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

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Key words: Smart Sketchmaps, Eastern Africa, Q-methodology, Fit-For-Purpose Land Administration, Land Administration Domain Model, Societal Pull, Technology Push, Stakeholders.

SUMMARY

This paper explores the potential of smart sketchmaps for delivering fit-for-purpose land administration in Eastern Africa. It does this by assessing whether smart sketchmaps include the 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.

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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 colonial times (Williamson & Ting, 2001). These land titling tools were developed in the context of Western Europe, and have been proven to be difficult to adopt 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.

The research reported in this paper was conducted in the context of the European Union-funded 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 which aim to deliver fit-for-purpose land recording services include smart sketchmaps, Unmanned Aerial Vehicles (UAVs), automated feature extraction and geocloud services (its4land, 2016c) [1]. This paper focuses on one of the tools: smart sketchmaps.

[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.

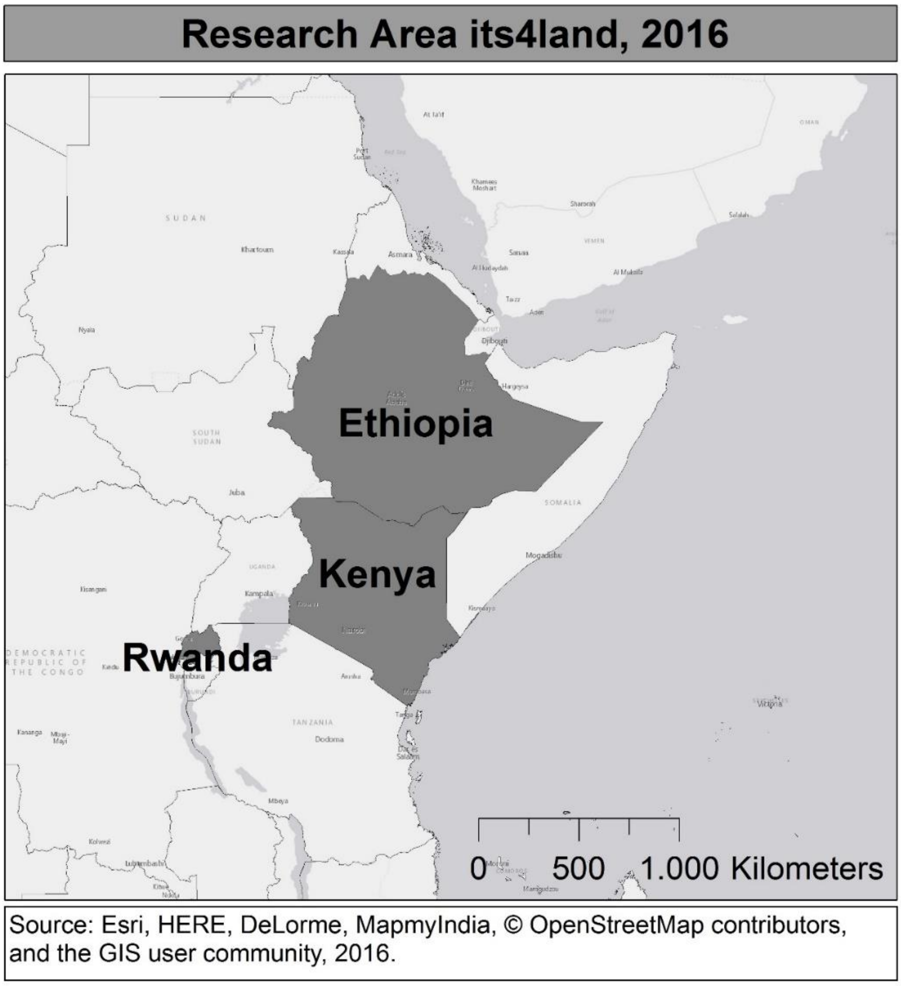


Figure 1. Countries of focus for its4land project. Source: its4land, 2016a.

1.1 Smart sketchmaps

Smart sketchmaps aim to create and facilitate interactions with land tenure information in the context of land administration systems (its4land, 2015). Smart sketchmaps have been previously developed by Muenster University as a prototype in the SketchMapia project (Schwering, et al., 2014). However, this was in the context of topographic information in urban areas. This paper 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, 2016b; 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, 2016c). A first demo of the tool is shown in the below figure. 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 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.

Figure 2: First alignment demo smart sketchmaps.

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, the Global Land Tool Network (GLTN), an alliance of partners supported by UN-Habitat, which aim to contribute to poverty alleviation through land reform, improved land management and provision of tenure security (GLTN, 2014) 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 are proposed as such a tool to enable the inclusion of 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, 2016b). 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.

1.2 Research Objectives

The goal of this paper 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 paper 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 paper 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 paper 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.

1.3 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?

2. RESEARCH APPROACH

The societal demands of land administration are identified according to literature. The technological possibilities of smart sketchmaps are researched according to some available documentation and experts. Semi-structured interviews are held with experts on the topic who have extensive knowledge on the tool development and application domain. This information answered the first research question which created a baseline for the second research question.

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 paper 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.

3. RESULTS

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 3).

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 3: 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 1 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 1: 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 2 presents to what extend the participants loaded on a specific factor.

Table 2: 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 3). 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 3: Correlations between factor scores.

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

According to the results per fit-for-purpose elements the different factors are interpreted. The Q-statements and accompanying factor scores can be found in Annex 1. For all three factors is determined how the represented views value smart sketchmaps.

3.1 Factor 1

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.

3.2 Factor 2

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.

3.3 Factor 3

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.

4. DISCUSSION

This paper importantly fills a knowledge gap, 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 paper 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.

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 4 the research results are summarized, the table evaluates smart sketchmaps according to the fit-for-purpose land administration elements. 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.

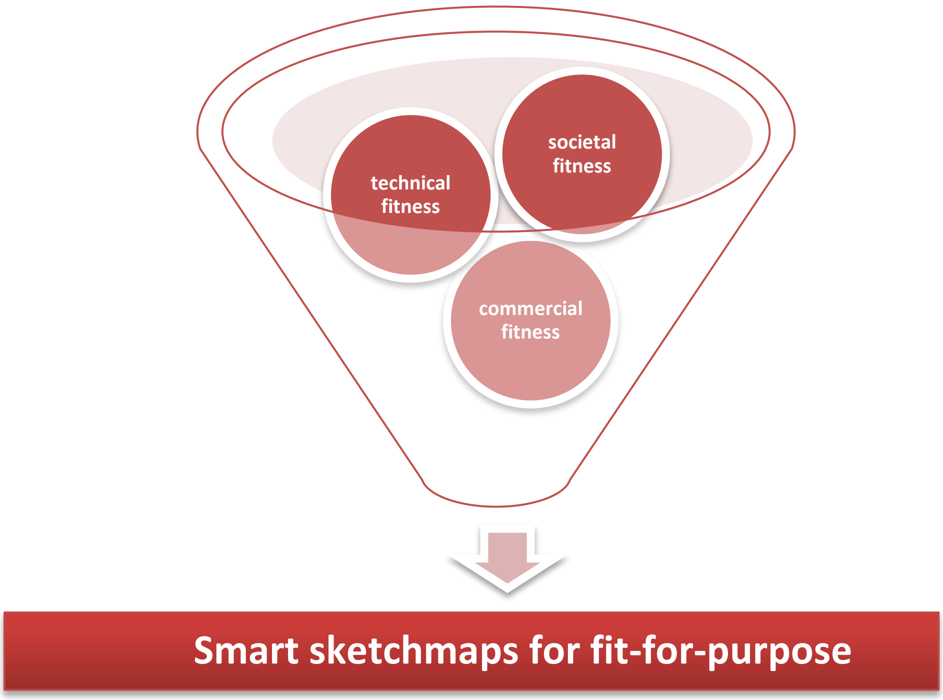
FFP element	**Theory**	**F1**	**F2**	**F3**	**To note:**
Flexibility	…in the spatial data capture approaches to provide for varying use and occupation				Different technologies are required for different situations.
Inclusiveness	…in scope to cover all tenure and all land				Anyone in Eastern Africa 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.

Table 4: Summarized evaluation smart sketchmaps according to fit-for-purpose land administration elements.

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 4 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 4: Funnel to smart sketchmaps for fit-for-purpose land administration.



Research limitations

For this paper 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. (2007). 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 paper. 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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BIOGRAPHICAL NOTES

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ANNEX 1

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*
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***
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***
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***
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
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**
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*