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Participative ICT4D and living lab research: The case study of a mobile social media application in a rural Tanzanian University setting

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ABSTRACT

The ICT4D field has for a long time focussed on rather unilinear processes of technology transfer. This focus was initially caused by the short time frames in which key actors in the ICT4D field had to operate. Different authors acknowledge that the ICT4D ideology has to be reconceptualised, recognizing the fact that technology is not neutral and that context and cultural complexity need to be taken into account in its development. This article argues that the living lab approach, involving the end user in the process of problem identification, technology design, implementation and evaluation, might be a suitable approach to move towards a more participatory ICT4D framework. The underlying study investigates how a location-based and community-oriented mobile app could improve the quality of life of Tanzanian University students. The research was part of an ongoing living lab study in order to gain insights into the local context and ensure a user-centric approach. The outcomes suggest that a mobile app can support student life in several ways, but that location-based services are not likely to be massively adopted and infrastructural limitations should be taken into account. The results demonstrate that ICT4D projects can benefit from adopting participative practices and that living lab research is an adequate tool to do so.

1. Introduction

We live in a networked society in which web-based information and communication technologies (ICTs) are interwoven in our daily life. Access to ICT enables access to information and knowledge, and new technologies support and facilitate everyday-life activities. In many parts of the world, it is hard to imagine life without these new technologies. Yet, access to and usage of new technologies remain unequally distributed. Developing countries lag behind in terms of uptake and use of phones, computers, internet and other technological services and products. These disparities hinder development, as access to information and the creation of knowledge is considered to be essential in development processes (ITU, 2005). In addition, ICTs have become enablers of openness and innovation, can support performance improvements of state organizations, and health and education services, and have participative democratic and empowering potentialities (Avgerou, 2010).

Despite the unequal distribution of ICT access and use, ICTs have been used to support development processes in developing countries. For instance, mobile technology (SMS and internet based) has been used to train and support health workers

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in rural areas (Ramachandran et al., 2010). New technologies have also been used to assist in raising awareness concerning HIV, malaria, tuberculosis and other health related issues via spreading educational materials and reaching people in remote areas (Baelden, 2013). Collaborative learning technology offers opportunities for universities in developing countries as they can not only support teaching and learning processes, but also forms of distance education (Adam et al., 2011). Mobile applications have been used for crowdsourcing purposes and enhance citizen collaboration. For instance, community mapping-applications have been used for mapping water points and other community assets and text messages have been used to report and map cases of harassment (Peuchaud, 2014; Welle, 2005).

Despite these promising examples, the use of ICT for development (ICT4D) is still too often focused on technology transfer aimed at bridging the digital divide. While improving access to technology is unquestionably essential for development, the mere diffusion of technologies in developing countries is not enough. More attention should be paid to the context in which technology will be used, the community's needs, and the fact that technology is not neutral and value free. Heeks (2008) argues that innovation in the ICT4D field should take new forms and makes a distinction between 'pro-poor', 'para-poor' and 'per-poor' innovations. Pro-poor innovations are done outside and for poor communities. While these efforts could lead to the development of innovations that do not fit local realities and that as a result are prone to failure (e.g. the initial telecenter concept), Heeks (2008) argues that there should remain space for such innovations. If developed while taking into account local realities, pro-poor innovations can succeed, as is shown for instance by the innovative pre-paid pricing plans. Per-poor efforts are innovations done by and within poor communities who adapt technology to local needs. A well-known example is the innovative business model of using of mobile phones as bank accounts. Para-poor innovation is done in collaboration with poor communities. Para-poor innovation is what Heeks (2008) calls "*ICT4D2.0*" and addresses the need to design innovations in a participative and user-centred way.

This article focuses on the latter form of innovation. It first presents an historical overview of how ICT4D has been conceptualised. It then argues why the ICT4D tradition could benefit from adopting a more participative stance and how living lab research can support this shift in relation to digital technologies. Next, it focuses on the results of an ongoing living lab study on a location-based and community-building mobile app for Tanzanian students in a rural university setting. The discussion focuses on why living lab research can assist the shift to a more participative ICT4D tradition.

2. ICT for development (ICT4D): a historical perspective

ICT4D can be defined as "*the application of information and communication technologies for international development*" (Heeks, 2009). While the concept of ICT4D was only introduced around the 1980s (Thapa and Sæbø, 2014), technology has played an important role in development processes ever since the field of development studies emerged in the post-World War II period (Baelden, 2013). The ways in which the use of technology for development is conceptualised has however changed drastically over the years. These changes can be understood in terms of the different development paradigms (Thapa and Sæbø, 2014), which have generally shifted from a focus on modernization towards participation.

Within the modernization paradigm, which has been dominant from the 1950s till the turn of the century, development was conceived as economic growth aimed at bridging the gap with the western world. Modernization scholars believe in the linear effects of information dissemination and view communication as means for persuasion (Baelden, 2013). Scholars like Lerner (1958) and Schramm (1964) considered mass media technologies as tools for modernization and agents for social change, because they were believed to enable the diffusion of 'modern and Western ideas' to developing countries. Mass media technologies were in other words viewed as driving forces of development and were therefore transferred to developing countries on a large scale (Servaes and Malikhao, 2008). The amount of mass media channels (e.g. the amount of TV sets for every 100 individuals) distributed in developing countries was then seen as an index of modernization (Lerner, 1958).

The modernization paradigm has been heavily criticized for its ethnocentric view on the world, its lack of attention to local contexts and cultural diversity, and its assumption that mass media technologies are neutral and value free and can therefore easily be transferred to other contexts. These critiques have led to the emergence of the participatory, or multiplicity paradigm in which development is conceived as a process of change that should occur from within local contexts, taking into account cultural multiplicity and local needs. In this paradigm, communication is viewed as a two-way process, meaning that participation of all partners involved in development projects is the key to change (Baelden, 2013). These different views on development imply altered views on the role of technology. In the participatory paradigm technologies are considered as tools that can support (instead of drive) development processes as they enable interactivity and participation, which in turn facilitates the identification of indigenous knowledge, practices and meanings (Thapa and Sæbø, 2014).

The introduction of new web-based technologies, and web 2.0 in particular, has supported the altered ways in which technology for development is being conceptualised (Van Audenhove et al., 2009). New technologies have a number of characteristics that are unique compared to traditional media. In contrast to technologies like television and radio, ICTs have a dual character in the sense that they allow data processing activities that can be used to sustain human reflection and action and can be networked, which enhances interactive forms of communication and the automation of processes (Mariën et al., 2010). In addition, new technologies allow for what Castells (2007) has called 'mass-self communication', which means that users can easily distribute (self-produced) content to large audiences via web 2.0 applications. These characteristics contain participatory and democratic potentialities, which can be used for supporting the process of social change. ICTs should thus no longer be viewed as indices for development, but as an instrument that can be integrated in a more global vision on social change (Mariën et al., 2010).

While the participatory paradigm started to emerge almost two decades ago (Baelden, 2013), the ICT4D field has for a long time continued to focus on rather unilinear processes of technology transfer. According to Heeks (2008) the continued focus on technology transfer was caused by the short timeframes in which the key actors in the ICT4D field had to operate. The almost simultaneous introduction of the internet as a medium used by large audiences and the Millennium Development Goals (MDGs) sparked a renewed interest in how ICTs could be used for development in general and for supporting the MDGs in particular. This led the World Bank in 1998 to highlight the role of ICT in development and the G8 Digital task force to create an ICT4D agenda in 2000 (Nulens and Van Audenhove, 1999). Also the World Summits on the Information Society of 2003 (Geneva) and 2005 (Tunis) contributed in forming the ICT4D agenda. According to Heeks (2009) this agenda was focussed on short-time delivery of results: "*With timescales short and pressure to show tangible delivery, the development actors involved with ICT4D did what everyone does in such circumstances: They sought a quick, off-the-shelf solution that could be replicated in developing countries' poor communities. Given that poverty concentrates in rural areas, the model that fell into everyone's lap was the rural telecottage or telecenter that had been rolled out in the European and North American periphery during the 1980s and early 1990s*".

The roll out of telecenters was aimed at providing people in developing countries with access to information, communication, knowledge, and services through access to technology. While practitioners did acknowledge the importance of training users and staff, the focus of telecenters remained on technology transfer and diffusion (Gómez and Hunt, 1999). Many of the telecenter initiatives unfortunately proved to fail due to a number of reasons, including a lack of sustainability, scalability, and objective evaluation (Heeks, 2008). The telecenter concept was however also never fully successful due to its focus on technology transfer and access provision. Leye (2009) argues that often proponents of the ICT4D paradigm have tended to lapse into technological deterministic views, believing that the introduction of ICT in developing countries will lead to social change. The inequality in terms of access to ICT – i.e. the digital divide – has been a focal point in this discussion, given that a lack of access to ICT is considered to result in unequal opportunities to participate in the global economy (Leye, 2009). Resulting from this ideology is once again a quantitative measurement of the amount of ICTs diffused in a society as indicator of development (Ojot, 2004). In order to avoid a relapse into the linear thinking of the modernization paradigm, it is essential to reconceptualise the ICT4D ideology. This includes looking at technology in a different way, realizing that the dichotomous notion of the digital divide is outdated, that attention should be paid to the broader mechanisms of digital exclusion, and acknowledging that technology is not neutral and value free.

In recent years digital divide researchers have started to focus not only on disparities in access to ICT, but also on the underlying drivers for inequality in access, on inequalities in usage patterns and on disparities in the outcomes of the use of ICT. In this respect, several scholars argue that digital inequalities are closely related to inequalities in economic, social and cultural capital (Mariën and Van Audenhove, 2011; Selwyn, 2004). Wilson (2006) identifies eight aspects of the digital divide: "*physical access*" (access to computers and networks), "*financial access*" (costs of ICT-related to income), "*cognitive access*" (skills to use ICT and information for one's own benefits), "*design access*" (usability of the technology in general and for specific groups, such as individuals that are visually impaired, illiterate people, people living in regions with limited access to electricity, etc.), "*content access*" (the availability of relevant applications and information in relevant languages), "*production access*" (skills to produce own content), "*institutional access*" (institutions that enable access), and "*political access*" (access to the political agenda and influence on policy initiatives, e.g. telecommunication regulations and price setting).

These new conceptualisations of the digital divide go beyond the mere question of access by acknowledging that issues like design, content and production are equally important in the process of digital inclusion. Technology should therefore be developed taking into account local contexts and cultural multiplicity. This can only be achieved by involving the end user in the process of problem identification and technology design, implementation and evaluation. The ICT4D field should therefore answer to the emerging call for a more participative approach.

3. ICT4D: a focus on mobile technology

Despite the call for a more participative ICT4D it should be acknowledged that access and infrastructure unquestionably remain a barrier in developing countries. The latest ICT report of the ITU (2014) estimates that currently only 0.4% of the sub-Saharan African population has a fixed (wired)-broadband subscription and that only 11% of the African households has internet access. The household survey (2011/2012) of the Research ICT Africa institute (RIA) shows that computer usage remains very low in many African countries. In countries like Uganda, Rwanda, Ethiopia and Tanzania, less than 5% of the population is estimated to use computers (Calandro et al., 2012). Yet, the African users seem to 'leapfrog' the wired networks and increasingly use mobile phones to access the internet. The ITU (2014) expects that by the end of the year, mobile phone penetration will reach 90% in developing countries. Whereas there were only 21 million mobile phones in use in Africa in 2001, this number increased to 735 million in 2014 (M and C Saatchi Mobile, 2013). Not all countries grow at the same rate however. According to the RIA study, only 35.8% of the Tanzanian adult population (15+) owns a mobile phone. Yet, when compared to the 1.9% of this population that uses a computer, this number is relatively high (Calandro et al., 2012). In addition, Tanzanian users spend substantial amounts of money on mobile phones. In rural Tanzania, users spend on average US$22 per month on mobile phone access and use, which is an equivalent of 20% of their total income (Heeks, 2010).

The ITU study (2014) also expects that by the end of the year 20% of all the Africans will be online. It is also expected that 55% of all the mobile-broadband subscriptions worldwide, will be in the developing world, indicating that users in

developing countries use mobile internet more than those in developed countries. This also indicates that African users mainly use the internet via mobile devices. In Tanzania for instance, 70% of the internet users access the internet through a mobile phone. In addition, 54.2% of the adult population used a mobile phone when first accessing the internet (Calandro et al., 2012).

There are several factors accounting for the popularity of mobile phones and mobile internet. Using a mobile phone requires less ICT skills and does, in contrast to computers and fixed internet access, not rely on electricity at home (Calandro et al., 2012). In addition, buying mobile phones requires less financial means compared to buying computers. Smartphones and other data-enabled devices are becoming more and more affordable due to competition, technological developments and economies of scale (Reed et al., 2013). In developing countries, mobile broadband is also less expensive than fixed internet for low-volume users (ITU, 2012). The use of mobile phones and mobile internet can also offer economic, political, and social incentives. For instance, innovative mobile money applications have emerged in a number of African countries. These applications facilitate financial transactions via mobile phones. One of these systems is known as M-Pesa, which is being used in countries like Kenia and Tanzania where they address an important need: in 2008 only 9% of the Tanzanian population had a formal bank account and in 2006, Kenia only had 450 bank branches, or less than 2 per 100.000 inhabitants (Aker and Mbiti, 2010). Services like M-Pesa therefore fill an important gap and address real-life needs of local communities.

4. Living lab research: answering the call for a more participative ICT4D ideology

The example above illustrates that technology can support development when it is embedded in local realities and addresses real needs. When developing or introducing new innovations it is therefore important to study and design them in collaboration with local communities. The involvement of end users in the early stages of an innovation and design process is the core idea of living lab research. Ballon et al. (2005) note that living labs have been defined as "*experimentation environments in which technology is given shape in real-life contexts and in which (end) users are considered* "*co-producers*". They argue that these real-life experimentation environments are set up with specific goals and structures, but that they are also governed by day-to-day life influences that cannot be controlled. Living labs are therefore also described as open innovation ecosystems in which end users are co-producers and in which technology is being shaped by social and cultural contexts (Ballon et al., 2005). The theoretical underpinnings of living lab research can be found in (1) Human Computer Interaction research given its focus on co-creation and participation (Ballon et al., 2005), (2) the field of Social Innovation due to its focus on interpersonal collaboration to identify local needs (Coetzee et al., 2012), and (3) the Social Shaping of Technology tradition, as it departs from the idea that social factors have an influence in shaping technological innovations (Pierson and Lievens, 2005).

On a very practical level Pierson and Lievens (2005) define living labs as: "(...) facilities for designing, developing, testing and evaluating communication technologies and services in early stages of the innovation process by involving (early) users (...). These can take the form of some sort of lab (like a house), in order to test and experience (uses of) technologies. This corresponds to the smart house idea, which has been around since the eighties. However our focus is on living labs that have a broader geographical reach, covering a range of (mobile) people, several households, a specific area (e.g. campus), a community, a neighbourhood or even a town".

The living lab research cycle contains a number of phases, including (1) contextualization (defining research focus and framework, and identifying potential users), (2) concretization (describing the everyday life of the recruited respondents in relation to the innovation that is being studied and in some cases co-design research), (3) implementation (experimental implementation of the innovation), and (4) feedback and evaluation (research on the attitudes of the user sample and the identification of technological recommendations). This final phase can then be used as input for a second iterative cycle of living lab research (Pierson and Lievens, 2005).

Living lab research has been used for technology development in a variety of fields, such as healthcare, agriculture, e-commerce, transport, tourism, and governance. According to Coetzee et al. (2012), who carried out a review of living labs in South Africa, living labs in Africa seem to focus on technological innovations (both products and services) that support capacity building, community development and empowerment. They also note that the importance of living lab research in developing countries is increasingly being emphasised in the literature and the academic community: "*The necessity to establish more LLs and LL networks in Southern and other parts of Africa to address Africa's immanent socio-economic and developmental needs was expressed during the inaugural IST-Africa LL w-Workshop in Gabarone, Botswana in June 2011*".

5. Study design en methods

This study was set up to examine whether living lab approaches can assist in making ICT4D research more participative. In order to do so, it aimed at investigating in a user-centric way, and by making use of living lab research methods, whether and how a location-based and community-oriented mobile app could improve the quality of life of students in a rural Tanzanian higher education setting. This app was initially developed by the University of Ghent (UGent) in Belgium as a sharing application for and by the student community. The app was built to allow "*its users to combine time and space coordinates in order to find interesting events, activities and notices available in their vicinity. (...) But users can also (anonymously)*

upload events and requests, and interact by sending reactions to posted events or requests in a particular zone" (Stroeken and Van de Weghe, 2013). The app is different from social networking sites in the sense that it aims to operate within the boundaries of trusted communities and that it combines a virtual noticeboard with location-based interaction.

A Tanzanian rural university setting is however hardly comparable with a Belgian university located in an urban environment. Resources were therefore foreseen to adapt the app to the local context on the level of both its design and content. In order to examine whether this app could support Tanzanian students in their daily activities and how it should be adjusted to meet local demands, it is essential to involve local users for (1) identifying their specific needs, (2) investigating the ways in which the mobile app could address these needs, and (3) co-designing the app in a way that it fits within the local context and meets real user expectations. To ensure the social and user acceptance of the app and to understand the social and technological context in which the app could be implemented, the innovation was studied using a living lab approach. This article reports the results of an ongoing study and therefore of the first two research cycles of the living lab research, namely contextualization and concretization. This means that (1) potential users were identified based on the description of user profiles, (2) data collection focused on describing the everyday life of users in relation to the innovation, and (3) potential users participated in participative co-design sessions.

The remainder of this article reports the results of this study as an illustration of (1) how co-creative living lab research methods can be used for participative ICT4D research, and (2) how these methods can lead to local, cultural, and context sensitive insights that can support the development of technologies that address real-life needs and fit local usage patterns.

5.1. Profile identification and respondent recruitment

The user profiles were identified by university staff and students and consisted of bachelor, master and PhD students; non-employed and employed students; students that privately finance their studies and students that are granted a loan board or scholarship; and students that live on campus, off campus in rented accommodation, or at home with their family. These profiles were selected because they might influence the way in which students experience their everyday life on campus and therefore their needs and expectations. In total 50 respondents were recruited to participate in this study via non-probability, purposeful sampling taking into account the different user profiles, the university's faculties and gender balance. This way of sampling aims at maximum variation to facilitate analytical diversity.

Students were recruited in two ways. First, a message was sent to the WhatsApp groups of all classes on campus explaining the purpose and set-up of the study and inviting students to participate in the research. Second, students were invited to take part in the study via word of mouth on campus grounds. In order to stimulate participation, a small incentive in the form of airtime was provided.

5.2. Data collection

Data for this study was collected in three stages via different research methods. First, users were asked to fill out a one-day diary. In this diary, users were invited to (1) give a detailed description of every activity they carried out that day, (2) describe the transport means they used to travel to that activity, (3) draw the route they followed to arrive at the location of the activity on a map of the campus and campus environment, and (4) describe how they felt when carrying out this activity by using emoticons. The diary also contained a section in which users were free to provide any type of information (e.g. pictures, drawings, text, collage, etc.) on the concerns they had as a student and on how an app would look like if they were free to design it. The results of this one-day diary were not used for in-depth analysis, but rather as a technique to elicit more information during the interview. Studies on participatory research techniques have shown that diaries are a good way to make respondents actively engage with the research topic before the interview. While people usually do not reflect on their daily routines, a diary is a way to sensitize the participants to do so (Sleeswijk Visser et al., 2005). In addition, diaries have been found effective in eliciting stories, dreams and unspoken feelings (Sanders, 1999). These aspects enhance the richness and quality of the information the respondents give during the interview.

Next, the respondents that filled out a diary participated in in-depth interviews. The main aim of the in-depth interviews was to gain insights into (1) user needs, which may occur on a daily basis, or may be related to specific moments during the academic year (e.g. during registration, orientation week, exams, etc.), (2) current practices and tools that are used to address those needs, and (3) tools or methods that could possibly offer a better solution for these needs.

Third, focus group interviews and co-design sessions were organised to complement the needs analysis and to gain insights in student preferences concerning the look and feel, architecture, affordances, and design of the mobile app. In addition to traditional focus group interview techniques, the researchers used participatory projective and generative techniques such as brainstorm and conceptual mapping exercises, image association, lists of statements (i.e. agree/not agree), prioritizing techniques, drawing exercises, and the evaluation of mixed fidelity prototypes.

Finally, validation focus group interviews were organised to validate the results from the previous research steps. All sessions were audio- or videotaped with the respondents' consent and all tapes were transcribed ad verbatim for qualitative thematic data analysis.

All participants were also asked to fill out a brief survey that aimed at collecting socio-demographic data, as well as information on the respondents' smartphone and mobile internet usage. The survey was not developed for complex statistical analysis, but rather for enabling the contextualization of the information the respondents provided.

5.3. Challenges when recruiting respondents and collecting data

We experienced a number of challenges when carrying out this research. Aside from some practical challenges, such as power cuts, or heavy rainfalls, it appeared to be difficult to recruit sufficient respondents for this study. The incentives that were provided did increase the interest to participate; yet there was an overrepresentation of students from the informatics department. While lead users can be interesting to include in participatory research, we aimed at using a balanced sample. We did succeed in doing so, but it proved to be a labour-intensive process. The fact that participatory research techniques put a rather heavy burden on respondents in terms of time possibly explains this challenge. Next, some participatory techniques appeared to be more feasible and culturally sensitive than others. For instance, the oral evaluation of the mixed fidelity prototypes elicited little response and had to be changed into a written exercise. This compelled the researchers to adopt a flexible way of working and adjust some of the exercises during the course of the research. It would be interesting to do more research on the use of participatory techniques, both projective and generative, in a non-Western context on order to get a better view on which techniques work best in which contexts.

6. Results

The sections below elaborate on the results of this study to illustrate how participatory research techniques can lead to context and culturally sensitive insights into what an innovation should consist of and look like. First, attention is paid to the profile of the respondents. This is followed by a discussion of what needs an innovation could address and by a description of what the innovation could look like according to the respondents of this study.

6.1. Profile of the respondents

The average age of the respondents taking part in this study is 26, with the youngest student being aged 19 and the oldest 53. All but one respondent indicated to live on campus in university housing, or in rented accommodation off campus. The observation that very few students live at home with family can be explained by the rural location of the university. Respondents that live off campus commute on foot, by motorbike taxi, or by other public transport means. Only 1 student reported to own a car. The majority of the commuting students indicated that traveling to campus is difficult, mainly as a result of the bad conditions of the road during the rainy season. During this season the roads turn to mud, which makes commuting on foot impossible.

A small minority ($n = 2$) of the respondents indicated to not own a mobile phone. Of the respondents that do own a mobile phone ($n = 48$), almost 9 in 10 ($n = 41$) owns a smartphone. This means that 9 students in this sample (=18%) do not own a smartphone. Almost all smartphone owners in the sample use their phone to go online. Only 1 respondent indicated to not surf the web or use mobile apps. A quarter of the respondents ($n = 12$) have access to a monthly data bundle of 1 GB or less. 18 students have 2 or more GB of data available on a monthly basis and 11 respondents reported to not know how much data they have available each month. This can possibly be explained by the fact that students often use daily or weekly bundles based on their internet needs of the moment. In general the numbers indicate that the amounts of the monthly data bundles is relatively large for many of the respondents in this sample. This can most likely be due to the fact that the mobile phone operators Vodacom and Tigo provide university promotions for students physically located on campus grounds.

When accessing mobile internet on their smartphones, the respondents most often use search engines, job related websites, and university related websites. This top three suggests that the mobile internet behaviour of the students in the sample is mainly guided by academic and job related activities. The mobile app use of the respondents is in contrast mainly guided by social networking activities. The top 3 of mobile apps that the respondents use consists of WhatsApp, social networking apps other than WhatsApp (i.e. Facebook, Instagram, Twitter and Viber), and internet browsers (e.g. Opera mini). Also apps related to video, music and pictures were mentioned quite often. The observation that WhatsApp is more popular compared to emailing programs, can probably be explained by the fact that apps work faster and are more reliable, even when the quality of the internet connection is poor.

6.2. What do Tanzanian students need?

In line with the aims of living lab research, the qualitative data collection and analysis focused on identifying the needs of the student community, the tools that the community currently uses to address those needs, the ways in which these tools do or do not answer those needs, and the way in which a location-based and community-oriented mobile app could possibly offer a solution. In total, the respondents identified 13 needs for which a mobile app could offer a solution. These needs were collaboratively ranked according to importance. The results of the ranking exercises were combined and an average score (i.e. based on their place in the ranking, where number 1 signifies the most important and number 13 the least important need) was calculated for each need. The results of this ranking exercise as well as the reasons why a mobile app could offer a solution are discussed below.

Need	Score	Why can a mobile app offer a solution?
Administrative notifications	1.5	Students use WhatsApp groups, the university's e-learning system and the noticeboards on campus to be informed about administrative issues. Students reported problems with accessing the e-learning platform and indicated that checking the noticeboards requires physical presence on campus. A mobile app could offer a solution because it would gather all information in one place, no longer require physical presence on campus, which would especially be appreciated during the rainy season, and solve access problems, as mobile apps are more user friendly compared to websites when mobile internet connections are poor
Notifications of incidents on campus	3	Many students, especially those living on campus, identified the need for being notified about incidents and emergencies on campus. The mobile app could be used to provide students with real-time notifications of how long a power cut is expected to last, when water shortages will be finished, how crime waves in student housing are being addressed, and so on. Currently students are not being informed about these issues
Sharing and storing study materials	3	Students acquire their study materials in different ways (e.g. via lecturer, e-learning platform, library, WhatsApp groups, websites, etc.). Not all students have the financial means to buy hard copies, possess the adequate skills to find relevant information online, or belong to the WhatsApp groups in which materials are being exchanged. A mobile app would make it easier to obtain materials as it can gather all relevant study materials and as operates in a more open way compared to the closed WhatsApp groups. The respondents also favour connecting the e-learning platform with the mobile app, which would enable receiving real-time notifications when new study materials are uploaded
Information on university services	5.5	The respondents experience a lack of information concerning the different services and facilities available on campus. They support the development of an app that provides information on for instance laundry services, food and canteen facilities, health care services, registration procedures, fee structures and sponsorship opportunities, and so on
Open discussion forum	6.5	Students often organize evening discussion groups on campus grounds in order to discuss course related issues. The demand for an online platform to organize these discussion groups was high. This would be especially interesting for students residing off campus, as it would enable them to avoid travelling home late in the evening
Schedules and practical information	7	The respondents raised the idea of providing practical information like course schedules, timetables, routes and costs of the different public transportation options on the mobile app. Currently this information is advertised through the noticeboards, requiring physical presence on campus
Accommodation off campus	7.5	When looking for private housing, the respondents consult the ads on the campus noticeboards and university website, use middlemen, or walk around in the villages. These strategies are time consuming and the information that is published on the notice boards or provided via the middlemen is not always reliable. As a result, students still have to travel to the villages to check the accommodation. As many students live far from campus, this proves to be difficult and students tend to rent rooms based on unreliable information. A mobile app could gather all the ads on one single platform. This would not only give a better overview of available accommodation, it would also enable student reviews of the information that is being provided by landlords and middlemen, which would improve the quality of the information
Notifications of events	8.5	Social, academic and religious events are advertised via noticeboards, announcements in class, WhatsApp groups, word of mouth, email, flyers, university website, Facebook pages, or via SMS. The respondents identified number of challenges related to these tools: (1) the "*flows of speech*" tend to be confined to a number of "*closed communities*" on campus, (2) also WhatsApp and Facebook groups are confined to a limited number of students, and (3) students living off campus find it more difficult to be updated on events,

* (*continued*)

Need	Score	Why can a mobile app offer a solution?
		because they don't pass by the noticeboards everyday. Most respondents favour the development of a digital platform that gathers information on events. This would enable students living off campus to be updated about events and guarantee a broader reach compared to communication via WhatsApp or Facebook groups. A mobile app could also be used to notify students about last-minute changes in the programme of activities
Detailed map of campus and surrounding area	8.5	Orientation on and around campus is challenging because there is no detailed map of the campus and the broader campus area (i.e. the surrounding villages). The respondents support the development of an app that contains a detailed location-based map. They however also identify a number of challenges related to the use of location-based maps, which will be discussed below
Buddy system	12	At the beginning of the academic year, senior students walk around on campus for assisting incoming students in finding their way around. The senior students are however not always very visible. A mobile app could facilitate a matchmaking process between senior and incoming students
Transport from town to campus	12	After 8PM, when public transport is no longer available, travelling from town to campus is done in private taxis, which is expensive. A mobile app could be used for broadcasting one's travelling plans within the trusted university community. This way, students can contact each other for sharing taxis and decreasing travel costs
Transport from campus to town	13.5	Also travelling from campus to town in the evening is financially challenging, because taxis need to be called in from town. Students reported however that sometimes, when taxi drivers drop off someone on campus, they allow students to join the ride to town for a minimal contribution. A mobile app could be used to notify the student community that a taxi will be arriving on campus and that there therefore is an opportunity to travel to town

The ranking of some of these services can be explained by the specific university context. For instance, the fact that *administrative notifications* was ranked highest in the list results from the fact that students still need to visit the noticeboards in order to be informed about administrative changes/notifications. This requires their physical presence on campus, which is – certainly for the students living off campus – not convenient. Especially during the rainy season, when commuting takes a lot of effort, students would like to be notified of administrative information via their mobile phone. The fact that *notifications of incidents on campus* ranks high in this list can also be explained by the context in which the students live and study. The campus regularly gets confronted with infrastructural challenges such as power cuts and water shortages, which complicates students' life. They are therefore in favour of receiving push messages about these incidences (i.e. how long they are expected to last, what measures are taken to assist students, etc.).

While there was agreement among the respondents concerning the ranking of most needs, some needs elicited more debate. These debates were induced by the presence of different user profiles in the ranking exercise. For instance, sessions that included many students living in rented accommodation ranked *accommodation off campus* much higher than students living on campus. The reverse was true for *notifications of incidents on campus.* First year students still had a fresh memory of how lost they felt during their first weeks on campus and therefore ranked the buddy system higher then more senior students, and needs related to *transport* were ranked higher by students with limited financial means compared to students that have more financial means to pay for private taxis.

6.3. What do Tanzanian students design?

The co-design sessions also focused on the look and feel of the app, the affordances, and a number of other important requirements. This was done via an evaluation of the app as it is currently developed and via exercises in which students designed a mobile app from scratch.

The respondents designed a mobile app that is more vibrant then the existing version. Users prefer more lively colours, the use of more visuals and less text, and a younger, less professional look and feel. The respondents also emphasised the importance of customizability (e.g. background pictures and colours) and the possibility to add profile and background pictures. The home page of the app should be dynamic, showing a quick overview of the most important news, newest notifications, new events, entertainment news, friends that are online, dates of upcoming tests, and so on. The integration of the university colours and logo was also suggested by a number of students as a way to clarify that the app operates within a trusted community.

In order to keep the use of the app within the boundaries of the trusted community, most respondents believed that a registration procedure is necessary and that for doing so, student numbers should be used. Creating a profile would also allow students to make groups that are restricted to certain people (e.g. a class group for discussing course work). Most students prefer to use the app in a non-anonymous way. Using real names is important if the app will be used as a tool to notify students about administrative issues (e.g. test results, exam schedule, etc.). In addition, anonymity would negatively impact the reliability and trustworthiness of the information that is spread via the app.

Next, the app should provide a moderation system. While not all services should be moderated, moderation is deemed important for the administrative notifications (i.e. to prevent rumours and false information from spreading). All respondents also feel that the app should include an interactive feature. This feature would be used for both non-recreational activities (e.g. discussing course work) and entertainment (e.g. discussing whether or not to attend an event).

Notifications are important to students, but the way in which students receive notifications does not seem to matter. There should be a possibility however to switch the notifications off. The app should also have a help module providing user guidelines. The respondents also prefer the possibility to customize the design of the app in terms of notification sounds and privacy and language settings. Most students prefer to have the option to choose between at least two languages (English and Swahili) when using the app, or prefer the app to provide a translation function.

The respondents emphasized that the app should be free, use low memory, work fast, and be easy to use. The app should also be usable on all operating systems, adaptable to all screen sizes, and usable on feature phones, computers and laptops. This was believed to be very important as not all students have smartphones. The app should also be usable without needing internet access.

7. Discussion

The results from this study suggest that the development and implementation of a mobile app could address a number of real-life needs the university community currently struggles with. A number of these needs – e.g. an open discussion forum, or event notifications – are situated on the level of community building, one of the core aspects of the innovation. Many respondents also valued the fact that the accessibility to the app would be confined to the trusted community. The respondents often discussed their commitment and ties to the university community. This can most likely be explained by the fact that the campus is relatively isolated in terms of location. Students therefore seem to be strongly embedded in the campus community. These community feelings support the development of an app that serves the specific needs of the community and that is designed with clear links to the university (e.g. university logo and colours).

In general, the respondents held positive attitudes towards the app; they felt that the app would be able to address a number of real user needs. Nevertheless, they did raise some issues, such as the fact that the app should not only be made available for smartphones, but also for laptops and tablets. In addition, while the respondents seemed interested in the location-based aspect of the app – the second core feature of the app – many students also raised concerns. For instance: "*The GPS location part should be reconsidered in our country, because our technology is not there yet*" (respondent 41). Or: "*They [students] don't know how to use maps*" (respondent 36). These concerns are related to (1) infrastructural challenges (i.e. readiness of the technology), (2) challenges related to user readiness (i.e. knowledge and skills of students with regard to knowing how to use location-based services), and (3) challenges related to cultural routines (i.e. using maps is not deeply ingrained in the everyday practices of students, which may lead students to prefer to use the tools they are used to). In addition, the campus and surrounding villages cover a relatively small area. After spending a few weeks on campus, it is easy to find your way around. These observations do not imply that there is no place for a location-based app, but they should be taken into account in the development process. It could for instance be recommended that location-based services be added to the app as an extra affordance, or as a supporting tool, rather than as its core function. This way, users can become used to location-based services, while using the app for other purposes. In addition, much attention should be paid to the user friendliness of the location-based services and technical research should be done to examine the extent to which the university area has already been mapped in detail.

The results of this study also demonstrate that living lab research offers an important added value when investigating the development and implementation of ICT in a developing context. The needs analysis and the co-design sessions showed that this type of participative research provides many insights in what the innovation should look like, both on the level of content and design. It was for instance shown that the community needs heavily depend on the context (e.g. the poor conditions of the roads during the rainy season and the whish of students to receive real-time administrative notifications) and on user profiles (e.g. students residing off campus attached much more value to a services assisting them in finding accommodation, compared to students living on campus). Context also plays an important role in terms of design. In order to facilitate a successful adoption in the community that participated in this study, the app should be usable offline, on as many operating systems as possible, and on feature phones and laptops. In addition, the concerns related to the location-based aspect of the app should be taken into account when redesigning the app.

Finally, while the participatory research techniques did provide relevant and context sensitive results that will enhance the development of an innovation that meets real user needs; this study has also shown that using participatory and living lab research methods is not always without challenges. As mentioned previously, not all research techniques were equally cultural sensitive. While the respondents greatly appreciated the fact that they were asked to be closely involved in the development of the innovation, they were not used to this type of research, which occasionally evoked some hesitation,

shyness, or reluctance to participate in some of the exercises. Sometimes these feelings were overcome once the respondents actively engaged in the exercise, but at other times the researchers had to adjust some of the techniques. In addition, this study has shown the importance of expectation management when carrying out this type of research. Often, the respondents were eager to know the exact timing of actual implementation and they expressed expectations that all their personal wishes and needs would be addressed in this app. Such expectations should be managed carefully in order to not disappoint or mislead the respondents.

8. Conclusion

This living lab research demonstrates that the needs and expectations of the Tanzanian student community with regard to the community-oriented and location-based mobile app differ from how the app is currently conceptualised. These differences are caused by context and user profiles and should be taken into account when further developing and implementing the app. The outcomes of this study strongly support the idea that ICT4D research could profit from using more collaborative practices in general and living lab research in particular. Adopting a living lab approach ensures the participation of local communities, which provides insights in what an innovation should look like and which real-life needs it should address. This will not only increase the chances of adoption and ensure a better embedment in local contexts; it will also support context-sensitive processes of social change and development.

More research is however necessary to gain more insights into how and which participatory projective and generative research techniques can be best applied in a non-Western context. In addition, more research is needed on the other cycles of living lab research. The process of creating the right ecosystem, finding sufficient test users, and iteratively testing and adapting the innovation, will probably have to be adapted to the local context.

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