Assessing technological possibility against societal need: smart sketchmaps for fit-for-purpose land administration

Master's Thesis

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Preamble

I gladly present to you the final result of a six-month lasting research process in the domain of international land administration. A research field which got my attention during my Bachelor study in Human Geography and Planning at Utrecht University. I pursued this field of interest during my Master study in Geographical Information Management and Applications as well. I have always been interested in the developing world around us and would like to make a small contribution to increasing recognition of land rights for all.

This MSc research is conducted in the context of the research project its4land, a Horizon 2020 project which commenced in 2016 and aims to develop innovative land tenure recording tools in Eastern Africa. I first heard of this project during a presentation from Rohan Bennett at the fourth Young Surveyors European Meeting in Amsterdam, July 2016. I would like to thank Paula Dijkstra for introducing me to Rohan which resulted in the opportunity to contribute to its4land with this research. This is all made possible due to the wonderful guidance and support of my thesis supervisors, Rohan Bennett and Serene Ho. I want to thank them for investing their time, energy and knowledge during the supervision process. I also want to thank Jaap Zevenbergen who safeguarded the scientific process of this thesis in his role as professor.

I hope this research can make a contribution to the field of international land administration. I hope to pursue this field in the future furthermore.

Enjoy the read.

Wageningen, 28 February 2017, Carline Amsing

Summary

This research seeks to explore the potential of smart sketchmaps for delivering fit-for-purpose land administration in Eastern Africa, especially by assessing whether smart sketchmaps include fit-for-purpose land administration elements according to different stakeholder perceptions. Whilst the use of sketch mapping itself is not new in land administration, smart sketchmaps' technologies and processes allow for conversion of hand drawn sketch maps into topologically and spatially corrected maps. Smart sketchmaps can provide qualitative spatial information in areas where conventional cartographic and geospatial knowledge is often limited. Including these maps in the land administration system not only adds to existing data about visible boundaries, but importantly introduces records of those less obvious socially or temporally constructed de facto boundaries that are significant in customary tenures.

Smart sketchmaps can be seen as the next generation of hand drawn mapping that fully embraces the age of digital interoperability, automated processing, and fit-for-purpose land administration. Since recording certain land tenures is extremely difficult, if not impossible, using conventional technical survey prescriptions, smart sketchmaps may be the fundamental key in removing these barriers. This will be particularly beneficial for public-, private-, or grassroots mappers who cannot always adhere to those technical requirements. Smart sketchmaps in land administration are proposed in the Horizon 2020 'its4land' project. its4land commenced in 2016 and aims to develop innovative land tenure recording tools in Eastern Africa, being smart sketchmaps, UAVs, automated feature extraction, and geocloud services. All in order to deliver fit-for-purpose land recording services.

The focus of this research is on developing countries, specifically in Eastern Africa, that have the urgent need for innovative tools that support the continuum of land rights. The continuum of land rights is key in acknowledging different types of land tenure: it can support the road to ownership and control over land by all people and sustain their livelihood and survival. In fit-for-purpose land administration, land administration systems are flexible and focus on citizens' needs, consequently informal tenure types have to be taken into account as well. Assessing fit-for-purpose land administration elements can be difficult, especially for a tool that is yet to be proven in pilot studies, let alone adopted. Therefore, perceptive input from different stakeholders from different backgrounds is sought. Stakeholders are identified from different user groups: international users (investors, donors, other organizations), industry users (large geo-related companies), emerging users (NGOs or businesses increasingly engaging in fit-for-purpose land recordation activities) and research users (academia from different research institutions). Perceptive input from these stakeholders is sought by applying the Q-methodology.

Thirteen participants have conducted the so-called Q-sorts in which they ranked thirty statements on a forced distribution chart ranging from strongly disagree (-4) to strongly agree (+4). After the Q-sort an accompanying interview was held in which participants reflected on the sorting and motivated their choices. The gathered data was factor analysed, according to which three factors with clusters of perceptions are identified. Factor 1 perceives smart sketchmaps fit-for-purpose from the viewpoint of its societal fitness. Stakeholders in this factor mainly have a background in the societal processes concerning land administration. Societal fitness of any tool is of high importance in order to have effective outcomes and make significant impact. This factor is not so much focused on the added value of smart sketchmaps, if societal demands can be met is more important. Whether with smart sketchmaps or another technical tool. Factor 2 perceives smart sketchmaps fit-for-purpose from the viewpoint of its technical fitness. Stakeholders in this factor mainly have technical backgrounds. Technical fitness of the tool is of high importance as well, especially while the development is ongoing. Technical specifications have to be taken into account and piloted in the case areas. Specific elements to take into account are how to extend the LADM by including sketched information, while still remaining flexible to local situations. Besides, the means of sketching should remain flexible as well. Either by drawing freehand on blank paper or by annotating aerial images should be possible. The question remains how to provide sound base maps for the system when these are not present. Satellite imagery might be too low of resolution and flying UAV imagery has high costs to it which governments in Eastern Africa possibly cannot afford. This will be a challenge and costly element when scalability is required. Factor 3 perceives smart sketchmaps fit-for-purpose from the viewpoint of its commercial fitness. Stakeholders in this factor mainly have a background in business. This factor is interested in possible cooperation to use the tool within their organizations for commercial purposes.

The development of smart sketchmaps in its4land focuses on the three identified factors in this research in their work packages. Though, just as for the researched stakeholders, a balanced consideration of all work packages is key for a successful outcome of the development process. Without balanced consideration of one another's findings successful outcomes will be more difficult to achieve. By taking into account all of the three views represented in the three factors, smart sketchmaps are deemed suitable for a fit-for-purpose land administration approach.

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List of Acronyms

Acronym	Explanation
FFP	Fit-for-purpose land administration
FIG	International Federation of Surveyors
GIS	Geographic Information System
GLTN	Global Land Tool Network
LADM	Land Administration Domain Model
NGO	Non-Governmental Organization
SSMs	Smart sketchmaps
STDM	Social Tenure Domain Model
PCA	Principal Components Analysis

Glossary

Eastern Africa: Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mayotte, Mozambique, Réunion, Rwanda, Seychelles, Somalia, South Sudan, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.

Fit-for-purpose land administration: applying the spatial, legal and institutional methodologies that are most fit for the purpose of providing secure tenure for all. This approach will enable the building of national land administration systems within a reasonable timeframe and at affordable costs. The systems can then be incrementally improved over time.

Land administration: the processes of recording and disseminating information about the ownership, value and use of land and its associated resources.

Land administration system: should include a form of land registration in which ownership of land is recorded and in some countries guaranteed.

Smart sketchmaps: the technologies and processes that enable hand drawn non-metric spatial representations to be converted into topologically and spatially corrected maps.

Societal pull: growing demand for new services, for instance; e-governance, sustainable development, electronic conveyance, and the integration of public data and systems.

Stakeholder: Can affect the achievement of an organization's objectives or who is affected by the achievement of an organization's objective.

Technology push: rapid developments in technology, for instance; the Internet, geospatial databases, modelling standards, open systems, and GIS.

These definitions are based upon several sources all to be referred to in the remainder of this proposal. Unless otherwise stated the definitions are applied and used within the context of this work.

1. Introduction

1.1 Background

'By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to … ownership and control over land'

- United Nations, 2015

According to the Sustainable Development Goals, the United Nations wants to ensure ownership and control over land by all men and women will be recognized by 2030. This represents an immense challenge. In many western societies ownership and control over land goes without saying, but it is estimated that 70 percent of the world's people-to-land relationships are not documented and fall outside the formal land administration domain (GLTN, 2015). The figures for sub-Saharan Africa are especially daunting: it is estimated that up to 90 percent of rural holdings are not recorded despite many people being dependent upon land as a resource for their livelihood and survival (Byamugisha, 2013). Land tenure insecurity often causes land-related issues which result in many conflicts worldwide, prolongs informal settlements, land grabbing, land disputes, impedes tax governance, and so forth (Bruce & Boudreaux, 2013; Zevenbergen, De Vries, & Bennett, 2016)

Often, land administration systems in sub-Saharan Africa are based upon a *narrow land administration paradigm* using conventional mapping methods introduced in the colonial times (Williamson & Ting, 2001). The land titling tools used are developed in the context of Western Europe, these methods cannot be adopted one-to-one in developing countries since they tend to be time consuming and capacity demanding; alternative approaches should therefore be adapted to local needs (Zevenbergen et al., 2016). In addition, the international land administration sector is calling for a more inclusive approach which is pro-poor, since the narrow land administration paradigm has often worked against the poor by not recognizing land rights of marginalized groups. Acknowledging the continuum of land rights is key to incorporating formal, informal and customary land rights in a land administration system (Zevenbergen, Augustinus, Antonio, & Bennett, 2013). This will support the establishment of land tenure security for all. An example of such an approach is fit-for-purpose land administration, developed for managing current land issues in a participatory and inclusive manner (Enemark, Bell, Lemmen, & McLaren, 2014). This approach argues for the use of "spatial, legal, and institutional methodologies that are most fit for the purpose of providing secure tenure for all" to "enable the building of national land administration systems within a reasonable timeframe and at affordable costs. The systems can then be incrementally improved over time" (Enemark, Mclaren, & Lemmen, 2015, p. 31). Several countries in sub-Saharan Africa have started to apply this approach by taking into account various forms of tenure, resulting in the adoption of innovative national land laws, this is an important stepping stone in the land administration domain (Byamugisha, 2013).

Acknowledging different forms of land tenure requires new forms of land registration. New tools for spatial data acquisition and recordation are needed to support the continuum of land rights and fit-for-purpose approach (Enemark et al., 2014; Van der Molen, 2006). This is confirmed by Bennett, van Gils, Zevenbergen, Lemmen and Wallace (2013) who point out these tools should reflect "pragmatism, diversity in approach and innovation" (p. 3). Besides the need for the development of new tools, the countries should be willing to adopt them.

This research is conducted in the context of the Horizon 2020 'its4land' project, which aims to develop innovative land recording tools in Eastern Africa. The project commenced in 2016 and identified Ethiopia, Kenya and Rwanda as case locations (Figure 1). The innovations include smart sketchmaps, Unmanned Aerial Vehicles (UAVs), automated feature extraction and geocloud services, which aim to deliver fit-for-purpose land recording services (its4land, 2016b) [1].

[1] its4land is a European Commission Horizon 2020 project funded under its Industrial Leadership program, specifically the 'Leadership in enabling and industrial technologies – Information and Communication Technologies ICT (H2020-EU.2.1.1.)', under the call H2020-ICT-2015 – and the specific topic – 'International partnership building in low and middle income countries' ICT-39-2015.

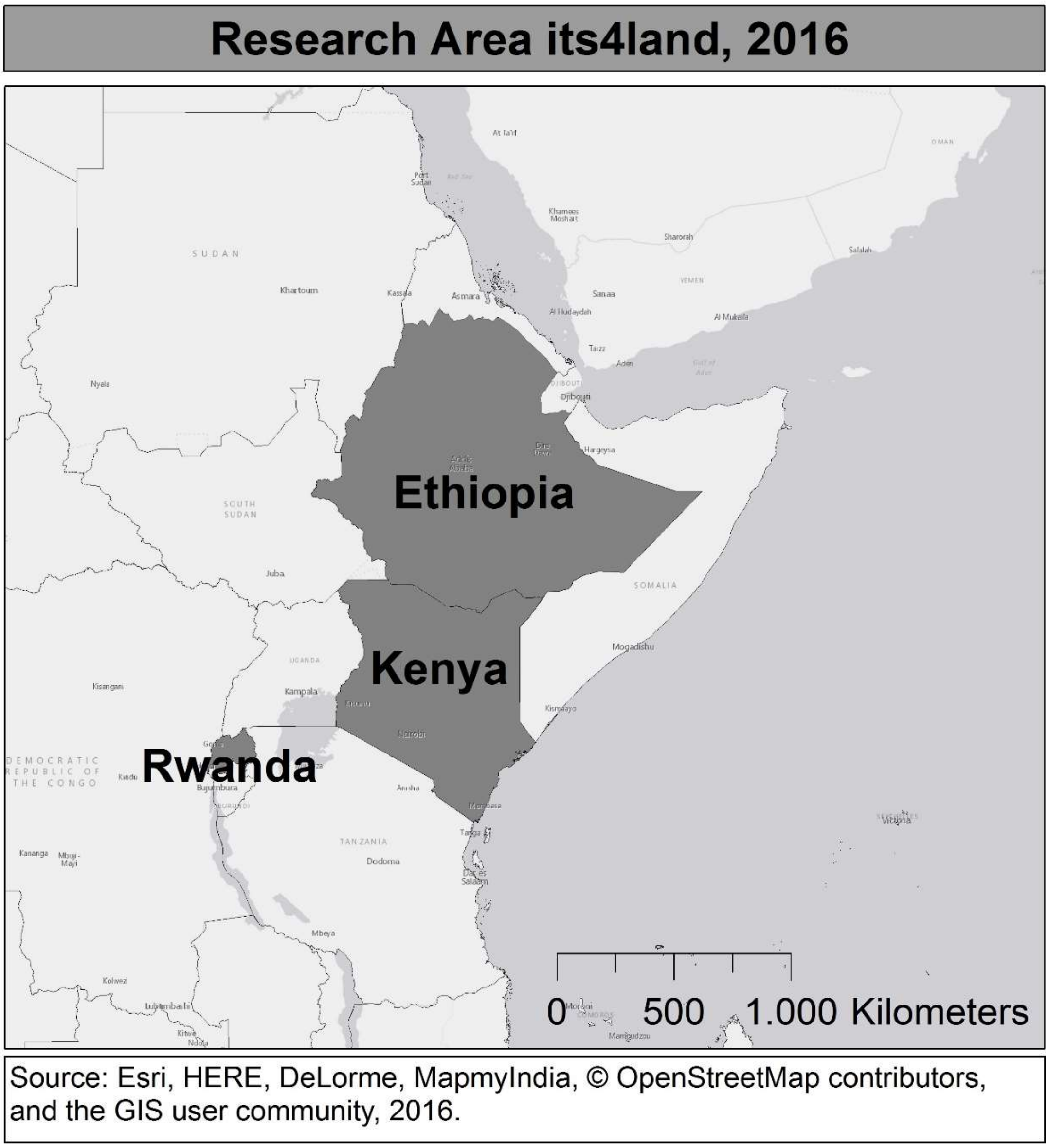


Figure 1. Countries of focus for its4land project. Source: its4land, 2016a.

1.1.1 Smart sketchmaps

This research focuses on such a new land recordation tool: smart sketchmaps. This tool aims to create and facilitate interactions with land tenure information in the context of land administration systems (its4land, 2015). This research specifically seeks to link the opportunities of smart sketchmaps to the contemporary societal needs of land administration in Eastern Africa. The use of sketch mapping itself is not new; sketch maps have an extensive tradition in modern geography, and are still widely used (Boschmann & Cubbon, 2014). Local knowledge of places is increasingly recognized as a key element in understanding different processes which impact inhabitants; therefore a sketch map can be utilized to collect, analyse and communicate that local knowledge (Curtis, 2016).

Sketch maps are helpful in land administration and frequently used in developing countries where cartographic and spatial knowledge is usually limited (its4land, 2016c; Zevenbergen et al., 2013). The application of smart sketchmaps, however, has not been explored before in the context of land administration. Smart sketchmaps can be defined as the technologies and processes that enable hand drawn non-metric spatial representations to be converted into topologically and spatially corrected maps (its4land, 2016d). its4land aims to develop a tool for extracting spatial information from sketchmaps for the purposes of land tenure recording and wants to enable the capture of descriptive land tenure information from sketchmaps for incorporation and extension of the Land Administration Domain Model (LADM) (its4land, 2015). LADM provides a standard for describing land administration systems worldwide based on quantified geometric information (ISO/FDIS 19152, 2012). its4land aims to extend the LADM with a shared vocabulary for sketching qualitative spatial information. The smart part of this tool relates to the semantic object recognition: “Explicitly drawn spatial objects are identified and assigned a semantic category. This makes them amenable to manipulation and deeper analysis” (its4land, 2015, p. 16). The semantic categories are to be described in the extended LADM.

1.1.2 Innovation

Introducing such new techniques requires insight into the actual user needs of the mappers who are likely to use the tool to reduce the possibility that the new technique fails to deliver the expected benefits. This may occur when one emphasizes too much on the technology push rather than the demand pull coming from society (Petch & Reeve, 1999). ‘Technology push’ can be defined as rapid developments in technology, for instance: the internet, geospatial databases, modelling standards, open systems and GIS (ISO/FDIS 19152, 2012), or in this case, smart sketchmaps. ‘Demand pull’ can be defined as a growing demand in society for new services, for instance: e-governance, sustainable development, electronic conveyance and the integration of public data and systems (ISO/FDIS 19152, 2012). Ghawana et al. (2016) point out the importance of supporting clients in land administration rather than the internal processes. However, only focusing on the demand pull, may lead to technological capabilities being ignored; only focusing on the technology push may fail to adequately account for current needs and market conditions. In order to successfully innovate, both sides interact with one another (Nemet, 2009). The technology push should be in equilibrium with the demand pull coming from society and vice versa.

In the land administration sector there is a need for innovation which will lead to more market oriented and socially demanded solutions (Ghawana et al., 2016). When new technologies are user-centric, faster and cheaper methods for land recordation can be enabled (Bennett et al., 2013). Though, without a balanced consideration of the technology push and the demands of people, the unacceptable ‘cadastral divide’ between countries will remain (Bennett, van der Molen, & Zevenbergen, 2012).

1.1.3 Stakeholders

In this sense it is important to sketch a first identification of stakeholders in this research. A stakeholder can be defined as someone who: “Can affect the achievement of an organization's objectives or who is affected by the achievement of an organization's objectives" (Freeman & Reed, 1983, p. 91). For this research that would be someone who can affect the achievements of its4land’s objectives or who is affected by the achievements of its4lands’ objectives regarding smart sketchmaps in fit-for-purpose land administration.

Currently, there are two parties working on the smart sketchmaps tool development within its4land. University of Leuven (KUL) is developing work package 2: Get Needs. University of Muenster (WWU) is working on the actual development of the tool in work package 3: Draw and Make. KUL will gather knowledge on the societal pull in land administration in Eastern Africa, WWU is more focused on the technology push, taking into account their previous studies on smart sketchmaps.

With regards to smart sketchmaps one should make a distinction between the end user and actual beneficiaries. The direct end users are the mappers - they possess the geospatial knowledge necessary to produce smart sketchmaps with the communities. These can be: 1) conventional top-down surveyors, usually embedded in the processes of a conventional government-run land administration system; 2) bottom-up grassroots mappers, often from NGOs working closely with target communities; or 3) emerging private sector SMEs engaged in surveying and mapping activities, but, able to work outside conventional land administration processes. The key difference between the first two groups and third group is that the latter will possibly use smart sketchmaps as a tool if there is a market and its use is cost-effective, the former can use the tool to map without market or cost-effectiveness; since they are supported by donors. The beneficiaries are those who may benefit from the processed outcome of smart sketchmaps. These are most likely the land holders, such as peasant farmers, urban smallholders, nomadic pastoralists and African or European small and medium-sized enterprises (SMEs), the public and private sector, research institutions and NGOs.

An overview of the stakeholder groups is presented in Figure 2. One can identify international users, which can be investors, donors or other organizations, they may endorse smart sketchmaps for projects. Industry users are likely to be the large companies which may develop geo-related hardware and/or software and are therefore able to develop smart sketchmaps on a larger scale. Emerging users are likely to be non-governmental organizations or businesses which are increasingly engaging in fit-for-purpose land recordation activities. Research users are likely to be the academia coming from different research institutions focusing on land administration who may test and scrutinize smart sketchmaps. When analysing the figure from the perspective of its4land, it seems that KUL and WWU are mainly focusing on the East African users, being the pilot communities, local NGOs and the national government. The other users seem to be somewhat neglected in the process, thus far (Figure 2). This brings the opportunity for this research to analyse the prevailing perceptions of the other stakeholders who have a broader impact with regards to the utilization of smart sketchmaps for fit-for-purpose land administration, apart from the East African users. In the future these stakeholders may actually adopt, apply and use smart sketchmaps in one way or another. These stakeholders can affect the achievements of its4lands' objectives or vice versa. They can be broad experts on the topic or have a specific expertise in the research area.

Figure 2: Identified stakeholders. Source: its4land, 2016.

1.2 Problem Description

Acknowledgement and inclusion of the continuum of land rights in land administration systems imposes an information challenge. Conventional land administration systems, adopted in developing countries during colonial times, acknowledge formal tenure types and work with highly accurate land records which prevents marginalized groups from acquiring land tenure security (Zevenbergen et al., 2013). Therefore, Enemark, Bell, Lemmen & McLaren (2014) propose a fit-for-purpose approach in which land administration systems are flexible and focus on citizens' needs; consequently informal tenure types have to be taken into account as well. Acknowledging informal tenure types requires the development of new tools for spatial data acquisition and recordation (Enemark et al., 2014; Van der Molen, 2006). Participatory mapping and participatory GIS is already used as a means to include local knowledge in data collection and to contribute to fit-for-purpose land administration (Boschmann & Cubbon, 2014; Enemark et al., 2014; Zevenbergen et al., 2013). For instance, by the Global Land Tool Network (GLTN), an alliance of partners which aim to contribute to poverty alleviation through land reform, improved land management and provision of tenure security (GLTN, 2014). Through UN-Habitat, they developed the Social Tenure Domain Model (STDM), which is an example of a flexible pro-poor land administration system. STDM incorporates informal tenure types (Lemmen, 2010) and aims to create the needed flexibility in land administration systems by using a participatory approach. Nevertheless, "recording tools that work within the confines of existing norms and approaches to land are required" (Zevenbergen et al., 2013, p. 596)

Smart sketchmaps is proposed as such a tool with the potential to include local norms and approaches to land in the land administration system. Smart sketchmaps can provide qualitative spatial information in areas where conventional cartographic and geospatial knowledge is often limited (its4land, 2016c). Sketch mapping itself is not new in land administration, though smart sketchmaps' technologies and processes allow for conversion of hand drawn sketch maps into topologically and spatially corrected maps (its4land, 2016d). Including these maps in the land administration system not only adds to existing data about visible boundaries, but importantly introduces records of those less obvious socially or temporally constructed de facto boundaries that are significant in customary tenures.

Smart sketchmaps can be seen as the next generation of hand drawn mapping that fully embraces the age of digital interoperability, automated processing, and fit-for-purpose land administration (Schwering et al., 2014). Since recording certain land tenures is extremely difficult, if not impossible, using conventional technical survey prescriptions, smart sketchmaps may be the fundamental key in removing these barriers. This will be particularly beneficial for those public, private, or grassroots mappers who cannot always adhere to those technical requirements (Schwering & Wang, 2010).

Although a smart sketchmap prototype has been developed for topographic mapping efforts in urban areas (Schwering et al., 2014), to date, little to no research has been published that examines the potential of smart sketchmaps in the context of delivering fit-for-purpose land administration.

1.3 Conceptual Diagram

This paragraph addresses the conceptual diagram of this research; it illustrates the different fields this research relates to and combines. On the one side there is a societal pull which can be identified as 'secure land tenure'. On the other side there is a technology push, which are emerging geospatial technologies that offer technological opportunities for meeting society's needs. When these two sides are in balance innovation can take place. As a response to the societal pull in land administration, fit-for-purpose land administration strives to secure land tenure (Enemark et al., 2014). At the same time, its4land scrutinizes several emerging geospatial technologies, among which smart sketchmaps. As a third part of this research one can identify stakeholder perceptions. Smart sketchmaps are analysed from the viewpoint of the involved stakeholders discussed in paragraph 1.3.3, since they tend to have a large influence on the final utilization of smart sketchmaps as a fit-for-purpose approach in the land administration domain. This is summarized in the below conceptual diagram (Figure 3). In the diagram one can identify an overlap between the three aspects involved; that is where this MSc thesis research took place. It specifically focuses on the intersection between the technology push (smart sketchmaps), societal pull (secure land tenure) and stakeholder perceptions and hence evaluates smart sketchmaps for fit-for-purpose land administration.

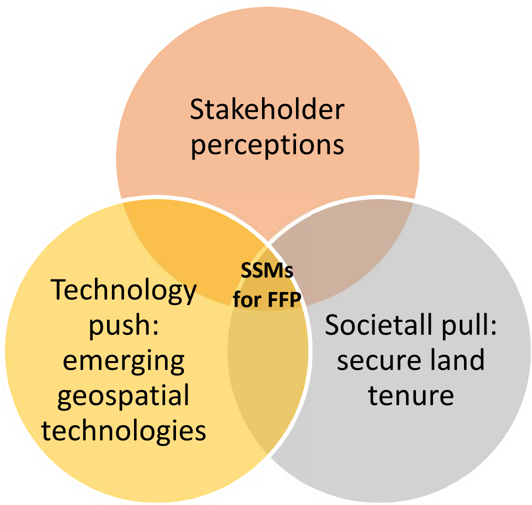


Figure 3: Conceptual Venn diagram smart sketchmaps in land administration.

By taking into account stakeholders' perceptions, the use of smart sketchmaps as a fit-for-purpose approach in the land administration domain is clarified. Depending on the position and experience of stakeholders, their perceptions differ; therefore, individual stakeholders identified from different user groups are the unit-of-analysis in this research. It seemed interesting to analyse how stakeholders understand smart sketchmaps and how they perceive the different elements of fit-for-purpose land administration in relation to the tool. Do their perceptions differ and why? These questions will be handled in the next section which focuses on the research objectives and questions.

1.4 Research Objectives and Questions

This paragraph builds upon the problem identification outlined in the previous paragraph. It provides a clear formulation of the research objectives and research questions.

1.4.1 Research Objectives

The goal of this research is to examine the potential of smart sketchmaps for delivering fit-for-purpose land administration in Eastern Africa. The fit-for-purpose elements include: flexibility in the spatial data capture approaches, inclusiveness in scope to cover all tenure and all land, participatory in approach to data capture and use to ensure community support, affordable for the government to establish and operate, and for society to use, attainable within time frame and resources, reliable, and upgradeable over time (Enemark et al., 2014, p. 6).

These rather abstract elements can be difficult to measure, especially for a tool that is yet to be proven in pilot studies, let alone adopted. Therefore, this research assesses if smart sketchmaps are seen to include the fit-for-purpose elements according to different stakeholder perceptions. Since its4land focuses on the East African stakeholders, this research focuses on the perceptions of external stakeholders (i.e. outside Eastern Africa) who may actually adopt, apply, and use smart sketchmaps in one way or another. Stakeholders come from international organizations, businesses, NGOs and research institutions, but whose activities may impact developments concerning land administration in Eastern Africa. They comprise both broad experts on the topic and those who have a specific expertise in the research area. Studying stakeholders' perceptions of smart sketchmaps brings a deeper understanding of the potential utilization of the tool and in doing so, provide the initial impetus in revealing the relevance of smart sketchmaps for supporting fit-for-purpose land administration.

The goal of this research is subdivided into several objectives:

Objective 1: To review the technological possibilities of smart sketchmaps in the context of societal demands of fit-for-purpose land administration in Eastern Africa according to experts and literature.

Objective 2: Based on the literature review, develop an appropriate framework to collect data on the perceptions of stakeholders regarding the potential of smart sketchmaps for delivering fit-for-purpose land administration in Eastern Africa.

Objective 3: To interpret the data collected on the perceptions of stakeholders to a) identify key clusters of perceptions pertaining to the potential role of smart sketchmaps in land administration, and b) identify whether the perceptions differ and why.

1.4.2 Research Questions

In order to reach the mentioned objectives several research questions are drafted. The main research question is: What are the prevailing perceptions amongst different stakeholders with regards to the potential utilization of smart sketchmaps in the context of delivering fit-for-purpose land administration in Eastern Africa? The main research question is subdivided into several sub-questions:

1. What are the key concepts of smart sketchmaps in relation to contemporary land administration needs in Eastern Africa?
    a. What are the societal demands of land administration according to literature?
    b. What are the technological possibilities of smart sketchmaps in land administration according to literature and experts?
2. What appropriate framework can be developed to collect data on the perceptions of stakeholders regarding the potential of smart sketchmaps for delivering fit-for-purpose land administration in Eastern Africa?
3. How can the collected data on the perceptions of stakeholders be interpreted?
    a. What clusters of perceptions can be identified pertaining to the potential role of smart sketchmaps in land administration in Eastern Africa?
    b. Do the perceptions of different stakeholders differ and why?

1.5 Related work and innovation

This paragraph addresses the related work and innovativeness of this research. A smart sketchmap prototype has been developed and applied in urban areas for topographic mapping efforts. In that project, SketchMapia, sketchmaps offer benefits over web-based GIS as an interaction medium since the former reflects a person's spatial knowledge (Schwering et al., 2014). The study focuses on the future challenges for GIS, which have to be more intuitive for users, handle imprecise information from users and possess lower technical requirements (Schwering et al., 2014).

Comparable with SketchMapia studies, research concerning smart sketchmaps mainly relates to the field of *spatial cognition* and *qualitative spatial representation.* The former relates to people's knowledge about their spatial environments, and how they communicate this knowledge. The latter relates to the use of sketch maps as a means of interaction between humans and computers (Schwering et al., 2014). Since this research focuses on the potential *utilization* of smart sketchmaps, the fields of spatial cognition and qualitative spatial representation will not be explicitly addressed. This research relates more closely to the field of responsible land administration: it addresses the use of a new technology which has the potential for improved alignment with user needs coming from society compared to conventional approaches in land administration (Zevenbergen et al., 2016). Therefore, this research aims to bridge the technology push of smart sketchmaps and the societal pull of land administration. This work is exploratory in nature and complementary to other researches in providing the perceptions of stakeholders on smart sketchmaps for fit-for-purpose land administration.

The innovativeness of this work is in the new application domain. Since the use of smart sketchmaps is not yet explored in the land administration domain, a knowledge gap can be identified. Compared to SketchMapia the application of smart sketchmaps in land administration has different requirements. For instance, for SketchMapia many metric maps were readily available, while in Eastern Africa this is less obvious. It has to be taken into account that often cartographic and geospatial information is not available (its4land, 2016c). Conducting this research can potentially fill the identified knowledge gap on smart sketchmaps for fit-for-purpose land administration.

1.6 Research scope

This research focuses on stakeholders who may adopt, apply, and use smart sketchmaps in one way or another. How the tool can be utilized for fit-for-purpose land administration is of main importance, the specific technological requirements of smart sketchmaps in the land administration domain will not be researched in-depth. Key concepts which are important in the understanding of the tool are gathered by means of literature review and interviews with experts.

Secondly, primary and secondary data is used in this research. The identified stakeholders conducted the Q-sorts by means of an online platform. Where possible participants were interviewed face to face since this purportedly produces better outcomes (Webler, Danielson, & Tuler, 2009). Where this was not possible, the Q-sort was conducted online with participants asked to share their screen during the sorting process. In this method, participants were supported by the researcher via Skype, but observation possibilities were limited.

1.7 Thesis structure

The first chapter of this thesis addressed the background information and research objectives and research questions. On top of that the related work and innovation and the research scope are also addressed. In the remainder of this thesis, the second chapter will address the theoretical framework on the societal demands of fit-for-purpose land administration with regards smart sketchmaps. The third chapter continues with the research approach and the fourth chapter presents the technological possibilities of smart sketchmaps according to literature and experts. The fifth chapter will present the research results and the sixth chapter presents a discussion of the implications of the research. Finally, the seventh chapter ends with the conclusion.

2. Theoretical Framework

This chapter presents the theoretical framework. It addresses the societal demands of fit-for-purpose land administration with regards to smart sketchmaps according to literature and aims to answer research question 1a.

2.1 Fit-for-purpose land administration

Land administration can be defined as the processes of recording and disseminating information about the ownership, value and use of land and its associated resources (UNECE, 1996). A land administration system should include a form of land registration in which ownership of land is recorded and in some countries guaranteed. It is estimated that still 70 percent of the world's population have no access to formal land administration systems and are not able to register and secure their land rights (Enemark et al., 2014). When comparing land administration systems all over the world there seems to be a clear 'cadastral divide' between more and less developed land administration systems, which should be diminished (Bennett et al., 2013). The absence of a well-functioning land administration system, prevents a safe and certain foundation for the acquisition, enjoyment and disposal of land rights (UNECE, 1996, p. 11). On top of that land tenure insecurity impedes sustainable development, since there will be little willingness to make long-term investments when land is not legally owned (UNECE, 1996).

How land management is organized in countries and regions differs widely, these different structures reflect local, cultural and judicial frameworks (Enemark, 2006). Until recently, many sub-Saharan Africa countries have had land administration systems based upon a narrow land administration paradigm, which originates from colonial times and uses conventional land registration and cadastral mapping techniques (Williamson & Ting, 2001). The main issue of land administration in developing countries is the continued preference for conventional, high accuracy, expensive surveying techniques to record land rights (Enemark et al., 2014). Conventional land administration approaches are often rooted in historically developed views on land management which often work against the poor (Zevenbergen et al., 2016); therefore, a new notion of responsible land administration has been developed. This aims to align with the changing needs of the individuals, governments and societies in developing countries to "align technical and administrative requirements of land administration better to the social and legal requirements" (Zevenbergen et al., 2016, p. 4). Alternative land administration approaches should be developed to take into account local needs and circumstances, and these should be founded upon legitimate and acceptable societal and institutional practices and customs (Zevenbergen et al., 2016). Responsible land administration calls for the use of innovative techniques which fit specific societal challenges.

The mentioned societal challenges are recognised and described by Zevenbergen et al., (2016), hence they stress: "The characteristics of fit-for-purpose land administration, as espoused by Enemark et al. (2014), should be better incorporated into land information maintenance" (p. 146). This fit-for-purpose approach supports the development of flexible land administration systems better suited to providing tenure security for all (Enemark et al., 2014). The concept fundamentally focuses on purpose, flexibility and incremental improvement. Initially, the 'what' of a land administration system is more important than the 'how', the (societal) needs are the main focus. Flexibility is needed in accuracy, recordation of different tenure types and in the legal and institutional framework. In addition, systems should be able to improve over time, in line with economic development (Enemark et al., 2015). The fit-for-purpose approach basically consists of three interrelated frameworks: the spatial-, legal- and institutional framework (Figure 4). Each have four core principles which altogether aim to support a country's land policy objectives.

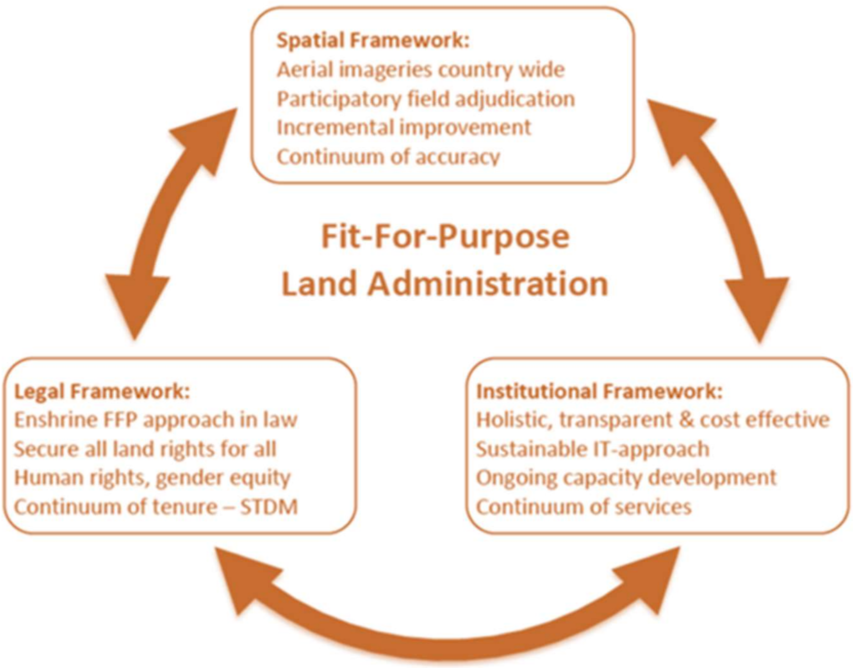


Figure 4: Key Principles fit-for-purpose land administration. Source: Enemark, et al., 2015.

Based upon these key principles Enemark et al., (2014) define seven elements which a fit-for-purpose approach should include:

1. Flexible in the spatial data capture approaches to provide for varying use and occupation;
2. Inclusive in scope to cover all tenure and all land;
3. Participatory in approach to data capture and use to ensure community support;
4. Affordable for the government to establish and operate, and for society to use;
5. Reliable in terms of information that is authoritative and up-to-date;
6. Attainable in relation to establishing the system within a short time frame and within available resources;
7. Upgradeable with regard to incremental upgrading and improvement over time in response to social and legal needs and emerging economic opportunities.

The first element relates to the need for different supplementary spatial data capture approaches. These different approaches together can capture varying use and occupation of land. In the fit-for-purpose approach, the relative accuracy of the position of the parcel boundaries seems to be of main importance, if possible these should be delineated from aerial imagery. Remaining gaps of invisible individual boundaries can subsequently be mapped by terrestrial survey methods (Enemark et al., 2015, p. 50), such as sketchmaps. The chosen mapping methods depend on the topography and density of the area.

The second element relates to acknowledging a continuum of land rights. Acknowledging the continuum of land rights means incorporating the different forms of tenure in a country in the land administration system, instead of only focusing on individual land titling. Forms of tenure can range from formal to informal land rights for individuals and groups as well (Figure 5). The approach is therefore pro-poor and gender-responsive since many people are taken into account, like pastoralists and slum dwellers for instance (GLTN, 2015; Payne, 2001). Acknowledging the continuum of land rights supports the establishment of land tenure security for all people and all forms of tenure (GLTN, 2015). This approach requires a detailed national typology of the various forms of tenures and their mapping (Enemark et al., 2014, p. 76). Several countries in sub-Saharan Africa use this new approach which has resulted in the adoption of innovative national land laws. Whilst implementation is still in its infancy, this is an important stepping stone in the land administration domain (Byamugisha, 2013).

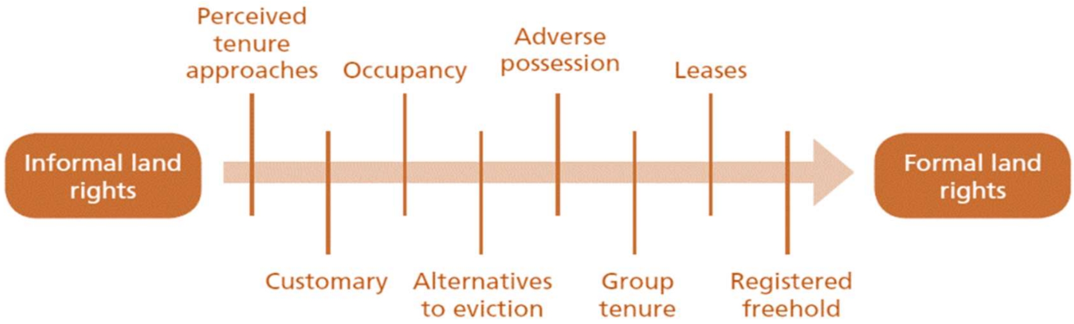


Figure 5: The continuum of land rights. Source: GLTN, 2015.

Subsequently, with the third element the use of participatory mapping and participatory GIS is addressed. Data capture should be participatory in approach and use to ensure community support. As stressed by Bryan (2011), participatory mapping is usually a suitable approach in spatially complex terrains where claims of ownership and authority tend to overlap.

The fourth element relates to the affordability of the approach for the government to establish and operate and for the society to use. As stressed by Zevenbergen et al. (2013), many governments in developing countries cannot afford to give land documents to all citizens; a pro-poor system must assist governments to scale up their work (p. 597). Besides, Payne (2001) identifies affordability for the poor to use the land administration system as a key issue in providing tenure security. Different projects and models arose as a response; although still in their infancy, these provide a starting point for affordable pro-poor land recordation systems (Enemark et al., 2014; GLTN, 2015; Lemmen, van Oosterom, & Bennett, 2015; Zevenbergen et al., 2013).

The fifth element relates to the reliability of the approach in terms of information that is authoritative and up-to-date. As stressed by Chambers (2006), one does have to take into account who is producing the spatial information and whether this person can act upon the communities' behalf. This largely depends upon whether the smart sketchmapping exercise is conducted with the community or with a community representative. "Most of the time crowdsourcing applications are using locally trained land officers, within communities … to provide a good level of authenticity and trust in the crowdsourced information" (Enemark et al., 2015, p. 53).

The sixth element relates to the attainability in relation to establishing the system within a short time frame and within available resources. Enemark et al. (2014) indicate that a participatory approach that is scalable can provide the necessary tenure security within an intermediate timeframe. "Ideally, there is a reciprocal understanding between the researchers and community representatives of each other's capabilities and limitations for designing a methodology that uses but does not overestimate the abilities and resources at hand" (Herlihy & Knapp, 2003, p. 305).

The seventh element relates to the upgradeability with regards to incremental improvement over time in response to social and legal needs, and emerging economic opportunities. It is often forgotten that western land administration systems were not implemented till the early 1800s as advanced as they are at present, and fit for the purpose at that time. They started out less developed as well and as economies advanced, the land administration systems developed along (Enemark et al., 2015).

2.2 Innovation in land administration

Acknowledging different forms of land tenure using the continuum of land rights requires new and innovative pro-poor forms of land recordation (Zevenbergen et al., 2013). Conventional methods based on individual land titling are not able to deal with the different forms of tenure (Enemark et al., 2014). Hence, new affordable tools for spatial data acquisition and recordation are needed to support the continuum of land rights (Enemark et al., 2014; Van der Molen, 2006).

Therefore, innovation is deemed necessary. In the early years of the computing industry, innovations in information technology (IT) were mainly developed from a techno-centric computing perspective (Nemet, 2009).

Many new technologies arose because of technical innovation; hence, the role of the user was often completely neglected (Petch & Reeve, 1999). Many solutions were developed because science and technology made them possible (technology push), whilst there was no genuine demand for them (demand pull). These technologies did not comply with the actual user needs which eventually was bad for business. Too little attention was paid to the human and organizational aspects of the products (Petch & Reeve, 1999). Over time user needs became more central in developing IT solutions, one came to realize that technologies should be developed because they are needed by the user. The shift from techno-centric- to socio-technical computing is displayed in Figure 6.

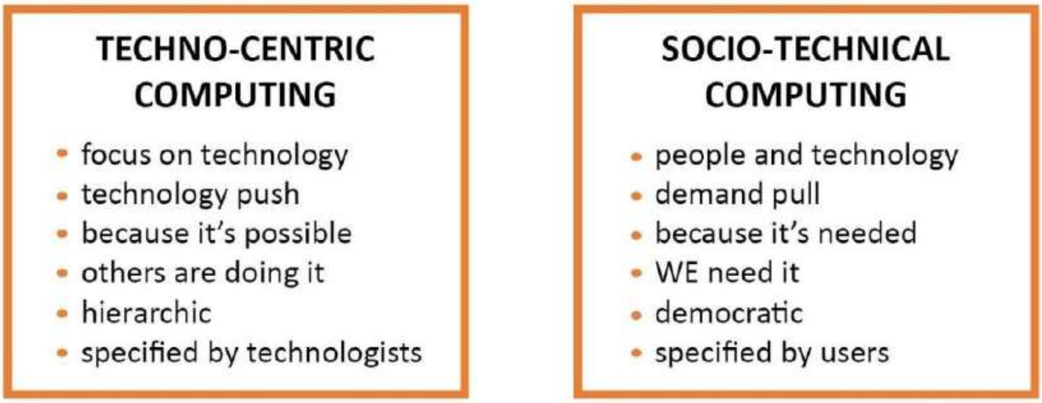


Figure 6: Shift from techno-centric computing to socio-technical computing. Source: Petch & Reeve (1999)

The technology push mainly looks at science and technology when developing innovations, the demand pull takes more features into account and mainly focuses on the needs of the end user and the whole economy (Di Stefano, Gambardella, & Verona, 2012). When only focusing on the technology push one fails to account for market conditions, whilst a primary focus on the demand pull can ignore technological capabilities.

Ghawana et al. (2016) define innovation as the process of creating something that is replicable at an economic scale and that answers to a specific need. They stress there is a need to make land administration more visible and innovation-oriented, which will lead to more market oriented and socially demanded solutions. “ICT solutions will have to be adapted to support overlapping rights and new relationships prevalent in social tenures, and data recording procedures in the spatial framework modified to capture these relationships” (Enemark et al., 2015, p. 35). New user-centric technologies can enable faster and cheaper methods for land recordation (Bennett et al., 2013). Besides, modified administrative processes can ensure good governance, improve grassroots knowledge and increase the present knowledge in more conventional institutions (Bennett et al., 2013). Though, the technology push should be in equilibrium with the demand pull coming from society and vice versa. Without a balanced consideration of both sides, the unacceptable ‘cadastral divide’ between countries will remain present (Bennett et al., 2012).

2.3 Sketch maps

In the sixties and seventies, sketch mapping gained attention in research as one can identify in Figure 7. Curtis (2016, p. 339) identifies three works of main influence: Kevin Lynch's ‘The Image of the City’ (1960), Roger Downs and David Stea’s ‘Image and Environment’ (1973) and Peter Gould and Rodney White’s ‘Mental Maps’ (1974). These works mainly discuss the opportunity to map what is in one’s mind; which is also referred to as cognitive mapping. Cognitive mapping is defined by Downs and Stea (1973) as “a process composed of a series of psychological transformations by which an individual acquires, codes, stores, recalls and decodes information about the relative locations and attributes of phenomena in his everyday spatial environment” (p. 312). All people store information about their environment which they consequently use to make spatial decisions (Kaplan, 1973; Kitchin, 1994). When one externalizes this cognitive map by means of a sketch map, local knowledge of one’s understanding of an environment will come to the surface.

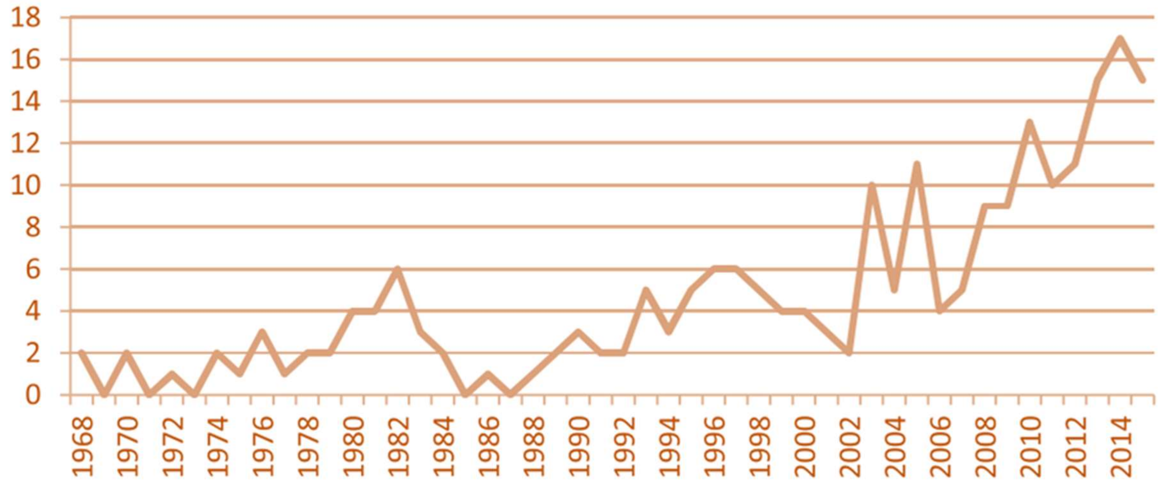


Figure 7: Frequency of articles addressing sketch mapping. Source: Curtis, 2016.

Many researchers use hand drawn mapping as a means to externalize qualitative spatial information on maps (Boschmann & Cubbon, 2014). Particularly relevant especially in recent times where citizens are increasingly involved in the voluntary production and dissemination of geographic information (Goodchild, 2007). Voluntary Geographic Information systems (VGI) increasingly incorporate the creation of sketch maps as a function (Schwering et al., 2014). Initially sketch mapping was mainly applied on a global scale and had structured characteristics to gather formal information; in recent times sketch mapping is used as a means to gather informal local knowledge, especially in combination with GIS, sketch maps are used to: “represent the views of marginalized populations in decision-making processes” (Curtis, 2016, p. 348). Sketch maps can be used for different purposes, Schwering et al. (2014) identify four: to contribute information about landmarks, complete non-mapped areas, describe locations of vernacular places (e.g. downtown) or to describe routes. By gathering qualitative information with sketch maps one is able to introduce people’s perceptions of their relationship with land in maps, analyse detailed spatial information of individuals, and facilitate data interpretation (Boschmann & Cubbon, 2014). Curtis (2016) points out that: “Using sketch maps in a GIS creates opportunities for spatial analysis and visualization, to produce novel and authoritative maps of an otherwise invisible landscape” (p. 339). These can be for instance socially constructed de facto boundaries, conflict areas or pastoralist routes.

2.4 Participatory Mapping

Sketch mapping is often used in the context of participatory mapping where sketch maps are used to put invisible boundaries from indigenous lands on the map (Chapin, Lamb, & Threlkeld, 2005; Herlihy, 2003; IIED, 2006; Offen, 2003; Sletto, 2009; Smith, 2003). The first indigenous mapping projects arose in Canada and Alaska in the 1950s and 1960s, they aimed to document land use and occupancy to discuss the rights of the native inhabitants (Chapin et al., 2005). Participatory indigenous mapping approaches are broadly used to secure tenure, manage natural resources, and strengthen cultures, the approach commenced in Africa in the nineties (Chapin et al., 2005). In participatory mapping one mainly uses sketch maps on paper or on the ground, or GIS. Naturally, the chosen method and its facilitation influences the outcome of the participatory mapping process (Chambers, 2006).

Often, community representatives are trained to conduct the participatory mapping activities, often in collaboration with NGOs, public institutions, or other organizations (Herlihy & Knapp, 2003).

Herlihy and Knapp (2003) identify the work to be done in a participatory mapping process:

- Hold community meetings;
- Administer questionnaires;
- Record place names;
- Draw sketch maps;
- Build diagrams;

- Collect field data;
- Plot cognitive information about place directly onto standard cartographic sheets.

This work results mainly in cartographic paper maps, though in the late 1990s, with technological developments, participatory mapping techniques allowed for combinations with new technologies, for instance GPS, GIS and remote sensing (Chapin et al., 2005). Though, especially in the early days, governments acted with caution when it came to the overall accuracy and dependability of ICT-based approaches. According to Huggins & Frosina (2016), governments tended to be afraid to lose their control on the land administration process when ICT-based approaches were used despite these approaches providing governments with more insight and knowledge on informal areas as more and more spatial information about these areas become available.

In this sense, one can identify a demand pull and technology push. On the one hand participatory mapping approaches aim to include local knowledge from communities: through participation one wants to build local capacity, empower communities, facilitate communication, break down power structures and foster democratic institutions (Chapin et al., 2005, p. 628). On the other hand, one can identify the technology push; in which participatory mapping approaches introduce compatibility with GIS, which allows for increased availability and visibility of local spatial knowledge.

3. Research Approach

This chapter describes how this research is carried out. The steps taken in order to realize the objectives are set out. The needed data, software and research materials are identified as well.

3.1 Methodology

This research focuses on different motives and understandings from stakeholder groups with regards to smart sketchmaps for fit-for-purpose land administration. It is defined as exploratory research, which aim is to gain familiarity with a phenomenon or to achieve new insights into it (Kothari, 2004). This type of research brings understanding of possible relations and motives between different variables. It is often used to explore new fields which are not yet explored in research. The exploration is done by observing the stakeholders and understanding their perceptions. This exploratory research can be used for future research on the use of smart sketchmaps for fit-for-purpose land administration. This field has not yet been explored in science, therefore this research is of an exploratory nature.

When analysing the problem identification different methods have been taken into account. In order to reveal the different motives and understandings of stakeholders the Q-methodology is found most useful. The workflow of this method allows to deal with all research questions. The method is originally developed by Stephenson (1935) and focuses on subjectivity. The method evolved from factor-analytic theory in the 1930s and has been applied in many different knowledge domains (Brown, 1980). The method is widely used in social science to reveal different perceptions, though only recently it has been introduced by De Vries, Groenendijk, Musinguzi, & Selebalo (2016) to the land administration domain. This method is specifically suitable for this research since smart sketchmaps are yet to be proven in pilot studies, therefore perceptive responses are needed. The Q-methodology allows to compare the different subjective perceptions of stakeholders on smart sketchmaps. The approach is used in comparable studies as well (Chandran, Hoppe, De Vries, & Georgiadou, 2015; de Vries, Muparari, & Zevenbergen, 2016).

The Q-methodology is used to reveal factors with clusters of perceptions among participants with regards to a specific topic. The method allows for a detailed and consistent comparison of perceptions since the same set of statements are ranked by every participant (Webler, Danielson, & Tuler, 2007). Davies and Hodge (2007) stress that the method provides a: “valuable way of demonstrating the nature of the mental frameworks of actors in a particular context” (p. 323). The method uses Q-statements on a specific topic which participants have to rank on a grid during the Q-sort. The grid contains of a normal distribution with scales ranging from ‘strongly disagree’ to ‘strongly agree’. Factors with clusters of shared perceptions are calculated according to corresponding ranks of the statements. Factors are derived on the statements in which each factor represents a perspective, ‘composed of a set of shared and connected values and beliefs among a certain sample of participants’ (de Vries, Muparari, & Zevenbergen, 2016, p. 203). Q-statements are drafted which address the different fit-for-purpose land administration elements. It seems interesting to identify the perceptions of different stakeholders on smart sketchmaps in relation to those elements. The scope of this research is limited to experts, coming from international organizations, businesses, NGOs and research institutions. These experts were not all physically accessible, which demanded the need for an online platform. The findings reveal how stakeholders understand the potential role of smart sketchmaps for fit-for-purpose land administration in Eastern Africa. Ultimately the findings can be compared and analysed along with the its4land findings which are community-based.

The Q-methodology is based on a combination of qualitative and quantitative research. This offers a triangulation of sources, methods and theories which increases the validity of the research. Qualitative research is often based on the constructivist paradigm, in which the subjective creation of meaning is of main importance (Baxter & Jack, 2008). Baxter and Jack (2008) stress that in research, truth is often relative and depends upon ones’ perspective. The Q-methodology is developed to study people’s subjectivity (Brown, 1980; Stephenson, 1935). The qualitative part of the method contains the expert interviews conducted beforehand, the statement creation and the interviews conducted during the Q-sort and the narrations derived from the interviews. The quantitative part of the method is the ranking process and the statistical processing (de Vries et al., 2016).

The Q-methodology is used to identify the prevailing perceptions of stakeholders with regards to smart sketchmaps for fit-for-purpose land administration. Different insights are identified, which sheds light on the smart sketchmaps' technology push in relation to the contemporary societal demands of land administration.

Subsequently, how the different research objectives are met is discussed:

Objective 1: To review the technological possibilities of smart sketchmaps in the context of societal demands of land administration in Eastern Africa according to experts and literature.

Meeting the first objective creates a baseline for the rest of the research. By identifying the key concepts of smart sketchmaps one can thoroughly understand the tool and its application in the land administration domain. On the one hand the societal demands of land administration are identified according to literature in the theoretical framework. On the other hand, the technological possibilities of smart sketchmaps are researched according to literature and experts, thus far little scientific literature is available on the topic. Together this creates a baseline for the second objective. The information is gathered by means of an extensive literature review combined with semi-structured interviews with experts on the topic. Reviewed articles are ISI or grey literature, since the rather low availability of scientific literature on this new topic. Interviewed experts have extensive knowledge on the tool development and application domain. The theoretical framework concerning the societal demands in land administration is presented in Chapter 2. The technological possibilities of smart sketchmaps according to literature and experts is presented in Chapter 4. Together these two sections aim to meet the first objective.

Objective 2: Based on the literature review, develop an appropriate framework to collect data on the perceptions of stakeholders regarding the potential of smart sketchmaps for delivering fit-for-purpose land administration Eastern Africa.

The second objective develops an appropriate framework to collect data on the perceptions of stakeholders with regards to the potential of smart sketchmaps for delivering fit-for-purpose land administration in Eastern Africa. This is done using the Q-methodology for which Q-statements are created according to fit-for-purpose land administration elements, by using the outcomes of the first objective. In order to collect stakeholders' perceptions on smart sketchmaps for fit-for-purpose land administration. The appropriate framework is presented more extensively in chapter 3.2 which addresses the research approach step by step. Chapter 4.3 contains the summarized concourse according to the first objective and chapter 4.4 addresses the statement creation. Together these sections aim to meet the second objective.

Objective 3: To interpret the data collected on the perceptions of stakeholders to 1) identify key clusters of perceptions pertaining to the potential role of smart sketchmaps in land administration, and 2) identify whether the perceptions differ and why.

The third objective interprets the collected data on the stakeholders' perceptions. Different factors with clusters of perceptions are identified with regards to smart sketchmaps. Data from the Q-sorts are factor analysed, this results in composed factors of Q-sorts that are highly similar in their rankings of the statements. The factor analysis is interpreted to analyse the Q-statements that receive the highest and lowest correlation score, the accompanying interviews help to interpret the factors (Cuppen, Breukers, Hisschemöller, & Bergsma, 2010). According to the analysis different perceptions of stakeholders are identified. By interpreting the Q-data and accompanying interviews it is found whether the perceptions differ and why. This objective provides input to its4land, which gathers community-based findings.

The below table summarizes the used methods and results per research question and objective (Table 1).

Objective	Research Question	How (Methods)	Result
Objective 1: To review the technological possibilities of smart sketchmaps in the context of societal demands of land administration in Eastern Africa according to experts and literature.	What are the key concepts of smart sketchmaps in relation to contemporary land administration needs in Eastern Africa? What are the societal demands of land administration according to literature? What are the technological possibilities of smart sketchmaps in land administration according to literature and experts?	• Literature study ISI articles and grey literature • Expert interviews	• Chapter 2: Theoretical Framework • Chapter 4.1 and 4.2: Technological possibilities of smart sketchmaps
Objective 2: Based on the literature review, develop an appropriate framework to collect data on the perceptions of stakeholders regarding the potential of smart sketchmaps for delivering fit-for-purpose land administration Eastern Africa.	What appropriate framework can be developed to collect data on the perceptions of stakeholders regarding the potential of smart sketchmaps for delivering fit-for-purpose land administration in Eastern Africa.	• Conduct Q-methodology: create framework based on fit-for-purpose land administration elements by using the outcomes of the first objective in order to create Q-statements, select Q-participants and conduct Q-sorts.	• Chapter 4.3: Summarized concourse • Chapter 4.4: Creation 30 Q-statements • 13 Q-participants • 13 Q-sorts
Objective 3: To interpret the data collected on the perceptions of stakeholders to 1) identify key clusters of perceptions pertaining to the potential role of in land smart sketchmaps administration, and 2) identify whether the perceptions differ and why.	How can the collected data on the perceptions of stakeholders be interpreted? What clusters of perceptions can be identified pertaining to the potential role of smart sketchmaps in land administration in Eastern Africa? Do the perceptions of different stakeholders differ and why?	• Interpretation software PQMETHOD • Narrations from interviews during Q-sorts	• Factors with clusters of perceptions • Interpretation factors

Table 1: Research Matrix.

3.2 Steps

The ‘How’ of the research matrix mainly refers to the Q-methodology. The work is structured according to the five steps from the Q-methodology (Cuppen et al., 2010; de Vries et al., 2016):

1. Identifying the concourse of values and beliefs which are composed of the full range of ideas, perspectives, opinions, discussions, values and theories on the particular issue under study;

2. Creating and selecting suitable Q-statements from this concourse, and identifying a sample of Q-participants in the domain of this concourse;
3. Executing a Q-sort, Q-participants have to rank and prioritise the Q-statements on a forced distribution chart, based on their own insight;
4. Executing a factor analysis with software which can calculate clusters of shared perceptions on the basis of the shared ranks of statements;
5. Interpreting the factor analysis with regard to the original research question.

Step 1: Definition of the concourse

The first step in this research is to gain information and gather all information available on the smart sketchmaps topic. This is done by conducting an extensive literature review and expert interviews. This step brings understanding of the history and context of the study and creates the concourse which allowed for the Q-statements to be created (Webler et al., 2007). The first step has three sub-steps. The deliverable of this step is the Chapter 2 and Chapter 4.1 and 4.2, and aims to meet the first objective.

a. Create theoretical framework

The theoretical framework creates a baseline for the rest of this research. This is necessary for understanding the key concepts. In the theoretical framework an extensive literature review addresses fit-for-purpose land administration, innovation in land administration, sketch maps and participatory mapping. Altogether this creates a complete understanding of the research setting. Important authors of scientific literature are: Allen, Bell, Bennett, Chipofya, De Soto, De Vries, Ghawana, Enemark, Lemmens, Macharis, Maxwell, Sahib, Schwering, Wang, Zevenbergen.

b. Conduct expert interviews

The expert interviews provide a deeper understanding of the smart sketchmaps concept and its context in land administration. The interviewed experts are identified via the its4land network. They are interviewed according to a topic list which makes these interviews semi-structured (Appendix 1). The interviewed experts were either expert on the societal pull or the technological push. The findings of these interviews are presented in chapter 4.1 and 4.2. Due to confidentiality the transcripts of the interviews are not made public.

Step 2: Select Q-statements and Q-participants

The second step of this method creates the Q-statements and identifies the Q-participants. This step contains of two sub-steps. The deliverable of this step is the selection of Q-statements and Q-participants, which is necessary for meeting the second objective.

a. Create and Select Q-statements

According to the interviews with experts and the literature review, which together make up the definition of the concourse, many statements are created during an iterative process. The statements should cover for the whole understanding of smart sketchmaps and are structured according to the mentioned seven elements from fit-for-purpose land administration. A selection of statements is made in order to have the right number of statements which allow for the identification of different perspectives. For small Q-studies it is advised to have twice the number of statements as participants (Thompson, 1981). Others advice a 1:3 or a 1:2 participant:statements ratio as well (de Vries et al., 2016; Webler et al., 2007). Though, according to many researches this remains a rule of thumb, generally speaking it is advised to use 20 to 60 statements (Webler et al., 2007). This research aimed to use 30 to 40 statements and ended up with 30 statements (Appendix 2). In Chapter 4.4 the statement creation is addressed more elaborately.

b. Select Q-participants

Q-participants are selected who carried out the Q-sort. Q-participants are not supposed to be a sample of a certain population; they are selected purposively to cover different perceptions on a new method in fit-for-purpose land administration, such as smart sketchmaps (Webler et al., 2009). The Q-participants are also referred to as the person sample (P-sample). In the Q-methodology working with a small P-sample is desirable since this increases the probability to reveal individuals' subjectivity (Valenta & Wigger, 1997). Since this research aimed for 30 to 40 statements and the advised ratio is 1:3 or 1:2, this research aimed to interview 10 to 15 Q-participants. Since the research finally consisted of 30 statements an amount of thirteen participants was found adequate.

Step 3: Execute Q-sort

In this step Q-participants carry out the Q-sort. The Q-sorts are conducted by means of an online platform. An online tool, Q-sortware is used which allows to carry out the Q-sort online. The preference was to conduct interviews face to face where possible, this purportedly produces better outcomes since it is originally a one-on-one technique (Webler et al., 2009). Where this was not possible, for instance when participants were physically inaccessible for the researcher, the alternative was to conduct the Q-sorts online-supported. This step contains of three sub-steps. The deliverable of this step is the Q-sorts, carried out by the Q-participants and the accompanying recorded interviews.

a. Invite Q-participants and send instructions

Twenty-three Q-participants are selected and invited to take part in the Q-sort. Thirteen participants confirmed their participation after which a set of instructions was send (Appendix 3). The instructions describe the setting of the research and identify the steps to be undertaken during the Q-sort. On top of that an its4land information sheet and informed consent form is send, during the Q-sort the Q-participants are asked to confirm whether they agree upon all terms described in the informed consent form (Appendix 4).

b. Conduct Q-sort and accompanying interview

The Q-sort is conducted with the Q-sortware, in this online tool the 30 statements are uploaded and an invitation with a private link to the Q-sort is send to the Q-participant. The Q-sort is conducted during an interview and took 45 to 75 minutes. A topic list is used to guide the Q-sort and accompanying interview (Appendix 5). During the interview firstly the research setting is explained, secondly the Q-sorting process is addressed. When the participant had no further questions the Q-sort commenced. The participants firstly had to sort the 30 statements on three piles, agree, neutral and disagree. This is to get familiar with the statements and share some first comments per statement (Webler et al., 2009). Secondly participants have to sort the statements on a forced distribution chart ranging from strongly disagree (-4) to strongly agree (+4) as can be seen in Figure 8. It is requested that the participants think out loud during the Q-sort. This provides a better contextual understanding when the analysis is performed later on. When the Q-sort is finished the participant is asked to reflect on the sort and to address the motivation for certain choices in the ranking. When the interview is finished the participant is requested to save the work and some concluding remarks can be made.

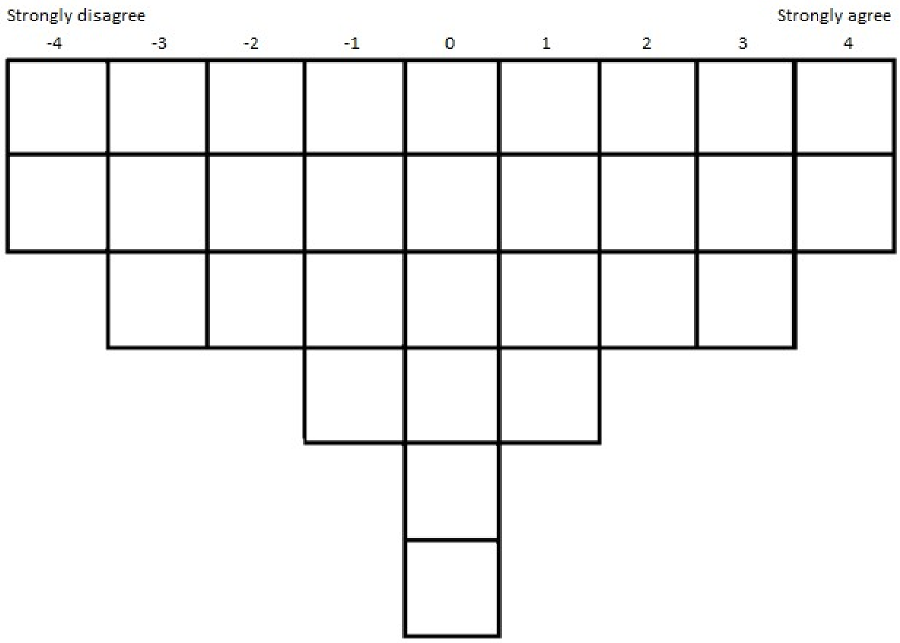


Figure 8: Forced distribution chart Q-methodology.

c. Process and analyse interviews

The interviews accompanying the Q-sort are processed and analysed. A summary of the interview is made which covers different motives and comments which are transcribed per statement. These are analysed according to fit-for-purpose elements which eventually assist the interpretation of the data. Due to confidentiality the interview transcripts are not made public.

Step 4: Execute factor analysis

This step analyses the Q-sorts by means of factor analysis. Factor analysis is used in order to identify patterns in a data set. The analysis produces factors, which are arrangements of Q-statements, the different factors are interpreted by means of the interviews (Webler et al., 2007). In order to carry out the factor analysis two sub-steps are conducted. The deliverable of this step is the interpreted factor analysis, and there with the different factors with clusters of perceptions on smart sketchmaps for fit-for-purpose land administration.

a. Extract data from online software

Since an online data acquisition method is used the gathered data has to be extracted from the online software. This is easily done by exporting the data in .CSV format.

b. Insert and analyse data in PQMETHOD

For the factor analysis the PQMETHOD software is used. The project is created in the programme and the statements are uploaded in .TXT format. The lines have character limits so some statements are shortened. The used forced distribution ranging from -4 to +4 is entered and consequently the Q-sorts are loaded. Subsequently, the factor analysis is executed using two different factor analysis algorithms; Centroid or Principal Components Analysis. The resulting factors are rotated in order to get the best solution. The motivation for the steps undertaken are described in the results chapter.

Step 5: Interpret factor analysis

This step interprets the factor analysis in combination with the analysis summaries and analysis of the interviews. The factors are interpreted and descriptions are written in order to summarize them. The descriptions of the factors are often referred to as factor narrations (Webler et al., 2009). This step contains of no further sub-steps. The deliverable of this step are the factor narrations, thus the interpretation of the factor analysis. Herewith the third objective can be met.

3.3 Research Area

As mentioned previously this research is conducted in the context of the its4land project, which focuses on six case study areas in Ethiopia, Kenya and Rwanda. Therefore, this research focuses on Sub-Saharan Africa, more specifically Eastern Africa, since the implementation of the tool is most likely in that specific area. In the United Nations (2014) statistics Eastern Africa consists of the following countries: Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mayotte, Mozambique, Réunion, Rwanda, Seychelles, Somalia, South Sudan, Uganda, United Republic of Tanzania, Zambia, Zimbabwe (Figure 9).

The research area is interesting for the topic of this Master's Thesis since most innovative tools in land administration are currently tested and implemented in Eastern Africa (Zevenbergen et al., 2016). Besides, the stakeholders who impact smart sketchmaps are mainly knowledgeable in that specific area.

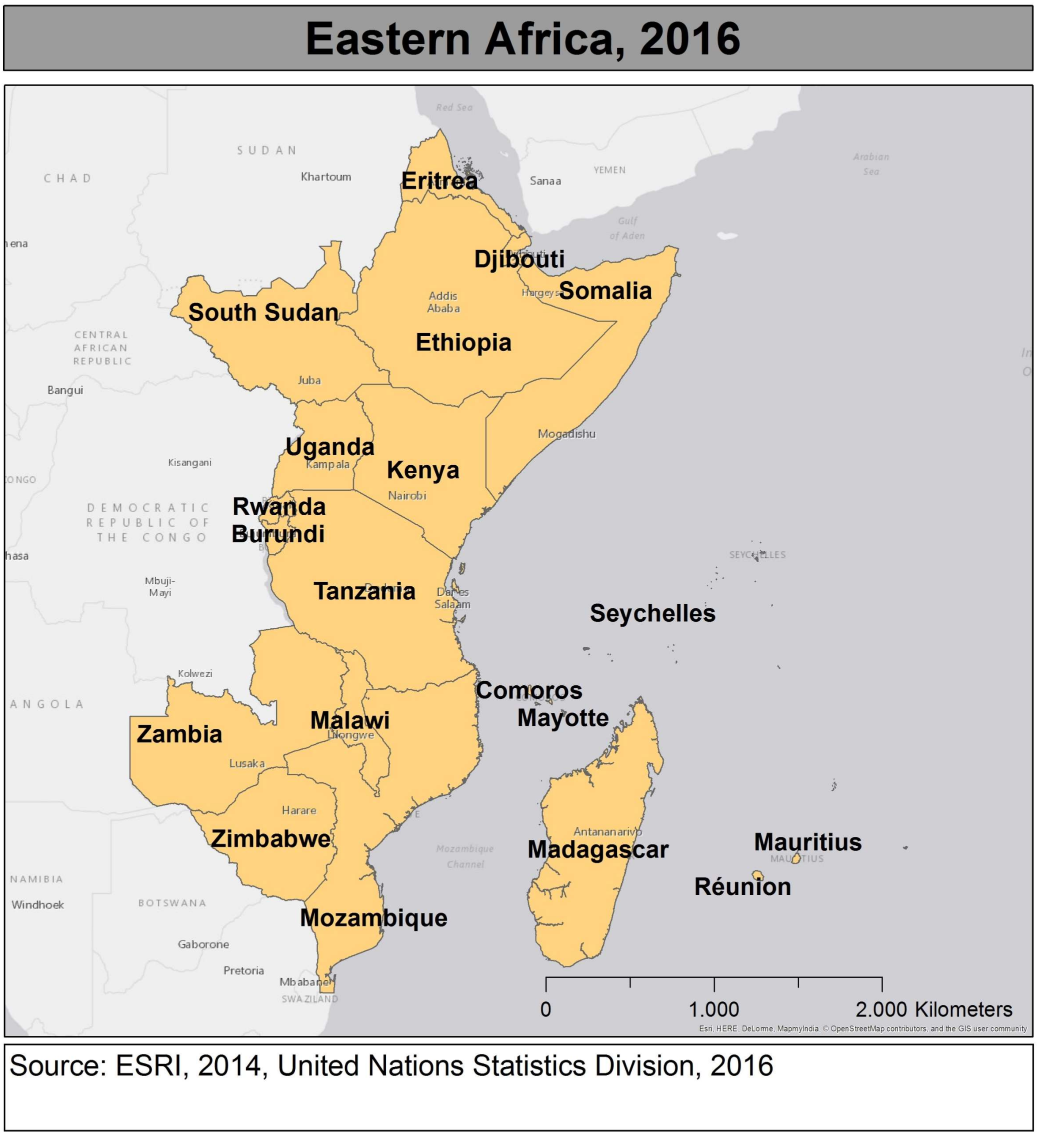


Figure 9: Eastern Africa, United Nations, 2016.

Sub-Saharan Africa is known as a less developed region where poverty is extremely severe. According to the Millenium Development Goals Report from the United Nations (2015b) the Sub-Saharan Africa region is still underperforming in reducing the proportion of people living in extreme poverty in comparison to other developing regions in the world. In 2011 the region did not meet the target of halving that percentage and still the region continues to lag behind. In 1990, 57 percent of the population lived on less than $1.25 a day, in 2011, 47 percent and in 2015, still 41 percent was living in extreme poverty. In urban areas Sub-Saharan Africa has the highest proportion of urban population living in slums, which is estimated at 55 percent in 2014. Besides, in Sub-Saharan Africa the digital divide is clearly present, less than 21 percent of the population uses the Internet (United Nations, 2015b).

According to Enemark et al. (2014), in the Sub-Saharan region two thirds to ninety percent of the land is not registered in the formal land administration systems. While many (rural) land rights are mainly based on social relations and hence fall in the customary tenure category where land is managed by tribal chiefs or councils (Enemark et al., 2014, 2015). These people are not served by the formal land administration systems, hence many people experience tenure insecurities. Generally speaking, no customary land management is applied, though customary and formal land related institutions do cohabitate within countries (Simbizi, Bennett, & Zevenbergen, 2014). One has to carefully take into account the different power structures which can be present within a country on local, regional and national level (Enemark et al., 2014). The lands which are under customary tenure should be formally recognised and upgraded to a legal status (Enemark et al., 2015).

In recent times many sub-Saharan Africa countries have introduced national land information systems mainly covering rural land (Simbizi et al., 2014). Though most of the time conventional approaches are used which tend to be too expensive, time consuming and capacity demanding for providing a suitable land administration system (Enemark et al., 2014). Recently, unconventional tools which are friendly to sub-Saharan Africa land tenure contexts are being proposed increasingly (Zevenbergen et al., 2013). These methods should be fast, cheap, complete and reliable (Enemark et al., 2014). GLTN has made increasing efforts in developing and disseminating such pro-poor and gender-sensitive land tools (GLTN, 2014).

3.4 Risks and Contingencies

Beforehand, risks and contingencies during the research process have been identified that might obstruct the project. A selection of risks and contingencies is drafted in a Risk Matrix in Table 2. On the vertical axis the impact of a certain risk is defined, and on the horizontal axis the probability of a risk. The colour of a risk indicates the possible consequence of a specific risk. Green indicates a negligible risk, yellow indicates marginal consequences. Orange indicates critical consequences and red disastrous consequences. When a risk lies within the orange or red area a risk is critical and requires a response. These are drafted in Table 3. Luckily, no significant risks or contingencies have obstructed the research process. There was a slight software malfunction during the second Q-sort which could be solved by reconstructing the entered data which was lost according to the audio recording of the interview. No further risks or contingencies have arisen.

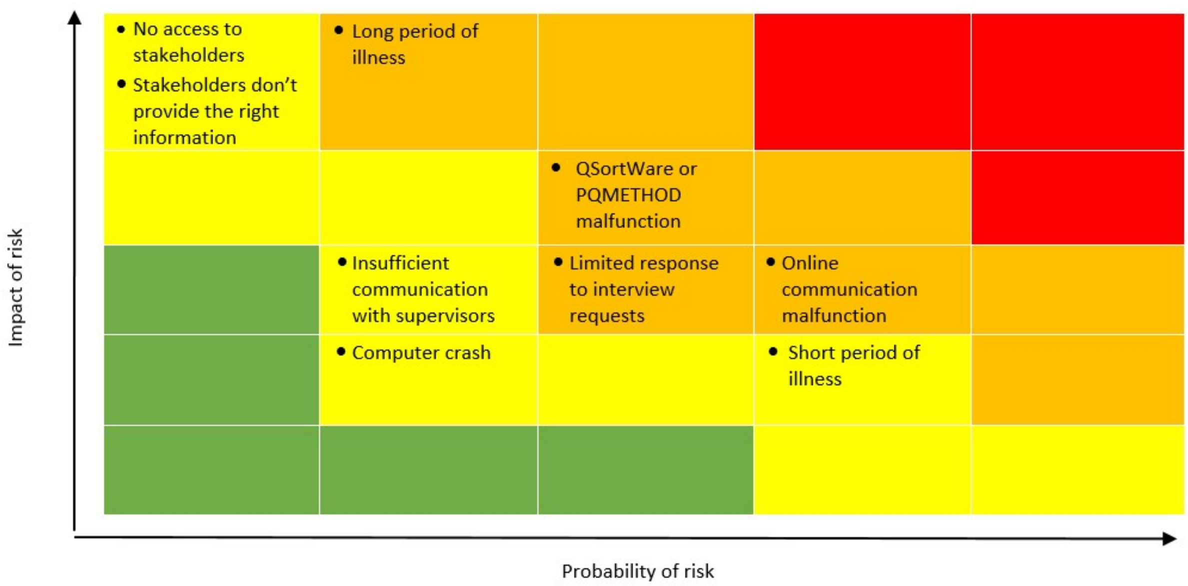


Table 2. Risk Matrix.

Critical risk	Response
Long period of illness	Accept the consequences and discuss with the supervisors a postponed deadline.
Q-sortware or PQMETHOD malfunction	Use alternative software like the Google tool draw.io, Q-Assessor or SPSS.
Limited response to interview requests	Broaden the group of interviewees.
Online communication malfunction	Use alternative software and send the interviewees the summary of the interview for confirmation.

Table 3. Responses to critical risks.

3.5 Required Resources

Beforehand several required resources have been identified for this research. These can be found in Table 4. No other resources were found necessary.

Data	Software	Research material
Interview summaries	Microsoft Office	Audio recording device
Scientific literature (ISI and grey)	Transcription Software Express Scribe	Laptop
its4land project documents	PQMETHOD	
Q-statements	Q-sortware	
Q-sorts	Skype	

Table 4: Required Resources.

4. Technological possibilities of smart sketchmaps

Based on literature and expert interviews this chapter provides a conceptual description of smart sketchmaps. Since smart sketchmaps are yet to be developed in land administration there is no documentation available for this application domain. Therefore, three expert interviews were conducted to gain more information on the concept. These experts were identified because of their extensive knowledge on the topic being studied. Two of the interviewees are actually developing the system and the other has many years of working experience in the field. Due to time constraints it was unfortunately not possible to interview a fourth expert. In light of the absence of a coherent body of literature, the experts' views and literature review are used to construct the concourse around smart sketchmaps for fit-for-purpose land administration.

4.1 Conceptual description of smart sketchmaps

Smart sketchmaps can be defined as the technologies and processes that enable hand drawn non-metric spatial representations, to be converted into topologically and spatially corrected maps (its4land, 2016d). Hence, the sketch maps will be part of a human-computer interaction, which is where the innovation of this tool can be identified. Often, parcel information gathered by mappers is based on qualitative information, based on the local knowledge from inhabitants of the to be mapped area. Sketchmaps are most useful in this process since they externalize someone's mental image of their environment (Schwering et al., 2014).

A smart sketchmap prototype has already been applied in urban areas for topographic mapping efforts in the research project SketchMapia. In this project from Muenster University, it is proposed to use sketched maps over web-based GIS as interaction medium, since the former reflect a person's spatial knowledge (Schwering et al., 2014). Muenster University is now developing the smart sketchmaps system for the land administration domain in the its4land project. In SketchMapia, the researchers gathered sketched symbols in city maps and tested these to represent certain sketch aspects. Consequently, a procedure could identify these symbols in the sketch and match them to metric map elements. The SketchMapia prototype aligns sketched information on a map with a metric base map in a VGI system. In the last years, different applications have been developed for sketch maps though none of these automatically processes the sketches (Schwering et al., 2014).

Since a sketch map is based on a person's spatial knowledge, errors are likely to arise. Schwering et al. (2014) identify four different types of errors which can appear in sketched maps: errors of distance, direction, structure and other notable errors. These errors have to be taken into account when analysing a sketch map. With regards to the SketchMapia application, the following citation from Schwering et al. (2014) explains how the system should be used: "In SketchMapia users draw a sketch map by hand on a piece of paper. Today, sketchmaps can be easily digitized by taking a picture of it with a mobile phone. The user uploads the digitized sketch map to SketchMapia and selects the corresponding metric map. The user can identify landmarks via their unique addresses and post codes, geo-reference any points on the sketch map or specify the corresponding bounding box on the metric map. SketchMapia analyses the geographic information from the sketch map, aligns it with the corresponding metric map and integrates the information with other sources of information. This way, additional sketched information such as information on the usage of the buildings … can be transferred to the data repository (pp. 225-226)." In essence, the deployment of smart sketchmaps is highly comparable to SketchMapia, though the new application domain requires adjustments; "the type of map differs (rural land tenure maps instead of urban survey maps) which influences relevant cognitive aspects, the specific application of exploring land tenures specific spatial concepts and terminology, and capturing semantic information (labels and annotation) is important in this context, whilst previous work (i.e. SketchMapia) only focused on purely spatial information" (its4land, 2015, p. 16).

Smart sketchmaps will initially be deployed as a participatory mapping approach. However, the final steps of the approach may potentially offer added value in comparison to typical participatory mapping approaches, since smart sketchmaps aim to convert hand drawn sketch maps into topologically and spatially corrected digital maps. Consequently, this information could be digitized automatically which would allow governments to take into account qualitative information, for instance in the land administration system. Including sketchmaps in the land administration system would increase the amount of available spatial information which is often limited.

In Figure 10 a draft of the main UML Use Case Scenario Diagram of smart sketchmaps, as developed by the its4land project, is provided. As one can see, an agent would be able to register land tenure information or query land tenure information. The former adds information to the integrated sketch database and the latter fetches information from the integrated sketch database. The sketches would be mapped and send through as geo-referenced data to a database (Expert 1, personal communication, December 9, 2016).

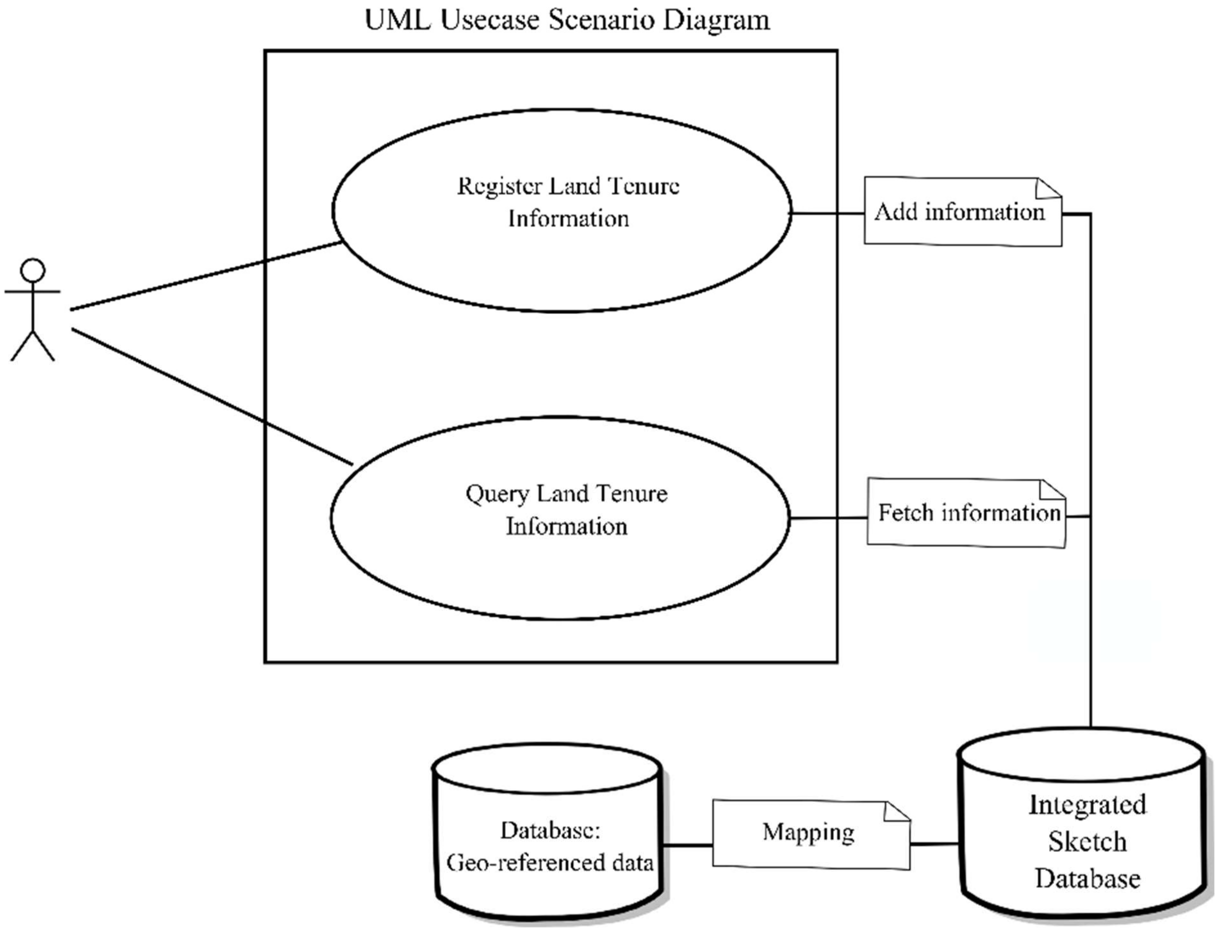


Figure 10: Draft Main Use Case Diagram Smart sketchmaps.

Figure 11 depicts two draft activity diagrams, as developed by the its4land project, which show how land tenure information would be queried and registered. The community could engage with the system without a programme, and just send in photos of their sketches with a phone to a certain number which is connected to a server which automatically uses relative spatial referencing based on landmarks and archives the sketch (Expert 1, personal communication, December 9, 2016; its4land, 2015). Or, the system could be run over a web service with an easy to deal with client interface (Expert 3, personal communication, December 14, 2016). A next step could be to implement the qualitative sketched information into the land administration system. Where the sketches could be recognized as a record, for instance to provide a first proof of ownership or provide spatial information of an area (Expert 1, personal communication, December 9, 2016; Expert 2, personal communication, December 13, 2016) .

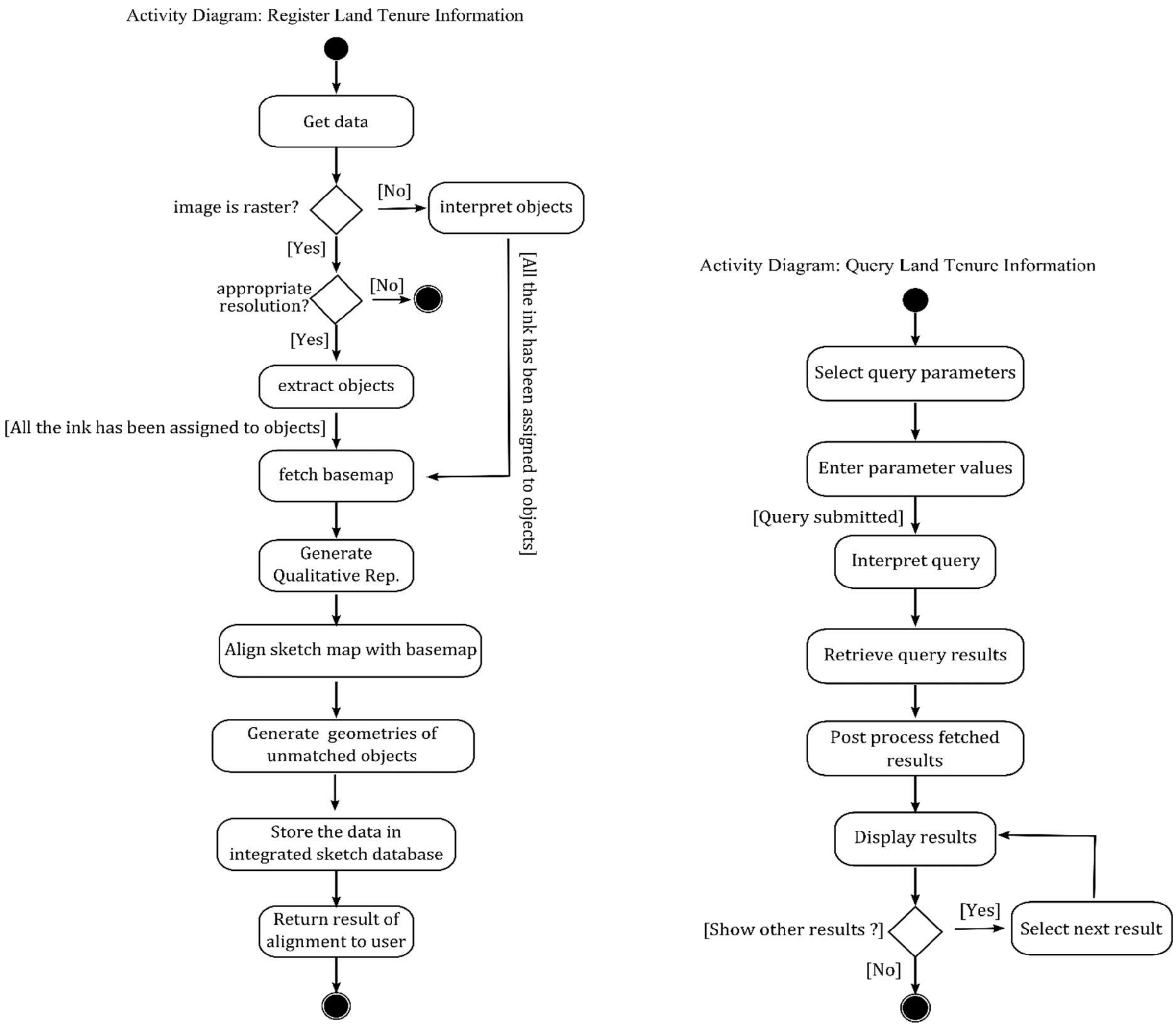


Figure 11: Draft Activity Diagrams to Register and Query Land Tenure Information

For the participatory mapping exercise there are two different options, either to draw freehand on blank paper, or to annotate an aerial image. When people will sketch a map of their environment they are likely to use certain concepts that are significant to them. Certain significant symbols will be deployed to mark a boundary, a tree or a house, for instance. Therefore, its4land proposes to gather different sketch concepts that will be relevant into a domain model. These concepts will have to be implemented in the system so that the software will be able to recognize these concepts. Naturally, when people sketch there will be deviations in how the symbols will be sketched. Therefore, the system is taught to recognize a large set of variations of a certain symbol, referred to as a template. An extension of the LADM has to be developed to organise these different templates into a class hierarchy, subsequently a boundary template can have different specializations which all relate to a boundary (Expert 3, personal communication, December 14, 2016).

Figure 12 depicts a very first demo of the sketch to metric alignment provided by Expert 1 (personal communication, December 9, 2016). In this demo a sketched map was put into the system which recognized 22 drawn objects. The system georeferenced the sketched map relatively to the metric base map.

Figure 12: First alignment demo smart sketchmaps with 22 matched objects. Source: Expert 1 (2016)

4.2 Key findings expert interviews smart sketchmaps

This section describes what is learned from the expert interviews on current technological possibilities of smart sketchmaps and societal demands in land administration. By means of different topics the experts were asked to mainly reflect on the below two key aspects:

1. Smart sketchmaps as a land administration data collection approach;
2. Smart sketchmaps as a potential application to meet societal needs in land administration.

The experts expressed different sentiments around these two aspects which will be elaborated on.

4.2.1 Smart sketchmaps as a land administration data collection approach

The first element the experts reflected on during the interviews concerns the possibilities smart sketchmaps provide as a data collection approach. its4land aims to develop a technical solution for extracting spatial information from sketchmaps for the purposes of land tenure recording (its4land, 2015). The experts stressed that the sketches can be used for cadastral purposes by adding spatial information on parcels and living areas. Though, collecting information for cadastral purposes should not be the sole goal according to the experts. Other spatial information can be included in the sketches as well, for instance on natural resources and pastoralist routes. Gathering this spatial information could be especially essential for municipalities in Eastern Africa who are often struggling with an information challenge. In many governments spatial information is usually not available. So gathering this spatial information can be of added value for the local governments in the region (Expert 2, personal communication, December 13, 2016).

The experts stressed that smart sketchmaps offer data collection characteristics that are beneficial to land administration needs in Eastern Africa, mainly that it is a participatory approach and is collaborative in nature. This of vital importance in customary situations where tenure is communally constructed and recognised. The experts agreed that producing the map should be a community effort where maps are produced which are legit for both the government and community. All community members should be able to participate in the data collection with a small amount of training provided. The experts agreed this training can be provided by a trained community member or a local NGO who can explain the workflow: who should mediate during the participatory sketching process will depend on the cultural setting (e.g., this could be a chosen community representative).

The experts indicated that after the data collection in the field the smart sketchmaps system has to be used to upload the sketches to the database. The project aims to deliver an open source system to operate via cloud computing, to ensure everyone will be able to use or adapt the system for their own needs. Recently, open source software is proposed more often in the international land administration domain. Enemark et al., (2015) advocate for a flexible ICT approach within land administration systems, in which open source solutions should be perceived as opportunities complementary to market based products (p. 104).

The experts expressed some challenges of concern with regards to smart sketchmaps as a land administration data collection approach. The degree of participation in the community during the data collection was mentioned. Visualisation tools and simple software interfaces can lower the hurdle to participation (Expert 3, personal communication, December 14, 2016), although including all members of the community can only be reached by purposively organising the necessary societal processes surrounding the tool. Age and gender issues which can arise have to be taken into account during the data collection. Expert 2 provided an example (personal communication, December 13, 2016): engagement can be increased by especially including the young members of the community whom are often more comfortable with computers. The young normally do not participate in matters related to land so if they are included, this could increase participation and benefit the outcomes. Only by including groups that otherwise would not engage in the data collection can one gather land rights for all members of the community. This is vital in the road to ownership and control over land for all to sustain everyone's livelihood.

4.2.2 Smart sketchmaps as a potential application to meet societal needs in land administration

This section reflects on smart sketchmaps' potential application to meet societal demands in land administration in Eastern Africa. The experts raised different issues that should be taken into account.

For smart sketchmaps to be applied in land administration, the smart sketchmap system requires a common symbology to be able to recognize semantic objects from the extended LADM in the sketched maps. Though, the symbols communities use may vary nationally, regionally and even locally. The experts propose to develop the mentioned extension of the LADM though with some flexibility within the semantic categories provided. The local symbology used can be gathered by local organisations who can put these into the system. This would be ideal since "the local community knows their own cultural and cognitive sketching viewpoint best" (Expert 1, personal communication, December 9, 2016, r. 159). If local symbology is used for the data collection, then training has to take place. For instance, for communities to know which symbols to use or to indicate which symbols are significant in their community. Besides, if necessary a short training can be provided on how to sketch the spatial information. The experts stress that the training should not be overly burdensome and should be easy to pass on to other community members. This will reduce the barrier to participation in the sketching process.

During the data collection process, according to the experts, spatial information should be sketched either freehand on blank paper or by annotating aerial images. They stress that people usually provide less information when annotating an aerial image, since this is bounded by the features present in the map although the sketch to metric alignment is easier because the sketch is already georeferenced to the underlying aerial imagery. When using the freehand approach people often add more information to the sketch since they are not bound by the features available on the aerial image. In addition, sketches from different people can be compared more easily if drawn freehand. According to the experts both options should be deployed and future pilots will show whether one option is preferable over the other. With regards to fit-for-purpose land administration, often annotating aerial images is preferred because of efficiency: in many cases boundaries are visible on the aerial imagery according to which land rights can be identified and secured (Enemark et al., 2015). Enemark et al. (2015) acknowledge that not all boundaries are visible on aerial imagery, mapping non-visible boundaries requires complementary field surveys, which could be carried out by using smart sketchmaps.

According to the experts, smart sketchmaps do not necessarily produce authoritative data from a governmental point of view, since data is provided by the community and might differ from official sources. Smart sketchmaps aim to produce an outcome that the community agrees upon, which at that point in time, is perceived to be legitimate from the communities' point of view. Accordingly, the sketched maps can serve as an entry point to issue a legal, authoritative document, which would be of added value to the land administration system. The sketched map can be used by surveyors to produce an actual legal record of the land and possibly issue a certificate to actually achieve tenure security. Relative accuracy is acceptable for this purpose; at a later stage the absolute accuracy can be improved (Enemark et al., 2015). Experts do stress that sketched data has to connect to unique parcel identifiers at some moment in time; otherwise the utility of the data to be used in formal land administration processes becomes limited. Besides providing evidence of first rights, the experts agree that sketchmaps can also be used for planning purposes and information gathering.

Once the data collection in the field has taken place, the sketches have to be uploaded to the cloud system. This requires some basic technical skills from the community. Sketches can be uploaded by phone or web service; however one has to take into account that still less than 21 percent of people in sub-Saharan Africa uses the internet (United Nations, 2015b). Therefore, uploading a sketch via phone or webservice may be a challenge for local communities due to the absence of internet connection or due to a lack of knowledge on this aspect. Besides, "some people might have a lack of trust on using cloud computing, since they prefer to hold their data locally" (Expert 2, personal communication, December 13, 2016, r. 114-116).

The experts wonder how to keep the collected data maintained over time. Expert 1 suggests to explore possibilities to teach the community to update changes by uploading their sketches to the system (although this must be tested in the development). On the one hand, gathered data can quickly become outdated and therefore unreliable, which can be seen as a waste of investment. On the other hand, it could be that land recordation and primarily securing land rights is the main purpose (Enemark et al., 2015).

In conclusion, the experts agree the potential application of smart sketchmaps in land administration in Eastern Africa very much depends on the social and institutional support surrounding the tool. When there is no leadership or social cohesion in a community, working with smart sketchmaps will be challenging. In addition, if institutions do not support the use of this technology, the outcomes will not be effective.

Unfortunately, not much can be said with regards to necessary investments with regards to time and money. The tool is still in development and costs to deploy smart sketchmaps are still unclear. The system should be run on a server and the system and records have to be maintained. Investments also have to be made in training, hardware and software. In a later stage of the its4land project development more can be said on this note.

4.3 Summarized concourse

As discussed, a technology loses its worth if it does not answer to societal demands. Therefore, smart sketchmaps should connect with the needs in the land administration domain. To put it more strongly:

> *"Too often the technical has failed and the social hasn't worked. Too often the social has failed because the technical hasn't worked for the social. Actually building a bridge to integrate these two is extremely important" (Expert 2, personal communication, December 13, 2016, r. 280-283).*

The potential for smart sketchmaps to address land administration needs were discussed with experts in the context of their alignment with fit-for-purpose principles regarding data acquisition for land administration purposes. The fit-for-purpose theory and experts' perspectives are summarised in Table 5. A traffic light system is used to indicate the experts' sentiments on the different fit-for-purpose elements in relation to smart sketchmaps according to the interviews. The green colour indicates a positive sentiment, yellow neutral or not applicable, and red indicates a negative sentiment.

Table 5: Concourse according to expert interviews.

FFP element	Theory	Expert 1	Expert 2	Expert 3	To note:
Flexibility	…in the spatial data capture approaches to provide for varying use and occupation				Some types of information require authentication e.g. unique reference numbers.
Inclusiveness	…in scope to cover all tenure and all land				Gender may be a challenge.
Participatory	…in approach to data capture and use to ensure community support				Take into account limited computer skills and gender/age equality.
Affordable	…for governments to establish and operate and for society to use				Short training has to take place, software and hardware has to be accommodated for.
Reliable	…in terms of information that is authoritative and up-to-date				Qualitative information may not always be reliable or up-to-date. Though on the day of capture the information would be very reliable from the viewpoint of the community.
Attainable	…in relation to establishing the system within a short time frame and available resources				How much time would be needed to establish the system? Are needed resources in place?
Upgradeable	…with regard to incremental upgrading and improvement over time in response to social and legal needs and emerging economic opportunities				Smart sketchmaps can be used as entry points to issue legal document. Smart sketchmaps can be updated with surveys. Future precision may outweigh benefits smart sketchmaps.

Smart sketchmaps seem to score best on the first three elements, being flexibility, inclusiveness and participatory. Affordable, reliable, attainable and upgradeable score lower according to the experts. This concourse is adopted in the statements to identify how different stakeholders evaluate smart sketchmaps according to fit-for-purpose elements which will be presented in the next chapter.

4.4 Statement creation

In order to conduct the Q-sorts and gather factors with clusters of perceptions different statements are created. According to the extensive literature review some knowledge gaps were identified. Especially with regards to available documentation on smart sketchmaps, which is very limited. These knowledge gaps were filled according to three expert interviews, two with technological experts on smart sketchmaps and one with an expert on the societal demand in land administration. Together, the theoretical framework and expert interviews make up the concourse of which statements are created. Some sources indicate 50 percent of statements should be framed positive, others suggest to keep 90 percent of the statements positive, since participants rank positive statements more easily (Webler et al., 2009). Webler et al., (2009) state: "What is most important is that the statements should mimic, as close as possible, the tone and content of statements in the concourse" (p.17).

As mentioned previously smart sketchmaps are assessed according to fit-for-purpose elements. Therefore, the statements are categorized according to those elements. The statements have to be comprehensive and representative and reflect the views identified in the concourse. Therefore, many statement have been created according to the theory and interviews. The statements that mimic the tone and content of statements in the concourse best have been identified and selected for use in the Q-sorts. The selected statements are attached in Appendix 2.

5. Research Results

This chapter presents the research results acquired from the conducted Q-sorts and accompanying interviews among thirteen participants. The first paragraph presents the factor analysis; the second paragraph provides a description of the three identified factors and their views on smart sketchmaps. The third paragraph interprets the factors according to fit-for-purpose land administration elements.

5.1 Factor analysis

PQMethod was used to conduct the factor analysis on the Q-sorts. The statements and Q-sorts were entered. Subsequently, multiple factor analyses were conducted. One can perform a Centroid factor analysis or a Principal Components factor analysis (PCA). Historically, many Q-researchers prefer the Centroid facor analysis because this analysis was computationally more simple and allows for manual rotation of the factors. With PCA variance between factors is maximized and the mathematically best solution is produced (Webler et al., 2009). Compared to Centroid analysis researchers found that PCA provides similar results, possibly even better, since this analysis provides a more sophisticated superior solution (Watts & Stenner, 2005). For comparison both factor analyses were conducted and PCA was preferred. Unsurprisingly, PCA provided more variance between the factors compared to Centroid.

PCA provided a table with Eigenvalues which can be used to select factors for interpretation, all factors with an Eigenvalue lower than one 1.0000 are discarded (Figure 13).

Eigenvalues		As Percentages	Cumul. Percentages
1	5.4465	41.8961	41.8961
2	1.5106	11.6202	53.5163
3	1.3192	10.1480	63.6642
4	1.0467	8.0519	71.7161
5	0.9093	6.9943	78.7104
6	0.7181	5.5241	84.2345
7	0.5197	3.9978	88.2323
8	0.3929	3.0223	91.2545
9	0.3678	2.8295	94.0841
10	0.2788	2.1443	96.2284
11	0.2540	1.9536	98.1820
12	0.1699	1.3073	99.4892
13	0.0664	0.5108	100.0000

Figure 13: Eigenvalues from PCA in PQMethod.

Consequently, one has to identify a certain number of factors for interpretation; in this case analysis was conducted with two, three and four factors. With these factors, rotation was conducted manually and by using varimax, which rotates the factors automatically and produces the statistically best solutions. Varimax was preferred because the solutions provided more variance between the factors. Subsequently, the sorts that load high on each factor have to be flagged, a high loading is anything above $\frac{2.58}{\sqrt{n}}$ (for which n is the number of statements); with 30 statements, the score has to be higher than 0.4710. In that the indication is that there is a 95 percent certainty that this specific sort contributed to that factor (Webler et al., 2009).

An interpretable factor has to have at least two sorts that load significantly upon it (Watts & Stenner, 2005). With four factors only one sort loaded significantly on the fourth factor, therefore the option with four factors is discarded. The sorts were analysed with two and three factors. It appeared that using three factors reveals more variance between the factors. On top of that with two factors 54 percent of the variance in the correlation matrix is explained and with three factors 84 percent of the variance is explained. Therefore it is decided that three factors will better reveal the different views.

In Table 6 the correlation matrix between the different sorts is presented. There were thirteen participants which largely correlate positively with one another. The higher the correlation between certain participants, the more likely these participants will end up in one factor.

Table 6: Correlation Matrix between sorts.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	100	48	-4	26	44	40	26	45	35	51	50	13	33
2	48	100	24	47	33	15	49	27	46	47	38	7	23
3	-4	24	100	41	30	36	55	34	37	32	45	-7	35
4	26	47	41	100	11	40	35	23	19	41	29	-3	39
5	44	33	30	11	100	24	28	40	41	45	68	13	25
6	40	15	36	40	24	100	43	45	38	34	35	27	46
7	26	49	55	35	28	43	100	53	53	66	27	29	56
8	45	27	34	23	40	45	53	100	45	55	48	39	65
9	35	46	37	19	41	38	53	45	100	45	51	16	21
10	51	47	32	41	45	34	66	55	45	100	53	47	55
11	50	38	45	29	68	35	27	48	51	53	100	-3	37
12	13	7	-7	-3	13	27	29	39	16	47	-3	100	47
13	33	23	35	39	25	46	56	65	21	55	37	47	100

The factor analysis resulted in three factors which together explain 84 percent of the variance in the correlation matrix. Five participants scored significantly on the first factor which explains 24 percent of the variance. Another five participants scored significantly on the second factor which explains 21 percent of the variance. And three participants scored significanlty on the third factor, which explains 19 percent of the variance. Table 7 presents to what extend the participants loaded on a specific factor.

Table 7: Factor matrix with an X indicating a defining sort which significantly contributed to the factor.

	Factor		
	1	**2**	**3**
1	0.7562X	0.2796	-0.0591
2	0.5620X	0.0634	0.3915
3	0.1348	0.0490	0.8418X
4	0.1483	0.1081	0.7152X
5	0.7931X	0.1143	0.0577
6	0.2159	0.4728X	0.4122
7	0.2266	0.5140	0.6205X
8	0.4185	0.6525X	0.2302
9	0.5795X	0.1929	0.3520
10	0.5090	0.5920X	0.2984
11	0.8054X	0.0594	0.2966
12	-0.0201	0.8666X	-0.1952
13	0.1457	0.7491X	0.3575

Correlation between the factors ranges from 34.22 percent to 42.82 percent (Table 8). The correlations between factor 2 and 3 is reasonable (34.22 percent). The correlation between factor 1 and 2, and 1 and 3 is slightly high (40.01 percent, 42.82 percent). Lower correlations between factors are usually better, as highly correlated factors are saying similar things. Nevertheless, it is not necessarily bad to have high correlations as long as the factor is otherwise satisfactory. It may be that two factors agree on many issues, but their points of disagreement are particularly important (Webler et al., 2009, p. 31). On smart sketchmaps it can be that the factors are generally agreeing on certain issues, but have other issues in which they differ. These are to be identified in the interpretation of the factors.

Table 8: Correlations between factor scores.

	1	2	3
1	1.0000	0.4001	0.4282
2		1.0000	0.3422
3			1.0000

The results according to fit-for-purpose elements are described in paragraph 4.2, subsequently the factors are interpreted in paragraph 4.3.

5.2 Results according to fit-for-purpose elements

This paragraph links the statement rankings for the different factors to fit-for-purpose land administration elements. The factors and statement rankings are interpreted according to the scores and accompanying interviews. When information comes from a specific interview this is indicated by an # followed with the number of the concerning participant. Statements with **bold** scores indicate a distinguishing statement which scores significantly different compared to the other factors (p<0.05, * indicates p<0.01). *Italic* scores indicate consensus statements that do not distinguish between any pair of factors (p<0.05, * indicates p<0.01). Appendix 6 and 7 present the distinguishing and consensus statements in total.

Green indicates a positive sentiment for that fit-for-purpose land administration element, yellow indicates a neutral sentiment and red indicates a negative sentiment for smart sketchmaps with regards to that fit-for-purpose land administration element.

5.2.1 Flexibility

Flexibility in the spatial data capture approaches to provide for varying use and occupation.	**1**	**2**	**3**
1. Smart sketchmaps are a highly valuable addition to the land administration system.	2	4	3
2. Smart sketchmaps should only be used when conventional surveys with total stations cannot be undertaken*.	*-3*	*-4*	*-3*

The first fit-for-purpose element relates to whether smart sketchmaps can be a flexible spatial data capture approach to provide for varying use and occupation. For this element the participants in the different factors have similar views. All factors believe smart sketchmaps are a highly valuable addition to the land administration system. Participants in factor 2 are most convinced on this statement (+4). All factors disagree smart sketchmaps should only be used when conventional surveys with total stations cannot be undertaken. The factors are elaborated on separately.

The views in factor 1 can be interpreted to indicate a positive sentiment with regards to flexibility. Participants in factor 1 believe the added value of smart sketchmaps to the land administration system depends on the overall implementation. Besides, one has to identify the administration system which is already in place and whether sketched information would be of added value to include (#1). Participants do believe smart sketchmaps are easy to use, accessible and could be of added value to the land administration system, simultaneously with conventional surveys.

The views in factor 2 can be interpreted to indicate a positive sentiment with regards to flexibility as well. Participants in factor 2 strongly believe smart sketchmaps are a valuable addition to the land administration system (+4). They believe the tool can be used complementary to traditional surveys with total stations. Though they might even prefer the use of smart sketchmaps over total stations. Two participants stress that achieving a complete cadastre in the Eastern African context will require less effort with smart sketchmaps compared to using conventional surveys (#12, 13). They stress spatial accuracy does not equal quality and prefer a complete cadastre over achieving spatial accuracy.

The views in factor 3 can be interpreted to indicate a positive sentiment with regards to flexibility. Participants in factor 3 are also convinced smart sketchmaps can be a valuable addition to the land administration system (+3). Though, their views are well reflected in this quote: “Smart sketchmaps is one end of a spectrum, traditional surveys are another end of the spectrum … there are many things in between which are also very viable (#3).” One participant even wonders whether conventional surveys with total stations are beginning to be outdated, particularly in emerging economies and rural areas (#7). The main sentiment in this factor is; in order to be fit-for-purpose different situations require different technologies.

5.2.2 Inclusiveness

Inclusiveness in scope to cover all tenure and all land.	**1**	**2**	**3**
3. Smart sketchmaps are suitable for all instances of collecting land rights information.	**-4***	-1	0
4. Smart sketchmaps can only be used in rural contexts.	-2	-4	-3
5. Smart sketchmaps can be produced by anyone in the community.	2	2	**-1***

The second fit-for-purpose element relates to whether smart sketchmaps are inclusive in scope to cover all tenure and all land. For this element the views of the factors distinguish more. Factor 1 strongly disagrees smart sketchmaps are suitable for all instances of collecting land rights information (-4). While factor 2 and 3 disagree slightly or are neutral. All factors think smart sketchmaps cannot only be used in rural context but in other contexts as well, especially factor 2 (-4). Factor 1 and 2 agree smart sketchmaps can be used by anyone in the community while factor 3 slightly disagrees on this statement (-1).

The views in factor 1 can be interpreted to indicate a positive sentiment with regards to inclusiveness. Factor 1 emphasizes strongly that no tool is ever suitable for all instances, everything is case specific. Therefore, smart sketchmaps will not always be the most suitable method for data collection (-4). Participants stress that a sketchmap remains subjective and is more error bound, in some cases, the data level in a sketchmap is too low to be used in the land administration system (#9). Despite this, participants in this factor stress that the tool is suitable for many contexts, for instance, in urban contexts or informal settlements. However, one has to take into account more cluttered features compared to rural areas, which the technology should be able to deal with. This factor stresses that all people in the community can produce a sketchmap, though one has to be aware who is involved and who is potentially excluded (#1, 11). To make sure different people are involved in the data collection process.

The views in factor 2 can be interpreted to indicate a positive sentiment with regards to inclusiveness. Factor 2 has comparable views with factor 1. Smart sketchmaps are not necessarily suitable for all instances of collecting land rights information (-1). Participants strongly disagree smart sketchmaps are only suitable in rural contexts (-4). Participants mention differing argumentations. For instance, in Kenya land information in urban context is more regulated and uses fixed boundaries, compared to general boundaries and communal land rights in rural contexts (#6). So smart sketchmaps might be easier to use in urban contexts compared to rural contexts because information is more clear. Though in urban areas one does have to deal with high densities and complex features, which might be more difficult to automatically convert in the smart sketchmap system (#13). Like factor 1, factor 2 also believes smart sketchmaps can be produced by anyone in the community, though after providing a small amount of training. Especially since some people are not spatially aware and would need some extra assistance.

The views in factor 3 can be interpreted to indicate a neutral sentiment with regards to inclusiveness. Factor 3 has a more distinguishing view compared to factor 1 and 2. This factor has no strong feelings on whether smart sketchmaps are suitable for all instances of collecting land rights information (0). The factor stresses smart sketchmaps can predominantly be used in rural contexts, though can also be helpful in informal settlements or peri-urban areas (#6). This factor believes not necessarily anyone can produce a smart sketchmap (-1). Some people are better suited than others; still, anyone in the community can and should participate in the process.

5.2.3 Participatory

Participatory in approach to data capture and use to ensure community support.	**1**	**2**	**3**
6. Smart sketchmaps include the rights of vulnerable groups, like women and youth, in the map production.	**-4***	**3**	**1**
7. Smart sketchmaps can support resolution of land conflicts.	2	2	**4**
8. Smart sketchmaps lead to community-supported outcomes.	**-3***	1	1
9. Smart sketchmaps do not fill a gap in participatory land information collection*.	*-2*	*-2*	*-1*
10. For smart sketchmaps to work a common sketch symbology has to be used.	**0***	**3***	**-3***
11. Smart sketchmaps fit the technical skills of the rural communities*.	*1*	*0*	*0*
12. When there is no leadership or social cohesion in a community it is not possible to work with smart sketchmaps.	**-1**	**-3**	**2***

The third fit-for-purpose element concerns whether smart sketchmaps are participatory in approach to data capture and use to ensure community support. For this element the factors have quite some statements significantly distinguishing compared to the other factors. For instance, factor 1 strongly disagrees that smart sketchmaps include the rights of vulnerable groups, like women and youth, in the map production (-4). Though the factors do agree smart sketchmaps fill a gap in participatory land information collection and that smart sketchmaps (can) fit the technical skills of the rural communities. The statements will be discussed per factor.

The views in factor 1 can be interpreted to indicate a neutral sentiment with regards to this fit-for-purpose element. The main sentiment in factor 1 is concerned that the rights of vulnerable groups are not automatically included in the map production when using smart sketchmaps (-4). Neither are outcomes automatically community-supported (-3). One has to identify the axes of differentiation in a community beforehand (#1). In this way one can ensure that different voices of different people are heard and when there is a lack of leadership or social cohesion. Smart sketchmaps can be used to deal with a lack of social cohesion in a community; "leadership or social cohesion can come in as an important factor afterwards" (#2). Problems can be mitigated when there is moderation and people are brought together (#11). This factor feels neutral on the common symbology, participants do mention that a blueprint is not preferred and the symbology should be open to additions.

The views in factor 2 can be interpreted to indicate a positive sentiment with regards to this fit-for-purpose element. Factor 2 agrees that smart sketchmaps include the rights of vulnerable groups in the map production (+3), although this has to be organised: "for instance by using bylaws, civic education and focusing on gender equality" (#6). This factor agrees quite strongly that the use of a common sketch symbology is necessary for smart sketchmaps to work (+3). Participants emphasize the importance of standards, though the symbology could be adapted per region for instance (#10). Besides, this is perceived as a typical software matter (#12, 13). Whether standards are necessary, and to what extent, completely depends on the software developed. This factor believes that one can still work with smart sketchmaps when there is a lack of leadership or cohesion in a community (-3). "Never underestimate the power of a community doing things together and the kind of support that it brings out" (#6). Though, especially without leadership support the effects will remain limited and secure land rights difficult to reach.

The views in factor 3 can be interpreted to indicate a positive sentiment with regards to this fit-for-purpose element. Factor 3 strongly agrees smart sketchmaps can support resolution of land conflicts (+4). Since the tool provides documentation of how each party perceives the land which can be used for moderation. With regards to the symbology, participants stress that using too many standards can be overly cumbersome. A legend can be interpreted afterwards or during the sketch exercise as well (#3). Besides, symbology may differ per context, it has to fit with the context of the community and one has to recognize what is locally used (#4). Participants also stress that social cohesion and leadership is required and will lead to more effective outcomes. Especially if one has to deal with communal land (#4).

5.2.4 Affordable

Affordable for the government to establish and operate, and for society to use.	**1**	**2**	**3**
13. Smart sketchmaps are affordable to establish and operate.	0	**4***	0
14. Implementing smart sketchmaps will be useful for governments.	3	**0**	2
15. The East African society cannot afford to spend time and money on using smart sketchmaps.	-1	**-3***	0
16. Sketched data has to be connected to unique parcel identifiers, otherwise it will be useless.	0	1	**-4***

The fourth fit-for-purpose land administration element reflects on affordability for the government to establish and for society to use. For this element the factors have quite some distinguishing statements, especially for factor 2, there are no consensus statements. For instance, only factor 2 strongly agrees smart sketchmaps are affordable to establish and operate and something the East African society can spend time and money on (+4, -3). Only factor 3 strongly disagrees sketched data has to be connected to unique parcel identifiers, otherwise it will be useless (-4). The different views on affordability will be elaborated on per factor.

The views represented in factor 1 can be interpreted to indicate a neutral sentiment with regards to affordability. Compared to the other two factors, factor 1 has no significantly distinguishing statements. Participants believe implementing smart sketchmaps will be useful for governments (+3). On the other statements, participants have no strong feelings. In general participants believe land administration is a large priority in Eastern African countries "so smart sketchmaps could potentially be a way of improving the land administration system" (#1). Though this does not necessarily have to be done by using smart sketchmaps, alternative solutions can be suitable as well. "Smart sketchmaps can be used as a means to start the conversation with governments around using less accurate technologies" (#9). With regards to affordability, participants stress that smart sketchmaps seem more affordable than other land administration solutions, which could be a potential advantage. Though the affordability is mainly high in the field, the system itself does need accurate base maps, which may be costly in the end (#11).

The views in factor 2 can be interpreted to indicate a positive sentiment with regards to affordability. Participants stress the approach seems affordable to establish and operate (+4), especially in the field, the solution is likely to be afforded by the East African society (-3). The produced data must be organized directly in the field. Besides, on the sketching paper there must also be space for identifying the parcel and its owner(s) (#12). Despite smart sketchmaps' perceived affordability in the field, the system itself might have some potentially costly elements since the software has to be supported with satellite or aerial imagery (#6, 13). However, compared to conventional methods smart sketchmaps have the potential to reduce costs.

The views in factor 3 can be interpreted to indicate a neutral sentiment with regards to affordability. Participants strongly disagree the sketched data has to be connected to unique parcel identifiers, otherwise it will be useless (-4). The other statements are not ranked significantly distinguishing compared to the other factors. Participants stress that using unique parcel identifiers in general has many benefits, though they do not deem them a strict requirement for smart sketchmaps. At least not at first, according to the participants, the identifiers can be added later in the process as well (#3, 7). Participants stress that smart sketchmaps can be very useful in some areas, though in other areas it might pose a threat to the existing land administration establishment. Especially in Eastern Africa the land administration establishment often seems very political (#3).

5.2.5 Reliable

Reliable in terms of information that is authoritative and up-to-date.	**1**	**2**	**3**
17. Land information provided by the community is always the most authoritative source.	-1	-1	1
18. Smart sketchmaps enhance trust between the community and land registration authority.	-2	0	0
19. Smart sketchmaps have to be open source so that it is available for everyone to use.	3	3	**-2***
20. Communities will not like smart sketchmaps to be available via cloud computing as they want to hold their data locally.	**0**	**-3***	**-1**
21. Sketches can be used for planning purposes, information gathering and evidence of first rights.	4	**1***	3

The fifth fit-for-purpose land administration element relates to reliability, in terms of information that is authoritative and up-to-date. For this element the factors have some distinguishing statements, among others relating to the possible open source development and cloud computing. The distinguishment of the factors will be discussed more elaborately.

The views represented in factor 1 can be interpreted to indicate a neutral sentiment with regards to reliability. Participants in this factor agree quite strongly that smart sketchmaps have to be open source (+3). "Nowadays everything should be intrinsically open source" (#1). Participants see many benefits for open source development. For instance, it could enlarge the trust in the system when the system is open source. Though, when there is a lack of trust in a community this cannot be solved simply by using this tool. With regards to cloud computing participants stress that communities will generally not prefer cloud computing. Mainly because of the low availability of internet connection in the areas in Eastern Africa. Participants indicate one can make use of cloud servers and still store data locally. Updates can be processed when there is internet connection available. This will pose a challenge with regards to data maintenance since data cannot always be up-to-date.

The views represented in factor 2 can be interpreted to indicate a neutral sentiment with regards to reliability. Participants in this factor agree quite strongly that smart sketchmaps have to be open source (+3). Besides, participants believe quite strongly as well that communities will not have a problem with cloud computing (-3). When smart sketchmaps are open source one can customize the application over time for different areas and applications, which is ideal according to this factor. Cloud computing will simply be a feature of the system which communities will agree upon. This is not perceived as an issue by the participants in this factor. Though, data security and privacy is crucial and has to be accounted for. In the interviews, participants also elaborated quite extensively on the trust issue. They mostly stress that using smart sketchmaps does not enhance trust between the community and land registration authority "land registration authorities are mainly established during colonial times which many people distrust" (#6). Though, by involving community members in the land registration process, enabled by smart sketchmaps, people will be able to feel part of the process which can possibly rebuild trust.

The views represented in factor 3 can be interpreted to indicate a positive sentiment with regards to reliability. Participants stress smart sketchmaps should be a cloud solution for scalability purposes (#3, 7). Open source software can be used for research purposes; though eventually open source will be too costly to maintain in relation to the land administration system (#3). Participants agree quite strongly that smart sketchmaps can be used for planning purposes, information gathering and evidence of first rights (+3). And possibly for a lot more application domains.

5.2.6 Attainable

Attainable in relation to establishing the system within a short time frame and within available resources.	**1**	**2**	**3**
22. Smart sketchmaps can collect land information more quickly than conventional surveys.	**-3***	0	1
23. Smart sketchmaps require governments to set aside specially trained employees.	0	-1	-2
24. Sketching has to be done freehand on blank paper*.	*0*	*-2*	*-1*
25. Sketching has to be done by annotating aerial images.	1	0	**-4**

The sixth fit-for-purpose element concerns attainability, in relation to establishing the system within a short time frame and within available resources. For this element there are some distinguishing statements for factor 1 and 3, relating to smart sketchmaps' time intensity compared to conventional surveys and relating to sketching by annotating on aerial imagery. The factors have similar views on whether sketching has to be done freehand on blank paper. The different factor views on attainability will be discussed more elaborately.

The views represented in factor 1 can be interpreted to indicate a neutral sentiment with regards to attainability. The participants in this factor disagree quite strongly that smart sketchmaps can collect land information more quickly than conventional surveys (-3). It is stressed that conventional surveys can be quicker than smart sketchmaps because the latter requires more extensive societal processes for its successful use. Due to its participatory and democratic nature, smart sketchmaps will be more time intensive to establish. With regards to the means of sketching, participants prefer to keep the sketching options open. Either drawing freehand on blank paper, drawing in the sand, or by annotating aerial imagery. The latter might have the advantage of immediate georeferencing which cannot be changed afterwards and can possibly increase trust in the community (#1).

The views represented in factor 2 can be interpreted to indicate a neutral sentiment with regards to attainability. Participants do not express particular strong feelings with regards to the statements on attainability. Though, in the interviews some sentiments appear for instance on whether governments have to set aside specially trained employees. Participants stress that in order to scale governments have to train trainers, which subsequently can train trusted intermediaries from communities who go to the field to gather and maintain the spatial information (#13). This will result in a network of trusted intermediaries from communities. With regards to the means of sketching participants indicate either freehand on blank paper or annotating aerial imagery should be possible. Aligned with local possibilities.

The views represented in factor 3 can be interpreted to indicate a positive sentiment with regards to attainability. Smart sketchmaps collect a different type of information than conventional surveys which have to adhere to legal requirements (#3). The pure data collection is faster with sketchmaps than with conventional surveys. Though the surrounding governance process can take much longer (#7). Sketching does not have to be done either on blank paper or by annotating aerial imagery. Sketching on aerial imagery can be particularly useful in providing scale and context, though it should definitely not be strict a requirement.

5.2.7 Upgradeable

Upgradeable with regard to incremental upgrading and improvement over time in response to social and legal needs and emerging economic opportunities.	**1**	**2**	**3**
26. Smart sketchmaps can upgrade already existing spatial information.	3	**-1***	2
27. Smart sketchmaps can be used to maintain the land use rights system as well*.	*1*	*1*	*0*
28. In due course spatial precision outweighs the benefits of using smart sketchmaps*.	*-1*	*-2*	*-2*

The seventh fit-for-purpose element concerns upgradeability with regards to incremental upgrading and improvement over time in response to social and legal needs and emerging economic opportunities. There is only one distinguishing statement for this element, which relates to the upgradeability of existing spatial information by smart sketchmaps. Factor 3 agrees quite strongly (+3), while factor 2 disagrees slightly (-1). For the other two statements the factors are significantly in consensus. The factor views will be elaborated on more extensively.

The views represented in factor 1 can be interpreted to indicate a positive sentiment with regards to upgradeability. Participants agree quite strongly that smart sketchmaps can upgrade already existing spatial information (+3). They stress that upgrading and updating the land administration system is of great importance for keeping the system maintained. Especially updating spatial information over time is often expensive, it would be interesting to research whether the community itself can update the spatial information (#2). The other statements are not ranked significantly distinguishing. Though, participants did make some comments in the interviews. Especially with regards to spatial precision, one has to focus on which spatial information is necessary at which level of accuracy, which might be a political decision. “One has to focus on what helps the people most, and not necessarily on spatial precision” (#11).

The views represented in factor 2 can be interpreted to indicate a neutral sentiment with regards to upgradeability. Participants in this factor do not express strong feelings with regards to the statements. In the interviews participants mention when spatial precision is required smart sketchmaps can still be used. High resolution satellite data will become more widely available; though still much spatial information will not be visible on imagery. Therefore, sketching can still be used.

The views represented in factor 3 can be interpreted to indicate a positive sentiment with regards to upgradeability. Participants in this factor do not express strong feelings with regards to the statements. In the interviews participants mention smart sketchmaps can be very helpful in upgrading the available spatial information, which is often not maintained. Smart sketchmaps can help to verify completeness, accuracy and up-to-datedness (#7). In the future spatial precision will be required in urban areas, though less in rural contexts.

5.2.8 Other

Other	**1**	**2**	**3**
29. The outcomes of smart sketchmaps are desirable to me or my organization.	**1***	**0***	**4***
30. The institutional and social support for smart sketchmaps will be crucial to its successful use.	4	2	3

This eighth category is not part of one of the fit-for-purpose elements, though included for completeness of the statements. The sentiments around these two statements were represented in the concourse quite strongly so another category was deemed necessary. The factors have especially distinguishing views for the statement concerning the desirability of smart sketchmaps for themselves or their organisation. For this statement factor 1 slightly agrees, participants indicate to have an interest in the tool, though no direct benefit.

Factor 2 is neutral on this statement. Factor 3 strongly agrees with this statement (+4). Participants are especially interested from a commercial point of view, for instance to integrate the system with certain software of their own organisations.

With regards to the statement on institutional and social support factor 1 strongly agrees (+4). Participants stress this is key for a successful outcome, an improved land registration cannot be achieved only with a map, institutional and social support is needed (#5). Factor 2 agrees moderately with this statement (+2) and factor 3 quite strongly (+3). Participants in factor 3 stress institutional and social support is crucial, particularly when the project is developed open source. There have been many unsuccessful open source projects that were not maintained due to funding, so institutional support is crucial for future continuation.

5.3 Factor interpretation

According to the results per fit-for-purpose elements the different factors are interpreted in this paragraph. For all three factors is determined how the represented views perceive smart sketchmaps.

Factor 1: Societal fitness

The views represented in factor 1 can be interpreted to perceive smart sketchmaps as being fit-for-purpose from the viewpoint of its societal fitness. Participants are mainly concerned with the societal implementation of the tool. Most of the distinguishing statements which ranked significantly different than the other factors focus on the societal context in land administration, surrounding smart sketchmaps. This factor does not elaborate extensively on the (technical) added value of the tool itself. For instance, participants strongly disagree that smart sketchmaps include the rights of vulnerable groups in the map production (-4), nor agree smart sketchmaps lead to community-supported outcomes (-3). Besides, according to the views in this factor using smart sketchmaps is not quicker than using conventional surveys (-3). Participants stress that especially participatory data collection processes are time intensive. On top of that, participants strongly disagree smart sketchmaps are suitable for all instances of collecting land rights information (-4). In conclusion, in the interview data it seems the participants in this factor do perceive smart sketchmaps as a possible added value, though the impact of the tool itself is not perceived greatly. Given the expertise of the participants in this factor, their focus on societal fitness does not come as a surprise. Up-on re-inspection, most of the participants' (scientific) work is concerned with the societal processes surrounding land registration.

Factor 2: Technical fitness

The views represented in factor 2 can be interpreted to perceive smart sketchmaps as being fit-for-purpose from the viewpoint of its technical fitness. Participants are mainly concerned with the value of smart sketchmaps' possible data output and not necessarily with the societal fitness of the tool. The possible societal issues of smart sketchmaps are addressed in the interviews, though do not define the statement rankings. Participants in this factor believe the issues regarding the societal fitness can be addressed by organising societal processes around the tool. Subsequently, participants strongly believe smart sketchmaps include the rights of vulnerable groups in the map production (+3), and can still be used when there is a lack of social cohesion or leadership in a community. It is interesting that the participants in this factor mainly have a technical background and are subsequently more focused on the technical fitness of the tool than the societal fitness. For instance, participants believe smart sketchmaps require the use of a common sketch symbology for standardization (+3). Besides, communities will not perceive using cloud computing for the provision of sketchmaps as a problem, since, according to the participants in this factor, this will be accepted as a given (-3). On top of that, participants believe smart sketchmaps are affordable to establish, operate, and something the East African society can spend time and money on (+4, -3). Participants in this factor have extensive knowledge on fit-for-purpose land administration and deem smart sketchmaps as a highly suitable tool for that approach, taking into account the societal processes which have to be organized for different contexts.

Factor 3: Commercial fitness

The views represented in factor 3 can be interpreted to perceive smart sketchmaps as being fit-for-purpose from the viewpoint of its commercial fitness. Participants in this factor deem smart sketchmaps to be a suitable tool which can support the resolution of land conflicts (+4). They agree that a predefined sketch symbology should not be prescribed (-3), and the sketched data does not have to be connected to unique parcel identifiers in order to be useful (-3). In addition, smart sketchmaps should not only be made available by annotating aerial images (-4), flexibility is preferred over providing one solution. This factor significantly distinguished itself from the other factors on smart sketchmaps being desirable to themselves or their organisations (+4) possibly for future developments or scalability of this tool for commercial purposes. Besides, the participants are completely neutral on the two statements concerning affordability of this tool for governments and society in Eastern Africa. From a commercial point of view these participants probably do not feel comfortable making suggestions about this issue without knowing specific numbers. Besides, it is the only factor which stressed that the tool should not preferably be developed open source (-2). This can be an indication of a preferred feature from a commercial point of view. Participants in this factor mostly have a commercial background which is reflected in this factor, the tool is mainly reflected on as a potential commercial opportunity.

6. Discussion

This chapter discusses the implications of this research according to its key outcomes. This thesis importantly fills a knowledge gap by presenting the available literature and knowledge according to expert interviews on smart sketchmaps for fit-for-purpose land administration. By reviewing the societal demands in land administration and the technological possibilities of smart sketchmaps as emerging geospatial technology a bridge has been built. Still it remains challenging for land administration professionals to accurately develop technology which is needed by society. However, the gathered knowledge in this research can be used for that purpose in the development of smart sketchmaps within its4land. Stakeholder perceptions on smart sketchmaps for fit-for-purpose land administration have been analysed and three different viewpoints are found. The three identified factors perceive smart sketchmaps fit-for-purpose from their own viewpoints. Hence, different aspects are highlighted per factor.

Factor 1 perceives smart sketchmaps fit-for-purpose from the viewpoint of its societal fitness. Stakeholders in this factor mainly have a background in the societal processes concerning land administration. Societal fitness of any tool is of high importance in order to have effective outcomes and make significant impact with regards to local needs. What clearly has to be taken into account is the fact that sketchmaps are more error bound by nature, and therefore not necessarily suitable for all instances of collecting land rights information (Schwering et al., 2014). This is stressed by multiple stakeholders as well. For areas of high value or with high density sketchmaps are probably not suitable, so as stressed by the fit-for-purpose approach different techniques are required for different situations (Enemark et al., 2014). Altogether, this factor is not so much focused on the added value of smart sketchmaps, if societal demands can be met is more important. Whether with smart sketchmaps or another technical tool. Factor 2 perceives smart sketchmaps fit-for-purpose from the viewpoint of its technical fitness. Stakeholders in this factor mainly have technical backgrounds. Technical fitness of the tool is of high importance as well, especially while the development is ongoing. Therefore, technical specifications have to be taken into account and piloted in the case areas. Specific elements to take into account are how to extend the LADM by including sketched information, while still remaining flexible to local situations. In addition, the means of sketching should remain flexible as well. Either by drawing freehand on blank paper or by annotating aerial images should be possible. The question remains how to provide sound base maps for the system when these are not present. Satellite imagery might be too low of resolution and flying UAV imagery has high costs to it which governments in Eastern Africa possibly cannot afford. This will be a challenge and costly element when scalability is required. Factor 3 perceives smart sketchmaps fit-for-purpose from the viewpoint of its commercial fitness. Stakeholders in this factor mainly have a background in business. This factor is interested in possible cooperation to use the tool within their organizations for commercial purposes.

In Table 9 the presented results from chapter 4 are summarized, the table evaluates smart sketchmaps according to the fit-for-purpose land administration elements. Compared to the summarized concourse in chapter 4.3 the factors turn out to be more positive than expected on this note. The three factors mainly represent views which deem smart sketchmaps suitable as a fit-for-purpose land administration approach. Some critical notes are added to take into account in the ongoing development of smart sketchmaps.

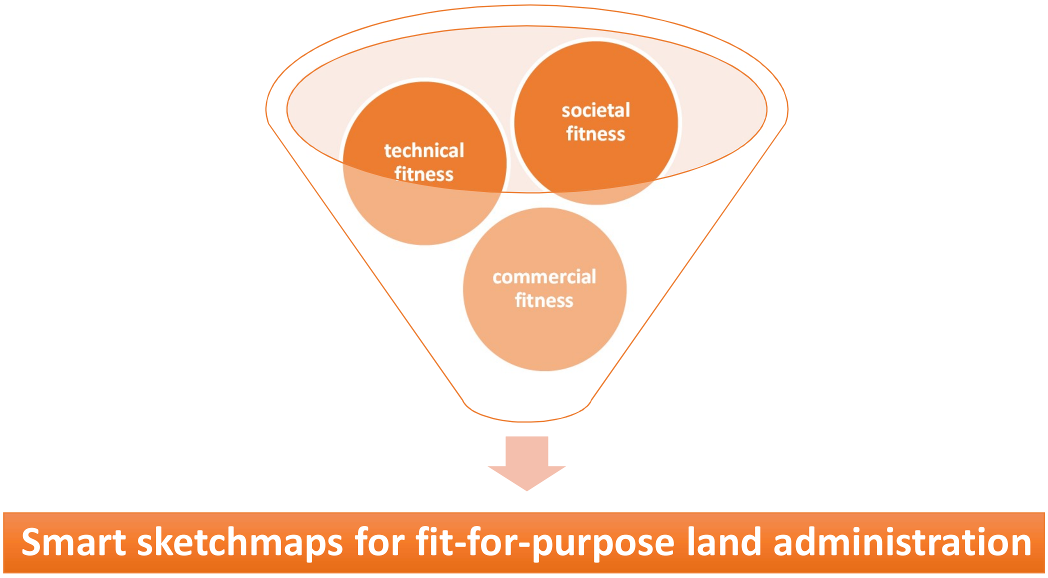
Table 9: Summarized evaluation smart sketchmaps according to fit-for-purpose land administration elements.

FFP element	Theory	F1	F2	F3	To note:
Flexibility	…in the spatial data capture approaches to provide for varying use and occupation				Different technologies are required for different situations.
Inclusiveness	…in scope to cover all tenure and all land				Anyone in Eastern Africa can produce a smart sketchmap from any land or tenure type, if needed with a small amount of training provided.
Participatory	…in approach to data capture and use to ensure community support				Focus on the surrounding societal processes. A participatory approach cannot solely be achieved by a tool. Communities in Eastern Africa will benefit from a flexible common symbology.
Affordable	…for governments to establish and operate and for society to use				In the field smart sketchmaps may seem more affordable compared to conventional techniques, though do take into account the time intensive participatory processes which might increase costs.
Reliable	…in terms of information that is authoritative and up-to-date				Trust has to be rebuilt between land registration authorities and communities in Eastern Africa. Possibly by involving communities in the land registration process by means of smart sketchmaps.
Attainable	…in relation to establishing the system within a short time frame and available resources				The system should be able to handle drawing freehand on blank paper and by annotating aerial images. Aerial imagery or a sound base map is not always available in Eastern Africa and can potentially be a costly element.
Upgradeable	…with regard to incremental upgrading and improvement over time in response to social and legal needs and emerging economic opportunities				Despite technological developments many spatial information in Eastern Africa will remain invisible and can only be gathered by e.g. smart sketchmaps. Also in the future these can verify completeness, accuracy and up-to-datedness.

The three identified factors represent the values and beliefs present on smart sketchmaps by the different stakeholders. The perceptions held by the different stakeholders represent quite strongly their professional background. However, this does present the different stakes which are at play in the development of smart sketchmaps as a new tool for fit-for-purpose land administration. These stakes have to be taken seriously in the future development of the project, since they will play an important role in the future utilization and effectiveness of smart sketchmaps. According to the stakeholder perceptions the technology obviously offers many technological possibilities, though the local users and societal context have to be taken into account. Otherwise the technique itself cannot be effective in the East African context.

The three identified views are represented by the different work packages in the its4land project as well. Though, just as for the researched stakeholders, a balanced consideration of all work packages is key for a successful outcome of the development process. Without balanced consideration of one another's findings, successful outcomes will be more difficult to achieve. By taking into account all of the three views represented in the three factors; smart sketchmaps are perceived suitable for fit-for-purpose land administration. Only by taking into account all of the three aspects, smart sketchmaps can make a significant impact in land administration in Eastern Africa. As visualised in Figure 14 the factors are currently perceiving smart sketchmaps fit-for-purpose from their own viewpoints. The factors have to be linked together, which can be done by its4land. The project can act as a funnel which can link those different viewpoints together and successfully develop smart sketchmaps for fit-for-purpose land administration.

Figure 14: Funnel to smart sketchmaps for fit-for-purpose land administration.



7. Conclusion

The overall objective of this MSc research is to examine the potential of smart sketchmaps in the context of delivering fit-for-purpose land administration in Eastern Africa. By assessing if smart sketchmaps are seen to include the fit-for-purpose elements according to different stakeholder perceptions. The main research question is: “What are the prevailing perceptions amongst different stakeholders with regards to the potential utilization of smart sketchmaps in the context of delivering fit-for-purpose land administration in Eastern Africa?” Several research activities have taken place in the search for the prevailing perceptions amongst different stakeholders. Accordingly, different conclusions can be drawn which will be elaborated on according to the three sub-objectives.

The first research question is: “What are the key concepts of smart sketchmaps in relation to contemporary land administration needs in Eastern Africa?” This research question aims to review the technological possibilities of smart sketchmaps in the context of societal demands of fit-for-purpose land administration in Eastern Africa according to experts and literature. The research question is divided into two parts; the first sub-question identifies the societal demands of land administration according to literature. In Chapter 2 the theoretical framework is drafted accordingly; an extensive literature review is conducted in which land administration principles are addressed and the shift from conventional techniques to fit-for-purpose innovations in land administration was found. Though, in order to reach the needed innovations one has to account for a balance of the technological push and societal pull. Technological innovations should be carried out because these are needed by the society and vice versa. Subsequently, the sketch mapping concept is addressed, sketch mapping has a long tradition and is increasingly used in the last years. Especially in the context of participatory mapping exercises, sketch mapping is widely used. This gives ground for smart sketchmaps which aims to use participatory sketch mapping for collecting land rights information in Eastern Africa. Especially by extracting spatial information from sketchmaps for the purposes of land tenure recording and to enable the capture of descriptive land tenure information from sketchmaps for incorporation and extension of the LADM (its4land, 2015). The second sub-question researches the technological possibilities of smart sketchmaps according to literature and experts. In order to answer research question 1b smart sketchmaps as innovative mapping solution is discussed with three experts on the topic. Together with the literature review this resulted in a summarized concourse. Constituting of values and beliefs on the technological possibilities of smart sketchmaps in the context of societal demands of fit-for-purpose land administration in Eastern Africa.

The second research question is: “What appropriate framework can be developed to collect data on the perceptions of stakeholders regarding the potential of smart sketchmaps for delivering fit-for-purpose land administration in Eastern Africa?” The appropriate framework is developed according to the Q-methodology which was found most useful for this aim. The method is conducted with thirteen participants from different user groups: international, industry, emerging and research users. According to the summarized concourse statements are created and categorized according to the fit-for-purpose elements.

The third research question is: “How can the collected data on the perceptions of stakeholders be interpreted? A) What clusters of perceptions can be identified pertaining to the potential role of smart sketchmaps in land administration in Eastern Africa? And B) Do the perceptions of different stakeholders differ and why?” In the fifth chapter of this research the collected data on the perceptions of stakeholders is interpreted. Three factors with clusters of perceptions on the potential role of smart sketchmaps in land administration are identified and discussed.

Research limitations

For this research it was found a highly valuable addition to actually assess technological possibility against societal need in land administration. In general, not much literature has been found on this subject, while it is found a valuable approach for actually developing required innovations for fit-for-purpose land administration. Naturally, this research has its limitations and strengths. Looking back to the research process some comments should be made.

Firstly, the available time for the statement creation turned out to be too limited. Due to time constraints the process had to be accelerated. This resulted in some faults for the created statements which affected the factor outcomes. As an example, afterwards the statements turned out to be focused mainly on the data collection, and not so much on the data outcomes. Particularly the connection to metric maps turned out to be a missing element in the selected statements. Another note on the statements relates to the wording, due to choice of words some statements were interpreted differently by some participants than others. This issue was found unavoidable and dealt with through oral explanation by the researcher, though could still have affected the statement ranking of the participants. These issues have to be accounted for in the outcomes of the research.

Secondly, the stakeholders in this research were purposively identified, as advised by Webler et al. (2009). Though, the correlation scores between the factors turned out to be fairly high. So possibly the identified stakeholders hold too homogeneous views. Looking back, all the participants had heard of fit-for-purpose land administration before. Possibly also novices to this approach should have been included in the research. The high correlation scores could have been prevented by using Q-methodology for the stakeholder selection as well, as proposed by Chandran et al. (2015) and Cuppen et al. (2010). They advise to also use Q-methodology for the stakeholder selection, in order to find stakeholders with opposing views beforehand and subsequently conduct the Q-methodology to find factors with clusters of perceptions. For this approach a larger time frame would have been necessary. Nevertheless, this approach can be advised for less homogeneous and hence improved outcomes. Another note on the stakeholder identification relates to the exclusion of the East African user group in this research. For a complete evaluation of smart sketchmaps according to fit-for-purpose land administration this group should have been included as well. Though, due to time and funding restraints this was not possible. Besides, this task is conducted by its4land so importantly this does not remain undone.

Q-methodology is found to be a useful approach for identifying different factors with clusters of perceptions. The hybrid approach with data collection in real life and online-supported is found feasible. No great differences were experienced in conducting the Q-sorts either in real life or online-supported. So if necessary this approach can be advised for other research purposes as well. Looking back, it was challenging to identify different perceptions on a yet to be developed tool. Since many factors are still unclear it was sometimes difficult for participants to express their opinion on issues which still have to be settled. It may have been better to conduct the Q-methodology in a later stage of the project development.

Recommendations for future work

According to this research some suggestions for future work are made. It is advised to its4land to further investigate the perception of the East African users on the potential utilization of smart sketchmaps in the context of delivering fit-for-purpose land administration in their region. As scheduled to take place within work package 2 of the project. It is advised to take the research findings of this thesis into account and verify the results with the East African user group. Besides, participants in this research pointed out they deem smart sketchmaps highly valuable to be researched in other application domains as well. For instance, in informal settlements, in urban areas and for planning purposes. This can be taken into account in the further development of smart sketchmaps.

It is strongly believed more work should be done which bridges technological developments with the societal demand for secure land tenure. Besides, in the future the by nature abstract fit-for-purpose elements can possibly benefit from a higher level of specification. On top of that, it is advised to start the development of an evaluation framework for fit-for-purpose land administration which can be used to evaluate cases and specific technologies which already deploy fit-for-purpose land administration.

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Appendices

Appendix 1: Topic lists Expert interviews

Topic list background interview with expert 1 on technical possibilities smart sketchmaps and fit-for-purpose land administration

Introduction

- Introduction – what is your role within its4land?
- Background information thesis research
- Ask permission for recording

Smart sketchmaps

- Introduction smart sketchmaps
- Which issues do smart sketchmaps address according to you?
- Discuss the different elements in the smart sketchmaps use case diagram.
- How does the data collection look in practice? What symbols are planning to be used for the common symbology?
- Do the sketches get distorted because of the referencing?
- What kind of ground control points can be used?
- Which types of base maps can be used?
- What means of sketching is preferred? Blank paper or aerial imagery?
- What happens after the sketch? Who will use the program to transform from sketch to map?
- How are you planning to align with LADM?
- Where are you now in the development?
- How to train local representatives?
- Which case area is most suitable and why?
- Which key alterations are necessary in the context of land administration compared to SketchMapia?
- How is the alignment of Smart sketchmaps with fit-for-purpose land administration elements? According to the fit-for-purpose approach land administration should be: flexible, inclusive, participatory, affordable, reliable, attainable, and upgradeable.
- What guidance is needed for the use of smart sketchmaps?
- Which challenges can be identified for Smart sketchmaps in land administration?
- How could smart sketchmaps be used in the land administration system?
- How could smart sketchmaps be used in the future? Are they upgradeable when countries develop?

Conclusion

- Summarize findings

Topic list expert interview with expert 2 – societal demand in land administration for smart sketchmaps for fit-for-purpose land administration

Introduction

- Personal introduction
- Background information thesis research
- Ask permission for recording

Smart sketchmaps

- Introduction smart sketchmaps.
- What is your view on participatory mapping approaches / smart sketchmaps?
    - o Is sketching still relevant in our digital age?
- Do you think such a tool can answer to the societal needs in Eastern Africa in land administration?
- Which issues can be identified in participatory mapping approaches / smart sketchmaps?
- Do you think sketchmaps should be added in the land administration system?
- Do you think smart sketchmaps will be embraced by locals in Eastern Africa, or rejected?
- Do you think smart sketchmaps can be drawn by any community member – or is training needed?
- According to you: to which elements of FFP do Smart sketchmaps answer and which not?
    1. Flexibility in the spatial data capture approaches to provide for varying use and occupation
    2. Inclusiveness in scope to cover all tenure and all land.
    3. Participatory in approach to data capture and use to ensure community support.
    4. Affordable for the government to establish and operate, and for society to use.
    5. Reliable in terms of information that is authoritative and up-to-date
    6. Attainable in relation to establishing the system within a short time frame and within available resources
    7. Upgradeable with regard to incremental upgrading and improvement over time in response to social and legal needs and emerging economic opportunities.
- What guidance should be needed for the use of smart sketchmaps?
- Which challenges can be identified for smart sketchmaps in land administration in Eastern Africa?
- How could smart sketchmaps be used in the future when countries start to develop?

Conclusion

- Summarize findings

Topic list background interview with expert 3 technical possiblities of smart sketchmaps for fit-for-purpose land administration

Introduction

- Introduction – what is your role within its4land?
- Background information thesis research
- Ask permission for recording

Smart sketchmaps

- Introduction smart sketchmaps.
- Which issues do smart sketchmaps address?
- How does the data collection look in practice? What symbols are you working on to use?
- Which ground control points can be used?
- What will be the means of sketching, on aerial imagery or freehand on blank paper?
- What happens after the sketch? Who will use the program to transform from sketch to map?
- How are you planning to align with LADM?
- Where are you now in the development?
- How would Smart sketchmaps be integrated in the land administration system?
- How to train local representatives?
- Which case area is most suitable and why?
- How to secure gender inclusiveness?
- Which key alterations are necessary in the context of land administration compared to SketchMapia?
- According to you: to which elements of FFP do Smart sketchmaps answer and which not?
    1. Flexibility in the spatial data capture approaches to provide for varying use and occupation (Smart sketchmaps in combination with other data collection types)
    2. Inclusiveness in scope to cover all tenure and all land. (suitable for all tenure?)
    3. Participatory in approach to data capture and use to ensure community support. (how can this be ensured?)
    4. Affordable for the government to establish and operate, and for society to use. (what about maintenance costs)
    5. Reliable in terms of information that is authoritative and up-to-date (will outcome be legit or legal?)
    6. Attainable in relation to establishing the system within a short time frame and within available resources (which resources are necessary)
    7. Upgradeable with regard to incremental upgrading and improvement over time in response to social and legal needs and emerging economic opportunities.
- What guidance is needed for the use of smart sketchmaps?
- Which challenges can be identified for smart sketchmaps in land administration?
- How could smart sketchmaps be used in the future? Are they upgradeable when countries develop?
- Have things developed differently than you expected at the start of its4land?

Conclusion

- Summarize findings

Appendix 2: Q-statements

All statements relate to the East African context.

Flexibility in the spatial data capture approaches to provide for varying use and occupation.

1. Smart sketchmaps are a highly valuable addition to a land administration system.
2. Smart sketchmaps should only be used when conventional surveys with total stations cannot be undertaken.

Inclusiveness in scope to cover all tenure and all land.

3. Smart sketchmaps are suitable for all instances of collecting land rights information.
4. Smart sketchmaps can only be used in rural contexts.
5. Smart sketchmaps can be produced by anyone in the community.

Participatory in approach to data capture and use to ensure community support.

6. Smart sketchmaps include the rights of vulnerable groups, like women and youth, in the map production.
7. Smart sketchmaps can support resolution of land conflicts.
8. Smart sketchmaps lead to community-supported outcomes.
9. Smart sketchmaps do not fill a gap in participatory land information collection.
10. For smart sketchmaps to work, a common sketch symbology has to be used.
11. Smart sketchmaps fit the technical skills of the rural communities.
12. When there is no leadership or social cohesion in a community it is not possible to work with smart sketchmaps.

Affordable for the government to establish and operate, and for society to use.

13. Smart sketchmaps are affordable to establish and operate.
14. Implementing smart sketchmaps will be useful for governments.
15. The East African society cannot afford to spend time and money on using smart sketchmaps.
16. Sketched data has to be connected to unique parcel identifiers, otherwise it will be useless.

Reliable in terms of information that is authoritative and up-to-date

17. Land information provided by the community is always the most authoritative source.
18. Smart sketchmaps enhance trust between the community and land registration authority.
19. Smart sketchmaps have to be open source so that it is available for everyone to use.
20. Communities will not like smart sketchmaps to be available via cloud computing as they want to hold their data locally.
21. Sketches can be used for planning purposes, information gathering and evidence of first rights.

Attainable in relation to establishing the system within a short time frame and within available resources.

22. Smart sketchmaps can collect land information more quickly than conventional surveys.
23. Smart sketchmaps require governments to set aside specially trained employees.
24. Sketching has to be done freehand on blank paper.
25. Sketching has to be done by annotating aerial images.

Upgradeable with regard to incremental upgrading and improvement over time in response to social and legal needs and emerging economic opportunities.

26. Smart sketchmaps can upgrade already existing spatial information.
27. Smart sketchmaps can be used to maintain the land use rights system as well.
28. In due course spatial precision outweighs the benefits of using smart sketchmaps.

Other

29. The outcomes of smart sketchmaps in land registration are desirable to me or my organization.
30. The institutional and social support for smart sketchmaps will be crucial to its successful use.

Appendix 3: Instructions Q-methodology and introduction smart sketchmaps

MSc Research Carline Amsing: smart sketchmaps for fit-for-purpose land administration

Instructions Q-methodology

Q gathers clusters of perceptions by means of rank ordering perceptions on statements according to your agreement and by means of an accompanying interview

Research Aim

This research seeks to explore the potential of smart sketchmaps for delivering fit-for-purpose land administration in Eastern Africa. SSMs are the technologies and processes that enable hand drawn non-metric spatial representations to be converted into topologically and spatially corrected maps. This research assesses if SSMs include the fit-for-purpose land administration elements according to different stakeholder perceptions.

Why Q?

In fit-for-purpose land administration, land administration systems are flexible and focus on citizens' needs, consequently informal tenure types have to be taken into account as well. Assessing fit-for-purpose land administration elements can be difficult, especially for a tool that is yet to be proven in pilot studies, let alone adopted. Therefore, perceptive input from different stakeholders from different backgrounds is needed.

These are the steps

#1
Schedule interview

#2
Receive private Q-link

#3
Conduct Q-sort and interview*

#4
Save data!

*How to conduct the Q-sort

After a short introduction we can start the Q-sort, you are urged to think out loud while sorting the statements; this will be very helpful in the final interpretation. The Q-statements will first be ordered on three piles, you can order the 30 statements in three boxes (Disagree, Neutral, Agree). When finished, the first sorting is complete, click continue when you are ready. Consequently, the three piles will have to be spread on the forced distribution chart. Carefully choose where to put which statement, the forced distribution makes sure you carefully weigh your choices against each other.

Q-intro smart sketchmaps

A tool to extract spatial information from sketchmaps for the purposes of land tenure recording

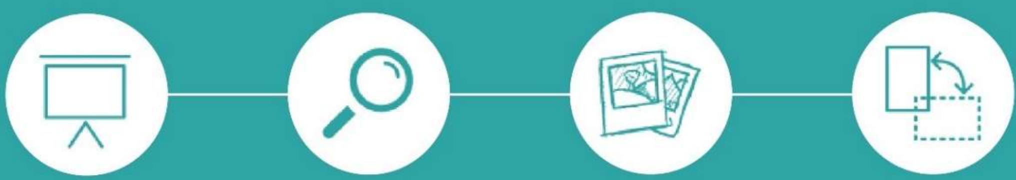
Definition

Smart sketchmaps are the technologies and processes that convert sketches into spatially corrected maps. The aim of developing this tool is to provide a technical solution to extract spatial information from sketchmaps on the one hand, and on the other hand to enable the capture of this qualitative land tenure information for extension of the Land Administration Domain Model.

Application

To use smart sketchmaps in a community firstly a short training would take place. Secondly, the local symbology used for sketching would be gathered and entered into the system. Thirdly, the sketches can be drawn with the community to identify resources, buildings and boundaries for instance. Either freehand on blank paper, or on aerial images. Fourthly, the sketched maps can be digitally converted to a spatially correct map and stored in a sketch database. Which potentially can be integrated in the land administration system.

Potential smart sketchmaps workflow



#1 Train community

#2 Gather symbology

#3 Sketch maps

#4 Convert and store sketch

Link technology with societal demand

This research seeks to link this technology with the needs in land administration. Therefore, this tool is evaluated according to the fit-for-purpose land administration approach. It is stressed that technology on its own will not provide tenure security for all, the surrounding institutional and social framework are of key importance.

Fit-for-purpose land administration: applying the spatial, legal and institutional methodologies that are most fit for the purpose of providing secure tenure for all. This approach will enable the building of national land administration systems within a reasonable timeframe and at affordable costs. The systems can then be incrementally improved over time.

Land Administration Domain Model: International standard with conceptual model for basic information-related components of land administration. It provides a shared vocabulary, for instance to combine land administration information from different sources more easily.

If questions: contact me any time via carlineamsing@gmail.com

Appendix 4: Informed Consent Form

Research Participant

Informed Consent Form

Dear Participant,

Thank you for your involvement in our study.

Introduction: You have been invited to take part in a research study. Before accepting, please read this document. If anything is terms or meanings are unclear, or if you would like clarifications on what the involvement means, please ask questions.

Purpose of the Study: its4land is a European Union Horizon 2020 project that aims to develop new tools to make land rights mapping faster, cheaper, easier, and more responsible. You can read more about the project on the information sheet provided. This study aims to gather perceptive responses on smart sketchmaps for fit-for-purpose land administration.

Procedure: to be able to do so we would like to receive some information from you about land in Eastern Africa. Your perception will be asked on the smart sketchmap technology being developed. This will be done by using the Q-methodology in which you will have to sort 30 statements from strongly disagree, neutral, to strongly agree.

Duration: It is expected that the entire study will last no more than 60-75 minutes.

Potential Risks and Benefits: The study will require some of your time, and you will be asked to rank different statements on smart sketchmaps. No other risks are foreseen. The benefits of being involved the project includes being potentially exposed to a new mapping tool. Your input will also help us to design and adapt the tool for the local context.

Privacy: Your responses might be recorded. What you say will be anonymised and only processed in aggregate. In this anonymised form, it might be published in academic journals, presentations or other media that directly relate to the its4land project. The information will never be published in a way that would allow anyone to identify you individually. The information will never be passed onto any other 3rd parties. Any other re-use by the its4land project must adhere to the strict procedures in the project's ethical guidelines and data management plan. You are free to stop, quit the study and retract your data **at any time during the study** with no further consequences.

Contact: For questions and complaints, you can contact the coordinator of the project: Dr. Rohan Bennett, r.m.bennett@utwente.nl

Information Sheet

For Research Participants

its4land is a European Commission Research Project, funded through the Horizon2020 research and innovation program (Grant No 687828; Program: H2020-ICT-2015). It runs for 4 years (Feb 2016 to Feb 2020). its4land seeks to create a set of land tenure recording tools that are cheap, fast, easy, and responsible. It is built upon fit-for-purpose and ICT innovation thinking. We aim to counter conventional approaches to land tenure recording that often administratively burdensome and costly. The project responds to the range of barriers that are known to exist using strong networks across Eastern Africa.

its4land is a consortium is made up of members from the University of Twente (Netherlands), INES Ruhengeri (Rwanda), KU Leuven (Belgium), Bahir Dar University (Ethiopia), WWU Munster (Germany), Technical University of Kenya (Kenya), Hansa Luftbild (Germany), and ESRI Rwanda (Rwanda). The experienced consortium is multi-sectorial, multi-national, and multidisciplinary. It includes SMEs and researchers from 3 EU countries and 3 Eastern African countries.

its4land also aims reinforces collaboration between the EU and Eastern Africa. It is using established local, national, and international partnerships. We are seeking to combine emerging geospatial technologies, including smart sketchmaps, UAVs, automated feature extraction, and geocloud services- in an end-user responsive and market driven way. We are also developing supportive models for governance, capacity development, and business capitalization.

its4land incorporates gender sensitive analysis and design and is set in rapidly developing Eastern Africa: Rwanda, Kenya, and Ethiopia. It includes 3 major phases and 8 work packages for contextualization, design, and eventual land sector transformation. We are seeking to use 'Living Labs thinking', localized pilots and demonstrations. We have tailored project management for milestones, deliverables, dissemination and exploitation.

You can learn more about its4land at the following places:

Website: www.its4land.com
Twitter: https://twitter.com/its4land1
Newsletters: https://its4land.com/newsletters/

Appendix 5: Topic list Q-sort interview on smart sketchmaps and fit-for-purpose land administration

1. Introduction (10 min.)

- Ask **permission for recording** – indicate the results will remain anonymous
- **Background information** thesis research
- **Explain smart sketchmaps** visually: http://chipofya.staff.ifgi.de/tech4land/alignment_demo.html
- Explain again the **Q-process** and what you hope to learn from it.
    - With Q the participant ranks 30 statements according to his/her agreement. Herewith qualitative data can be quantitatively analysed with factor analysis. I hope to gather clusters of perceptions on smart sketchmaps for fit-for-purpose land administration. So groups of opinions.
- Explain that I am interested in their **authentic perspective**, that there is no “right” or “wrong” answer. Some people may want to express their “official” organizational views.
- Urge people to “**think out loud**” during the Q-sort, this may provide important contextual information for understanding the results of the study. During the Q-sort I will observe and make notes, questions may be asked though after the Q-sort we will reflect on the statements.

2. Q-sort (35 min.)

- Observe the participants’ behaviour during the sort
- Make notes on specific comments
- Give further explanation on the sorting or statements if requested

3. Conclusion (15 min.)

- At the end it is most useful to ask the participants **to interpret their sort**, to ask if it captures their perspective on the issue.
- Ask the participant to **reflect on their two outer views**.
- Ask the participant **to reflect on the statements (s)he feels neutral about**.
- Reflect on the other statements.
- During **reflection link to fit-for-purpose elements**.
- Indicate where they would put the zero salience line. That is, where would they draw the midpoint between cards they feel positively and negatively about
- Ask if there are any important Q-statements missing from the sample (for future studies).
- Other comments or questions?

Appendix 6: Distinguishing statements

Table 1: Distinguishing statements, ranked significantly different compared to the other factors (p<0.05, *p<0.01).

Distinguishing statements for factor 1	**1**	**2**	**3**
29. The outcomes of smart sketchmaps in land registration are desirable to me or my organization.	1*	0	4
20. Communities will not like smart sketchmaps to be available via cloud computing as they want to hold their data locally.	0	-3	-1
10. For smart sketchmaps to work, a common sketch symbology has to be used.	0*	3	-3
12. When there is no leadership or social cohesion in a community it is not possible to work with smart sketchmaps.	-1	-3	2
22. Smart sketchmaps can collect land information more quickly than conventional surveys.	-3*	0	1
8. Smart sketchmaps lead to community-supported outcomes.	-3*	1	1
3. Smart sketchmaps are suitable for all instances of collecting land rights information.	-4*	-1	0
6. Smart sketchmaps include the rights of vulnerable groups, like women and youth, in the map production.	-4*	3	1
Distinguishing statements for factor 2	**1**	**2**	**3**
13. Smart sketchmaps are affordable to establish and operate.	0	4*	0
6. Smart sketchmaps include the rights of vulnerable groups, like women and youth, in the map production.	-4	3	1
10. For smart sketchmaps to work, a common sketch symbology has to be used.	0	3*	-3
21. Sketches can be used for planning purposes, information gathering and evidence of first rights.	4	1*	3
14. Implementing smart sketchmaps will be useful for governments.	3	0	2
29. The outcomes of smart sketchmaps in land registration are desirable to me or my organization.	1	0*	4
26. Smart sketchmaps can upgrade already existing spatial information.	3	-1*	2
12. When there is no leadership or social cohesion in a community it is not possible to work with smart sketchmaps.	-1	-3	2
15. The East African society cannot afford to spend time and money on using smart sketchmaps.	-1	-3*	0
20. Communities will not like smart sketchmaps to be available via cloud computing as they want to hold their data locally.	0	-3*	-1
Distinguishing statements for factor 3	**1**	**2**	**3**
29. The outcomes of smart sketchmaps in land registration are desirable to me or my organization.	1	0	4*
7. Smart sketchmaps can support resolution of land conflicts.	2	2	4
12. When there is no leadership or social cohesion in a community it is not possible to work with smart sketchmaps.	-1	-3	2*
6. Smart sketchmaps include the rights of vulnerable groups, like women and youth, in the map production.	-4	3	1
5. Smart sketchmaps can be produced by anyone in the community.	2	2	-1*
20. Communities will not like smart sketchmaps to be available via cloud computing as they want to hold their data locally.	0	-3	-1
19. Smart sketchmaps have to be open source so that it is available for everyone to use.	3	3	-2*
10. For smart sketchmaps to work, a common sketch symbology has to be used.	0	3	-3*
16. Sketched data has to be connected to unique parcel identifiers, otherwise it will be useless.	0	1	-4*
25. Sketching has to be done by annotating aerial images.	1	0	-4*

Appendix 7: Consensus statements

Table 2: Consensus statements, those that do not significantly distinguish between any pair of factors (p<0.05, *p<0.01).

Consensus statements	**1**	**2**	**3**
2. Smart sketchmaps should only be used when conventional surveys with total stations cannot be undertaken.	-3	-4	-3
9*. Smart sketchmaps do not fill a gap in participatory land information collection.	-2	-2	1
11*. Smart sketchmaps fit the technical skills of the rural communities.	1	0	0
24*. Sketching has to be done freehand on blank paper.	0	-2	-1
27*. Smart sketchmaps can be used to maintain the land use rights system as well.	1	1	0
28*. In due course spatial precision outweighs the benefits of using smart sketchmaps.	-1	-1	-2