

Visual Interfaces as an Approach for providing Mobile Services and Mobile Content to Low Literate Users in South Africa

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Abstract: Mobile services and mobile content is available to diverse users in possession of the necessary mobile phones. However, some of the mobile services and mobile content is text intensive and this discounts low literate users in participation in the related mobile applications. Exploring typical challenges experienced by low literate users and adapting these mobile applications using visual interfaces can provide low literate users with usable access to mobile services and mobile content.

Keywords: Mobile service, mobile content, low literate user, visual interface.

1. Introduction

The aim of this paper is to illustrate that mobile services and mobile content can be made accessible to low literate users by minimizing the text intensity inherent in these mobile applications. The approach proposed in the paper is to use visual interfaces in designing mobile services and mobile content so as to make them accessible to low literate users. The approach is prompted by investigations from literature that low literate users are better served by mobile interfaces that provide graphical content in relation to text based interfaces [1], [2], [3].

The research will isolate an instance of a mobile service and that of mobile content having characteristics of being text intensive and illustrate as directed by literature that these mobile applications are not accessible to low literate users. This will be concluded based on attributes determined through the exploration of appropriate literature that describes and characterises a low literate user. Next a proposition will be made to design mobile content and services supporting visual interfaces and show that the design, following appropriate heuristics, results in an improvement in the accessibility of the mobile service and the mobile content based on the characteristics of the profiled low literate user.

The motivation behind the research is that mobile services and mobile content offer users a number of advantages beyond simple communication. These advantages further extend toward socio and economic participation with implications to industry and the research community. The industry for mobile phones and related services in Africa is one of the fastest growing industries globally [30].

The advantages that mobile services provide can be attributed to the rapid evolution of mobile phone technology in moving from simple devices initially providing an alternative to fixed line telephones to the multimedia communication devices that provide services to consume and create information anytime and anywhere in the presence of coverage. In fact some mobile services even support offline capabilities in the absence of coverage with the mobile service synching once coverage is present. An in-depth classification of the different uses of mobile phones is beyond the scope of the current research but is however provided in [13].

Globally, and in South Africa mobile operators have made considerable strides in providing coverage to as many users as economically viable. In fact, in South Africa the telecommunications regulator, the Independent Communications Authority of South Africa (ICASA), can institute severe penalties on telecommunications providers, mobile and fixed, that fail to meet the minimum service requirements [27]. The Broadband Presentation [18] estimates population coverage of 75 percent in South Africa. Mobile operators are constantly exploring and improving technologies supporting the provision of mobile services and mobile content, and are further exploring approaches for economically rolling out these technologies to as many users in the general population as possible. Despite these efforts, text intensive mobile services and mobile content though available, remain inaccessible to low literate users [17]. In this paper we propose that designing mobile services and mobile content using visual interfaces can minimize their text intensity and make mobile services and content not only available but with usable access to low literate users. A brief evaluation will be undertaken of the proposed designed application using usability heuristics envisaged to support the provision of usable access to low literate users.

Illiteracy and low literacy are challenges that continue to plague developed countries and even developing countries like South Africa [1, 7, 17]. Literacy trends in South Africa and even projected literacy information show that low literacy will remain a challenge in the country [9, 10], thus indicating relevance of a research effort intending to address the challenges experienced by low literate users in relation to useful access to mobile services and mobile content.

The rest of the paper is organized as follows; in section 2 the background of the research is provided, followed by a presentation of some related work in section 3. Section 4 provides the motivation for designing mobile services and mobile content that minimizes text through the use of visual interfaces and the significance thereof. Section 5 presents a case study of the research, followed by the heuristic evaluation and the preliminary results in sections 6 and 7 respectively. The proposed methodology of the research is presented in section 8 and finally section 9 concludes the research.

2. Background

Mobile services and mobile content are provided through mobile applications running natively on the operating system of the device [19, 20, 13]. Such mobile devices include but are not limited to smartphones and related variants - phablets, feature phones and tablet computers. Future trends in mobile services and content is directed towards smartphones and variants with these devices providing extensive support to data services [6]. Consequently the current research acknowledges but will not involve feature phones and lower.

The mobile operating systems are normally owned by mobile operating system providers who develop core mobile applications including a distribution application on a particular mobile operating system which further allows downloading of non core mobile applications developed by the same mobile operating system providers or other external developers [19, 20]. An example of such a distribution application is iTunes in the case of Apple Incorporation and Google Play for Google.

The general significance of mobile services and mobile content is that they provide a number of services including but not limited to banking services, educational services, government services, entertainment services and information services, hence affording users socio economic participation. These mobile services and mobile content are available to all types of users, but are however typically accessible to experienced and literate users due to their numeracy and literacy requirements. This discounts among other users, low literate and novice users. Literate novice users can through practise and over time gain access to mobile services, but this is not the case for low literate users.

Next we explore and define low literate users as relevant to the research. Low literate users are users affected by literacy. According to the Millennium Development Goals Report 2010 [31] low literacy occurs when individuals have at most grade 6 or 7 of formal schooling. Matyila, Botha, Alberts and Sibiyi [6] relate low literacy in individuals to the literacy skills they possess in their day to day needs. Typically these users may be individuals employed in low levels of farming, mining, or even casual informal employment with limited education requirements.

Low literate users normally have limited education background and the main challenge they experience lies in the fact that these users generally experience problems discerning numerous text [21]. The problem is exacerbated in the case of mobile services and mobile content which may require navigation actions like scrolling, possibly following links and perceiving animations on a device that normally fits on the palm of the user's hand. Visual interfaces can be used successfully to minimize text in typical applications and using them for mobile applications can in turn enable the related mobile services and mobile content to be accessible to low literate users.

3. Related work

In this section we provide a brief overview of existing work for the minimizing of text using visual artifacts towards low literate users.

In the field of pharmacy, there are challenges with non-adherence to medication regimens due to low literacy [4]. Visual artefacts in the form of pictograms are used to minimize text for low literate users. The field of pharmacy has made strides in the standardization of this conversion [5]. Practitioners in the field have optimised to the level of including cultural considerations [4, 5, 14]. Some of the human immunodeficiency virus (HIV) patients have experienced challenges properly adhering to Antiretroviral (ARV) medication due to lack of understanding of the related side effects. In some instances the poor adherence has been attributed to low literacy [14]. When visual images and pictograms are used in the counselling sessions adherence has improved [14].

According to Thatcher, Mahlangu and Zimmerman [15], illiterate users can benefit from icon-based automatic teller machines (ATMs). Chipchase [1], Chittaro [16], Chaundry, Siek, Welch and Connelly [7] and Medhi, Patnaik, Brunskill, Nagasema Gautama, Thies and Toyama [17] all agree that low literate users can benefit from designing mobile devices and mobile interfaces of mobile applications using visual interfaces as a mechanism of minimizing their text intensity. In this way it would be possible to provide low literate users with usable access to mobile applications. Concerns exist in terms of testing the interfaces [15], possibly depending on the culture of the user population. This testing is considered as key in the design of mobile services and mobile content based on visual interfaces. However the current research will not focus on testing as it is considered higher up in the development cycle of visual interfaces. Instead heuristic evaluation will be employed.

4. The need and significance of visual based mobile services and content

Matyila, Botha, Alberts and Sibiya [6] establish that there is a need to design mobile services and mobile content usable and accessible to low literate users. In South Africa, similar to developed and other developing countries, the numbers of low literate users make up a considerable user base which potentially lacks usable access to mobile services and mobile content [21, 1, 7, 17]. According to Chaundry, Siek, Welch and Connelly [7], visual interfaces can be used to design mobile services and mobile content. Chipchase [1] further extends this idea by pointing out that low literate users can benefit from minimizing text in mobile interfaces using visual interfaces thus providing low literate users with usable access to mobile services and mobile content.

The significance of designing text based mobile services and mobile content is based on two factors, one being that low literate users form a significant percentage of the general population in South Africa and the other being that mobile services on top of communication advantages can afford general users important socio and economic participation.

Next the research explores the relative size of the population of low literate users. In 2001 the South African census showed that low literate users were 48 percent of the general population [8]. These numbers have improved over the years, however Posel [9] performed calculations based on the Labour Force Survey (LFS) undertaken by Statistics South Africa in 2007 and the survey undertaken in 2008 by the Southern Africa Labour and Development Research Unit (SALDRU), University of Cape Town (UCT) to low literacy for adults above the age of 15 to be over 25 percent. A more consolidated treatment of low literacy trends in South Africa including subsequent projections is provided by the United Nations Educational, Scientific and Cultural Organization (UNESCO). These are summarised in the table below:

Table 1: Trends in literacy rates (Adapted from UNESCO, 2013)

Country	Year	Literacy Rate (Percentage)
South Africa	1996	82.4
South Africa	2007	88.7
South Africa	2011	93.0
South Africa	2015	94.2

In the table, the results for 2015 show a projection. These trends show a clear improvement over previous years, despite the actual results being different from studies by [8] and [9]. Illiteracy and low literacy are shown to be declining in South Africa [10]. Similar trends and projections apply to the rest of Sub-Saharan Africa in terms of low literacy [10]. South Africa, despite meeting their UNESCO Education For All (EFA) goal 4 in 2011 of reducing adult illiteracy by 50 percent, still shows projections of low literacy of over 5 percent in the population of adults aged 15 years and over. The general population in South Africa is over 52 million, and specifically over 37 million for adults are aged 15 years and older according to Mid-year population estimates [11]. This equates to around 1.8 million individuals aged 15 years and over who are illiterate or low literate in the country. These are users potentially experiencing challenges with usable accessibility to mobile services and mobile content.

The second significance stems from the fact that mobile services and mobile content provide users in the general population with socio and economic participation. According to Acker and Mbiti [12], mobile services can provide users with socio and economic benefits, even in simply making information available to inform day to day decisions by users.

Mobile services can be used to communicate information, advertising of products and even provide platforms for the trading in new and used products [22].

From the brief discussions above it is clear that mobile services and mobile content of all forms are important to all users in the general population and consequently should be made available to all. However as pointed out, it is clear that text currently forms a barrier to useful access to mobile services and content by low literate users. As a result the proposition that text intensive mobile services and mobile content should be designed based on heuristics so as to be accessible to literate users in the general population warrants attention. Next we present a case study with typical attributes of low literate users as outlined by Matyila et. al. [6] and [31] and also typical attributes of a text intensive mobile service and text intensive mobile content and show that through redesign from text based to using visual interfaces, the resulting mobile applications provide usable access to low literate users.

5. Case study

The case study of the research provides a scene where a low literate user needs to perform a specific task on a mobile service and another specific task on mobile content. The tasks will initially be performed on text intensive mobile services and mobile content respectively, then finally performed on mobile applications that are redesigned to minimize text using visual interfaces.

A profile of the low literate user is presented next. Low literate user profile:

- Highest education level; grade 7, South Africa
- Age: 30 years
- Employment: Maize farmworker
- Task1 (Performed on mobile service): Find out if marriages concluded under traditional law are recognised by the South African constitution
- Task2 (Performed on a url using the native mobile browser): Get information on registering the birth of a child

Next the mobile service and the mobile content used in the case study will be described.

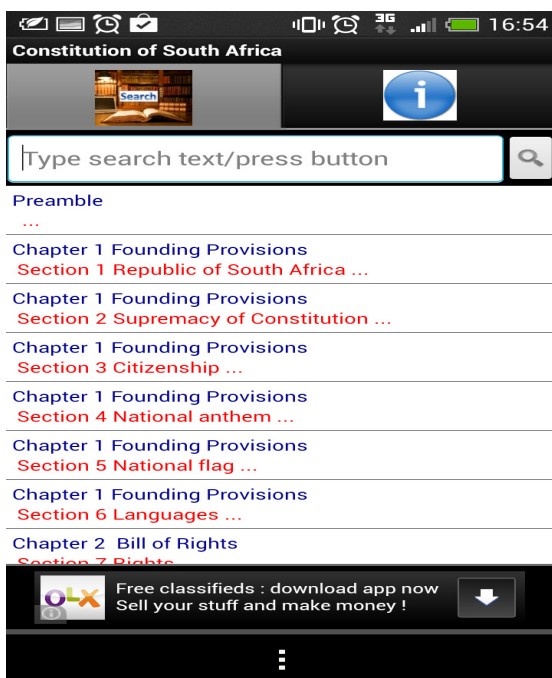


Figure 1

The mobile service and the mobile content used in the case study are running on Google's Android mobile operating system, version 4.2.2 Jelly Bean. The mobile phone being used is the HTC One X handset, which provides significant support for mobile services and mobile content. Task 1 will be performed on the South African Constitution application which has been downloaded from Google's Play store. Task 2 will be performed using the native browser of the phone to go to the the url www.services.gov.za. A mobile version of the website is unavailable, and the user is not redirected to such when accessing the url. The mobile service meets the criterion of being text intensive as the landing space contains an image of the application and an information icon providing user instructions and the author's contact information. The application is shown in Figure 1.

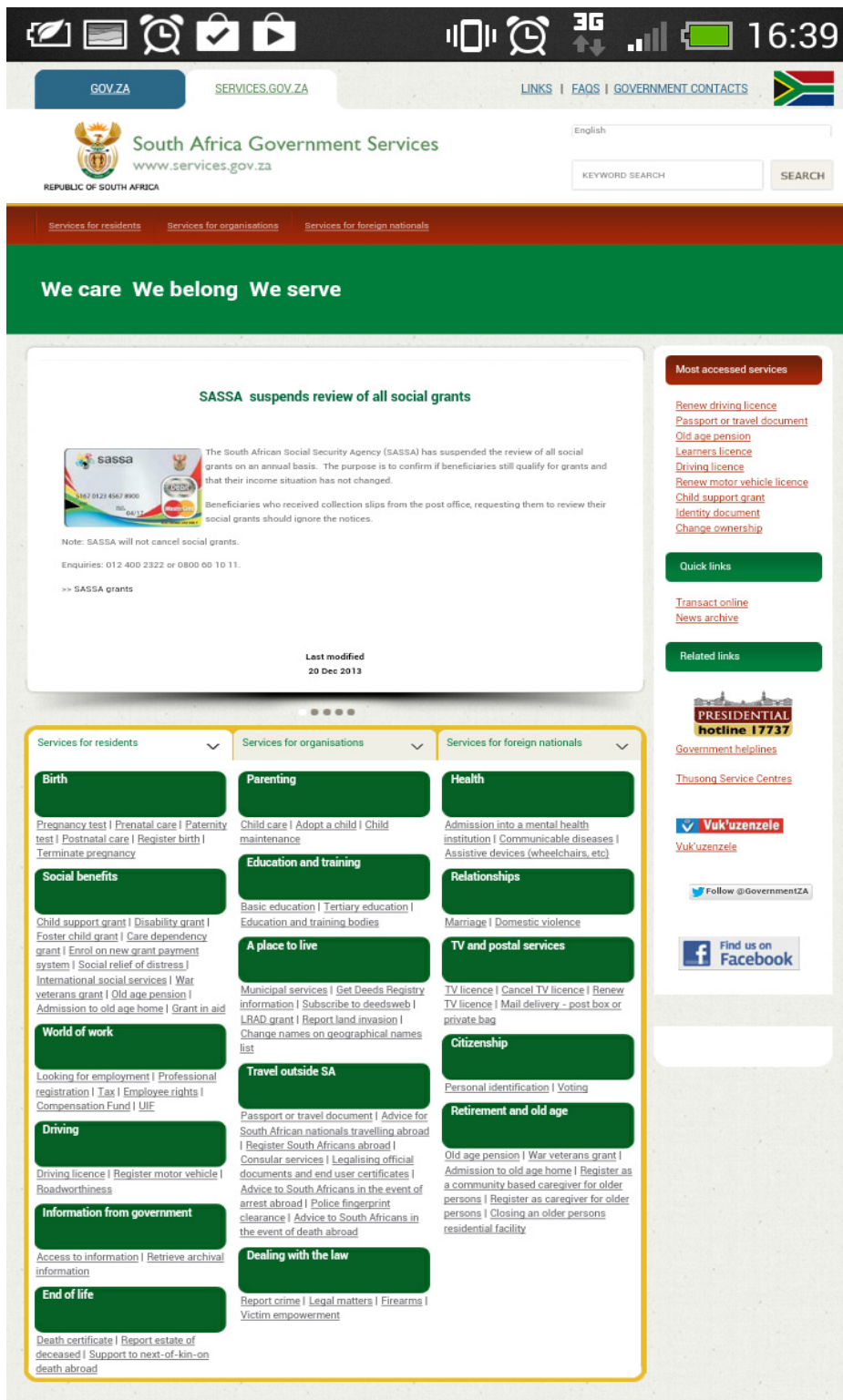


Figure 2

The mobile content also meets the required criterion and this is presented in Figure 2.

Intuitively the performance of the user on the prescribed tasks is anticipated and outlined as follows:

Performing task 1: The user performs task 1 using the mobile service. The shortcut to the South African Constitution application is placed on the desktop for easy access. On launching the application, Figure 1 is the screen that the user is presented with. From the

landing screen the user sees nothing relating to the following; marriage, tradition, traditional. The user then opts to use the search bar. The search terms the user uses are marriage, tradition and traditional. Neither search terms returns any results. The search results in failure.

Performing task 2: The user performs task 2 using the mobile browser and navigates to the required url. On the landing page there is information about birth registration, 'Register birth' and the user click on it. The user is presented with Figure 3 below:

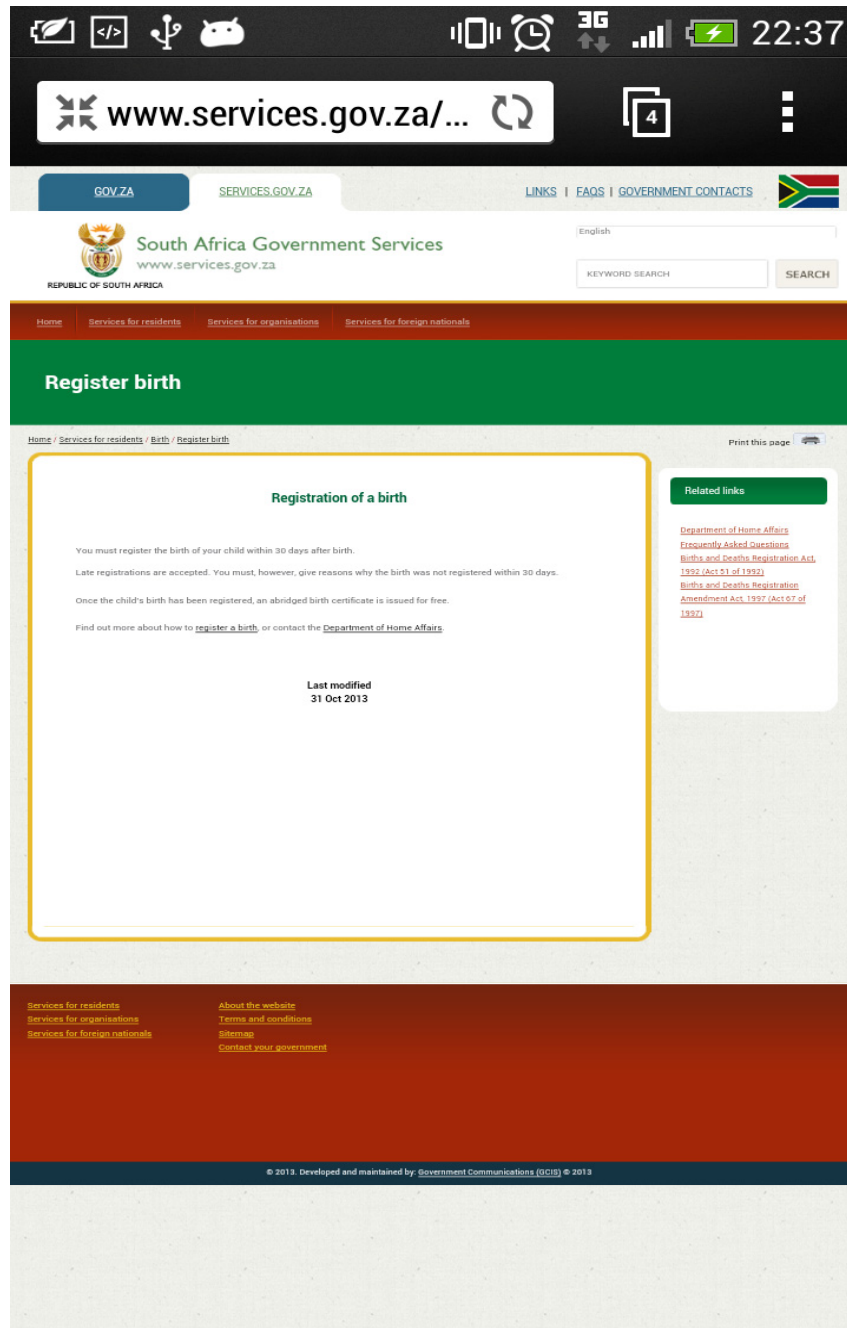
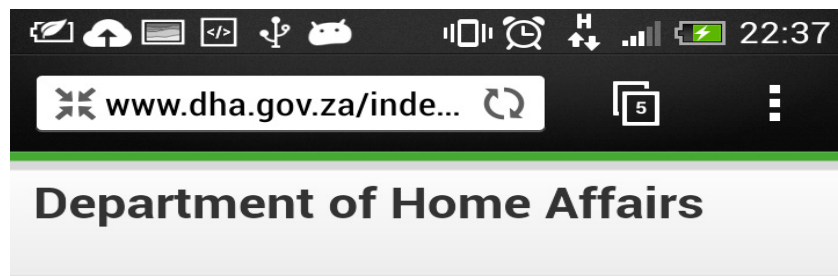


Figure 3

The page contains 2 links, one to register a birth and the other for the Department of Home Affairs. Clicking on the register a birth link the user is presented with Figure 4 below:



Birth Certificates

[Tweet](#)

Registering a birth

All children born in South Africa must be registered within 30 days of their birth (in terms of the Births and Deaths Registration Act, 1992).

A parent, parents, guardian or any other person legally responsible for the child must complete Form BI-24 (with black ink only) and it must be submitted to the nearest office of the Department of Home Affairs if you are in South Africa, or the nearest South African embassy, mission or consulate if you are overseas.

Once the child's birth has been registered, an abridged birth certificate is issued free of charge, usually a day or so after the registration application has been submitted.

Getting copies of birth certificates

Unabridged birth certificates are issued upon request to persons who are:

- South African citizens by birth or naturalisation
- Children of South African citizens who were born abroad

If you need additional copies of an abridged birth certificate (which could be either computer printed, a certified copy of the

Figure 4

The user is presented with numerous text but no direct information and instructions on how to register the birth of child successfully. After scrolling on the page in the hope of finding direction, the user gives up. The task also resulted in failure.

Mobile phones present interfaces that users interact with in using the devices. According to Nielsen and Molich [23] there are four ways of evaluating user interfaces, namely formally, automatically, empirically and heuristically. The formal evaluation involves an analysis technique as prescribed in the field, an automatic evaluation involves a computerised procedure, an empirical evaluation involves experiments with test users and a heuristic evaluation involves the researcher using intuition to perform an assessment of a user interface [23]. Shortcomings in formal and empirical evaluations are presented in the paper by Nielsen and Molich [23]. Further the current research is still at early stages and user involvement is not yet necessary. Consequently the heuristic evaluation is explored for the evaluation of an appropriate user interface that can be used on a mobile phone in eliciting the requirements for designing mobile services and content accessible to low literate users. This evaluation lends itself to earlier use in the research process [23, 24]. Next a preliminary heuristic evaluation of the presented mobile services and content is undertaken by the research process. The aim is to identify attributes and features that

minimises the text intensity of these applications so as to make them accessible to low literate users and encourage their participation in mobile services and content. It is acknowledged in the research that a more in-depth heuristic evaluation involving experts in the field or usability is necessary as to provide more grounding to the research [24]. This is proposed as the next step to be explored in future research.

6. Heuristic evaluation

According to Nielsen and Molich [23], heuristic evaluation is “an informal method of usability analysis where a number of evaluators are presented with an interface design and are asked to comment on it”. Zhang, Johnson, Patel, Paige and Kubose [25] formulates 14 heuristics which they call Nielsen-Shneiderman heuristics since they are based on works by Nielsen in describing 10 major heuristics for good interface design and works by Schneiderman in providing 8 golden rules. Allen, Currie, Bakken, Patel and Cimino [24] provide tabulation and a corresponding summary of these heuristics. The corresponding list of heuristics is as follows; consistency, visibility, match, minimalistic, memory, feedback, flexibility and efficiency, error messages, prevention of errors, closure, reversibility of actions, control and documentation. Following on the process used in the work of Allen et. al. [24], a selection of heuristics applicable to the current research is made, that is, heuristics applicable in evaluating a process of minimising the text intensity of a user interface typically involving high text intensity mobile service or mobile content. The selection of heuristics is as follows; consistency, visibility, memory, flexibility and efficiency, closure and language. Table 6.1, adapted from Allen et. al. [24], below summarises perceived benefits as envisaged in the research process.

Heuristic	Perceived benefit
Consistency	Most of the text reduced to widgets and icons that can be understood by users to achieve similar functionality. As such the user interface will use common standards
Visibility	Navigation on the system improved as most of the text is reduced to icons and widgets, thus minimising navigation challenges like scrolling
Memory	Icons and widgets are normally images which are easier to remember and more intuitive than text
Flexibility and efficiency	The icons and widgets in the interface will form shortcuts to functionality, however this will be more naturally laid out with icons and widgets on the user interface grouping common functionality
Closure	The completion of a task is expected to take less cognitive effort on the part of the user as such more visible
Language	Language will be minimised as much as possible. The bulk of the language will be carried by the icons and widgets, which when properly culturally defined can form a universal language

Table 2: Heuristics and associated benefits for low literate users

An in-depth evaluation, which extends over a number of experts as advocated in heuristic evaluation involves a severity rating of the heuristic violations which may involve a scale measuring the severity of a violation and the associated definition explaining a rating. Such will be extended in the future work providing more objectivity. Currently only a single evaluator is used in the research process making the findings subjective, however as mentioned this only forms the preliminary results.

7. Preliminary results

A design of the mobile applications and content based on the heuristics previously elicited will entail a reduction of text in favour of widgets and icons. The proposed user interface for the mobile services and content is envisaged to follow a design direction as in Figure 5 below:

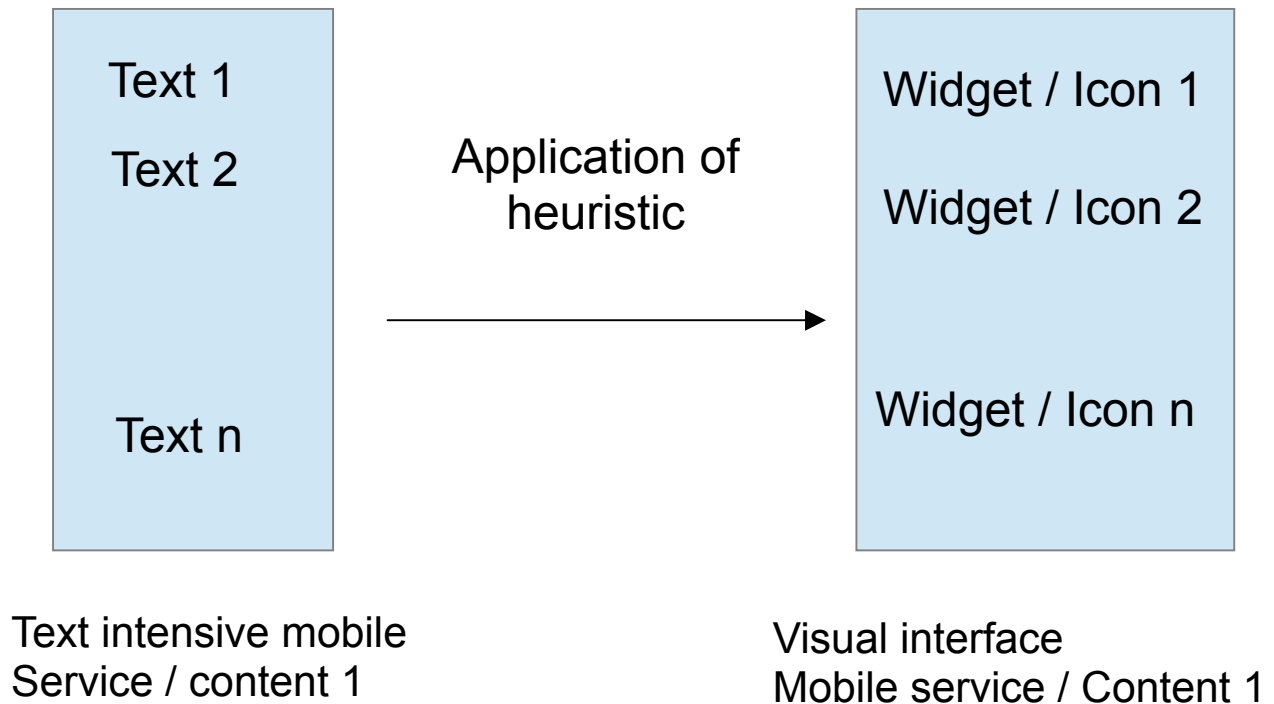


Figure 5

The design based on the selected heuristics can be extended to all the necessary interfaces. Since the design will result in the reduced text intensity of the mobile service or content, then it will provide usable accessibility to low literate users thus encouraging their participation in mobile services and content. The research process will employ a methodology supporting the design of an artifact based on grounding principles. One such methodology is the design science methodology.

8. Methodology

According to Kothari [26], a research methodology is a systematic way to solve a research problem. Design science lends itself to the construction of new and innovative artefacts, which aim to address a research problem [28]. According to Hevner, March, Park and Ram [29] the design science research can be presented as a three-cycle view wherein the relevance, rigor and design cycles are introduced. A summary of these three cycles is given by Matyila et. al. [6], and this is reiterated here. "The relevance cycle bridges the environment to the design research activities, the rigor cycle bridges the design research activities with the knowledge base and finally the design cycle is contained in the design research activities and is involved in building artifacts and evaluating them for relevance" [6]. In the application domain, the research will view the low literate users as the people, the mobile services or content to be designed based on heuristics will form the organisational and technical systems and the problems and opportunities will be getting the

necessary heuristics and using them in designing the mobile services accessible to low literate users respectively. Such opportunities have possibilities of informing practise and directing industry efforts. In the foundations, constituents of the knowledge base, the scientific theories and methods are usability and accessibility, cognitive walkthroughs and domain experts to participate in heuristic evaluations. The design science research cycle brings the two domains together so as to construct artifacts relevant to the application domain, in this case low literate users.

9. Conclusions

The research set out to illustrate that text intensive mobile services and mobile content can be made discernible to low literate users in South Africa through designing mobile services and content using visual interfaces. By supporting low literate users, mobile services and content can afford these users socio economic participation. The current research focuses mainly on the early stages of designing such an application. Future research will need to extend the heuristic evaluation to involve experts in usability, cognitive walkthrough and visual interface design and possibly provide a prototype that will form the initial part in user engagement.

References

- [1] J. Chipchase, (2005). "Understanding Non-Literacy as a Barrier to Mobile Phone Communication," [Online]. Available: http://www.kiwanja.net/database/document/report_literacy_barrier.pdf
- [2] L. Findlater, R. Balakrishnan and K. Toyama, "Comparing semiliterate and illiterate users' ability to transition from audio+ text to text-only interaction," CHI '09 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 1751-1760, Apr. 2009.
- [3] A. Thatcher, S. Mahlangu and C. Zimmerman, "Accessibility of ATMS for the functionally illiterate through icon-based interfaces," Behaviour & Information Technology, Vol. 25, No. 1, pp. 65-81, 2006.
- [4] R. Dowse and M.S. Ehlers, "The evaluation of pharmaceutical pictograms in a low-literate South African population," Patient Education and Councillng, Vol. 24, pp. 87-99, 2001.
- [5] R. Dowse and M.S. Ehlers, "Pictograms in pharmacy," International Journal of Pharmacy Practise, Vol. 6, pp. 109-118, 1998.
- [6] P.M.L. Matyila, A. Botha, R. Alberts, and G. Sibiya, "The design of accessible and usable mobile services for low literate users," ICAST, 2013
- [7] B.M. Chaudry, K.A. Siek, J.L. Welch and K.H. Connelly, "Mobile Interface Design for Low-Literacy Populations," IHI '12 Proceedings of the 2nd ACM SIGHT International Health Informatics Symposium, ACM New York, NY, USA, pp. 91-100, Jan. 2012.
- [8] J. Aitchison, and A. Harley, "South African illiteracy statistics and the case of the magically growing number of literacy and ABET learners," Journal of Education, Vol. 39, pp. 89-112, 2006.
- [9] D. Posel, "Adult literacy rates in South Africa: A comparison of different measures," Language Matters: Studies in the Languages of Africa, Vol. 42, No. 1, pp. 39-49, 2011.
- [10] "Adult and Youth Literacy National, regional and global trends, 1985-2015," UNESCO Institute for Statistics ., Montreal, 2013
- [11] "Mid-year population estimates. P0302," South Africa: Statistics South Africa., Pretoria, 2013.
- [12] J.C. Aker and I.M. Mbiti, (2010). "Mobile Phones and Economic Development in Africa," [Online]. Available: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1693963
- [13] H. Bouwman, A. Bejar and S. Nikou, "Mobile services put in context: A Q-sort analysis," Telematics and Informatics, Vol. 29, No. 1, pp. 66-81, 2012
- [14] R. Dowse, T. Ramela, K. Barford and S. Browne, "Developing visual images for communicating information aboutantiretroviral side effects to low-literate population," African Journal of AIDS Research, Vol. 9, No. 3, pp. 213-224, 2010
- [15] A. Thatcher , S. Mahlangu and C. Zimmerman, "Accessibility of ATMS for the functionally illiterate through icon-based interfaces," Behaviour & Information Technology, Vol. 25, No. 1, pp. 65-81, 2006
- [16] L. Chittaro, "Designing Visual User Interfaces for Mobile Applications," EICS '11 Proceedings of the 3rd ACM SIGCHI symposium on Engineering interactive computing systems, ACM New York, NY, USA, pp. 331-332, 2011.
- [17] I. Medhi, S. Patnaik, E. Brunskill, S.N. Nagasena Gautama, W. Thies and K. Toyama, "Designing mobile interfaces for novice and low-literacy users," ACM Transactions on Computer-Human Interaction (TOCHI), Vol. 18, No. 1, 2011.

- [18] "Broadband Presentation," South Africa: Department Of Communication South Africa., Pretoria, 2012
- [19] A. Charland and B. Leroux, "Mobile Application Development: Web vs. Native," *Communications of the ACM*, Vol. 54, No. 5, pp. 49-53, 2011
- [20] A. Holzer and J. Ondrus, "Mobile application market: A developer's perspective," *Telematics and Informatics*, Vol. 28, No. 1, pp. 22-31, 2011
- [21] J. Nielsen, (2005). "Lower-Literacy Users: Writing for a Broad Consumer Audience," [Online]. Available: <http://www.nngroup.com/articles/writing-for-lower-literacy-users/>
- [22] S. Shackleton, (2007). "Rapid Assessment of Cell Phones for Development," [Online]. Available: http://www.unicef.org/southafrica/SAF_resources_cells4dev.pdf
- [23] J. Nielsen, R. Molich, "Heuristic Evaluation of User Interfaces," *CHI '90 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM New York, NY, USA, pp. 249-256, 1990
- [24] M. Allen, L.M. Currie, S. Bakken, V.L. Patel and J.J. Cimino, "Heuristic evaluation of paper-based Web pages: A simplified inspection usability methodology," *Journal of Biomedical Informatics*, Vol. 39, No. 4, pp. 412-423, 2006
- [25] J. Zhang, T.R. Johnson, V.L. Patel, D.L. Paige and T. Kubose, "Using usability heuristics to evaluate patient safety of medical devices," *Journal of Biomedical Informatics*, Vol. 36, No. 1-2, pp. 23-30, 2003
- [26] C.R. Kothari, "Research Methodology Methods & Techniques", 2nd ed., New Age International (P) Limited, Publishers, New Delhi, 2004
- [27] "End-User and Subscriber Service Charter Regulations. Notice 20 of 2014," South Africa: The Independent Communications Authority of South Africa., Sandton, 2014.
- [28] J. Iivari, "A Paradigmatic Analysis of Information Systems As a Design Science," *Scandinavian Journal of Information Systems*, Vol. 19, No. 2, pp. 39-64, 2007
- [29] A.R. Hevner, S.T. March, J. Park and S. Ram, "Design science in information systems research," *MIS Quarterly*, Vol. 28, No. 1, pp. 75-105, 2004
- [30] T. Phillips, P. Lyons, M. Page, L. Viviez, M. Molina and T. Ensor (2011). "Driving Economic and Social Development through Mobile," *African Mobile Observatory*, [Online]. Available: <http://www.gsma.com/publicpolicy/wp-content/uploads/2012/04/africamobileobservatory2011-1.pdf>
- [31] "Millenium Development Goals - Country Report 2010," South Africa: Statistics South Africa., Pretoria, 2011.