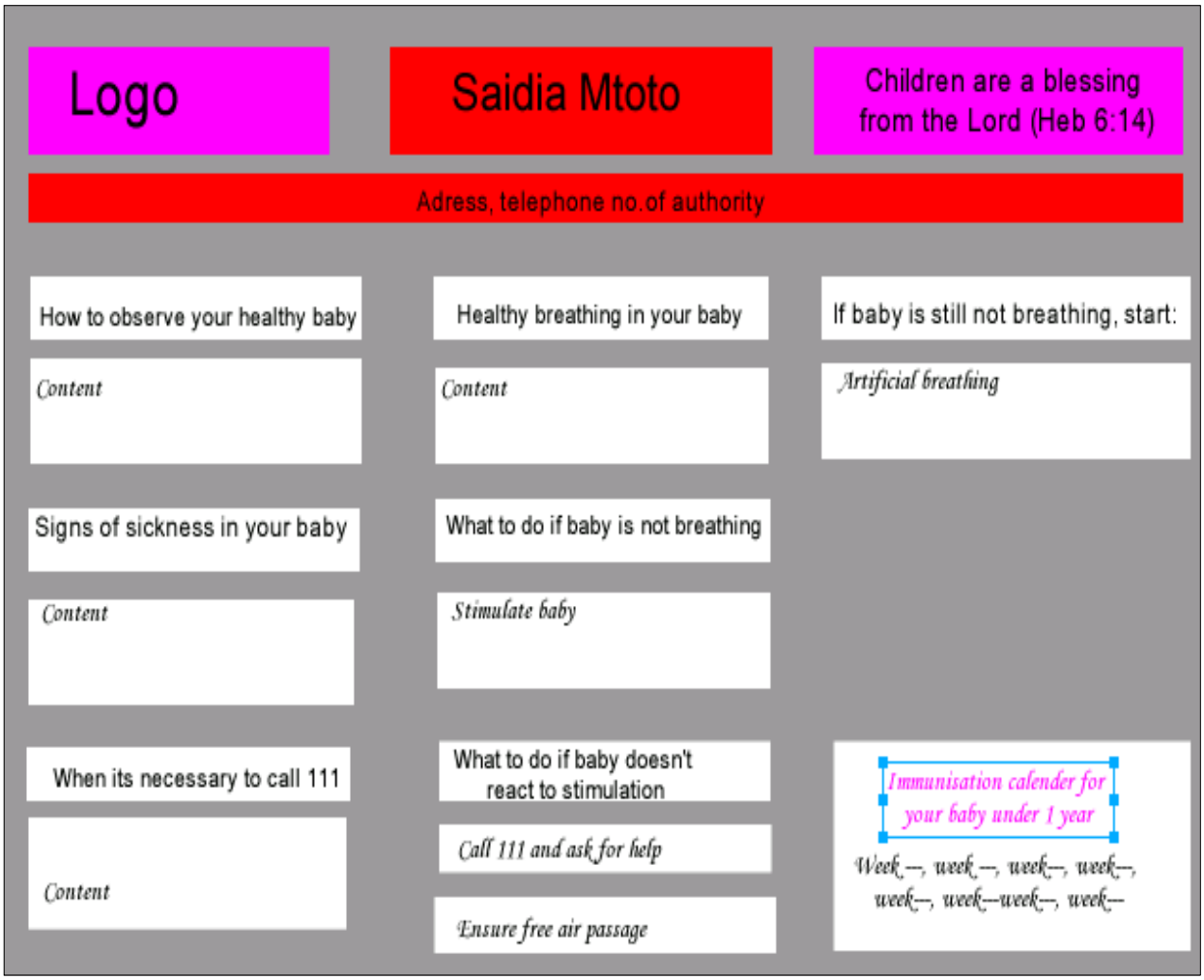


Figure 3: A low fidelity wireframe of Saidia Mtoto

2.3. Case two: ”Hope” system

” It is also clear that there were real user needs at the onset of design. This need inspired the design process. An Information Architecture product known as”Hope,”was designed and tested using user participation in a task analysis process, with the results showing that the user needs were met. The problem that remained to be studied was how to effectively integrate the product into the ecology.”

In my eighth semester design tasks during the course of this IA study program, the product was an effective system known as”Hope.” Hope was designed in response to a real need for social interaction between women members of a charity group. Some of the women were widows caring for orphans living in Kenya, while the others were from the Lutheran Church in Denmark.

Due to the constraints of long distance communication like time differences, monetary cost of telephone calling, delay in receiving urgent messages and others, I was able to observe the current work practice and get inspiration to design Hope. My purpose for that design task was to create a prototype of a mobile information system for the purpose of knowledge sharing, inspiration and progressive development amongst the target group.

For this purpose, the history of observing users at work, together with a task analysis and brainstorming exercise was carried out, resulting to user data that could be used towards the design

of the prototype. I designed a blue print that would help me communicate clearly and show the relationship between pages in the Hope system, and other content components. (Morville, Rosenfield, 2006) p. 296-309.

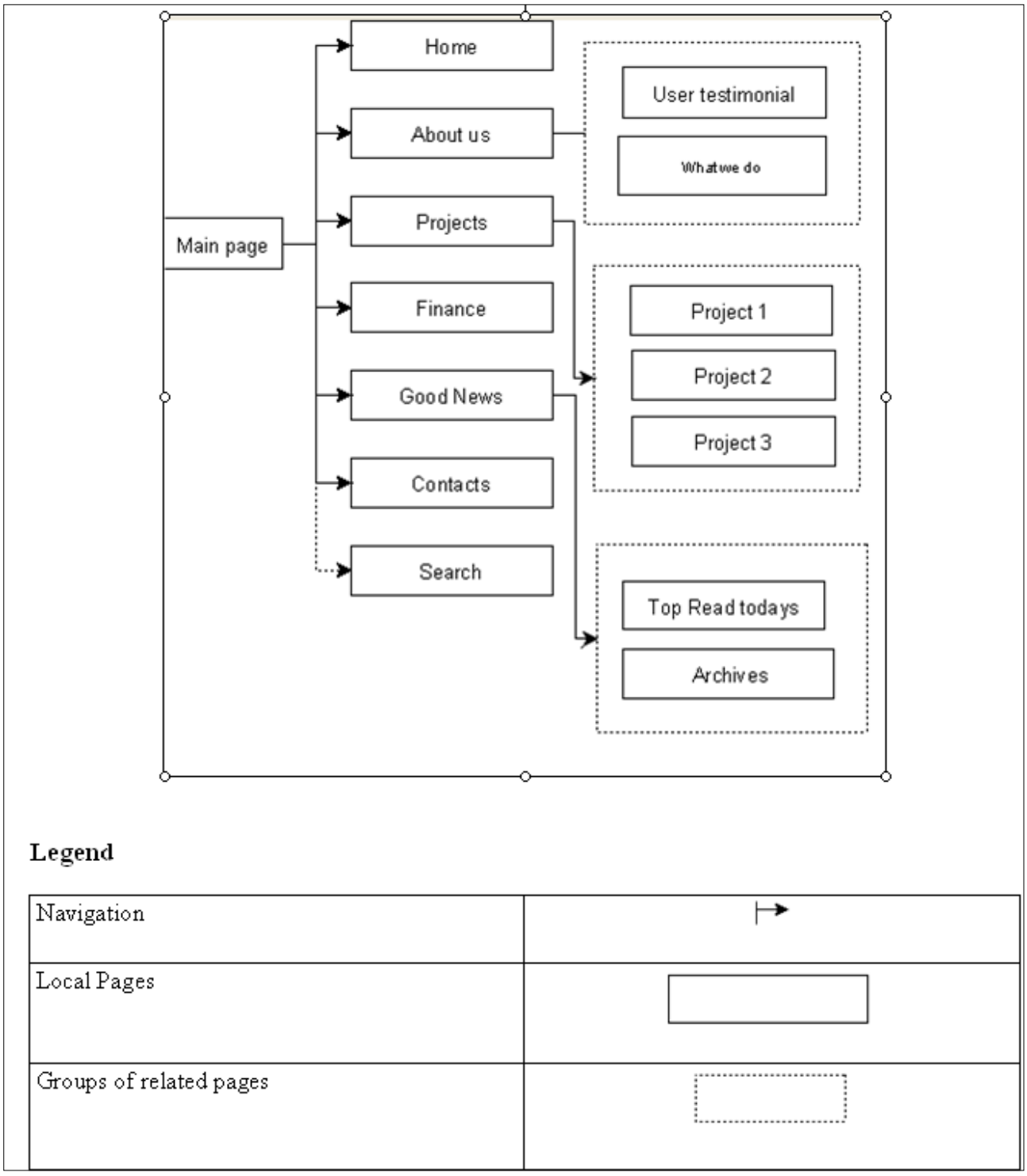


Figure 3.1: A blue print of Saidia Mtoto

I also designed a wire frame to help me try out possible ideas for the architecture as well as deciding how to group the few components, how to arrange them in order and knowing which components to prioritize to meet the needs and goals of the tertiary users. (Moville, Rosenfield,

2006) p.307. The tertiary users were the women in Kenya, who did not have access to the internet, except through a mobile phone interface.
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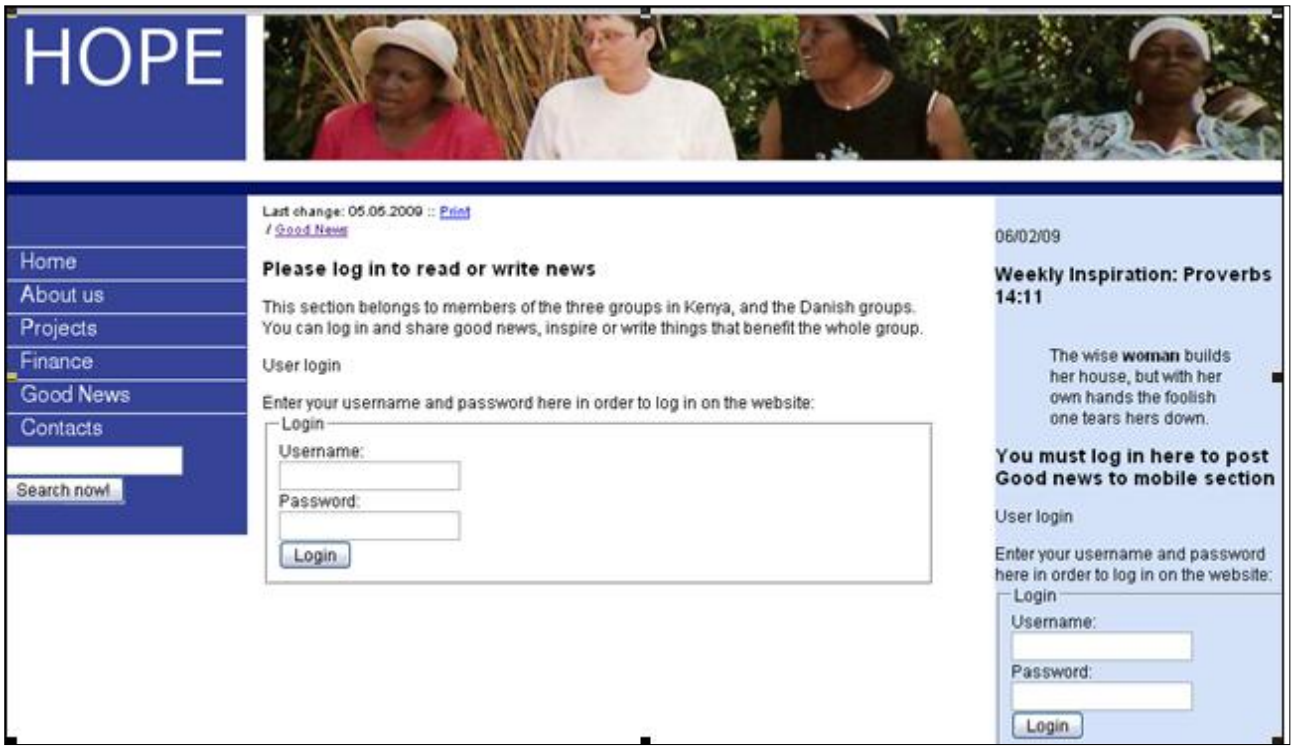
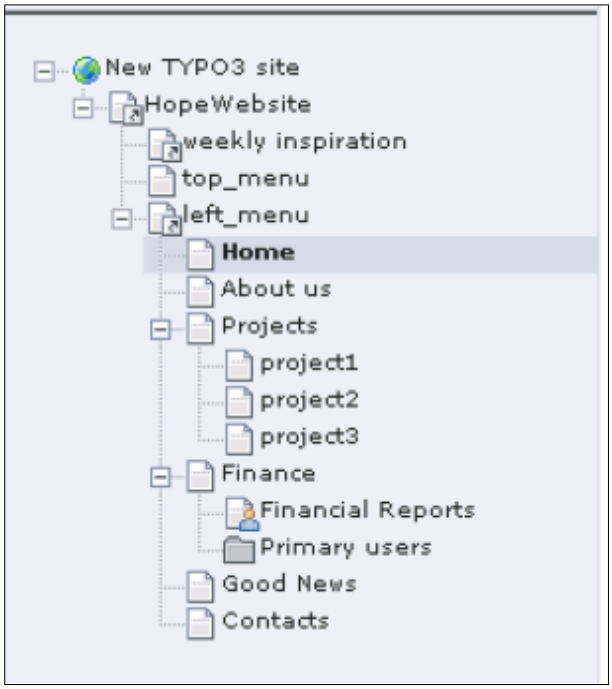
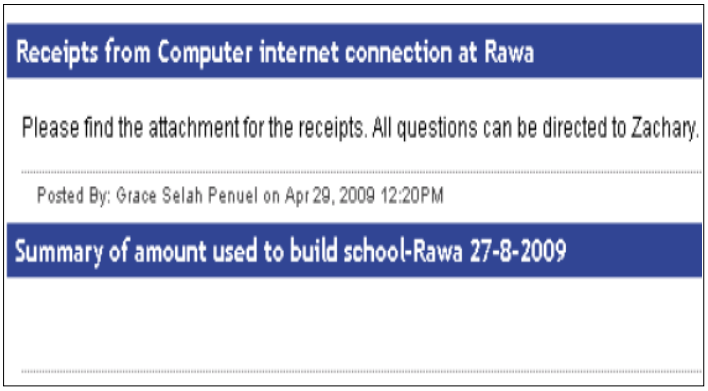


Figure 4: The News page and the mobile section of Hope

The challenge of designing a simple but teachable manual for the prototype was fulfilled. I was confident, as I did scenario tests, that the information architecture would meet the stipulated goals and needs of the primary, secondary and tertiary users. These are the main groups of users that the persona method of design employs, whereby if the primary user's needs are met, the system is considered effective.

Hope's effectiveness was also measured successfully using the information architecture value check list. (Moville, Rosenfield, 2006)p. 376-377

Information Architecture value	Feature that fitted value on Hope
Hope reduced the cost of finding information, finding wrong information, or not finding information at all for the women groups involved. The users could now find all the necessary information they needed on the common interface called Hope. It also improved knowledge sharing and solidified the organisational arrangement.	
It increased awareness of their activities, improved brand loyalty and product. An example is their monetary receipts that could easily be posted on Hope, to be viewed by all who wished to support their charity activities.	
It made using the site an enjoyable experience.	There were inspirational weekly updates on the Hope system. There was also news features that could be accessed on the mobile phone.
The group members could share knowledge across continental boundaries, thus improving communication and promoting economic growth.	

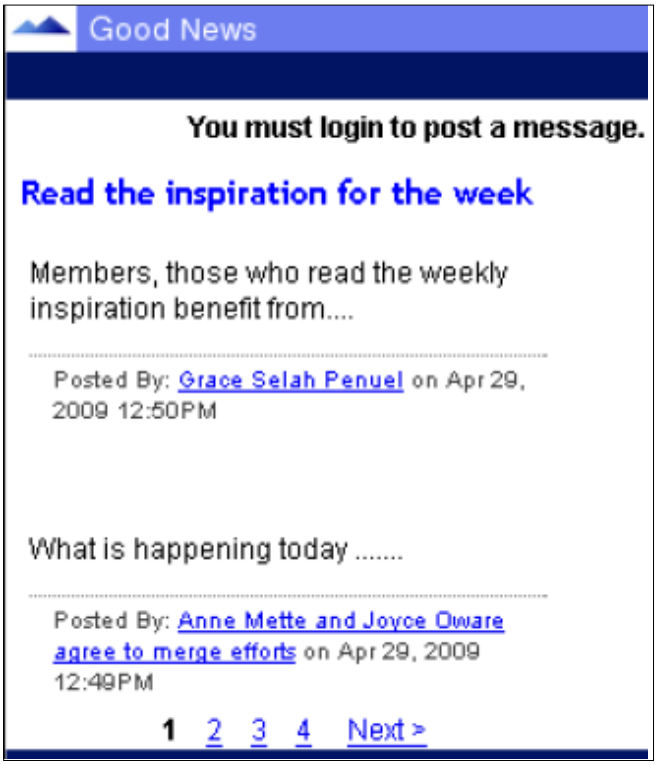
It greatly reduced the cost and hindrances of long distance communication. The interactive mobile interface ensured that information could be shared on mobile phone interfaces amongst users without other types of internet connections.	

Table 2: Information architecture features on system Hope

When the designed and effective product was delivered to the women groups who were the end users, they were delighted and satisfied with the potentials that lay beneath that interface, once learnt. Yet serious problems arose. The first one was that there were no mediators identified to shape and fit the new technology to the local use environment. Mediators are key stone species whose role, like bridges, help people to come from one area to another, from the area of little or lack of knowledge regarding how to use new technology, to an area of knowledge and even expertise.

The women groups, who were low technology user groups, compounded with low income and other problems tried to rely on me to become the system's administrator, mediator, and maintainer. This was a task that I could not meet, because I was committed enough. Consequently, there was a failed integration of this system “Hope. “

2.4 Case three: M-Mkulima

”M-Mkulima, which was also the main design and integration case for this master thesis, was not exempted from the integration problems in the information ecology for which it was designed. There were real user needs at the onset of design. This need inspired the design process. A functional Information Architecture prototype known as ”M-Mkulima, ”was designed and tested using user participation in a pen-and-paper simulation test. The results showed that the major user needs were met. The problem was how to successfully integrate the product into the Siaya information ecology.”

The general problem of integrating information architecture into an ecology and the afore mentioned 3 cases form the background for the problem formulation that guided this master thesis. As I wondered how to successfully integrate an information architecture into a given information ecology, my thoughts often went back to draw useful inspiration from how Olson, mentioned in my prologue, successfully integrated medicine into the Motilone Indian curing system. Then reference to literature by Nardi and O'day and Normans reference to the ”Schema theory” laid a basis for researching this clue and how it could work for information architects. (Nardi, O'day, 2000) p. 54.

My method of drawing inspiration from Olson agrees with Norman's argument that humans solve most of their current problems by refering to how a similar problem was solved in the past. (Norman, 2002) p.115-116

It is clear that the consequences of not considering the information ecology are information architectures, which are functionally well designed, but which cannot be adapted to fit the ecological environment. Such technology ends up being rejected or ignored, despite the fact that it might have cost so much time and money to design as seen in the cases of Saidia Mtoto and Hope systems. Therefore the problem of integrating information architecture into an information ecology gave rise to the following **problem formulation:**

How can information architecture be successfully integrated into an information ecology?

Section 3: Literature review, IA development process, Reflections

The Information architecture development process for M-Mkulima took the form shown in figure 5 below. Since a conceptual design was the main aim of this work, the implementation and administration, which involve the product, will follow at a later stage.

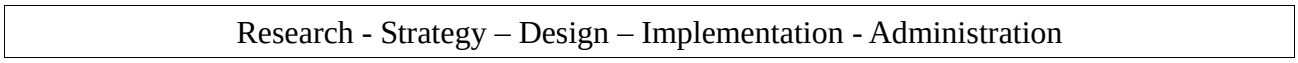


Figure 5: The information architecture development process

This process was adopted so as to define phases that gave clarity to the impending process. (Moville, Rosenfield, 2006) p. 232. Without this clearly defined phasing, the development process would most likely have left out important considerations that are vital for the success of the finished product. It could for instance have been total ignorance to sit in the lab and design a mobile based emergency system to be used in conjunction with helicopter services, without considering whether the organisational environment in the Siaya ecology could administrate such an expensive and resource craving system.

The information architecture development process began with a review of literature, whose main purpose was to:

- Gain insight into reliable resources that would help in solving the problem expressed in the current information practice.
- Find fresh perspectives into the problem and a solution, so as to know how to design and integrate M-Mkulima into the Siaya ecology.
- Bring up new information and ideas regarding the problem area, in order to improve the quality of the eventual solution.
- Find important sense making links to help in the interpretation of my findings and ultimately link the research to the work of other researchers.

The literature reviewed expounded briefly on the following chosen areas: Information ecology environments, Schema theory, aspects of the mobile phone that made it suitable for the design of M-Mkulima, interaction design on a mobile interface and ethical considerations for IA in M-Mkulima. I chose these specific literature areas because they expounded on important sections of the design and integration process of M-Mkulima. They also helped to give a theoretical foundation that supported the design and integration considerations and decisions that followed. Below is an expounding of the literature reviewed.

3.1 Three information ecology environments

Davenport's and Prusaks ecological model gave a good background for expounding on the fact that the Siaya information ecology has 3 important environments. This meant that the context under study was part of a broader environment. I had to consider these 3 environments when researching how to successfully integrate the information architecture. In this way, a holistic presentation of the Siaya information ecology could be considered, covering the external, organisation and information environment. (Davenport, Prusak, 1997) p. 28-45

a) The external environment

Siaya district is one of the twelve districts that make up Nyanza Province in the southwest part of Kenya. Kenya is divided into provinces and every province is subdivided into districts like Siaya, which is bordered by other districts. The total area of the district is approximately 1520 km². The District lies between latitude 0° 26' to 0° 18' north and longitude 33° 58' east and 34° 33' west.

Strengthening the agricultural sector and industry, is viewed by the government of Kenya as a prerequisite condition for arriving at its millennium vision. This vision involves economic growth and by extension, employment creation and poverty reduction. The vision forms part of the external environment for the Siaya ecology.

Agriculture contributes to about 24% of the Gross Domestic Product directly and over 27% indirectly. This indirect contribution is mostly through linkages with other sub- sectors like fishery, import and export. That means that any successful project that directly or indirectly increases agricultural production is an economic booster. This augers well for the eventual accept of M-Mkulima as an tool for accelerated economic growth by the external ecology.(www. ascu.go.ke) 16.06.2010.

Many times, the external environment overrides decisions made within the context of an information environment.The mission statement for the ministry of agriculture in Kenya (Figure 6) shows that the goverment, which is part of the external environment has its vision, mission and objectives for existence. These affect the information environment by impacting many of the decisions made, for instance, to invest or not to invest in a technology.

If M-Mkulima does not agree with the overall vision of the government, then it will be rejected. One cannot for instance, design an atomic bomb and expect it to be integrated into the information ecology of a government whose vision and core values has rejected such mass destruction weapons. Components of the external environment for the Siaya ecology are business, information and technology.

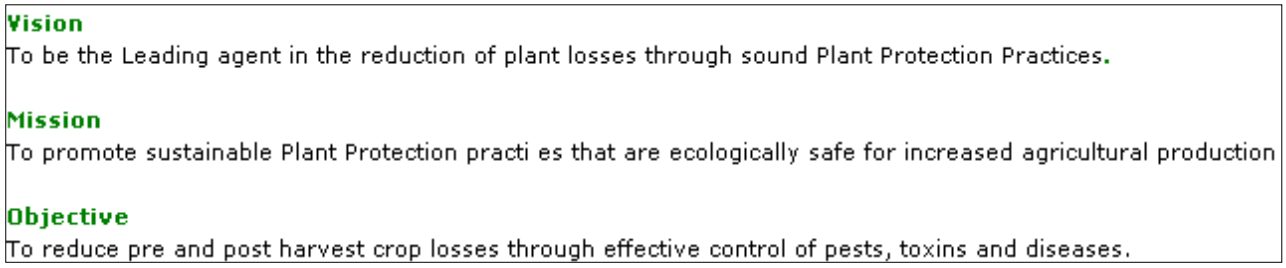


Figure 6: a screen shot from the Kenyan ministryof agriculture site at.www.kilimo.co.ke

The business environment determines the general business conditions affecting decisions made to acquire information and the type of information. Changes in this environment are external, but are reflected in the internal information practice. An instance is if the government of Kenya changes business partners, such that internet services are replaced with some other prefered technology, then the information practice within the Siaya ecology will be affected. Consequently, M-Mkulima's technological requirements must reflect the changes made externally by the central government.

The external information environment determines what information is available for gathering, its systematic capture and verification. Davenport and Prusak stress that there is no need to buy information which the information environment in the Siaya ecology can generate itself. That would amount to added costs of using information.

The relevance for M-Mkulima was that if the information gathering process and technological requirements for capturing it were expensive, then it would not have been successful as a low cost ICT.

The external technological environment entails the technological considerations of what is available in the market, and its value. The use of mobile technology is so widespread in Kenya because of other important mobile systems that effectively use mobile technology. An example is the mobile banking systems like M-pesa.Since those systems involve money, "and money is a guest that is welcome wherever it goes," there is widespread use of mobile phones for receiving money.[6]

M-pesa, a mobile based money transfer system and the first of its kind in the world was launched in 2007 in Kenya. The number of newly registered users exceeded 5000 per day in August 2007, and increased to nearly 10,000 that year. This reflects how quickly users adapted to the system, because it involved money. By August 2009, 7.7 million M-pesa accounts had been registered in Kenya. (http://hci.stanford.edu/courses/cs379l/readings/M-PESA.pdf) 24.06.2010

b) The organisational environment

Siaya district is rooted in a broader organisational environment. This environment has components like the overall business situation, existing technological investment and physical arrangement.

Business issues like strategy, cultural, organisational structure and human resources are important because they affect the information environment, and by extension the information architecture. In the Siaya ecology for instance, Luo is the local dialect, spoken by most end users. This is a cultural constraint for design because to meet the information needs of an end user who only reads and speaks Luo, a strategy of information distribution on M-Mkulima that included pushing and pulling information in the Luo language, had to be followed.

Davenport and Prusak argue that in the organisation the physical arrangement also plays a vital role in information practice. This is the relationship between individual locations to others in a common working environment. It includes physical structures in which people work and disperse information.

Face to face communication within an organisation is most highly rated because it is easy, often unplanned, rich in use of body language, vocal tone and facial expression and builds trust. These promote communication and sharing information in an organisation.

For M-Mkulima, the physical arrangement was important in the push of information, because the content author was not working alone. Instead he needed to communicate with a broad array of colleagues like researchers, fellow agricultural officers and even the subsistence farmers whom he served.

In M-Mkulima, technological investment involved the appropriation of ICTs like the Mobile phone to specific information needs, ease of connection to information by all staff in all locations of the Siaya ecology, assessment of how current technology affected existing work practices, and accessibility of staff and farmers to internal and external information that is understandable and usable.

c) The information environment

Information architecture is found within the information environment. (See figure 1)This is because architecture, simply serves the functional role of guiding the human subjects on where to find information now, and prescribing where information will be found in the future. (Davenport, Prusak, 1997)

This environment includes the staff, of which in every district of Kenya is an agricultural officer. I mention the agricultural officer here, because his role was vital within the Siaya information ecology. In this research, he was identified as a keystone species because of his pivotal role in mediating technology.

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6 The process of how M-pesa works can found at this link: http://www.safaricom.co.ke/index.php?id=747

Roles are an integral part of social settings. It is simply social actors engaging in ongoing interplay with others. They are important because they set the boundaries for the actions of individual actors, thus allowing some actions and limiting others, and creating trust. (Bekkers, Homburg, 2005), p108. A primary school teacher, for instance, has a role that allows him to teach his pupils, but limits him from terrorising them. Roles are however not eternally static, and can be subject to change.

The agricultural officer in the Siaya ecology has a role. Who is the agricultural officer and what role makes him stand out as a staff necessary for the integration of technology within the information environment here?

The agricultural officer: The agricultural officer is employed by the ministry of agriculture as a staff in the district agricultural office. His duties are guided by the overall core values of the ministry of agriculture, which is shown in the screen short from the Kenyan agriculture ministry site

in figure 7.

Figure 7: The core values of the ministry of agriculture in Kenya.

He cannot, for instance, refuse to recommend a well researched and recommended technology, just because it was developed by a woman. That would be against the core values of his employer, which demand gender equality.

The agricultural officer is historically a position that was introduced by the British colonial government in Kenya to provide agricultural services that included training and advising farmers on matters related to crop production, land development, planning and management of farming activities.

The functional role of the agricultural officer mentioned here is critical to his identification as a keystone species in the Siaya ecology under study. These functions are included in the general functions defined by the Kenyan ministry of Agriculture on their website[7] and govern crop protection practices.

The other critical components of an information environment are culture/behaviour, process, architecture, politics, process and strategy. These are briefly defined here because a consideration of all these components was important for a careful integration of M-Mkulima into the Siaya ecology. They form part of the overall landscape where information architecture is designed and integrated.

Staff: They are information/content providers who shoulder the responsibility for identifying, providing, creating categories, pruning and interpreting information. The agricultural officer, whom I have just mentioned belongs in this component of the ecology.

Strategy: This revolves around questions of what the organisation wants to do with information. Do they want to sell it, distribute in a pull or push method, promote knowledge sharing or something else? For M-Mkulima, the staff had a role of pushing information to farmers.

7 The crop protection functions of the Kenyan government are found at: www.kilimo.go.ke

Architecture: This is a guide for finding the structure and location of information. It can describe where to find information or prescribe where information will be found in the future. Architecture can act as maps for where to find current information resources, or build maps to show where they will be found in future through content mapping.

In designing M-Mkulima, the current information practice showed where information was to be found, but it was not easily accessible for end users. Therefore architecture helped describe where information will be found in the future.

Processes: This is a description of the current information practices. How is information work done? Whom do the people in the ecology currently contact in order to obtain specific information? In the Siaya ecology, it was established that there was an information provider, whom the end users contacted in case of disease outbreaks. This knowledge was important in determining the keystone species, who would mediate technology.

Culture/behaviour: These are information behaviours that determine how people share and gain long-term knowledge from information. Incentives are often necessary to help develop a culture of valuing information, sharing it across boundaries, disclosing it externally and externally and using it.

Behaviour was relevant in determining how end users could keep returning to use the information on M-Mkulima. I included a calendar on the information architecture because, from personal experience, I knew that it was a common item hanging on the wall of many rural homes in Siaya. The culture behind the calendar was that end users would keep returning to check important dates, appointments, days, and other services provided on the calendar.

Figure 7.1: An agricultural Officer talking to a subsistence farmer in Siaya.

3.2.Schema theory

Piaget first used the term Schema in 1926 and a respected educational psychologist named R.C. Anderson, expanded on it as a theory. It views knowledge as a complex network of mental structures which represent the way an individual views and understands the world around him. Norman adds that it has three reasonable beliefs which are:

- The existence of logic and order to individual structures also known as schema,
- The networking of this mental schema whereby each schema connects to and points to one or several others to help in its understanding.
- That deductive thought occurs through the use of the components of one schema in a deductive process in order to understand another. (Norman, 2002) p. 115-116

Its relevance to M-Mkulima was that the role of the agricultural officer as an information provider, whom the end users in the Siaya ecology trusted would help in the integration of M-Mkulima. This is because they already had a"Schema" that decoded him as the information provider.

3.3. Aspects of the mobile phone that made it suitable for M-Mkulima's design

In this section, I will focus on cost and time saving aspects of the mobile phone. Emergency workers like firefighters and other aid workers need to feel secure about using a new emergency system. This is because human life is involved in a highly stressful context. They have to depend on an emergency system to support their activities in trying to save the life of the human victims, as well as their own. This concern for security is understandable. Who wants to die under a burning building because the emergency system failed to work as it should? (http://www.mobile-response.org/uploads/media/iscram-09-workshop.pdf) 15.05.2010

However, M-Mkulima is an emergency system for plant disease management. Security was not as important as in the case of saving human life. Consequently, improvements in the way emergencies were handled currently in the Siaya ecology pre-design, and after its design were to be reflected mostly through the cost and time, as opposed to security.The cost and time saving aspects of the mobile phone that made it suitable for M-Mkulima are discussed here.

a) It is cheaper to purchase and operate than a laptop, or computer

The buying cost for mobile phones is currently less in comparison to laptops or computers. Where as an Ericsson mobile phone T630 like the one used by the end user interviwed in this project cost less than 25 Danish kroners, a good laptop with internet connection costs not less than1000 danish kroners. Besides, the mobile phone does not need initial connection's technical support costs, insurance against thieves and secure storage costs. (Dawson, 2007) p. 4.It can be bought and used right away to access online content, if it has the right platform.

b) It belongs to the owner and this is empowerment

The fact that I own a mobile phone means that I can take control of what I want to do with it. That implies that I am empowered with a tool, that I can adapt to my needs, without having to ask a second party on when to use it. (Dawson, 2007) p. 5

The technology also has a locality in the home of the end user, meaning that decisions about how it should be used are made locally. (Nardi, O'day, 2000) p. 55. It is thus easier to learn how to use it through trial and error, practice and teaching by peers.

This fact was relevant for M-Mkulima, because important information could be pushed by the content author right into the home of the end users, which they could then pull, thus accessing

information easily and saving cost and time.

c) It's as mobile as its name suggests

Subsistence farmers in the Siaya ecology mostly do their farmwork in the field. The nature of their practice must involve field work. Dawson indicates that learning materials especially targetting mobile devices can be designed for fieldwork locations. (Dawson, 2007)p. 8. This makes the identification of disease symptoms and diagnosis fast and effective, saving time and cost. A farmer can notice a symptom like streaked translucent lines on the leaves of a maize plant, consult his emergency system and find out if this is a warning about the presence of Maize Streak Virus quickly and easily.

d) Size and portability

Imagine if everyday, the farmer had to carry a computer or a laptop to the farm! This is not an easy task, and the transportation might require extra costs. These two hardware choices do not save costs in terms of transportation and operation. Besides, they need power supply connections, if they do not directly use solar energy. (Dawson, 2007) p. 8.

A mobile phone, on the other hand is easy to carry around and transport from work station to work station. If a farmer needs to pull some needed information while on the farm, he can easily proceed from his mobile phone. If he needs to contact the Agricultural officer for further consultation even while in the Matatu travelling, he can also do that using the small portable ICT device in his hand.

I reflected here that the farmer would not need to look desperately for extra space in the passenger packed Matatu[8] in order to be able to communicate.This transportability or portability aspect of the mobile phone would save the time needed to communicate emergency issues.

e) Attitude to mobile technology

Building on what the end user is already familiar with is critical to information practice. (Dawson, 2007) p. 9. The mobile phone did not appear complicated to end users in this thesis. They were already using it to pull information through famous mobile systems like the famous M-pesa system mentioned earlier in this master thesis, an argument that also fitted the Schema theory.

According to a report by Stanford University, never in history has there been an adoption of a technology as fast as the mobile phone.The reason being that mobile phone follows a path already eased by other preceding technologies, a fact that augers well for the integration of useful and needed mobile based technologies. The attitude to mobile technology is already good, and paves way for its adoption and use. (http://hci.stanford.edu/courses/cs379l/readings/M-PESA.pdf) 30.7.2010.

The attitude to mobile technology was an important issue to consider when integrating it into daily use. Like M-pesa, M-Mkulima, an emergency system on a mobile phone represented economic advantages that cannot simply be ignored by subsistence farmers in the target group. Any good farmer would be interested in seeing his maize crop, the main channel of his economic and dietary livelihood, saved from a ravaging disease that has the potential to wipe out whole acres within a very short time.

f) Collaborative learning

Social relations are interactions of natural relations, which are deemed to facilitate learning. In such natural and simplified ways," the social interactions are essential to achieve the desired learning, as a result of a continuous attempt to construct and sustain a shared and open point of view of the

8 A matatu is a type of minivan often used as public transport in Kenya.

problem.” (Vygotsky, 1978).

Mobile phones within a locality provide many opportunities for collaborative learning that promotes sharing of knowledge and building up on what the other person knows. (Dawson, 2007) p. 9. This is a cost saving factor in times of an emergency.

Continuous learning was important for the success of M-Mkulima because as information was distributed, it was hoped that the farmers could share it with family, friends, fellow farmers, this increasing in knowledge. This would also mean that they would know how to react before and during an emergency thus saving the cost and time involved in not knowing what to do. For example, plants extensively damaged by disease due to delay in applying pesticides, or a lack of correct information on the farmers part, are evidence of delayed reaction due to lack of knowledge.

3.4 Interaction design on a mobile interface

Definition: What is interaction design for the mobile interface, and does it have rules, guidelines or principles for the work process? Interaction design shines the touch on the user as products are shaped. In it are four basic activities: (Preece, Rogers, Sharp, 2002) p. 14

- Identifying needs and establishing requirements for the system
- Designing to meet those system requirements
- Building interactive versions of the designs so that they can be communicated and assessed.
- Evaluating what is being built through the process.

Interaction design here focused on meeting the user’s needs and involved iterative cycles of designing, formative evaluating and redesigning. (Preece, Rogers, Sharp, 2002) p. 462. Iterative cycles of designing meant that there was a cyclic process involving prototyping, testing, analyzing, and refining M-Mkulima. The test results acted as a basis for improvement and refinement of the designed product, because they were based on real data by end users of the prototype.

Considering the end users low technological levels, it was important that after interacting with M-Mkulima, they had enjoyed their interaction, accessed content intuitively and achieved their purpose for using the product with efficiency and effectiveness. The successful usability, findability and experience in interacting with M-Mkulima to meet needs and accomplish goals was expected to enable them to cultivate confidence and trust, thus paving way for acceptance of the technology and integration into daily use.

Rules, guidelines and principles of interaction design: Interaction design has some basic rules, guidelines and principles. Guidelines at a detailed level are called rules. Abstract design guidelines that require context related interpretation before application are known as design principles. They often consist of information on how to design based on theory. (Preece, Rogers, Sharp, 2002) p. 267.

Jakob Nielsen simplifies the task of interaction design. He gives ten general principles for user interface design. He also refers to these as rules of the thumb or "heuristics".[9] This is due to their detailed nature.

9 Jacob Nielsen's guidelines can be found at http://www.useit.com/papers/heuristic/heuristic_list.html

Nielsen's rules were important for M-Mkulima because it is also an interaction design product and therefore must use some basic design rules. Rules gave more precision to design due to their specific nature. For instance, Nielsen recommends that a system should support cancellation of error, because users often make mistake while using systems. This guideline determined the option for a user to cancel his registration in M-Mkulima if they wanted to. The alternative would have been a no return system, where once a user was registered in M-Mkulima, they were felt trapped inside and the trap door closed behind them! See figure 7.2 below:

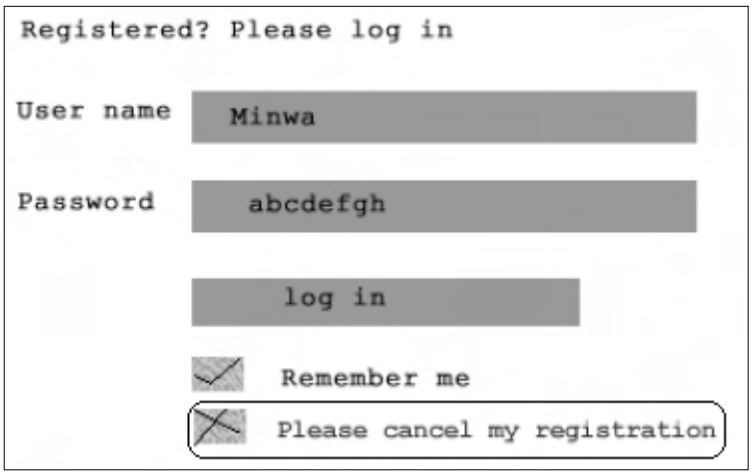

Figure 7.2: Users can cancel their registration (marked with a rectangle for clarification)

3.5. Ethical considerations for Information Architecture in M-Mkulima

Research like this thesis, carried out in developing countries, is said to be an issue of global concern. The subjects are often poor, and do not know their rights, meaning that they can be exploited. Research ethics being a broad subject, I will focus on the main areas where the rights and dignity of the subjects must be preserved. Ethics deals with right and proper conduct. (Israel, Hay, 2006) p. 12.

Nancy Walton, a professional in research ethics says that research ethics has three main goals, which also applied in M-Mkulima.[10]

- To protect human participants.
- To ensure that research is conducted in a way that serves interests of individuals, groups and/or society as a whole.
- To examine specific research activities and projects for their ethical soundness, looking at issues such as the management of risk, protection of confidentiality and the process of informed consent.

Ethics is an important but hidden aspect of every information architecture development process. Presented here will be a skeleton of six ethical considerations that I had to deal with during the design process and consideration for integration of M-Mkulima. (Moville and Rosenfield, 2006) p. 340-344

10 Dr. Nancy Walton is the Associate Director of the School of Nursing and an Associate Professor of Nursing. Dr. Walton has held the position of the Chair of the Ryerson University Research Ethics Board since 2004. See link here: http://www.researchethics.ca/what-is-research-ethics.htm

a) Intellectual access

Information architects connect people with the information they need, thus avoiding the waste of time and money while reducing frustration. Yet there must be governing ethics, which depend on the unique work context. The autosuggest on a search engine can easily be perceived to skew results thus showing a biased search with serious ethical implications. (Moville and Rosenfeld, 2006) p. 341

An instance is when a picture of Michelle Obama, the American first Lady was presented as a chimpanzee on the Google, when users typed "Michelle Obama" into the popular picture search engine. Google responded by not removing the offensive editing, but by placing a warning that sometimes search engines can bring up offensive images, a debate that brought up ethical strife issues.(political, racial and humanitarian)[11][12]

Intellectual access was relevant for M-Mkulima. I had to choose words that reflected a sincere desire to help farmers, even when they wanted to cancel their registration as shown in figure 7.3. The contrast is to use dictator language that manipulates them to use the system. Cases are known where overenthusiastic government authorities have overstepped the boundaries of how to handle the people they serve.

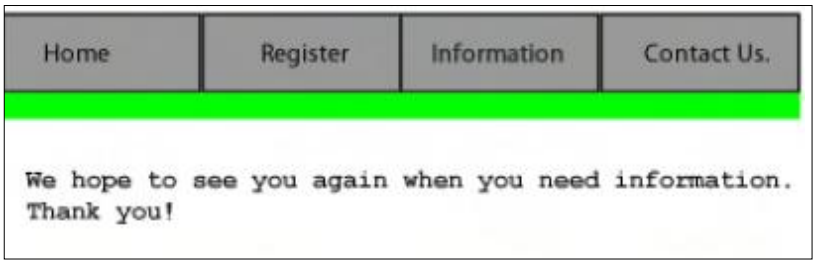

Figure 7.3: A system language that encourages the user to return

b) Labelling

Labels are so powerful because they have impact on end users and their perceptions. There should be a balance between the developed labelling system and controlled vocabularies, and the users labelling of the same words in order to create clarity and precision. (Moville and O'reily, 2006) p. 342

This ethical issue was observed in M-Mkulima through use of simple labels that users understand. Labels like disease, transmission and symptoms are all common labels in the field of Crop protection that end users understand.

c) Categories and classification

Design of classification schemes must be taken with care of the ethical consequences. The taxonomies built upon impact people's understanding of the subject, sometimes making it socially, ethically, and legally visible.

An example here again would have been the use of the word ”pathogenic virulent disease,”[13] to describe the nature of the maize streak virus, as opposed to just writing ”maize disease.” (Moville and Rosenfeld, 2006) p. 342. The former calls for urgency in handling the disease, so that it does not spread, while the latter does not. It was important therefore in such a case, not to shout an alarm where one does not exist just to draw attention to M-Mkulima.

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11 http://www.telegraph.co.uk/news/worldnews/northamerica/usa/michelle-obama/6928791/Michelle-Obama-racist-monkey-picture-reappears-online.html

12 http://www.hindustantimes.com/Michelle-Obama-s-racist-chimp-picture-reappears-online/Article1-493545.aspx

13 Virulent means extremely infectious, malignant, or poisonous. Used of a disease or toxin.

d) Granularity

In this case, the question to ask was how the chunking of the content in M-Mkulima affected their perceived meanings and understanding. (Moville, Rosenfield, 2006) p. 343.

An instance is where information about all maize diseases are chunked as content on M-Mkulima, as opposed to designing to give specific information for only one maize plant disease, the Maize Streak Virus. The unintended consequences are that there will be more users of the system, where all maize diseases are chunked as content in the system, as opposed to the latter case. The former represents ambiguity in that anyone can be able to use the system without necessarily having a crop suffering from the Maize Streak Virus, because the content covers other topics as well.

The latter mode of chucking as used in M-Mkulima is precise and represents specific information, because the target group is known.

e) Physical Access

Ben Schenedermann, an expert in the field of Human Computer Interaction extended the ACM code of ethics[14] into a notion of universal usability to computer resources. (Moville, Rosenfield, 2006) p. 343. He notes some conditions for technology to meet universal usability as affordability, usefulness, and usability. This is inclusive of the different technological varieties, differences in the levels of user knowledge and diversity.

M-Mkulima had to be designed to ensure that it could be accessed by a diverse audience. Thus it was designed to be usable, accessible, and of low cost in order to be usable to its target group, but also to others outside the target group.

f) Persistence

Persistence represents a foundation and stability in information architecture. Suppose one day, M-Mkulima has one type of global navigation at the top of the front page, and at the same time next year, a different navigation on the left of the front page, while the third year also shows a different navigation, this will show instability. Unless the usability of the site is changing drastically year after year, such changes would something wrong.

The Infrastructure of information has widespread and long-term impact. It affects the work of interface designers, programmers, content authors, and end users, because changes in one layer affect other layers.

In relevance to further development of Mkulima, there is a need for appropriated persistence, so that changes on the fast changing layers do not affect the quality of information finding process. Persistence could be ensured through the planning of the architecture, such that there is stability in the slow layers. Otherwise - 42 -problems would result, for example, the link to often cited content suddenly disappearing because the site has been reorganised.

14 ACM is the premier membership organization of computing professionals.(http://www.acm.org/about) 17.5.2010

3.6 The Design task description for M-Mkulima

The end users, as I have mentioned before were the subsistence farmers. For these end users, the task was to design a conceptual emergency system that would be used to manage and control a maize plant disease known as Maize Streak Virus.

Maize streak virus (MSV)is transmitted by insects and is a maize pathogen of the family Geminiviridae. It is considered to be endemic in sub-Saharan Africa.(http://en.wikipedia.org/wiki/Maize_streak_virus) 3/5/2010.

This system had to be findable and usable to the end users, in order to meet their information needs. However, there were problems. These problems faced in the current work practice gave a good idea of what the system should do when designed. This is because the purpose of the design was to help users overcome the problems in the current information practice, saving time and cost.

3.7 Work process of M-Mkulima

In the introduction of section three, I mentioned that the work process followed the information architecture development, and gave reasons why I chose to follow this detailed method, as stipulated by Morville and Ronsenfeld.

The research basically began by looking back at the target users, content and context of design for M-Mkulima with a view to establishing the existing structures in the ecology as a whole. For this purpose, I employed various research tools and methods as indicated in figure 8. I chose the methods based on the kind of data I needed. For instance, I did benchmarking because I wanted to adopt creative and working ideas from similar mobile sites. The alternative was to inovate new ideas, instead of building upon what was already working. This would have been time and cost consuming.

This research provided valuable data that was the foundation for an information architecture strategy. Due to the fact that I already knew the target group for M-Mkulima, the planned content and functionality, the main task was to establish a goal for the site, the method of information distribution and the timely accessibility of information. Time plays a vital role in every emergency system, of which M-Mkulima is one.

In the process of setting the strategy, Morville and Ronsenfeld advocate for a face to face meeting. This is in order to communicate effectively as can only be done, when people are comfortable with each other. Yet this face to face meeting was not possible for M-Mkulima because of the distance between Kenya and Denmark. Instead, I took strategical points based on my findings during the research face. For instance, finding a solution for the problems in the current information practice became a goal for the design. (Morville, Rosenfield, 2006)p. 236

The design of M-Mkulima involved giving visual expression to the information architecture strategy in order to create deliverables that would later be used by a production team. This included blueprints and wireframes. This is because after the conceptual design which was the purpose of this thesis, there is a production, where further testing takes place as implementation and administration are done to keep the product improving.

Here follows a brief description of the reasearch tools and methods, the strategy and the design creations.

3.6.1 Research tools and methods

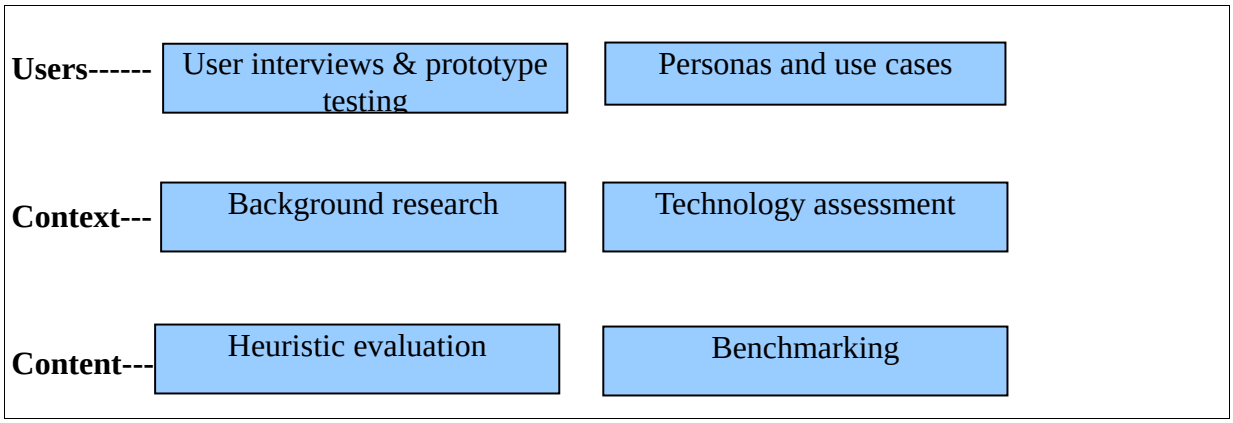


Figure 8: Tools and methods for the research in the Siaya ecology

I researched using tools and methods to help in the understanding of the user's context, and content for M-Mkulima in order to design a more successful solution. The methods that were used are shown in figure 8 above.

a) Technology assessment
This was very necessary at the beginning of the information architecture development process , because it helped me locate what technology was available in terms of tools, infrastructure and human resources.

Using my background research, I knew about the widespread use of mobile phones in Kenya. Yet I had to confirm what services could be supported by these phones, for instance internet access, browsing etc. Technology assessment also helped locate gaps through analysing user needs, the vision of the agricultural office in the ecology and the hindrances to achieving that vision because of practical limitations. These involved a lack of transport, a demand that they must know and provide information in the Luo language to the local people and a lack of internet accessibility.

The mobile phone used by the interviwed subsistence farmer was a Sony Ericsson T630. Based on benchmarking ideas that worked in Saidia Mtoto, it had the common features like Short messaging services, email, instant messaging, and MMS. The most important feature for M-Mkulima was the web browser WAP 2.0/xHTML, which is very important for internet acccess. Internet access was important to access M-Mkulima online.

b)Background research
This process involved a review of information and data related to the research topic, in order to find the mission, vision, content, management structure, culture and mental models that preceded the existing information architecture and practice.

In my thesis, a background research got hold of data related to the content. By this it is implied that it would not make sense to ask the end users what data they need in order to manage a Maize Streak Virus epidemic, since that kind of knowledge is based on scientific research. This becomes information that is pushed by the agricultural officer, and pulled by the villagers or end users through a strategy that covers information needs both during an out break and before the outbreak of disease.

c) Interview

Information gathered from a qualitative interview revealed the user problems that had to be solved by the system. These user problems were formulated thus:

How can M-Mkulima, an information architecture on a mobile interface be designed in order to:

- Help farmers meet their information needs and overcome the main problems in the current information practice.
- Help Agricultural Officer overcome the main problems he currently encounters in providing information effectively?

d) Heuristic evaluation

This was a formative evaluation I did in order to identify the existing structures with the aim of building on what is already working. I found out that the farmers knew whom to contact when they have information needs, a strong evidence of an existing information practice. (Morville, Rosenfeld, 2006) p. 239.

Information practice here is defined as an inclusive term that embraces the complex ways that the subsistence farmers in the Siaya ecology actively or indirectly look for information to help them meet their needs. This terminology encompasses

- Information needs
- Information pathways and sources
- Information barrier

In the evaluation, I identified concrete problems and opportunities for improvement. Using the interview results and the heuristic evaluation, I summarised the greatest problems in the current information practice in the Siaya ecology as shown in figure 9.

e) Benchmarking

I used benchmarking to collect data because benchmarking had various advantages which are:

It gave a standard against which to make comparison and adopt practices that were already working elsewhere. With careful benchmarking, the good ideas that worked in a similar information system were borrowed, saving time in trying to invent something that is already invented and working successfully.

Benchmarking created a point of reference from where the speed of improvement in “knowing what to do” during an emergency could be qualitatively and quantitatively measured. (Morville, Rosenfeld, 2006) p. 244-245

The benchmarking site from where ideas were adopted was: www.mydokta.com. This is because it was also a mobile health system, with functional IA features that worked successfully, for instance, the global navigation, the registration link and the section with the logo. Besides this, I also used the information architecture of Saidia Mtoto as a benchmark, because M-Mkulima's funtional features and idea were based on Saidia Mtoto.

f) Use cases

Use cases were an effective way to stimulate discussion about how the upcoming M-Mkulima should behave. (Cockburn, 2001) p. 1. They showed the behavioural requirements of the system both before and during an emergency. It was important that these behavioural changes be seen at particular stages of interaction because the success of M-Mkulima depended on users being able to learn how to react before the actual emergency occured (simulation) and during an emergency.

A clever wrestling champion does not wait to begin training his muscles on the day of the match. Instead he trains ahead of the match, so that he is ready when he steps into the ring. This illustration shows the need for the end users to learn before an emergency occurs, so that they know how to react during the real emergency.

g) Personas as a model for users and use context
I created personas from real user data, and research in order to avoid working with fictional characters that have far-fetched needs, which would have misguided design and integration decisions. They were very useful here, as an inspirational tool that improved the successful design of M-Mkulima.

Working from the problem formulated or information barriers, the two personas' gave me possible sub problem domains. This helped focus on the possible solutions resulting in the inclusion of more details to the design decisions. For instance, if the design only answered the problems formulated, then it might not have included the two different scenerios presented by the personas indicated in figure 10. This is because with the scenerios, I realised that there had to be different system requirements. Whereas the persona Mr. Jauyoma knew how to access the internet through a mobile interface, Mrs Ogwedhi was hindered by her low technological knowhow.

Mrs. Ogwedhi

"My maize crops are being wiped out by a strange disease, yet the agricultural officer cannot help me fast enough. Yesterday, I could not reach him by mobile phone. Today, when I finally saw him,after two hours of travelling, he had no motorbike to transport him here. What will I do to get quick answers."

Personal details
Age: 42
Occupation: Subsistence farmer
Location: Ahono Village Siaya
Family: Married with 5 children
Income: Less than I $ per day(aprox. 5.5 Kr)
Languages: Speaks Luo, Little Swahili

Technical profile
Mobile phone Ericsson T630, can send SMS, MMS, dial, flash. She does not have any knowledge of the computer, does not own any.

Mr. Jauyoma

"I have noticed some insects eating fast away at my maize crop, and need to know what they are. It takes me so many hours on these rough dusty roads to get to the Agricultural Office in Siaya. How can I get reliable quick information?"

Personal details
Age: 35
Occupation: Progressive subsistence farmer
Location: Ahono Village Siaya
Family: Single
Income: 1$ per day (aprox. 5.5 Kr)
Languages: Speaks Fluent Luo, Swahili, English

Technical profile
Mobile phone Ericsson T630, can send SMS, MMS, dial, flash. Uses open office frequently, has an old laptop without internet connection.

Figure 10: Personas created from real user data

Mrs. Ogwedhi's technological knowhow was much lower than Mr. Jauyoma's. This means that the solution that worked for him, could not have worked for her. Mr. Jauyoma needed a system where information could be pulled directly from the internet through his mobile phone because he had the technical knowhow and capacity. Internet access would not have worked for Mrs.Ogwedhi, because of her level of knowledge. These personas were advantageous because:

- I could see clearly what M-Mkulima should do to meet the two end users information needs and goals, thus giving a good basis for the design of an A4 information poster and a mobile phone interface.
- I could communicate design decisions and keep design centred on users using a common language that could be understood by all who needed to know why I had to design an A4 poster and a mobile prototype of M-Mkulima.
- A common language paved way to understanding, reducing the need to use raw data and structured diagrams with complex features to make the goal of design understood. Persona Mrs. Ogwedhi resembled a real person; therefore I could empathize with her and design to meet her needs.
- I could measure the design's effectiveness in solving the problem during the formative stages. The result was a more problem solving design baseline, when M-Mkulima was tested with actual people.
- Personas helped me understand the salient aspects of the end user's internal and external relationships within the ecology, and with the product M-Mkulima. For instance, Mrs Ogwedhi, a married woman with five children would scarcely have had time to spare in order to learn to use a complex and difficult system.

3.8 Problems that were identified in the current Information practice

The results from a telephone, Short Message Service and email interview with 2 users, a subsistence farmer and an agricultural officer revealed that there were major problems faced by both of these users in the process of actively seeking information or providing information.

These problems acted as guidelines for design in that M-Mkulima had to help solve these user problems or challenges and show an improvement in terms of cost and time. I considered the challenges/information barriers in relation to a scenerio where there was an outbreak of Maize Streak Virus.

The question I asked was what would be the greatest challenges to finding usable information in the current information practice? Here a scenerio helped focus on what was the problem and what was necessary to arrive at a solution.

	1. Farmers(end users seeking information)	**2. The Agricultural Officer(Providing information)**
Goals and needs	-Find information as quickly as possible -Be able to use the information found as soon as possible	-Provision of agricultural extension services, maintenance and management of all information within the division, guarded by the core values of professionalism, integrity, efficiency, partnership and finally gender equity. -Trust and dedication to build the farmers confidence and satisfaction in services in a way that encourages other farmers with similar problems or different problems to come for advice.
Major problem in current practice/barriers	-High travelling costs to the Agricultural Office -Too much time spent travelling to the agricultural office(2 hours) -Failure to procure information because the Agricultural Officer does not have it.	-Wasted time and money due to mobility and transport costs. This is because the agricultural officers used motorbikes for outreach to farmers. Available motorbikes are shared among staff going to work in different directions, meaning that waiting for transport can result during sudden unplanned visits by clients -Dialect: Local people are versed in the local dialect, meaning that the Agricultural Officer must know the language well. --Internet access: Under the Kenyan Agriculture ministry's employment structure, there is no free internet access. The Agricultural Officer can only access free services at Millennium village partner office in Yala.

Figure 11: The major problems in the current information practice in Siaya ecology

3.9.Strategy and Working method

An information architecture strategy, according to Morville and Rosenfeld, is like a bridge between research and design. Research brings information and knowledge into a design situation, while stategy brings focus on how the information will be structured and organised using an effective conceptual design framework. (Morvile, Rosenfeld, 2006) p. 265

A successful strategy in the M-Mkulima case had to consider the Siaya information ecology. This was because there were questions that needed answers; questions that pertained to the Siaya ecology. The questions that follow helped determine what strategy to apply.

a) Was the distribution of information going to be a push or pull method?
This was a vital question that I asked myself, as I considered the information destribution method. This was because given an example where there is an outbreak of Maize Streak Virus on one farm in Siaya, that is not the opportune time for other farmers to retrieve or pull information regarding how to recognise the symptoms, what to do, and why etc.

The pulling of information could be done before the outbreak, so that they were prepared. The fact that Maize Streak Virus is endemic in nature makes its impending presence predictable before hand. A pull strategy assumes the maximal distribution of information when it is most needed. (Davenport, Prusak, 1997) p. 148. Consequently, the system had to be strategically designed, such that the users could find information before an outbreak, as well as during an outbreak. Information to be found before an outbreak, is for instance,"prevention of the Maize Sreak Virus." It is common knowledge that no one tries to prevent a disease after it has already infected them.

Thinking in line with Davenport and Prusak, the Agricultural officer would push guidelines that allow subsistence farmers to find out what they do not know about the plant disease, and these end users would pull out what is made available to meet their information needs. Consequently, they would dig and delve deeper into the information increasing in learning, for example, new research results that might interest the farmers. Push and pull are interdependent on each other. Neither can exist effectively alone without the other. (Morville, 2005) p.99.

b) What would ensure that subsistence farmers returned to use M-Mkulima?
What would ensure that subsistence farmers returned to use the system? Returning to the system was important because it ensured continuos learning. Questions helped focus on the importance of having a working pull system as a strategy, through the inclusion of a calender.

A common calender is just a system of organizing days for social, religious, commercial, or administrative purposes. Yet it was a working concept for promoting learning before an emergency. As the end users look for various dates on the calender, they would hopingly absorb the information provided by M-Mkulima.

The calender system was important in the integration M-Mkulima as a pull information distribution strategy because many people still use calenders in Siaya for various reasons. Drawing on my knowledge from personal experience, I know that the calender hangs on the wall of many homes in the rural Siaya ecology. This is so vital to the product, because when the product designed also becomes"the calender," then it will be used, and not just left and forgotten in some corner.

c) Was it important to consider the use of M-Mkulima before and during an emergency?
The successful integration of M-Mkulima as an emergency system depended on its use by the end users before the outbreak of Maize Streak Virus and during the outbreak of Maize Streak Virus. This

would ensure learning before an emergency, and the application of what is learnt in knowing how to handle an emergency. This strategy is rooted in a similar research that involved an emergency system called a heart defilibrator that I successfully developed an A4 information poster for. Of the total number of respondents interviewed, 90.9% revealed that they prefered to know what to do about a heart failure emergency before it occured. This was more responsible than waiting until one of their colleages is unconscious and almost dead from a heart attack before taking a manual and trying to figure out what a heart failure is, and what to do about it.

Acting within time is crucial for helping save life during any emergency, whether human life using a heart defilibrator, or plant life as in the case of an outbreak of the endemic Maize Streak Virus. Helping save human life needs more urgent actions than plants though, and must take the priority place.

d) What was the goal of M-Mkulima?

M-Mkulima would have been unsuccesful if it did not solve the problems currently experienced by the subsistence farmers and the agricultural officer. Consequently a strategy was to appropriate the design of M-Mkulima to the problems noted in the current information practice. These problems, captured through research tools and methods and documented in Figure 11, helped me in sharpening the focus and goal of the design process.

3.10 Design creations

a) Blue print

I designed a blue print of M-Mkulima using Fireworks CS5 to enable a clear vision of the relationship between pages and other content components. Fireworks is a software that enables one to create expressive, highly optimized graphics for the web or virtually any device

The blue print also enabled me to communicate visually and to confirm that this design could be implemented on an actual mobile interface. (Morville, Rosenfield, 2006)p. 296-309

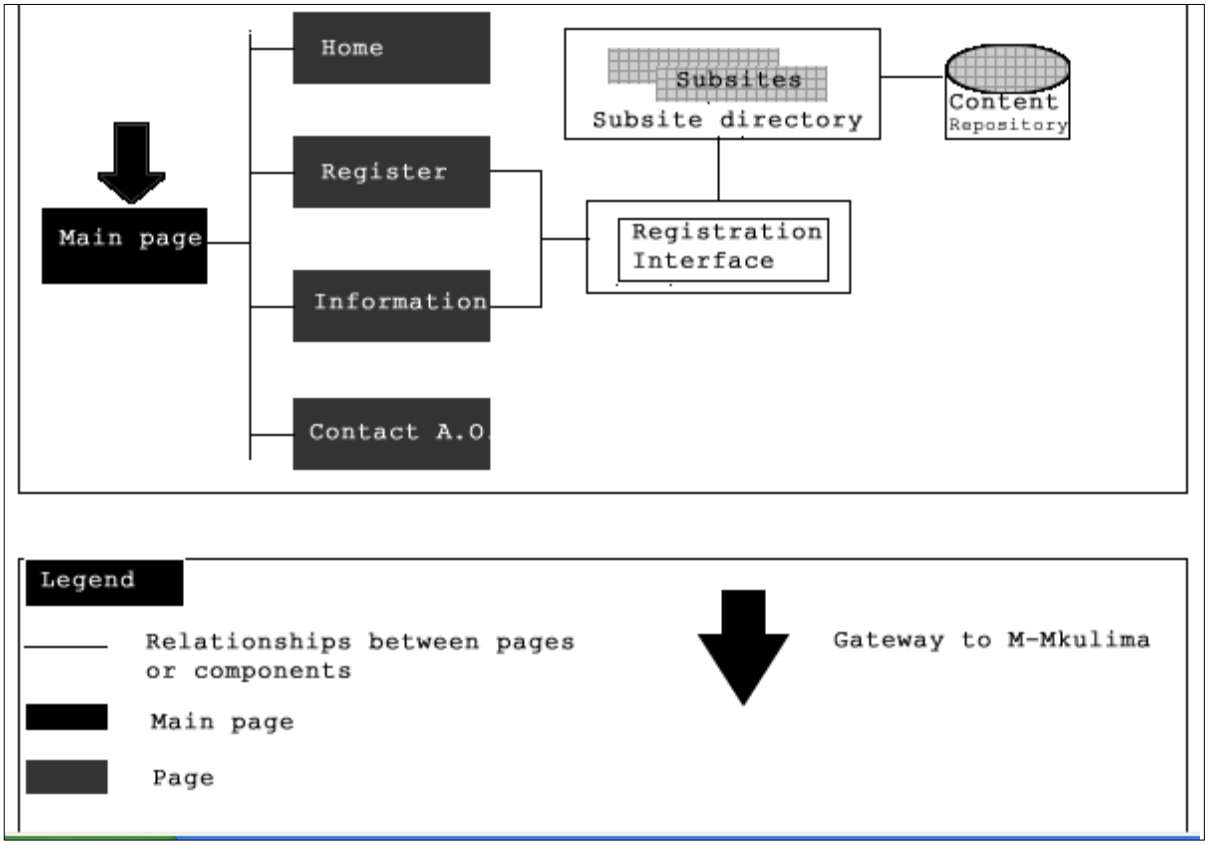


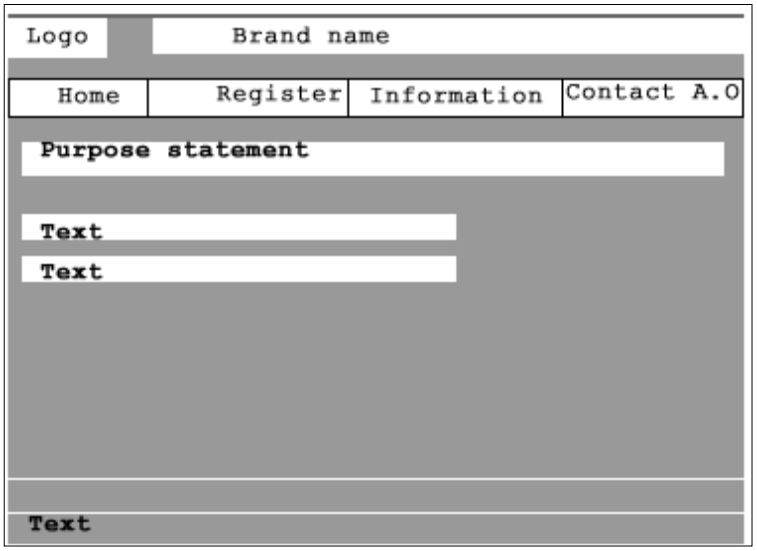
Figure 12: A Blue print of M-Mkulima

b) Wireframes

I also designed two wireframes. One was a depiction of the front page, because this is the gateway to M-Mkulima. Therefore it was an important page whose feel and look had to be visualised from an architectural perspective. The other wireframe was also an architectural representation of the information page. The information page was unique for M-Mkulima, because it was where the most important information about Maize Streak Virus is found.(Morville, Rosenfield, 2006)p. 307-309.

On the information page, content chunks were used. This involved finding content categories under which information could be grouped on the site. My knowledge of plant pathology played an important role here, because I was able to arrive at six basic categories that are most important. These were based on questions arising from knowledge of what Maize Streak Virus is, its transmission møde, prevention and when to call the Agricultural Officer. For instance, It was unnessary to give content chunks that included the biological and Latin names for the virus or pathogen. Such information belongs to researchers, and not to poor subsistence farmers who have

difficulty reading English. Latin names would only make them more confused. (Morville and



Ronsenfeld, 2006)p. 313

Figure 13: A wireframe of the front page of M-Mkulima

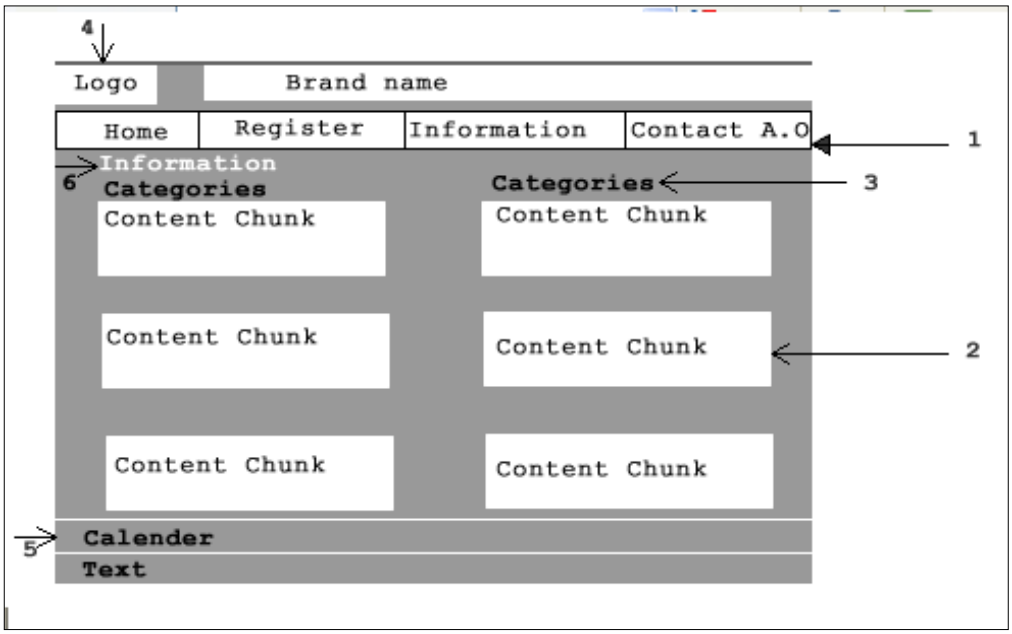


Figure 14: A low fidelity wireframe of the information page of M-Mkulima

Explanation: The following is an information architectural explanation of the important features of the wireframe for M-Mkulima. I have written this to enhance understanding of the structure.

Arrow 1= The global navigation: It is a sitewide navigation system that complements the hierachy of M-Mkulima, by allowing users to navigate through out the site, while knowing where they are. (Morville, Rosenfield, 1998) p. 53-55. It is supported by hyperlinks and local navigation systems to help guide users through the structure.

Arrow 2=Content chunks: These represent finely grained sections of the content that will be authored by the content author, and that require individual categories to make the content usable and understandable.(Morville, Rosenfield, 2006)p. 312-315

Arrow 3=Categories: These are classifications of information that influence how users navigate

through the structure of M-Mkulima, while trying to find information.

Arrow 4=Logo: The logo together with the brand name is important for the identity of M-Mkulima. A visitor arriving from any page within the site will see this Logo and name linked together and understand it as a brand. A brand is important for the mobile product's promotion. In marketing, brand name recognition can increase profits by between 10 and 20%.(http://EzineArticles.com/?expert=Charles_Fuchs) 23.6.2010

Arrow 5=Calender: The Calender is important because it ensures that the end users keep checking for certain dates on the system. As they check the dates, they also read the information section and continue in learning and updating themselves before an emergency. It also ensures that the agricultural Officer keeps updating the system, thus ensuring its continual use.

Arrow 6=You are here: This is a way to show context within the navigation system of M-Mkulima. As an end user navigates around the page in the example given and marked with arrow 6, he can see that he is in the information page.

c) Prototype M-Mkulima

My working process goal had been to come up with a prototype that could depict how well M-Mkulima will function, and test the design in a non-production setting. The prototype also helped me try out possible ideas for the architecture, while previously unidentified problems could be easily noted and rectified. For instance, the Luo language used on the A4 information poster to cover the needs of the primary end user, could not be used on the mobile prototype. This would require time, money and resources that were outside the scope of this thesis. (Morville, Rosenfield, 2006)p. 328

The prototype M-Mkulima consists of two conceptual forms:

- An A4 poster that works along with a mobile phone for users with the lowest technological knowhow.(I refer to it as M-Mkulima -1)
- An interactive mobile interface for users with more advanced technological knowhow.(I refer to it as M-Mkulima- 2.)

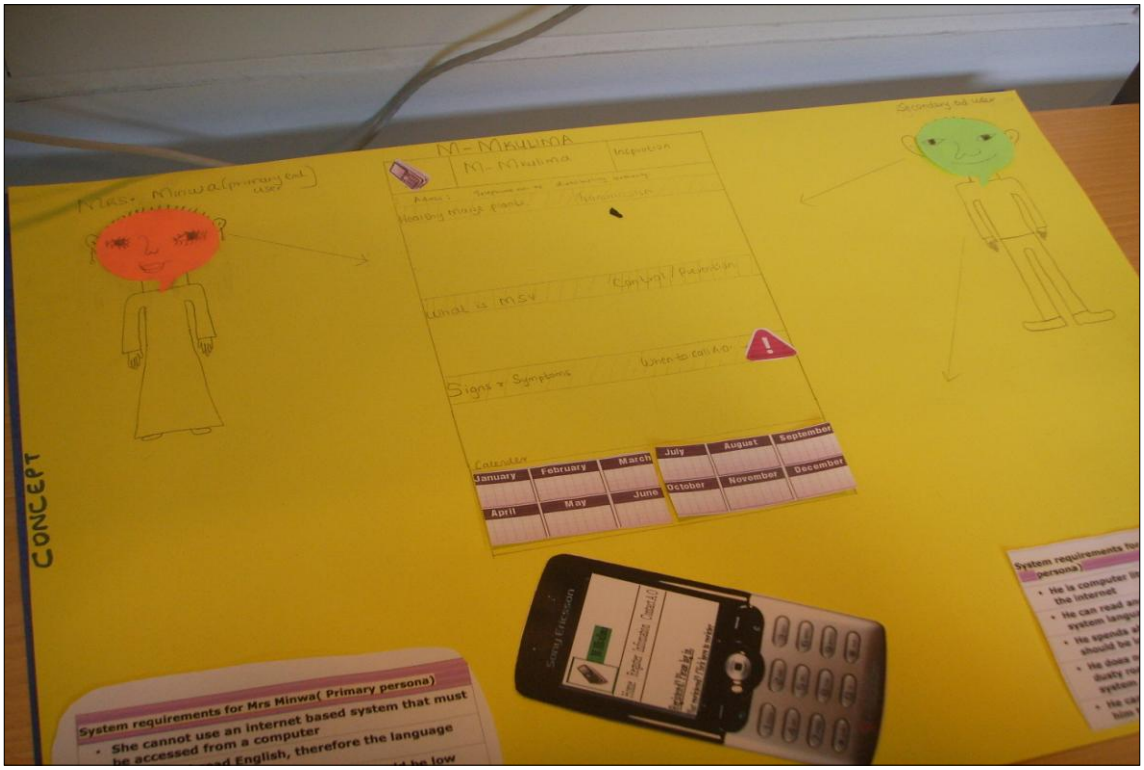


Figure 15: A design sketch of M-Mkulima -1 and 2.

The A4 information poster for M-Mkulima-1 in Luo and English languages

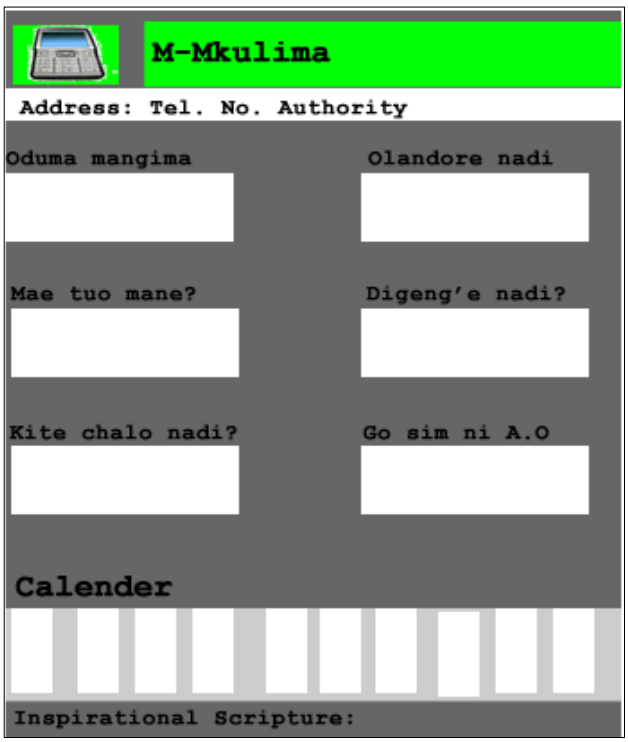


Figure 16: A Luo language poster of the mobile system M-Mkulima-1

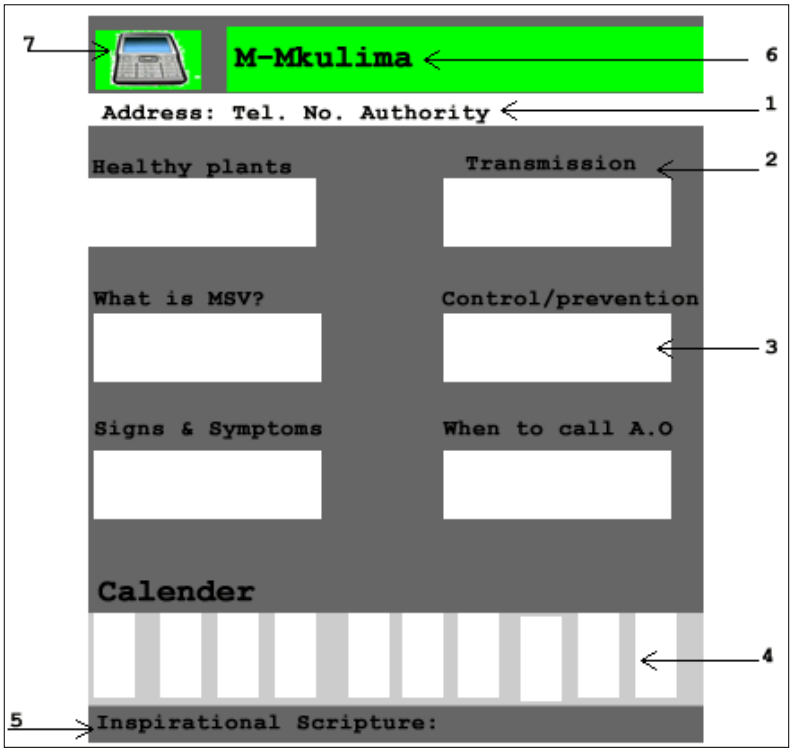


Figure 17: An English language poster of the mobile system M-Mkulima-1

The following is an explanation of the Information Architecture features of of M-Mkulima-1 for the purpose of enhancing understanding.

Arrow 1=Ethos: The Stanford web credibility guidelines, which also apply for credibility in this case, state that making contact information clear, i.e. phone number, physical address, issuing authority boosts the credibility of a site. [15]

Arrow 2=Categories: Categorisation affects the way information is understood, so that the intended meaning is advanced and captured by the end users of M-Mkulima. (Davenport, Prusak 1997)p. 144. Users visiting these categories find exactly what they are looking for.

Arrow 3=Content chunking: These represent fine divisions of the sections of the content that will be authored, and that require individual categories to make the content usable and understandable.(Morville, Rosenfield, 2006)p. 312-315

Arrow 4=Calender: This is a creative packaging method where information on M-Mkulima-1 is bundled together with a calender. The calender positively increases the value of the product, making it more useful. The end user can now, for instance, check for important dates on the product, thus valuing it. This can also increase passive learning before an emergency occurs, by encouraging the end users to return to M-Mkulima-1 for the purpose of checking important dates.

Arrow 5=Inspirational Scripture: This is a cultural feature, because spirituality is a vital aspect of the cultural life in the Siaya ecology. The church plays a central role in the life of the people in the Siaya ecology. Therefore association of this poster, with spiritual inspiration is a value adding packaging of information. (Davenport, Prusak,1997)p. 145. God is a central part of the cultural beliefs of the people. (Ting-Toomey, 1999)

Arrow 6 &7:=Brand name and Logo: This visual representation of the information gives a working visual image, because users know what they would expect just by seeing a mobile phone Logo. The name also gives a meaning and local identity to the product. ”Mkulima” means farmer, which is a local Swahili word that the end users would understand.

3.11 User test results

I conducted user tests to evaluate the concept so that improvements could be made to the information architecture, and usability features of M-Mkulima. These user tests gave quick returns in terms of tangible data that could be used to improve the prototype.

In this thesis, I have included the changes that were made as a result of the user tests. This is in order to show that the user tests carried out were indeed very valuable in helping me arrive at a more refined prototype.

a) M-Mkulima-1

Successful use case: In the Saidia Mtoto emergency system's Information Architecture development process, the A4 information poster had already been tested with successful use cases.

The use cases showed that the information architecture was successful as far as giving timely information, both before and during the emergency was concerned. Since the same principle was built upon in the design of the M-Mkulima-1, a retest was not necessary at this stage. Consequently, the user tests focused on the improving M-Mkulima-2.

15 These credibility guidelines can be found at: http://credibility.stanford.edu/guidelines/index.html

b) M-Mkulima-2

Scenerios: I used test scenerios in order to show that M-Mkulima-2 was indeed a cost and time effective technological improvement for the Siaya ecology. Scenerios helped me envision how the users would navigate and experience the site I designed on the mobile interface. Mr.Jauyoma, whose information needs as a persona helped focus on system requirements, (see figure 11), was again the main persona for the scenerio. Would the system meet his information needs?

Mr. Jauyoma

"*I know exactly what to do to prevent this disease outbreak from reaching my farm because I have been checking my M-Mkulima every now and then."*

Mr. Jauyoma receives a mobile telephone call one late evening. It is a friend in distress, whose maize field has developed strange symptoms. The stalks of maize are being eaten by a hungry worm that munches its way through the stalk. The friend suspects that this must be a symptom of the endemic Maize Streak Virus, which broke out recently in parts of Siaya District.

Mr. Jauyoma is well acquinted with the symptoms of maize streak virus. He has been using the information section of M-Mkulima-2 to learn and keep watch over his crop. Consequently, he knows exactly how the MSV virus signs and symptoms look like, its prevention, when to alert the agricultural officer and other details.

Calmly speaking on his mobile phone, he assures the friend, that what he has noticed on his maize crop is not the symptoms and signs of Maize Streak Virus. He suspects it to be armyworms, but cannot confirm yet. He promises to help him contact the agricultural officer for help, using the email section of his M-Mkulima-2. Meanhile, he advises his friend to register as a user in the M-Mkulima system. This would enable him learn about MSV,and be legible for quick responses by the agricultural officer during emergencues.

The above simple scenerio showed how, and why end users like Mr. Jauyoma would use M-Mkulima-2, before an outbreak of disease thus learning and obtaining information. It also showed how they would be empowered through knowing specific information, and thus knowing what to do during an outbreak of Maize Streak Virus.

Pen and paper simulation: The second method used for testing M-Mkulima-2's usability, navigation, labelling and other Information Architecture features was the pen and paper simulation. (Rubin, 1994)p. 21. This was because of the fact that test users could be located in any place, without necessarily having to sit in a lab, or any particular environment. This method was also cheap, quick, effective and productive in giving valuable results.

It involved showing users some information architecture aspects of M-Mkulima-2. 11 questions within the areas of rhetorics, knowledge organisation, and categorisation were prepared. The user was then asked to respond to these questions, within a time period of 15 minutes.15 minutes was the maximum time it would take a very slow person to answer all the questions.

The questions were based on obvious information architecture features in order to avoid tough technical questions that required high levels of IT qualifications.There were five users, who were all either doctorate, or master students at a local University. Non of them was a computer science student, but all had middle to high level technical knowledge, thus facilitating the testing of a group with similar characteristics.

Images from the user test sessions

1

2

3.

Figure 18: Users performing a Pen and Paper simulation test(1,2,3)

3.12. Presentation of data from user tests

The Pen and Paper simulation yielded very valuable data. The screen shot from a speadsheet with results shown below indicate the kind of data that was collected. This is followed by a graphic presentation of the data to enhance understanding and visualisation.

i) The user tested information Architecture principles

Tested information architecture principles	Respondents	Percentage %
1. Users can tell the homepage from other pages	5	100
2. Users can navigate with ease between pages	3	60
3. Users understand the labelling system	2	40
4. Users have an idea of which labels to click	4	80
5. Users have an idea of where links lead to	5	100
6. Users trust the information on the site	0	0
7. Users find the language easy to understand	5	100
8. Users can easily contact owner of the site	4	80
9. Users can tell what the site offers in less than 10 seconds	2	40
10. Users like the general appearance of the site	1	20

Figure 19.1: User test results showing respondent percentages to tested IA principles

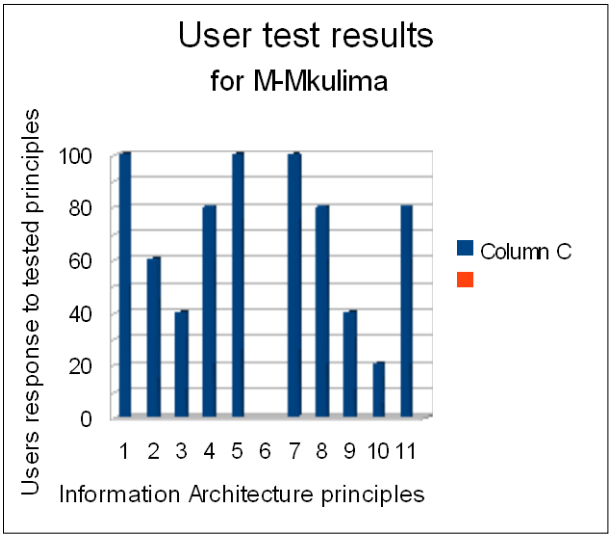
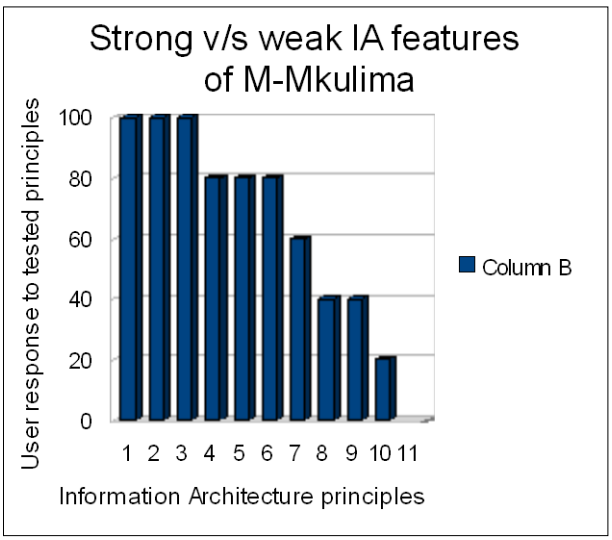


Figure 20: A graphic presentation of the user test results.

ii) Strong Information Architecture principles in descending order

Strong v/s weak IA features of M-Mkulima	Respondents %
1. Users can tell the homepage from other pages	100
5. Users have an idea of where links lead to	100
7. Users find the language easy to understand	100
4. Users have an idea of which labels to click	80
8. Users can easily contact owner of the site	80
11. Users know how to cancel registration	80
2. Users can navigate with ease between pages	60
3. Users understand the labelling system	40
9. Users can tell what the site offers in less than 10 seconds	40
10. Users like the general appearance of the site	20

Figure 21: User test results in descending order from the strong IA features of M-Mkulima-2 to the weakest.



Figures 22: Graphical representation of the strong and weak IA features of M-Mkulima-2.

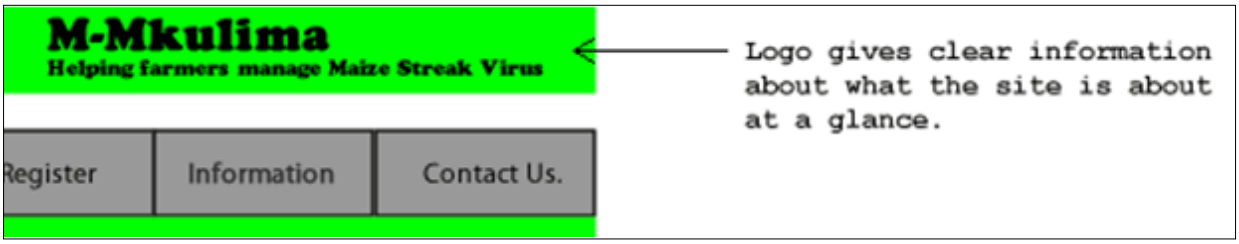
Key
(1)Represents the strongest features, while (11) represents the weakest features that had to be improved.

The data collected was represented graphically so that they could be visualised and understood. Consequently, further necessary improvements were made to the Information Architecture of M-Mkulima-2, based on the test results. I was able to rectify the 5 major problems noted as 7,8,9,10 and 11 in figure in line with information architecture guidelines as shown in the next section.

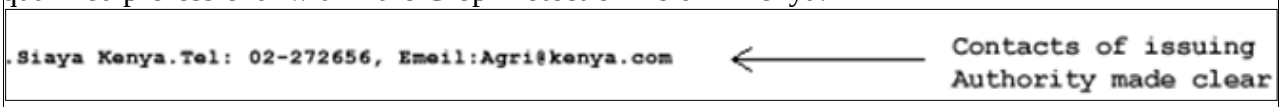
3.13. Improvements made on M-Mkulima-2 following test results

After the user test, I used the data collected to improve the five major weaknesses related to usability and information architecture. This was to make the site more usable, and the information more findable. The improvements, which are also in line with IA guidelines, are shown below:

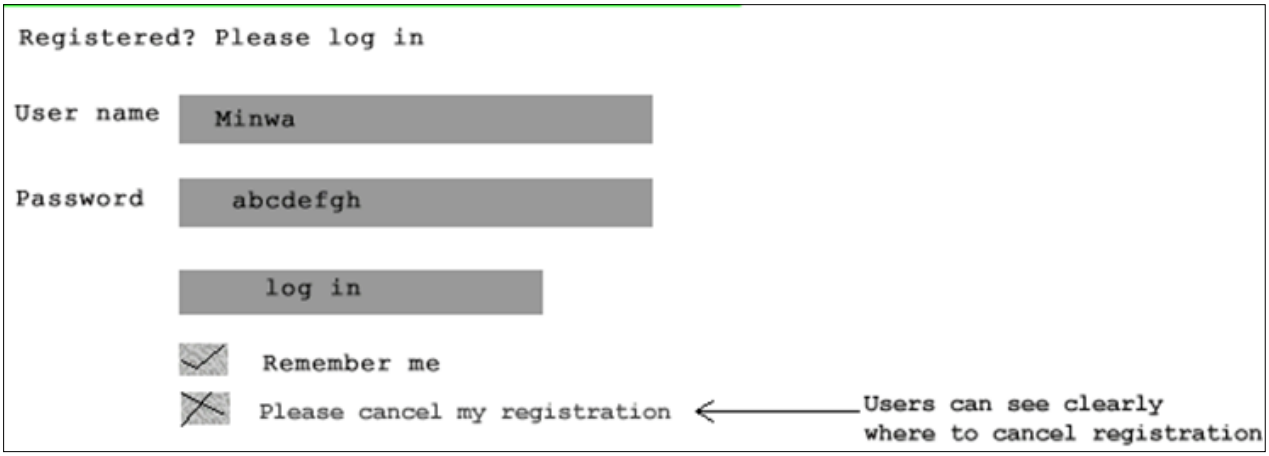
Users mentioned that the Logo should be more expressive, giving a clearer meaning of what the product is. This change was implemented.



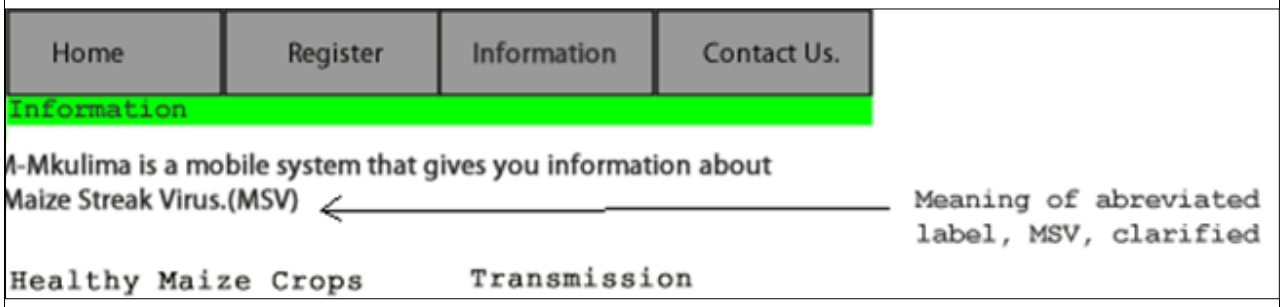
User tests showed that M-Mkulima's credibility should be improved. This was done by including physical address, telephone and email of issuing authority, as suggested by the Stanford credibility guidelines. Besides, it was also to be indicated that the issuing authority is an internationally qualified professional within the Crop Protection field in Kenya.



User tests showed that it must be clear where users can cancel their registration. This change was implemented by indicating clearly as shown below.



iv). Test data revealed that abbreviated labels must give users a clear indication of their meanings. This was improved by indicating what MSV stands for at the beginning of the page. This introduced users to the abreviation, enabling recall by recognition when used later on in the page, where space for the full name was limited.



The front page was improved, to show clearly what the site is about at a glance. This was by adding the text, ”helping farmers to manage Maize Streak Virus,” under the M-Mkulima logo

Table 3: Table showing improvements made on M-Mkulima-2 following test results

3.14. Conclusion

The purpose of this design task had been to solve the challenges encountered by the end users in the current information practice. The problems that were identified in the current information practice involving seeking and providing information are as shown in figure 22.1 below.

Farmers (end users seeking information)	**Agricultural Officer(providing information)**
-High travelling costs to the Agricultural Office -Too much time spent travelling to the agricultural office(2 hours) -Failure to procure information because the Agricultural Officer does not have it.	-Wasted time and money due to mobility and transport costs. This is because the agricultural officers used motorbikes for outreach to farmers. Available motorbikes are shared among staff going to work in different directions, meaning that waiting for transport can result during sudden unplanned visits by clients -Dialect: Local people are versed in the local dialect, meaning that the AO must know the language well. -Internet access: Under the Kenyan Agriculture ministry's employment structure, there is no free internet access. The Agricultural Officer can only access free services at Millennium village partner office in Yala.

Figure 22.1:Problems faced in information seeking and provision

Consequently, a prototype in form of M-Mkulima-1 and M-Mkulima-2 was developed using data obtained from various research tools and methods. This included user interviews, a heuristic evaluation, background research, persona, use cases, benchmarking and prototype testing.

Results were adopted from a previous use case scenerio test for the M-Mkulima-1 prototype, and a further Pen-and-Paper simulation test involving 5 users was carried out for envisioning how users would navigate and experience the mobile architecture for M-Mkulima-2. The purpose was to use the user test results for improving the information architecture and interaction of the design.

Based on the results obtained, and the improvements made thereof, I was confident that this conceptual design was an effective interactive information architecture in cost and time as well as a working solution to the problem or barrier in the end user's current information practice.

The problems/information barriers had been considered in relation to a scenerio where there was an outbreak of Maize Streak Virus in the Siaya ecology. The question I had considered during the interview with the Agricultural Officer was to identify the greatest problem to finding information in order to manage the disease outbreak? I used a scenerio was because it helped focus on the actual problem in the current information practice and what was necessary to arrive at a successful solution.

User tests showed that in terms of saving time and cost in the process of finding information, M-Mkulima generally helped farmers who were end users, meet their goals both effectively and efficiently. They could access information on M-Mkulima-1 and 2, and use it to learn, and to act within reasonable time during a plant disease emergency. M-Mkulima was also one working solution to solve the greatest challenges in the agricultural officer's current information practice.

3.15. Reflection on M-Mkulima's development process

a) Why I designed M-Mkulima as two prototypes

From the onset of the design, it was important that M-Mkulima be a system that is both low cost, and that required low technological knowhow for implementation. This was because the target group falls within the low income, low technology bracket. Therefore, the decision to use an A4 information poster for M-Mkulima-1 was also based on developing a very simple working prototype. However, I thought about those just outside the target group, or the secondary target group, whose information needs could be met in the same system. That resulted in the idea of using data to create the secondary persona, Mr. Jauyoma, and eventually became the basis for designing the M-Mkulima-2.

It was not necessary at this point to test M-Mkulima-1, because it had been previously tested when I designed Saidia Mtoto during my 9th semester studies. Use cases and scenarios had proved it effective.

Instead I focused on testing tM-Mkulima-2 using 5 test persons, and the results gave me the confidence that the use of the two different versions of M-Mkulima was going to work effectively for a broader end user group. This was much more effective and efficient in comparison to if I had only designed the M-Mkulima-1 as an emergency system.

Future considerations here could be the design of M-Mkulima-1 as an interactive mobile interface on more advanced mobile technology like IPods, a digital media from Apple computer. This would mean that as end users became more technologically advanced, and their income increased, it would be necessary to have a technological shift from low to higher technology or ICTs. Such a shift would eventually eliminate the use of the A4 information posters.

b) How M-Mkulima-1 enables the use of Luo language in design

Luo is the local dialect in the Siaya ecology. Most end users can read and understand it. Printing information on the A4 poster made it possible to have both versions of Luo and English languages, thus making the content comprehensible. The resulting flexibility means that end users information needs could be met in a language they understand, without having to work out complex programming codes.

In future however, the question of developing programming codes in the Luo language might arise as suggested by one agricultural profession, who was also a respondent in an online test of concept that was used to test the idea of M-Mkulima 1 and 2.

c) Conceptual design, not a production process

It was important for me to remember that this was a conceptual design, and not a production process. Conceptual design meant that I had to have a proof of concept tested and ready, in contrast to a production process where I had to deliver a finished product. It enabled me to see clearly the areas of the prototype M-Mkulima that had to be improved. An example was the clarification of the role of the Agricultural Officer, who would later play a major role as a keystone species and mediator for technology in the Siaya ecology.

During this formative evaluation, I noticed that if the concept were to be demonstrated to actual stakeholders, for instance, financiers with very little understanding of the technology and ecology concept behind the design, it would be necessary to use a layman's language. Terms like, end user, concept, and information ecology would not be understood by a person whose background did not

involve the study of such terminology. Instead, very simplified language would have to be used, in order to create understanding and convince financiers about the effectivity of the concept behind M-Mkulima.

d) Users are not always right
During the Pen and Paper simulation user test, only 20% of the users liked the general appearance of the site, 40% did not like the colour green, 10% like the simplicity while the rest were not sure. . The reason the 40% gave for not liking the general appearance is mainly because of the green colour. Since all these test users were not from the agricultural profession, I decided to ignore this observation, because green is the colour that would most likely appeal to farmers and others in the agronomy field. Most of the environments they work in is green. This argument is also evidenced by the extensive use of the green colour in the official website for the ministry of agriculture in Kenya at their site: *www.kilimo.go.ke.* and the Danish Plant Directory at: *http://pdir.fvm.dk/*

The results also showed that test users did not find the information on M-Mkulima-2 credible. The improvement in credibility came through updating the contact authorities according to the Stanford credibility guidelines and an indication of their recognised professional competence. Here I realised that I could not do more to make them trust the information on the site, until the content author who is the qualified agricultural officer in Kenya had mapped content into the various categories and labels. For instance, a political science doctorate student was not expected to fully trust a label informing him only about, what Maize Streak Virus, is without reading and understanding the content!

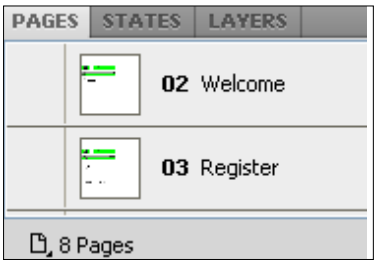
In order to obtain more accurate results regarding the general appearance, I would in future select agricultural professionals for the user tests, or literate farmers in general in order to have test users who understand the meaning of agricultural labels and categories, for instance, Maize Streak Virus.

3.16. Reflection on pros and cons of using Fireworks for M-Mkulima's design

Fire works has only one disadvantage that was special for my case. It is a valuable but expensive working tool for a student. I could only use the trial version available for one month otherwise; the advantages are quite numerous as shown on the next page.

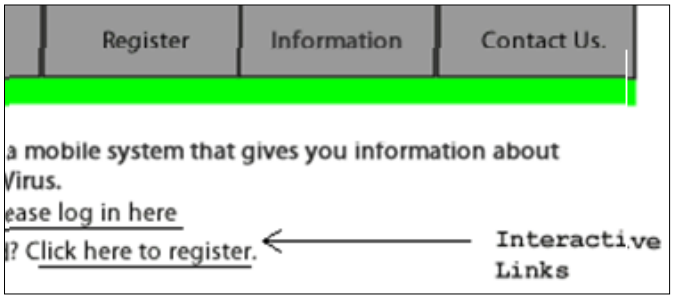
Advantages

a) I was able to work on several interfaces of the global navigation, by just alternating between them simultaneously, thus saving time. An example is that between the welcome and register page.



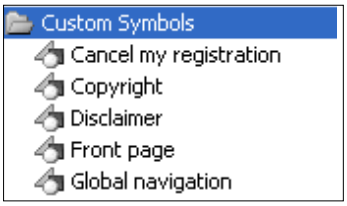
b) The quality of the interactive interface design on fireworks looked quite professional, thus adding to the ethos of the designer. This is better than a hastily drawn prototype using pencil and paper.

c) It was possible to illustrate the interactive nature of the interfaces for the prototype during user tests, as opposed to drawing on paper. This was important in evaluating the navigation system during the design. For instance I could navigate from the interactive links to the pages they led to, namely the log in and register pages.

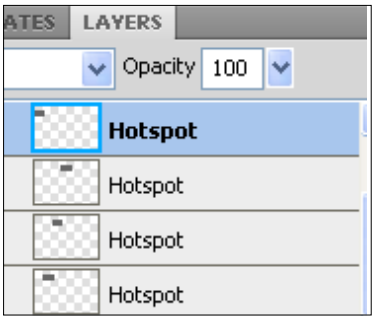


d) With Fireworks, I could simulate a whole interactive site, without having to switch back and forth between different tools like photo shop, Visio. This made adding details to the prototype much easier, than if I had to design the Logo in a different tool, the text in another tool, and then import and combine them to one interface. I could also view my work in a browser, to know how its interactivity will respond to clicks by visitors to the site.

e) Symbols allowed me to define one element or a group of elements into a single object. This was good because the defined elements could be imported and used on all interactive interfaces where needed. Furthermore, the symbols could be edited in a single place and these changes were reflected throughout my document. An example is the global navigation, which could be used on all interfaces.



f) The web layers allowed me to add hotspots and links between the pages of M-Mkulima. This effect was applied to the fully designed prototype's pages to illustrate how the finished site would be navigated.



g) There are many good tutorials that made Fireworks easy to learn and use.

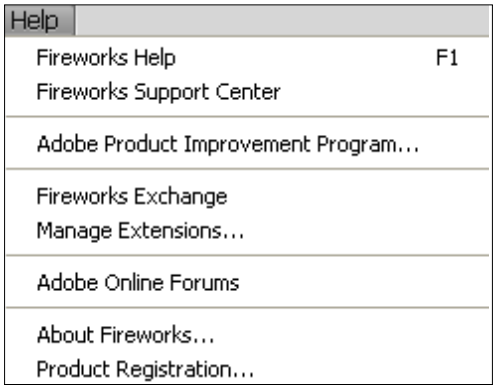


Table 4: Advantages of using fireworks

3.17. Reflections on current information practice

How is the general prototype M-Mkulima a solution to the problems in the current information practice? This reflection (table 6) was important because during the information architecture development process, it was apparent that M-Mkulima had to be a solution to the end user problems. I had already picked out the major problems, and if these could be solved through the design, the integration of the technology would be worthwhile for the Agricultural Officer.

Alot of time and money is wasted in the current information practice; from the poor subsistence farmer who often has to take long, dusty and uncomfortable trips to the agricultural office located 2 hours away, to the agricultural officer who wants to respond to emergency visits by needy farmers only to be totally stranded by lack of transport.

Subsistence farmer/end user's		
Problem	**A working solution in M-Mkulima**	**Improvement in time/cost**
-The farmer incurred high travelling costs and spent too much time travelling to the agricultural office,(2 hours)	-Information on M-Mkulima-2 is accessible right where the end user is or at home for M-Mkulima-1.	-Travelling cost to the agricultural office and time are saved.
-The farmer could fail to procure information on MSV virus because the Agricultural Officer did not have it.	-Highly specific information is accessible on M-Mkulima. There is no failure to procure this information. Users know what information is available for them on M-Mkulima and can use it.	-Travelling cost to the agricultural office and time is saved. -When users know exactly what information to find in M-Mkulima, they will not spend money and time trying to find and buy the same information elsewhere. Redundancy in information is thus cut down.
-I also deduced that the farmer could totally fail to obtain information because she does not know who has it.	-M-Mkulima points to the agricultural officer as the one who has the specific information about Maize Streak Virus. There is even contact information for those end users who want more information.	-Not knowing where to obtain information costs money.A farmer who knows that he can find information about how to prevent MSV virus saves money in case the disease breaks out, than one who does not know anything about it.

Table 6: Reflections on M-Mkulima as a solution in the Siaya ecology

AgriculturalOfficer /User / stakeholder		
Problem	**A working solution in M-Mkulima**	**Improvement in time/cost**
-For the Agricultual Officer, there is no free internet access under the ministry employment structure. -The Agricultural Officer can access free services at Millennium village partner office in Yala.	-Where internet is not available, M-Mkulima-1, the A4 poster is sufficient to meet the end users information needs. Where internet availability is limited, the Agricultural Officer can update information on M-Mkulima-2 when possible. -As an information provider, M-Mkulima-1 and 2 help the Agricultural officer improve accessibility to information, thus enhancing succesful use of the same. -M-Mkulima -1 and 2 are information Maps. They direct users to information available and where it can be found.	-The cost of delay in meeting user information needs due to internet inavailability is reduced. -Information accessibility through M-Mkulima cuts down on the cost of having to provide the same information 100 times to 100 needy farmers at different times. Farmers with M-Mkulima-2 only need to log in and access information that is already provided.
-The Agricultural Officer experiences wasted time and money due to mobility and transport costs. This is because they use motorbikes for outreach to farmers. Available motorbikes are shared among staff going to work in different directions, meaning that waiting for transport can result during sudden visits by clients	-Unless the case requires that the Agricultural Officer must travel to the farm, all other unnecessary farm visits are reduced by meeting the farmers information needs through M-Mkulima -1 and 2.	-Reduced travelling means that the cost and time of meeting information needs is also reduced.e.g. Instead of 10 trips per week costing 500 Kenyan shillings per trip, the Agricultural Officer can now make only 3 very necessary trips at the cost of 500 kenyan shillings per trip. That saves over 3000 kenyan shillings.
-Dialect was a problem.Local people are versed in the local dialect, meaning that the Agricultural Officer must know the language well.	-M-Mkulima-1 is designed in two languages; Luo for those that only understand information in Luo and English for those that can read and understand English	-Cost and time is saved, because a broader section of end users can be reached simultaneously by both the English and Luo versions of M-Mkulima-1.

Table 6.1: Reflections on M-Mkulima as a solution in the Siaya ecology

Note: In these reflections, wherenever I mention M-Mkulima, it means both forms i.e. 1 and 2 which is both forms of the prototype.

Section 4: Integrating M-Mkulima into the Siaya Information Ecology

4.1 The concept of M-Mkulima

The prototype M-Mkulima consists of M-Mkulima-1 and M-Mkulima-2. The later is an interactive information architecture developed on a mobile interface for rural subsistence farmers in Siaya Kenya, while the former is designed on an A4 information poster.

The interaction on its mobile interface has been designed to enhance the way the end users find information, communicate and interact, considering that they have low income and low technical knowhow. (Preece, Rogers, Sharp, 2002) p. 6.When users click on a label, the system reacts in a certain way. For instance, when the users click on"information," the system directs them to the information section. (Figure 22.1). When they click on"Contact us."

The interface is simple, usable and easy to navigate as shown by user tests. 100% of test users understood the links and where they lead to, 100% of the users knew that they were on the homepage just by glancing, and 100% found the language easy to understand. 80% of test users knew what to expect beneath the labels, how to contact the owner of M-Mkulima, and how to retrieve a registration error. Other information architecture features that needed to be improved following user tests were succesfully implemented as indicated in Figure 29.1.

M-Mkulima is organised to maximise the finding and use of information while saving cost and time. This is because the high cost of finding information and the time wasted in trying to access information were the main problems found in the information practice that preceded the design.

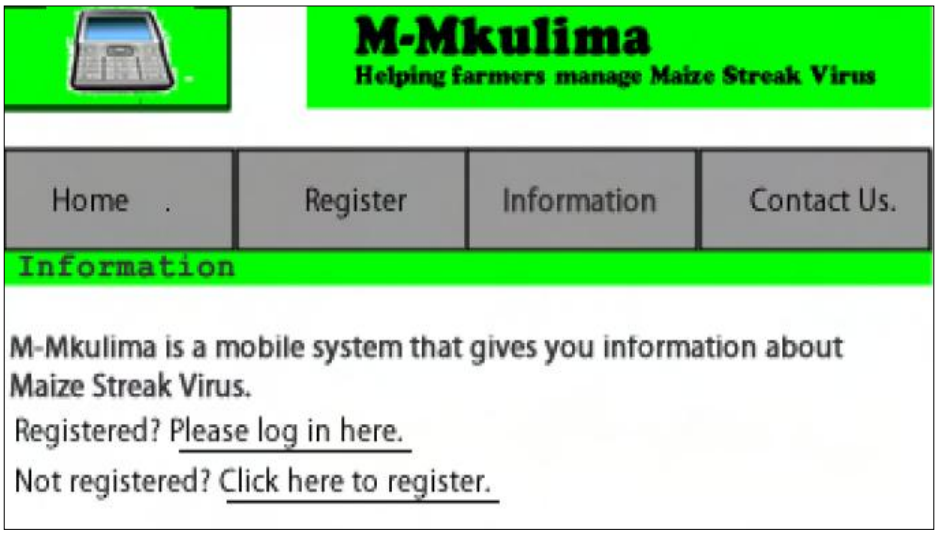


Figure 22.2: The front page of M-Mkulima -2

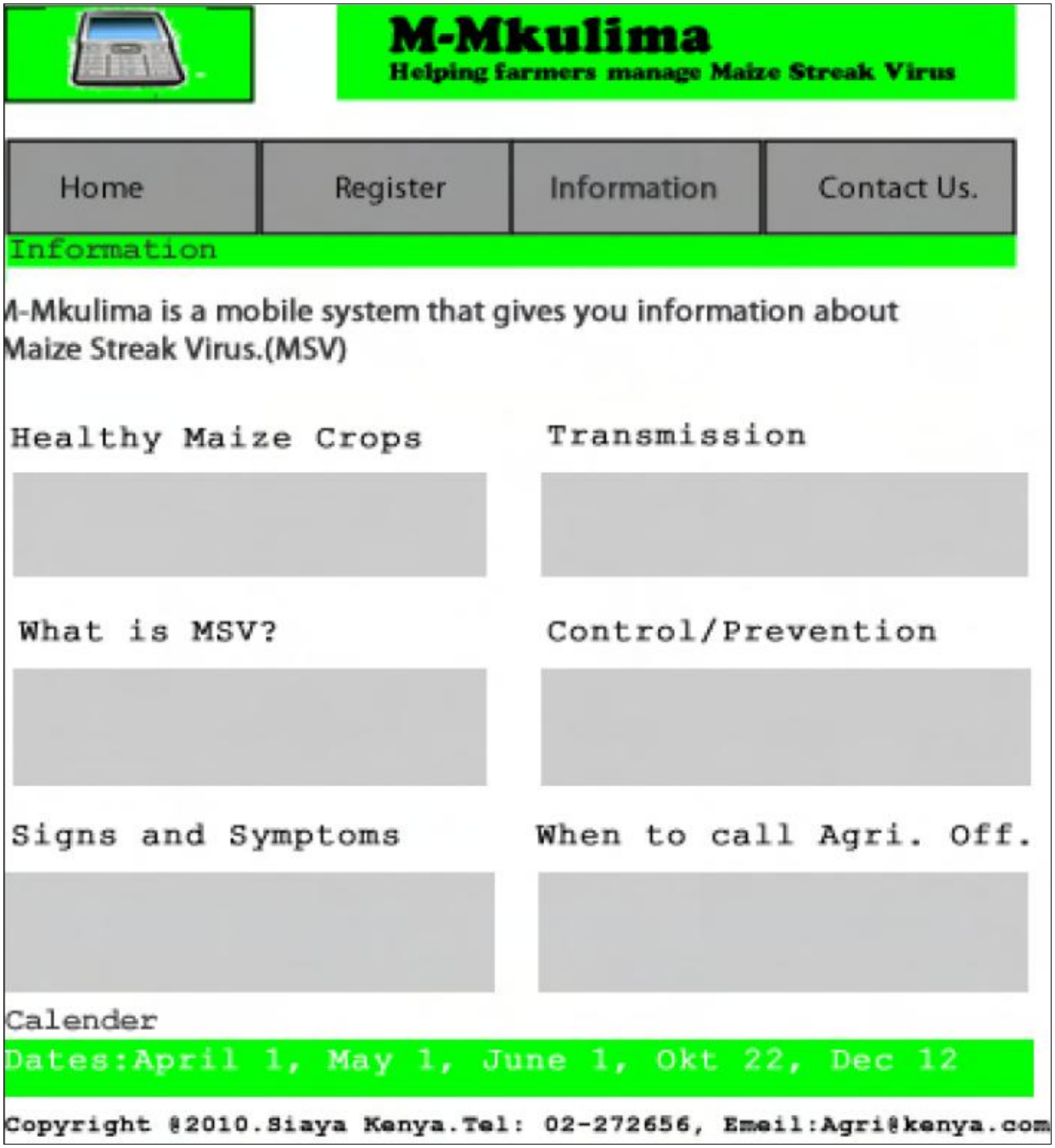
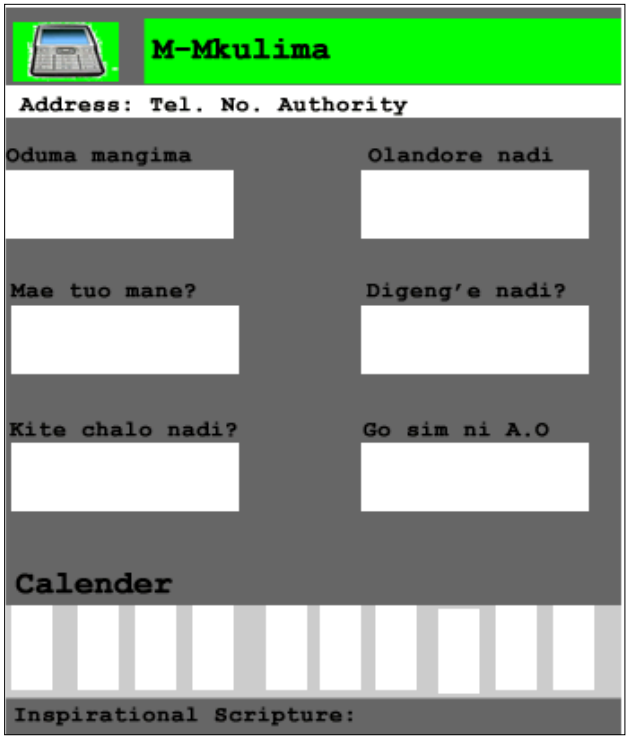


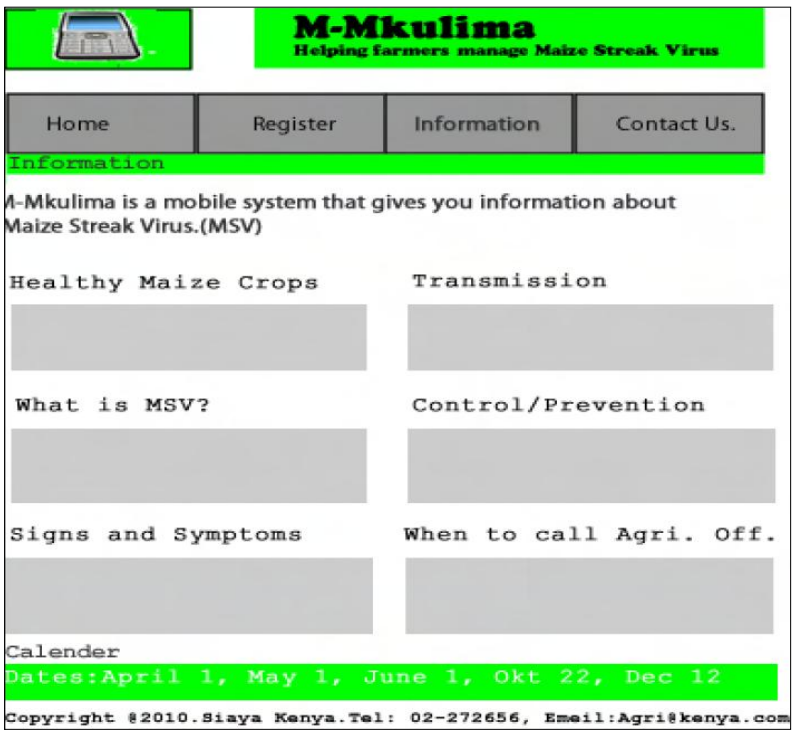
Figure 23: The information page of M-Mkulima-2

There are important facts concerning the organisation and operation in order to support the end users need for finding and using information as shown in figure 24.

Functional organisation of M-Mkulima	**Screen shot for visualisation**
a) The A4 information poster is accessible to end users with low technological knowhow and low income: For example **Mrs. Ogwedhi**  Personal details **Age**: 42 **Occupation**: Subsistence farmer **Location:** Ahono Village Siaya **Family**: Married with 5 children **Income:** Less than I $ per day **Languages:** Speaks Luo, Little Swahili	
b) The interactive mobile interface enables the accessibility, findability and use of information to users with higher income, and technological knowledge. For example: **Mr. Jauyoma**  **Personal details** **Age**: 35 **Occupation**: Progressive subsistence farmer **Location:** Ahono Village Siaya **Family**: Single **Income**: 1$ per day **Languages:** Speaks Fluent Luo, Swahili, English	

c) End users can access M-Mkulima-1 and 2 to find information about what to do:

- Before the disease outbreak.
- During the disease outbreak.



d) M-Mkulima-2 must be integrated into the ecological environment of use, because the content, maintenance and administration requires a mediator. Semi-illiterate farmers cannot use it without help.

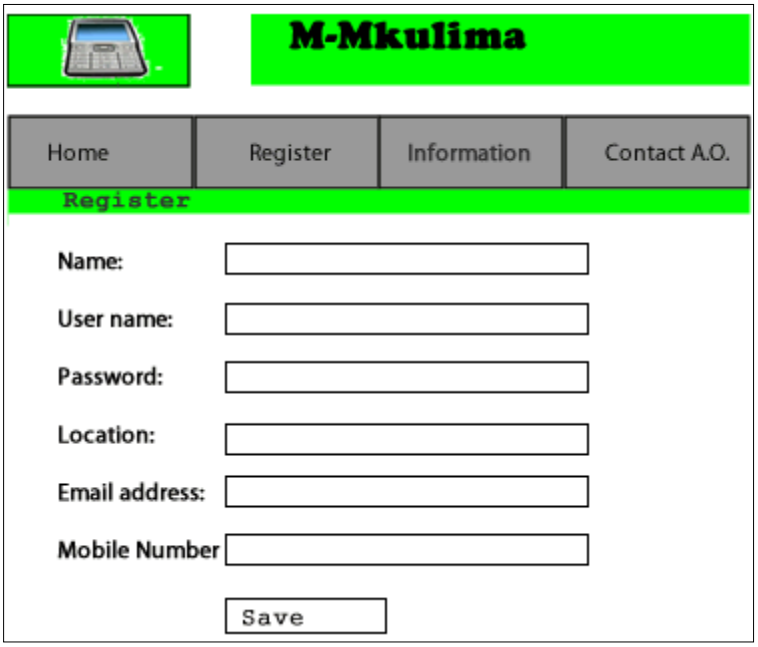


Figure 24: The functional organisation of M-Mkulima

4.2. Integration in Siaya information ecology

In integrating M-Mkulima into the Siaya ecology, the Olson example illustrated in the prologue of this thesis inspired me to think in terms of a human mediator for technology.

Bruce Olson's nagging problem was how to carefully integrate tropical medicine into the curing system of the Motilone ecology. He had tried to give the witchdoctor, who represents the keystone species in the Motilone ecology a sample of Terramycin. This antibiotic could easily cure the pink eye disease that was ravaging the eyes of the villagers. Did he succced? No, on the contrary, Olson was met with strong objection and an attribution of the Terramycin antibiotic to the"ways of the white people."

His ways though scientifically effective and correct, were considered by the Motilone to be different, and not applicable to them as an Indian people.The patient but determined missionary, Bruce Olson captures his dilemma of how to sincerely help these people who had rejected him, wounded and left him to lie for dead in the statement below:

> "The only thing I could do was to try to convince someone to let me try the medicine on him. Then I would have proof that my methods worked and those of the witchdoctor didn't. But then I would be in competition with the witchdoctor. Either I would destroy her and her role in the tribe, or she would have to get rid of me." (Olson, 1999), pg. 126.

As mentioned earlier, Olson did succeed in the end. Not by competing and eliminating the witchdoctor, but by appreciating her roles as the keystone species, and working through her to integrate the medicine into the curing system of the Motilone Bari Indians.

Nardi and O'day also point out the importance of a mediator as a keystone species, who shapes technology so that it can fit to the user information needs of an ecology.

Siaya, like all well functioning information ecologies, has 5 important charateristics. These formed powerful points around which design decisions for M-Mkulima were made. They are:

a) Locality: Only the participants of the Siaya information ecology can establish the identity and place of the technologies that are found in its environment. Consequently, M-Mkulima had to represent technology that could be positioned locally, and under the control of its users. It had to mean something to them. This was accomplished by interviewing end users and finding out what information needs they had, whom they contacted for these needs, if they trusted the information provider and finding out where M-Mkulima would fit in this ecology.

b) A system: Are there people, practices, values and technologies in this particular local environment? **(**Nardi, O'day, 2000) p.52-53. See the statement collected during the interview of the Agricultural Officer below to answer this question:

> "A lot of activities at government or ministerial level and partnership with millennium village's project means we are always on the move either attending meetings, trainings and group visits meaning I must just squeeze some time to attend to the emergency facing the woman." Agricultural Officer, Siaya Kenya.

The statement above reveals the fact that there is a concrete system in place in this ecology. The woman, whose emergency he must squeeze time to attend to was an example of a potential end user

in need of urgent information in order to avert a potential disease epidemic. [16]

It is clear that there is an impressive collection of people and technology working at the three environments that make up an information ecology; the external environment, the organisational environment and the information environment. (Figure 1.1.) Staff in the information environment are focused on the activity of building the farmers confidence and satisfaction in the problem solving and other services offered by the Agricultural office. The goal is to encourage other farmers with similar or other problems to seek advice.

A relevant question that I considered during the design and integration of M-Mkulima was: What if M-Mkulima is suddenly introduced to subsistence farmers for use, without consulting the Agricultural Officer? It could fail because farmers do not know much about plant diseases to update the content and neither can they handle emergencies without the necessary information from an authorised person with reliable sources.

The millennium villages, where the subsistence farmer interviewed for this project is located, are projects that are based on the findings of the United Nations Millennium Project. They try to curb extreme poverty. (http://www.millenniumvillages.org/aboutmv/index.htm)19.04.2010.

c) Diversity: Diversity is an important characteristic of an information ecology. It boosts the ecosystem's productivity where people with different roles no matter how small, all have an important role. See the statement made by the agricultural officer during the interview that reflects the diversity in the ecology.

> ”Through our partnership with Millennium, we have structures on the ground in terms of villages/units representative in charge of agriculture whom we rely on to pass information, mobilize the community for a meeting in case we must pass the information ourselves. ”

This Siaya information ecology is characterised by diversity, which is expressed through different kinds of people, with different kinds of tools working together in a complimentary relation. (Nardi, O’day, 2000). p.52-53. Apart from the government employed agricultural officers working in partnership with the millennium villages to give the farmer the most effective solutions to Agricultural problems, there are representatives in charge of agricultural operations in the millennium villages, who pass on information to mobilize the community for meetings. There are also area chiefs who impose government directives on the villagers. Chiefs in the Siaya ecology are government employees representing the local government at the location level. A location consists of several villages.

d) Co-evolution: In the Siaya information ecology, change in Information architecture triggered by the introduction of M-Mkulima would have a ripple effect on the social setting. This means that if suddenly, the chief who is responsible for effecting government directives on the villagers is removed and his role taken over by a few clicks on a mobile phone, the subsistence farmers who are end users of technology would have to adapt to this new role. They might have to develop more self discipline and responsibility so that they can carry out government directives without an authority to oversee their actions. What if they fail to do this?

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16 The question posed to the Agricultural officer to help him think how to react to a typical emergency was: Case: A widowed woman, with a low income practicing subsistence farming of maize and beans also keeps chicken. Suddenly there is an outbreak of an epidemic, and her chicken begin to die at the rate of 50 per day. She is devastated, because her source of income is dying and does not know what to do.

e) Keystone species: In the Siaya ecology, the interview involving one key subsistence farmer revealed that there is a person whose presence is very crucial to the ecology. This was the agricultural Officer and he was identified as the keystone species.

His working goals captured in statement from an interview reveals that he acts as the information mediator between the government and the subsistence farmer. This was confirmed by the subsistence farmer who when interviewed indicated that the Agricultural Officer was their main source of information concerning agricultural issues. Without him, they would not have access to the latest information within the Siaya ecology. The statement from the interview below, made by the agricultural officer agrees with this fact.

> ”As enshrined in the service charter, is provision of agricultural extension services, maintenance and management of all information within the division guarded by our core values of professionalism, integrity, efficiency and partnership and finally gender equity.” Agricultural Officer, Siaya Kenya.

4.2 The Agricultural Officer as a keystone species

How is the Agricultural officer’s”presence crucial to the survival of the ecology itself” then? The agricultural officer fulfils the definition of a keystone species in the Siaya information ecology. His presence is crucial to the survival of the ecology itself because the villagers trust the agricultural officer as the vital information provider. This is confirmed by the statement given by a subsistence farmer from the interview. She says that without her obtaining this information or raring to work without consulting the Agricultural Officer, the loses they would incur would be about 50%.

Why integrate M-Mkulima through the keystone species, who is the mediator?

New technologies are difficult to integrate into an ecology. The structures that exist cannot just be ignored, and new ones invented every time a new technology comes on the scene.

Often when new technologies are added to our own information ecologies, the work proceeds without a consideration of who the keystone species are. (Nardi, O'day, 2000)p. 54.This means that the species which is essential to the survival of the ecology is left out, thereby ensuring that these technological additions cannot find a place in that particular ecology. Who are these keystone species in an information ecology? They are often people, who like the Agricultural Officer in Siaya, possess certain skills and qualifications which are necessary to support the effective use of the new technology. They are human mediators.

A mediator is a person who builds bridges that connects one institution to another and translates technology into a language that is understandable in its local habitation. (Nardi, O'day, 2000)p. 54

He is the bridge builder because he understands his people. He has worked with hundreds of typical cases presented by the local people, and knows their typical needs. In reference to the Schema theory, the people have a schema for the information provider and his working methods by default in this ecology. (Norman, 2002) p.115-116.

It can be noted from the interview that this Agricultural Officer has another qualifications that help position him in the role of a keystone species within the confines of information ecology. He understands when to dispatch information, because he is connected to the external and organisational ecological environments in the Siaya ecology. This connection is important, so that he can access the latest research results regarding plant diseases, prevention, treatment and other sources of information needed by the villagers.

4.3 Formative evaluation

a) Evaluating M-Mkulima

I chose to do a formative evaluation by employing the help of 2 experts in the information technology field. The purpose of the formative evaluation was to test that the design and integration of M-Mkulima was a working idea. For this purpose, I created slides on PowerPoint and made a design sketch that reflected the users, the content and the context of M-Mkulima. This was because in the information ecology for which it was designed, there was an interaction between these three important aspects. Louis Rosenfeld, who is a chief practitioner in the field of art and science, mentions that Information Architecture is an overlap of users, content, and context.

Consequently, this formative evaluation involved a presentation to show that the core idea of designing and integrating M-Mkulima into the Siaya ecology was functional and feasible, before going further to the actual production.

The results gave room for further improvement of M-Mkulima. I could see clearly that the role of the agricultural officer in the Siaya ecology had to be very clear. After all, he was a keystone species facilitating the integration of M-Mkulima. I also received further comments from one of the evaluators, to explain what an ecology is in terms that could be understood by someone who did not belong to the field of information sciences. Consequently, I used a very common example in the natural environment; the water Hyacinth on Lake victoria, which has been an ecological problem of enoumous proportions. The expert then understood, and I knew that it was important to use common examples that enhance understanding, expecially to people from other professional and non professional fields, who were information technology experts.

Figure 25: Formative evaluation of the concept

b) Test of Concept

One challenge of working more than 4000 miles from the Siaya ecology, was that I could not readily test M-Mkulima using test users from Kenya. Neither could I present the proof of concept to actual stakeholders, or the agricultural officer in Siaya. However, I managed to put my project management skills into practice and contacted the secretary of the department of agriculture and ecology at Copenhagen University. I requested to contact 10 doctorate students from the department for a focus group session in order to test my concept. This was not possible because most of the students were on summer vacation.

The efficient secretary however managed to contact two doctorate students from Africa. One was from Kenya, and specifically an area near Siaya. This wonderful news that now I could test M-Mkulima also meant I had to find a different testing method. I could not travel to Copenhagen just to hold a focus group with two people. Therefore I created a detailed PowerPoint and had a video

recording session of my presentation of the concept. I also formulated a questionaire with relevant questions about the concept.The presentation session was then recorded, edited and loaded on the internet,[17] where the two professionals could view, respond to the questionaire and send the results to me by mail. The questionaire, the response from the participants and my reflections are included with this thesis as attachments numbered 2. In the reflection, I answer the questions posed by the respondents and reflect to enhance processes in M-Mkulima.

The most important results are summed up here, while the reflections and answers to the respondent's questions are included in the attachment named 2.

Question asked	**Respondents**	**Reasons given by respondents**
Whether to recommend or not recommend M-Mkulima	Both respondents agreed to its recommendation.	-Effective and effective communication between the farmers and information providers, which farmers desparately need. -The saving of time and cost
Whether farmers in the Siaya ecology trust the agricultural officer and would accept M-Mkulima as an improvement in his work approach	The response was yes and not sure	-The respondent who is familar with the Siaya ecology agreed that poor farmers would typically trust the agricultural officer. - The other respondent, who only learned about Siaya through the watching the video was not sure, until he investigated this fact.
Whether M-Mkulima works now but can be improved.	Both agreed that it works, but could be improved.	-Improvements suggested were that the mobile interface be in local dialect (Luo) so as the mobile interface replaces the A4 information poster. "This would facilitate effective and efficient evaluation of maize crop for pests and diseases in the field leading to correct identification of problems." -The respondent familiar with the Siaya ecology also suggested that M-Mkulima be availed as a package to include all technical recommendations for producing a specific crop eg. Maize.

Table 7: Results from the test of concept evaluation

The conceptual design officially ended at this point. I was confident that the obvious design challenges had been met, and improvements based on some of the recommendations made would follow at a later stage. This is where user tests would be carried out in Siaya by observing real users in their natural environment. The results can reveal any further improvements that need to be made before the final production of M-Mkulima begins.

Other details like maintenance procedures that involved day to day tasks required in order to maintain M-Mkulima and the administration would follow. Since concept more than production was the purpose of this design, I was satisfied that the most important requirement had been met in form

17 CD-rom handed in with this master thesis.

of a working concept.

4.4. Reflection of the integration process

This reflection is necessary in order to show some of the decisions I made as a result of stopping and thinking about what I was working with. It is also with the aim of improving processes so that the work can be more effectively done in future. Since this was not the firing line, where there is no time to stop and think, I believe that the inclusion of these reflections helps give the thesis a smooth flow.

a) Previous knowledge: In the process of identifying the keystone species in the Siaya ecology, my previous education as an agricultural professional in Kenya gave me the needed cue of who would be a keystone species.I knew who would be best placed in this role, and who could also be the mediator. It might be a more challenging task for an information architect who does not know where to start.

The process could be improved by developing a guideline for identifying the keystone species and mediator. This would save the time and resources consumed when an information architect has to start afresh in every design context.

b) Trust: I wanted to avoid a situation where a person, whom the farmers do not have a good working relation with, do not trust enough to consult, and who represents a symbol of authority comes along with M-Mkulima, only for the human subjects to recoil in fear and resentment.This aspect of trust was important because it is one thing to be an authority, but it is another thing to impose this authority on the human subjects. This could lead to a rejection of M-Mkulima.

c) Diaspora: Working from a distance thousands of miles away: My role as an information architect, who originates from Kenya, but stationed in Denmark has been more clearly defined by designing for Kenyan contexts. As I am positioned more than 4000 miles away, I realised that I could not just design, and introduce new technology based on user needs alone. For instance, no matter how much the subsistence farmers in the Siaya ecology were extremely poor, hungry and in need of information, I could not just design based on these needs. There was already a functional information ecology with staff positioned locally, working professionally and ethically, using the little resources they had to try and fulfill these needs. Overlooking these existing structures would create unnecessary competition and even confusion. Consequently, working with a goal to improving the information practices was best achieved through a mediator.

d) The production of M-Mkulima: User test show that the concept of M-Mkulima is working, and ideal for the Siaya ecology.However, before M-Mkulima becomes a finished product, I realised that further user tests would be needed. These tests would have to be done in Siaya, so that other important design issues which might have been overlooked can be corrected and implemented.

An example is the observation of test users in their natural surroundings, in order to get inspiration on how to maximise the effectivity of M-Mkulima. Is there, for instance, chances that the roof of one house where M-Mkulima -1 is placed could be leaking during the rainy season, thus ruining the information poster and rendering it unusable? What could be a possible solution to such a problem?

e) What if the organisational environment changes? During the integration process, I thought about gathering further evidence that the agricultural officer is indeed a keystone species and mediator. This was inorder to avoid the mistake of deciding that he is a keystone species, and

mediator, only to discover that he is actually not. Consequently, I gathered evidence from different sources: The interview information from a subsistence farmer, a second interview with the agricultural officer in Kenya, online survey from professionals within the field of agronomy in Africa and literature by Nardi and o'day on the use of a mediator who is a keystone species. Additionaly, the Schema theory supported the appropriation through a mediator.

However, it is clear the organisational environment in Kenya can change in future, thus necessitating the identification of a new keystone species and mediator.

f) Professional knowledge of the Siaya ecology

One noticeable fact during the test of concept was that the respondent from Kenya, was obviously more knowlegeable about the ecological environment of Siaya. Most of the answers he gave were a confirmation/affirmation or recommendation to improvement of the whole concept of M-Mkulima. This is obviously attributed to his immense knowlege in the field of agricultural extension in Kenya, and years of professional working experience, in contrast to the second respondent, who had several insecurities regarding the concept. Yet all it all, both agreed that it was a working concept that could be improved.

In future, I would prefer to get test users with similar or almost similar backgrounds, so that the insecurities that might result from one user not being familiar or very familar with the concept is minimised. This requires time and better planning, as well as some monetary investments.

g) Metaphor or metonym?

I found the the term keystone species to be closer to a metonym as used by Nardi and O'day, and not a metaphor. A metonym here will allow the use of a part of the terminology ”keystone species” as used in ecological sciences, to stand for the same in information ecology for the purpose of making inferences. (Larkoff, 1987)p. 77

Metonyms are different from metaphores because a metaphor involves two domains of experience while a metonymy only requires one. The metaphor is also based on similarity, while a metonym requires contiguity. Contiguity means closeness of association; therefore the question arises as to whether keystone species is a metaphor or a metonym?

4.5. Summary

My purpose for finding out how to integrate the information architecture M-Mkulima, into the Siaya ecology was to answer the question asked in the problem formulation. The problem formulation encased below was:

How can information architecture be successfully integrated into an information ecology?

To answer this question, I used inspiration from Olson, a Christian missionary who successfully introduced much needed medicine to the curing system of the Motilone Indians, background knowlegde from my professional agricultural education in Kenya, data collected from the ministry of agriculture's website in Kenya, and data collected from interviewing a subistence farmer and an agricultural officer in Kenya.

I further tested the concept of integrating through the Agricultural Officer as a mediator by performing an online test of concept, using a multimediated presentation whereby I described M-Mkulima's concept in full.The online test of concept test results from two agricultural professionals, who are also doctorate students at an agricultural university in Denmark confirmed that the agricultural Officer is in a position to be the mediator of M-Mkulima in the Siaya information ecology. Both respondents answered in the affirmative to the question”If you are the Agricultural officer, would you recommend M-Mkulima for your farmers?”

Finally, I refered to various literature sources, like Nardi and O'day, the Schema theory as presented by Norman, Davenport and Prusak and Morville and Rosenfeld.The final results were a trustworthy confirmation and identification of the Agricultural Officer as a keystone species and mediator in the Siaya ecology. He was best placed to be the human mediator of technology, through whom the information architecture, M-Mkulima, could be integrated into the Siaya ecology.

I considered this identification of the keystone species as a mediator and consequent successful integration in the Siaya ecology a major progressive step for information architects working in similar contexts; contexts involving low technology, low income subsistence farmers in rural areas of developing countries. It was also a support and expansion of Nardi and O'day's claim that new technology can be facilitated through a mediator, who is a keystone species in ecology.

This whole design and integration experience gave me the confidence to conclude that this master thesis presented a successful and working concept.

Section 5: The advantages of integrating technology through a mediator

My findings show that there is a channel of integrating technology in an information ecology. This is through the mediator. The mediator takes new technology, and gives them a shape that fits the context where they will be used, because he is familiar with the core values of the information ecology. This mediator is a keystone species, necessary for the survival of the given ecology.

When an information architect makes a decision to integrate through a mediator as I have shown in this thesis, there are several advantages as opposed to ignoring the mediator. The advantages are:

No static information environments: The information environments are always changing. There are no static environments, just like a physical ecology evolves over time. In the case where the mediator is a staff within that information environment, he is placed in a strategic position to moniter changes in people, practices, values and technology. The information architect working like I did from a location 4000 miles away cannot acurately predict how an information environment thousands of miles away will evolve over time and effectively adapt the information architecture designed to the local changes. (Davenport, Prusak, 1997).

An example can be ilustrated in M-Mkulima when end users become more technologically advanced and earn more money than currently.They will not need M-Mkulima-1 any more, and instead can effectively use M-Mkulima-2. This change can be quickly noted by the agricultural officer, a mediator and keystone species in their locality than a designer 4000 miles away.

Elimination of unnecessary competition: The mediator's role is already so vital, that it is necessary to the survival of the ecology. He is a keystone species.

An information architect can either choose to integrate through an already established mediator, or try to ignore the mediator and do it by himself, thus creating competition.Unnecessary competition has ugly consequences, including trying to eliminate the competitor.

Enhances the work of the mediator: Integrating new technology through the mediator enhances his information practice, by increasing effectivity and efficiency. This factors save cost and time. When such a positive working atmosphere is created, both the information architect working from a distance thousand of miles away and the mediator located in the local ecology greatly benefit. The former's professional competence is enhanced, while the latter’s status as an efective information provider is increased amongst his people.

Considering these advantages, it is better to integrate through the mediator, than to design and dump technology into en ecology, hoping that it would somehow find a way to survive and be used. To adapt new technology is to enable its survival in the specific ecology. This adaptation to survive is just like in a biological environment where every species has a unique set of features that specifically enable it to live in its environment. Some species exhibit wider tolerance to changes in environment, for instance humans that can survive in both hot dry deserts like Sahara, and cold freezing islands like Greenland.

Section 6: The general relevance of this research for Information Architects

The study regulations stipulated the goal of creative practical reflection in this thesis as having a view of improving processes and products. My reflections also enhanced my competence within the courses's professional field and created an understanding of the decisions that I made in the design and integration process of M-Mkulima.

Information Architect **· Researcher**

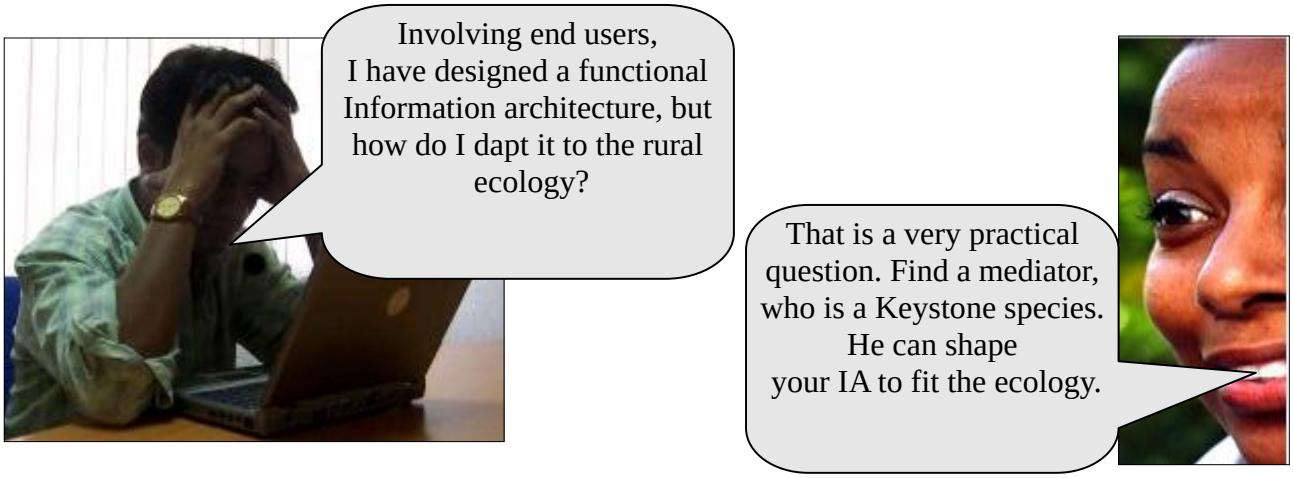

Figure 26: An illustration of the relevance of this research work for IA

My thesis works supports and expands on Nardi and O'day's claims by working with the concept of an ecology where:

- It gives guidance to information architects working in rural information ecologies of developing countries
- It supports and expands on Nardi and O'days claims of appropriation of technology through a mediator who is a keystone species

6.1 Guidance for Information architects working in rural ecologies of developing countries

My research has worked with the integration of an information architecture into an information ecology. The importance of adapting technology to the ecological environments cannot be overemphasised. This is because it is humans within that ecological environment that will use that piece of technology. It is them who will browse an interface in search of specific information, it is the human subjects who will experience total frustration with technology that is too complex to understand, and consequently it is them who will take responsibility for the technology.

It is true that technology cannot maintain and sustain itself, without human intervention. A website does not update itself, study its labelling system and optimise its functionality so that it can meet the needs of its human subjects in the best way possible! It is the human subjects using the website that are responsible for it!

In considering the human subjects and technology as part of an information ecology, this research specifically supports Nardi and O'day's use of the information ecology metaphor. It places emphasis on the human subjects who use technology, thereby guiding information architects working in similar contexts on working with the concept of an information ecology. Thereby, I show how to integrate much needed technology into the ecology, because without integration, even the best technology can be rejected and fail to be put to use.

The problem of integration in the cases I presented, Saidia Mtoto, Hope, and M-Mkulima case, had also been made made complex by the fact that I was working as an information architecture in Aalborg, more than 4000 miles away from Kenya. My guidance arrived at through researched here, therefore gives results that are very relevant for information architects working in similar ecological contexts. These are contexts within rural settings in developing countries, where the Information architect wants to develop designs that meet the information needs of end users with low technological knowhow and low income.

My research has also pointed to the appropriation of technology through a mediator, who is a key stone species. This is because the mediator, like the agricultural officer in the Siaya ecology, often has a role those augers well for the successful integration of technology. This role makes him a person the people know and trust, has working methods that are trusted, knows the ecological environment well and has the necessary skills to adapt the technology so that it can fit to the local ecological contexts, thus supporting the information finding practices of the human subjects.

Information Architecture should always have a purpose of helping the human subjects easily find the information that meets their needs, and be able to use it, thus reducing the cost and time of finding information. These human subjects are part of ecological environments with structures and most often well defined social settings. Such design, like that of M-Mkulima takes place within this social setting.

Every social setting is an information ecology because it is a system consisting of people, practices, values and technologies placed in a specific localized environment with 5 main identifying characteristics. (Nardi, O'day, 2000)p. 49-56. The Information Architecture must be adapted to the ecology, and a consideration of the 5 characteristics of an ecology made.

6.2 Supporting and expanding Nardi and O'day's claims

Nardi and O'day stressed the importance of a mediator, within an information ecology. Their literature shows a mediator as a keystone species in an information ecology, because it is often the mediators who can take the responsibility of shaping the designed technological tools like M-Mkulima, to fit the local context in which end users will use them.

They also mention the fact that many designers, including information architects, often ignore the role of mediators in the adaptation of the designed product to the ecological environment where it is introduced. This often leads to a rejection of the technological product despite the fact that its functionality is successfully as demonstrated through various user tests.

This research has supported and expanded on their work by supporting and expanding on the metaphor of an ecology, and the use of a mediator who is a keystone species to integrate new technology. (Nardi, O'day, 2000)p. 49-58. A mediator, as personified through the Agricultural officer here, was vital for M-Mkulima's successful integration in the Siaya ecology, because he already had a specific role within the ecological organisation. This role as an information provider was also a valuable Schema in the minds of the end users, implying that he could shape the new technology to fit the Siaya ecology, with acceptance from the users.

The other alternative was to introduce M-Mkulima directly to the end users, who are subsistence

farmers in the Siaya ecology. A lot of questions can be asked, for instance: Who will maintain the content and functions of the A4 poster? Where will the farmers ring to in case of an emergency? Who will teach the secondary users how to use M-Mkulima -2? Who will update content, make sure that the links are working, update the calendar etc? These are too many questions that cannot be answered by ignoring the Agricultural Officer, who is obviously a mediator and a key stone species in that ecology.

Is the claim that a mediator, who is a keystone species in an ecology can be used to integrate and appropriate new technology? Yes, the trustworthiness of this claim can be affirmed because of practical and theoretical reasons as shown below:

b) Data collected from the end user interview

The subsistence farmer who was interviewed revealed that it was the agricultural officer who gave them information regarding diseases. Without getting this information, they would incur loses of up to 50%, she stated. She knew and trusted the agricultural officer's role in provision of information. Her statement is supported by the respondent to my test of concept, who has also worked as an agricultural extension officer for more than 10 years in Kenya. He agrees that such subsistence farmers in rural, low income areas of Kenya typically trust the agricultural officer.

c) The agricultural Officers personal interview statements

The agricultural Officer affirmed through a second telephone interview that his role within the organisational environment meant that he could endorse new technology. The only condition was that the technology was tested and proved to make the provision of services more effective and efficient.

d) Data collected from professionals within the agronomic field.

During an online questionnaire, when asked to comment in less than 250 words about the concept of M-Mkulima, one respondent who is from Kenya commented,"M-Mkulima provides effective and efficient communication link between farmers and agricultural extension officers that is vital for rapid dissemination of technical information, which farmers desperately seek whenever they encounter pests or diseases in their crops." He endorsed M-Mkulima with a"Yes" to the question of whether it can be introduced through the agricultural officer. This answer strongly affirms the concept, considering that this respondent has over 10 years of horticultural research, teaching, on-farm training and consultancy, 5 years agricultural extension work has worked professionally as an agricultural Extension Officer, Horticultural Technologist, Lecturer and is currently a PhD Student at a leading agricultural university in Denmark.[18]

A second respondent, also answered that he would have no reason to object the introduction of M-Mkulima through the agricultural officer. He is also an agricultural professional from Africa, holding a bachelor in Agriculture, Master in applied biology, and PhD in progress in weed science.

e) Nardi and O'day's claims about a mediator in an information ecology.

Nardi and O'day suggest the facilitation of new technology through a mediator, who is a keystone species in information ecologies. "Ironically, their contributions are often unofficial, unrecognised, and seemingly peripheral to the most obvious functions of the work place." (Nardi, O'day, 1999) p. 54.This statement serves to propose more reasons why the mediator should not be ignored in the integration of M-Mkulima, thus enhancing the trustworthiness of this claim, by pointing to the important role of a mediator in an information ecology.

18 The Video used for the online survey and the results have been attached to this master thesis as attachment 2.

f) The Schema theory (propositional encoding)

Norman explains the third concept of the Schema theory using the terminology" propositional encoding." This is deductive thought, where knowledge from one schema is used to interpret another schema. Many Schema are known as schemata, and are simply units of human thinking, that help them perceive and interpret their environment. They influence how humans react to information, by directing focus to things that fit into the existing Schemata. (Norman, 2002)p.115-116

Applied in the context of integrating new technology, the end users already know and trust the agricultural officer and his effective working methods. They have Schemata for him and therefore when he introduces a new working technology, they will readily accept it in their Schemata by default.

There could be exceptions, that could create mistrust and failure, but generally the default applies. The default encoding places him in a key position as a mediator in the Siaya ecology, because of the Schema in the mind of the end users; an information provider whom they know and trust.

g) Added value to information

Davenport and Prusak further argue that an information provider, who is the agricultural Officer in this research, can have a value added effect by making information more accessible. According to a survey report that they referred to, managers spent sixteen percent of their time searching for information that was already available somewhere else within the company, but just inaccessible quickly when needed. This waste costed millions of dollars per year! (Davenport, Prusak, 1997) p.157.

Making information accessible is exactly one of the advantages of M-Mkulima, besides findability and usability. There is no doubt that whereas the end users had to travel long cumbersome distances to access information, now they can access it through the A4 information poster and interactive mobile interfaces of M-Mkulima.

This value added effect makes it a valuable tool for the end users and mediator, by giving them something that enhances information practice and work, saving cost and time. The value adding effect makes my claim more trustworthy, because I have a genuine claim in that I want to introduce an effective and efficient technology. It would be ethically, and morally wrong if this was a case of trying to introduce an atomic bomb through the mediator, just because the end users are desperately needy and trust his role.

Finally, Moville and Rosenfeld refer to a holistic information architecture strategy, whereby a solution that is considered a success should work within the unique information ecology. (Moville, Ronsenfeld, 2006)p. 265. That has been done through the appropriation process here.

Section 7: Summary and Conclusion

In section 5, I have presented a practical input to the information architect's box, by giving the advantages of adapting information architecture to the information ecology.

In section six, I have added to its theoretical background. Consequently, I have shown the relevance of my work to information architects working in similar contexts. This was through guidance for information architects working in rural ecologies of developing countries. I have documented how my thesis work supports and expands on Nardi and O'day's work. This is by using the metaphor of an information ecology, as well as appropriation of new technology through a mediator who is a keystone species.

Additionally, I have given solid reasons explaining why my work concerning appropriation of technology through a mediator is trustworthy. I have applied both practical and theoretical underpinnings that support my claim. These reasons range from user interview results, to results from a reliable online test of concept, to solid claims from research work by Nardi and O'day, Davenport and Prusak and finally the Schema theory as explained by Norman.

I conclude by noting that the whole concept of M-Mkulima has been a working idea that I have enjoyed developing. I am confident that it has good prospects for further development and appropriation through further work processes. This would require collaboration with content authors, software engineers, stakeholders and others in a production team that ensures that the final product is an efficient time and cost saving tool.

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Attachments

1. Saidia Mtoto paper presented at the ICCIR10 conference-2010

2. Results from the online test of concept and reflections that include a CD-rom with:

- Test of concept video
- The prototype of M-Mkulima as a PDF file
- Material used for the Pen and Paper Simulation test.

Table List

Figure List