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DESIGNING MHEALTH APPLICATIONS FOR DEVELOPING COUNTRIES

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Research

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Abstract

The effective use of mobile IS offers great opportunities for improving health systems in developing countries and enhancing their quality of life. A case in point and, hence, an interesting research subject is Papua New Guinea for being a country with one of the highest maternal mortality rates in the world. Despite the opportunities, many mHealth solutions remain prototypical due to their design and lack of empirical evidence and just little literature discussing success factors exists. To overcome this problem, we derived Design Requirements for the implementation of an mHealth app. We followed a Design Science Research (DSR) approach (a) embedding a triangulation of a literature study, a user survey and on-site observations, (b) working in a cross-cultural and interdisciplinary team and (c) evaluating the Design Requirements ex-ante by taking the example of an mHealth app to support midwives in Papua New Guinea. Practitioners, IS researcher, even design- or behaviourism-oriented, as well as transdisciplinary researchers can use the Design Requirement Framework for, on the one hand, design and implement applications in developing countries and, on the other hand, to take single already justified Design Requirements as starting point for a detailed investigation.

Keywords: Developing Countries, Papua New Guinea, Smartphones, mHealth, Midwifery.

1 Introduction

The increasing proliferation of mobile phones offers great opportunities to overcome current challenges in developing countries (Madon et al. 2014; Chiasson et al. 2007; Kaplan 2006) and directly improves the on-site quality of life. Papua New Guinea (PNG) is one of the most diverse countries in the world – geographically, biologically, linguistically, and culturally (WHO in the Western Pacific 2015). Infant and maternal mortality is a serious problem in PNG (WHO & National Department of Health PNG 2012) with one of the highest maternal mortality rates in the world. The majority of people (87%) in PNG live in rural areas, in widely scattered communities that are often not accessible by road (WHO in the Western Pacific 2015). Due to poor infrastructure, rural health workers typically have few support services and communication options (Watson et al. 2015). Nevertheless, in the last years, telecommunication providers have addressed the telecommunication problem and expanded the mobile communication networks which has led to an increase of mobile phones. Since entering the market in 2007, the two main providers by 2010 had over 4.3 million active subscribers, more than half of the population (Department of National Planning and Monitoring 2010).

According to the literature the main contribution of mHealth applications in developing countries (e.g. Mechael 2009; Kaplan 2006) is in improving the efficiency and sustainability of the healthcare system and to facilitate access to medical care for the population. However, by analysing 64 recent mHealth projects in developing countries through a systematic literature review, we found that only 1/3 of the identified applications are in use (Niemöller et al. 2016). Possible reasons for a deficit in using the application (app) after finishing the pilot stage might be found in the design of the app itself, but also in the lack of statistical evidence for the benefits of mHealth applications (Friederici et al. 2012). Additionally, for outside researchers, e.g. from developed nations, it is often hard to understand the local context and reproduce circumstances from developing countries. Moreover, the access to developing countries can be difficult considering language barriers or security warnings.

Against this background, the questions that guide our research are: *Q1: What requirements exist for the design of a mHealth applications in the context of developing countries?* as well as *Q2: How can these design requirements be implemented?*

For the sustainable design of a mobile Information System (IS) and the purpose of gathering strong statistical evidence, it is necessary to cooperate closely with the potential users of the IS as well as to understand the local circumstances. This is why we build our work on a two tier contribution. Firstly, we derived general success factors from literature considering mHealth applications in developing countries more broadly. Secondly, to understand the context-specific design requirements, we undertook an empirical analysis on-site in PNG.

Methodologically, we followed a Design Science Research Approach (DSR) after HEVNER ET AL. (2004). Considering that most often the designed mHealth systems are not in use anymore, we followed a mixed-method approach for designing our app. After having identified the research need, we justified the importance and novelty through collecting and analysing data from literature (section 3), an empirical survey and on-site observations in PNG (section 4). Based on the data, we derived Design Requirements (section 5) and conducted an ex-ante evaluation using Prototyping after SONNENBERG AND VOM BROCKE (2012) for testing the feasibility and applicability of the derived Design Requirements (section 6). The research artefact after OFFERMANN ET AL. (2010) is a Design Requirements Framework for building an mHealth application to support midwives at their point of service. Thus, we enhance the existing knowledge by describing how to design a sustainably used mHealth application in developing countries using the example of Papua New Guinea. Conducting an ex-ante evaluation and on-site research instead of a classical DSR project from distance, we also contribute to the knowledge base by pointing out an alternative research approach. We proceed as follows: In section 2 we give an overview about the research model. In section 3 and 4 we analyse the data as described above and conclude to 11 Design Requirements (cf. section 5). Section 6 comprises the ex-ante evaluation. Finally, in section 7 we conclude our approach and point to further research.

2 Research model

As our research focuses on the design of an artefact, we follow a DSR approach after HEVNER ET AL. (Hevner et al. 2004). Although DSR is a reputable research methodology in IS research, some might argue that the prescriptive knowledge (as mostly focused on in DSR) has no *truth statement* (Gregor 2009; Iivari 2007). Given this assumption, the validity of DSR outcomes can only be assessed by means of descriptive knowledge to be obtained at the conclusion of a DSR process (Sonnenberg & vom Brocke 2012). Hence, SONNENBERG AND VOM BROCKE (Sonnenberg & vom Brocke 2012) suggest to conduct an ex-ante evaluation before constructing the artefact, in this case the mobile application, itself. This is why we followed their evaluation framework, demonstrated in Figure 1, with conducting an ex-ante evaluation, on the one hand, to overcome the problem that mHealth applications in developing countries are not used sustainably due to the lack of statistical evidence and unsuitable design decisions (Friederici et al. 2012) and, on the other hand, to gain truth before implementing the app itself.

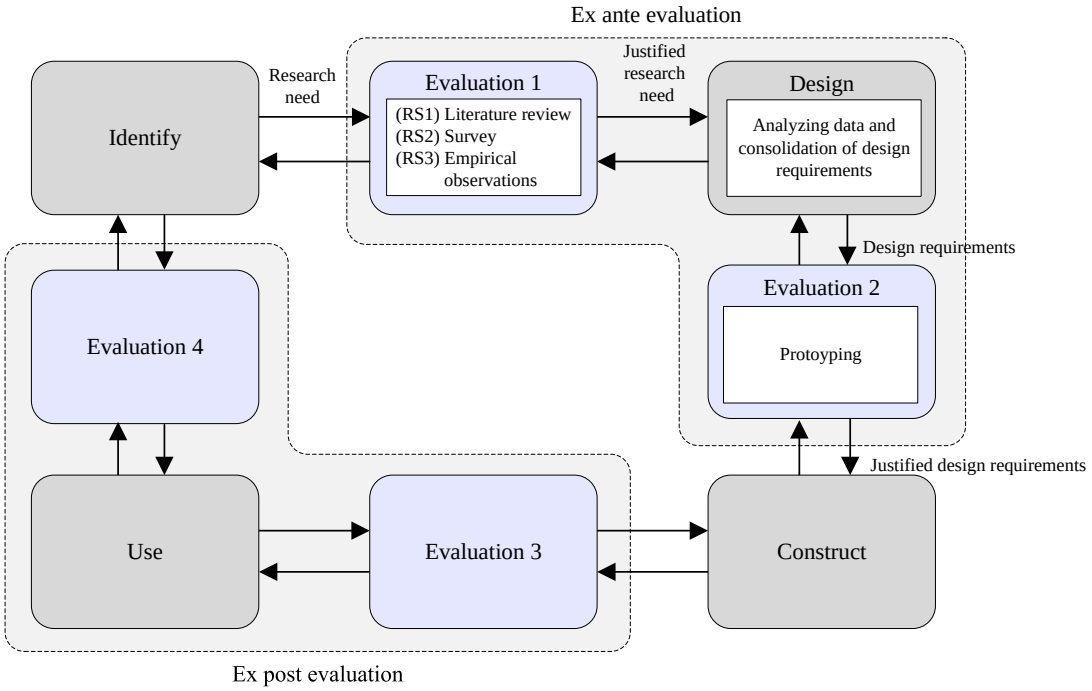

Figure 1. Research model referred to evaluation activities after SONNENBERG AND VOM BROCKE (2012)

With the first evaluation, we verify whether the research need is important and novel to address a justified research gap. With the second evaluation, we examine the feasibility, completeness, correct level of detail, internal consistency and applicability of our derived Design Requirements to gain a validated design specification (Sonnenberg & vom Brocke 2012) by Prototyping (Riege et al. 2009). An overview of the evaluation is given in Table 1. Thereby, we followed a mixed-method approach. Relying on different sources such as real-world observations, research literature and survey research allows us to calibrate and validate our conclusions (Myers 2009). To understand the circumstances on-site and to develop the appropriate questions, we worked in a cross-cultural and interdisciplinary team on-site in PNG. A detailed description of the single research steps is stated in each section (cf. section 3.1,4.1,5,6).

Phase	*Input*	*Evaluation criteria*	*Evaluation methods*	*Output*
Evaluation 1	Research need	Importance, Novelty	Literature review, Survey, Empirical observations	Justified research need
Evaluation 2	Design requirements	Feasibility, Completeness, Level of detail, Internal consistency, Applicability Operationality	Prototyping	Justified design requirements

Table 1. Evaluation overview based on SONNENBERG AND VOM BROCKE (2012)

3 Derivation of general success factors for the design of mHealth applications in developing countries

3.1 Research approach

First of all, we undertook a systematic literature review (vom Brocke et al. 2009; Webster & Watson 2002). The literature search was conducted by querying the scholarly databases in IS research: Sciencedirect, ISI Web of Knowledge, EBSCOhost, Springerlink, Emerald, Wiley online library and AIS electronic Library. The search was expanded to official websites of the WHO and UN, as there were multiple references within the results of the methodological literature research. Due to a significant growth of mobile phone users since the year 2008 (ITU 2014), publications relating mHealth in developing countries released in the time period of 2007 until 2014 have been taken into consideration. Overall, 64 projects addressing mHealth in more than 30 developing countries were identified. The projects were distinguished by the intended mobile device, the addressed type of mHealth Services and the status of the project. The literature review and corresponding findings are discussed in detail in NIEMÖLLER ET AL. (2016). In total, 23 applications can be considered as *pilot projects* while 20 projects are *in use*. The remaining projects are not in use, with 13 visions and 8 studies about mHealth applications in developing countries. Accordingly, the majority of the publications illustrate pilot projects or project reports on applications for simple mobile phone technology or smartphones.

3.2 Findings of the literature study

Only four of the publications included an approach to analyse success factors of the corresponding projects. Abstracting these specific factors of success and taking into account findings from the investigation of the remaining publications, five critical success factors for an enduring implementation of mHealth applications can be summarised:

SF1: Technology choice – Build on convening technology and user knowledge

A crucial contribution to the successful implementation is made through the choice of appropriate mobile devices (Mechael 2009). Hence, a study about existing technologies and the familiarity of inhabitants with the devices has to be conducted. In 2013, already 89 % of the population in developing countries were mobile phone users (ITU 2014). In 2015, 39,1 % of the population in developing countries and 12 % of the habitants in least developed countries used mobile broadband on the cellular phones (ITU 2015). Factored in the development of mHealth applications, the services can be provided on available mobile phones.

SF2: User-oriented design – Take special background into account

The development approach in the application´s design should consider the user as central (Vélez et al. 2014). There are diverse problems in various developing countries which have to be distinguished in the

specific context: Some key elements for consideration are the educational background, official and region-based languages of the user group. A barrier for text-based services is analphabetism which voice-controlled services or the operation with icons can overcome. For the variety of demands, a reliable functionality requires a close cooperation between designer and user.

SF3: Simplicity – Focus on reachable goals instead of providing a holistic approach

A comprehensive medical care for an entire population demands diverse applications to fit the heterogeneous requirements and user groups. A holistic approach sets goals that are difficult to achieve and has the detriment of high complexity. It should therefore be avoided (Friederici et al. 2012). From IS perspective, a focus on the most important functionalities and an agile approach can be beneficial.

SF4: Exploitation of synergies – Provide interoperability between applications

Especially in transregional projects, synergies between different applications can be useful (Friederici et al. 2012). For example, data generated by medical emergency services are beneficial to address the relevant topics in awareness services. The interoperability between services would maximise the benefits for the user and developer of the applications.

SF5: Strong partnerships for sustainability – Integrate partners to the mHealth project

Successful mHealth applications have supporters in different fields and bring various strengths to the project. The user and operator of the service can benefit from reduced user fees, promotion of the project and the connection to an existing or national database. Promising cooperation in active projects include local medical authorities, telecommunication companies, network operators and NGOs (mHealth Alliance 2013).

Although mHealth applications are proven to have positive effects on the countries' healthcare, there are some challenges to overcome to make mHealth services successful. For an appropriate use of the success factors the designer has to have a profound understanding of the field of application. Thereby, the collection of statistical data and a close collaboration with the user group could make a fundamental contribution to the design and implementation of an mHealth service (Vélez et al. 2014).

4 Elicitation of requirements for the design of an mHealth application to support midwives in Papua New Guinea

4.1 Research approach

The derivation of Design Requirements for an mHealth application is based on a quantitative data assessment through an on-site survey. According to GABLE (1994), survey research can be used for three purposes: exploration, description, or explanation. With the goal to learn more of the life of users in the investigated area and context, this survey falls under the *exploration* purpose. The population of interest was, in this sense, comprised of midwives who study or have already graduated from the University of Goroka. General advantages and disadvantages of a survey approach have been discussed by NEWSTED ET AL. (1998) and GABLE (Gable 1994).

The questionnaire was designed by a cross-cultural and interdisciplinary team including two German IS researchers, two Papua New Guinean researchers in Social and Creative Media, and two midwifery educators, one from PNG and one from Australia. After a pre-test with four midwifery educators in PNG, the survey was revised. The outcome was a questionnaire with the four main areas (A) demographic information, (B) technology access, (C) mobile phone use and experiences and (D) information about the organisation of midwives that are or were at the University of Goroka. As the pre-test revealed, the target group might require support with filling out the survey in regards to the technical questions, for example what kind of mobile phone they own. Hence, the survey was executed initially in two one-day-workshops at the School of Midwifery, with all researchers as well as midwifery students and graduated midwives. Afterwards, the questionnaire was handed and mailed out to midwifery students and

graduates in rural areas of the country. In the map shown in Figure 2 the heterogeneous locations of the survey participants can be seen. The red markers depict the originating village, enriched by two provinces (blue) that were used in case the answered village could not been found on the map. Each brown marker stands for the current workplace, i.e. the destination after completing the studies. This representation further illustrates the reach of the target group from all across the country of PNG, hence specific conditions of various rural areas could also be taken into account.

Figure 2. Origin and destination of midwives (based on Google Maps)

4.2 Findings of the survey

Overall, 38 participants completed the survey. 68.4% stated that they are currently enrolled as a midwifery student, 13.5% were graduates, and 18.4% worked at the university either as teachers or in other staff positions. The median age was 34, with a standard deviation of 8.9. More than three quarter of the participants were female (76.3%). Analysing the data, the following Design Requirements are elicited:

RQ1: Networking after graduation – Midwives should have the ability to network and socialize after their study, with technological support

A very clear majority of the respondents stated that they would like to keep in contact with their colleagues after completing studies while working in various parts of the country (82.4%). The wish to stay in touch with teachers was considered even more important (91.7%). Previous efforts by the Midwifery School to fulfil these demands lead to the establishment of a Facebook-group. However, 50% stated that they were not members of the group, and only 19.4% have posted actively. Thus, the demand of the midwife students and graduates is currently not met. In order to take a step towards fulfilling these wishes, the first requirement focuses on the general demand for a social network.

RQ2: Technology choice – The networking platform should be implemented as mobile (mHealth) application for the Android operating system

To support midwives from a technological point-of-view, a platform or environment that could achieve the networking connection amongst the midwives spread out over the whole country was to be found. As all of the survey's participants owned a mobile phone, and the Android operating system is used by most (81.6%), a mobile Android app should be chosen.

RQ3: Offline functionality – The application should have offline functionality available in case of a connection loss. Once the connection is re-established, the application should perform an online-syncing process

In Papua New Guinea internet connection might not be available at all times and locations. Even though 56.7% described the overall internet connection as strong and very strong, nearly one third of the asked midwives reported connection problems once a day or more (28.2%). Depending on the location, another 34.5% said their connection has problems at least once a week. This means that the application cannot rely on a steady and stable internet connection, especially if the midwives are working in rural areas or cities with overstrained networks.

RQ4: Application design – In order to provide easy access, the design of the application should be based on already frequently used apps like Facebook or WhatsApp

When asked about their typical usage patterns, the participants responded with a wide variety of interests and purposes. With the question of the four most used applications, the usage could be specified. Facebook, the Internet Browser, an E-Mail app and WhatsApp were the prominently used apps. To give the midwives an application at hand that can support them without requiring too much learning effort, a design close to these most used apps should be achieved. As the mention of an internet browser or an E-Mail application is ambiguous, the requirement was reduced to Facebook and WhatsApp.

RQ5: Battery economy – The application should work battery economic.

When asked about the battery charging behaviour of their devices, only half of the respondents (59.5%) stated that they would charge their phone at least once a day. Thus, another critical requirement is the battery life of the devices in use.

RQ6: Frequency of use – The app should be usable on an infrequent basis (i.e. once a week)

Survey further showed that only 37.1% used the internet at least once a day, while the biggest group (42.9%) stated to only go online between once a week and less than once a day. To include users wanting to keep their usage patterns, the app cannot be designed to require usage on a daily basis.

RQ7: Data economy – The application should work data and roaming economic (i.e. one sync a day, only limited size of updates).

Additionally, it was found that most of the survey's participants used daily data plans by the provider DIGICEL (60.3%). These plans are limited to 60 MB of data volume, rendering the internet connection unusable once the limit is reached. In order to not deplete the data plan, the app has to be data efficient and usable without having to install large updates frequently.

RQ8: Integration interface – The application should provide a solution to include users without access to current smartphones

While all polled midwives documented owning a mobile phone, 28.9% stated having access only to an older 2G phone. A mobile Android application would not run on such phones, thus a solution for users without access to current technology has to be found. For instance, by implementing E-Mail or mobile text messaging functionality, midwives without modern phones could be reached even though they cannot use the app itself.

RQ9: Ease of use – The application should be simple and provide high ease of use to the user

The average age of the participants was 35.4 years, and most of them (60.5%) only received their first mobile phone throughout the last 7 years. This means that first ownership of a mobile phone happened at a relatively high age, showing that the core group of the users are no digital natives. Special focus lies in making the application easy to use for non tech-savvy users. The last requirement lies in taking technological expertise and experience into account.

4.3 Empirical observations in Papua New Guinea

In addition to the conducted literature study with resulting success factors SF1-SF5 and the conducted survey resulting in requirements RQ1-RQ9, we analysed the data gained through empirical observations on-site. Relying on different sources allows us to calibrate and validate our conclusions (Myers 2009). The observations, conducted by two IS researchers in Papua New Guinea, included the visit of several medical institutions such as the hospital in Goroka and the Susu Mamas, an organisation that provides integrated family and youth health services. The period of observation was 10 to 26 September 2015. Through the observations implications on design requirements based on culture related behaviour could be raised. As the user background is crucial for the success of an application, we integrated empirical observations (EO1-EO4) to enhance the specification of design requirements (cf. 5).

EO1: Language openness – The application should be designed to add several languages

In PNG, over 800 indigenous languages are spoken (Papoutsaki & Rooney 2006). However, the observations lead to the experience that most of the midwifery students speak Tok Pisin and English. Additionally, the training of midwifery all over the country is conducted in English. Hence, the app can be designed in English, but should be realized in an adaptable architecture with the possibility to add several languages later in case of transferring the app to further user groups such as community health workers.

EO2: Networking functionality – The application should include communication functionalities

In PNG, a phenomenon called One Tok exists, including the fact that PNG people have a strong family cohesion based on a clan structure. People rely heavily on the opinion of their family or tribal leader. Their traditional identity stems from their tribe, rather than the individual (Watson 2011).

EO3: User Motivation – The application should motivate usage

While visiting the hospitals and other working places, we observed that many people do not turn up for work without giving notice. This observation was confirmed during several discussions with the educators in hospitals and management. Same was observed while visiting the paediatric ward, where the educators explained that freedom and the associated situational lack of motivation for an uninteresting task is rooted in the PNG culture.

EO4: Transferability – The application should be self-contained and transferable

The most often observed way of downloading software to mobile phones was the exchange via Bluetooth. This was confirmed during discussion with the midwifery students. They transfer apps, pictures and videos via Bluetooth due to the fact that using the internet is expensive and slow.

5 Construction of design requirements for an mHealth application in developing countries

By using triangulation consisting of a literature review, a survey and observations, a consolidated list of design requirements was constructed. The five success factors (SF1-SF5) from literature are adopted unaltered as they are grounded by their respective theory and argumentation of their author. The findings from the survey (RQ1-RQ9) are included and assigned to one of the existing design requirements where possible. However, some are taken as design requirement itself, if they do not fit into the existing list. Finally, the observations (EO1-EO4) are added and used either to back existing design requirements in the list or to add an additional design requirement. An overview of all Design Requirements with their relation to success factors (SF), requirements (RQ) and observations (EO) is given in Figure 3.

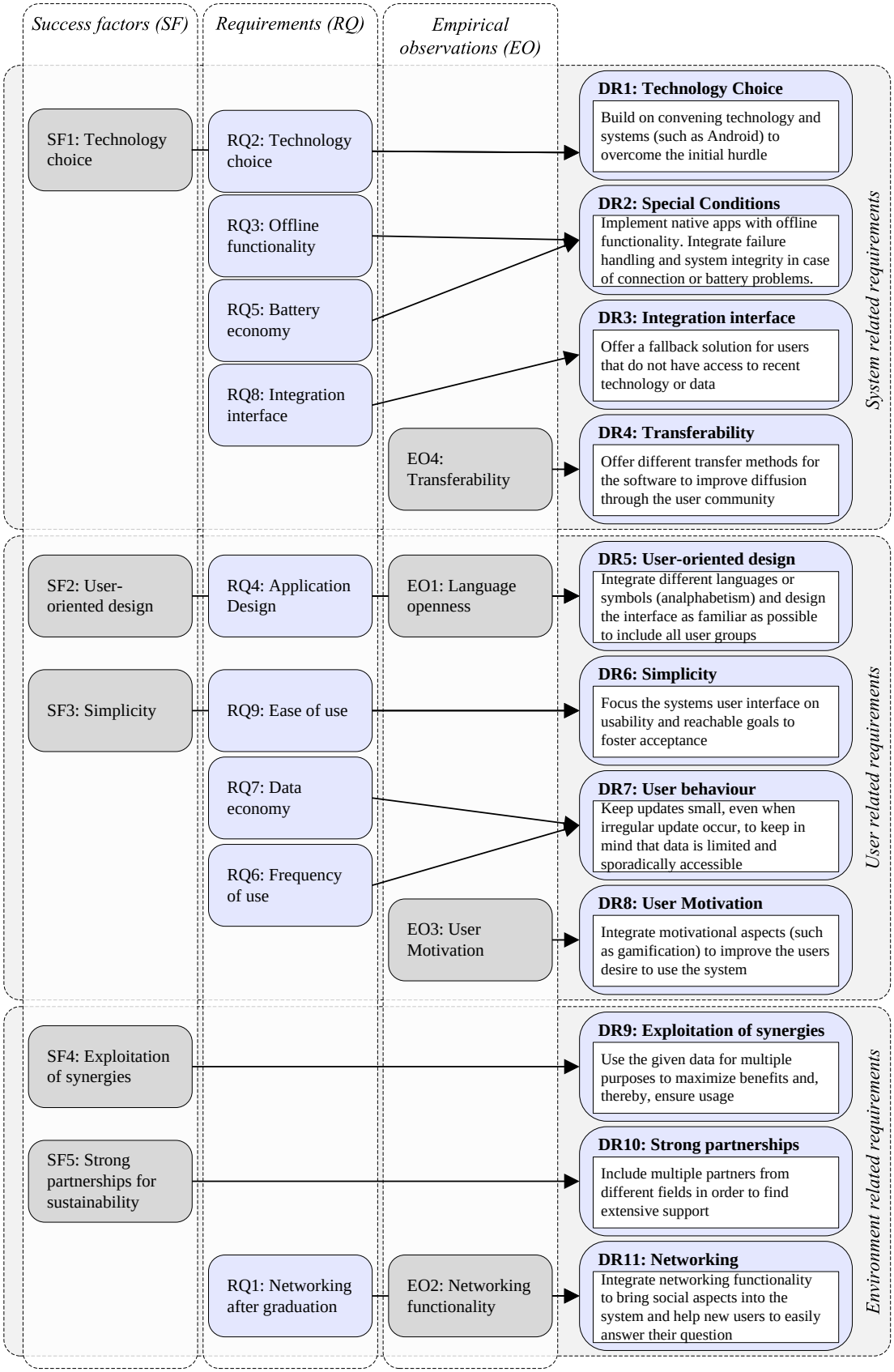

Figure 3. Framework of the derived Design Requirements

6 Evaluation of the design requirements through prototyping

In order to evaluate the Design Requirements and to show their feasibility, applicability and operationality to implement software based on them, we implemented a prototype that is currently in a testing phase used by midwives in PNG. While prototyping, we could also justify the appropriate level of detail of the Design Requirements and their completeness concerning the information necessary for the developer. Since the prototype is working, the internal consistency of the Design Requirements is approved.

Together with a project partner at University of Goroka we built a system consisting of four content-related parts and a setting functionality. As shown in Figure 4, the home screen clearly demonstrates the five parts. First of all, the app offers educators from the university the possibility to send news to all users, especially the midwives (News component); second, they can distribute content about midwifery structured as a wiki (Wiki component). Thus, the aforementioned functionalities (located on the right side of the main menu) are designed to encourage passive consumption through the users. On the left side of the menu, the users can actively communicate to colleagues and educators via one-to-one or group messaging (Messages component). The functionality is implemented similar to WhatsApp to integrate familiar functionalities. The forum option enables the users to discuss and share current problems or successes with the whole group (Forum component).

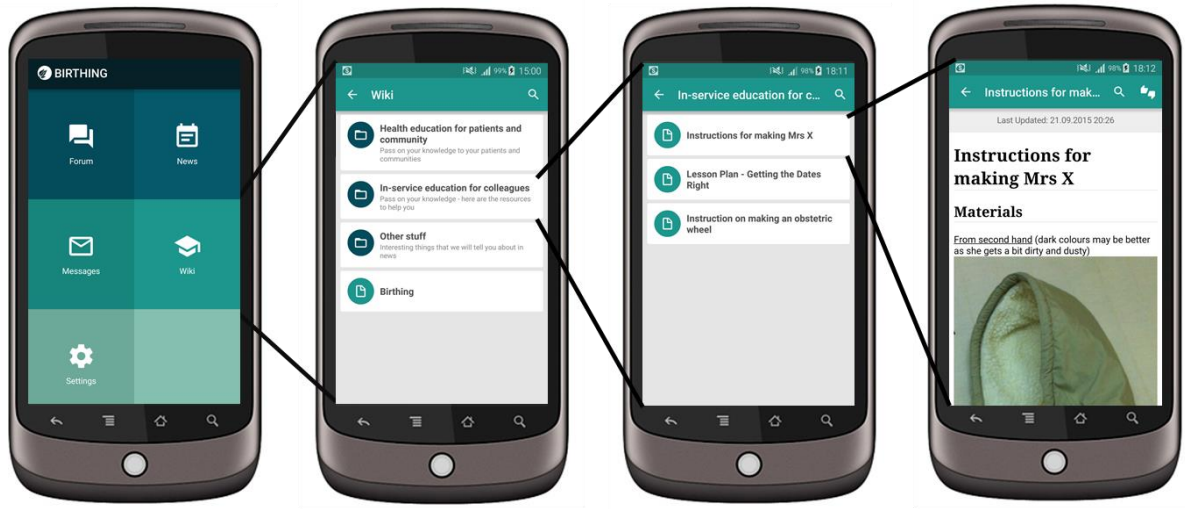

Figure 4. Exemplary screenshots of the instantiated prototype

Throughout the design and development process of the prototype, the previously reached design requirements were implemented as follows:

System related requirements

DR1. In compliance with DR1, Android was chosen as environment for the mobile application. **DR2.** Hence, a native app was constructed. The app has to be installed once. After that, the Wiki component as being the most data intensive part can be used offline to minimize traffic and, thus, battery exhaustion. For using the other three parts an internet connection is necessary. However, a cache was implemented, to enable the midwives to type in their messages and forum posts that are stored temporarily and are posted when they turn on their internet connection. Additionally, photos that can be posted in the forum are scaled to a minimal size to minimize traffic. Further, failure handling and system integrity in case of connection loss or battery problems were implemented. **DR3.** An integration and funding process was designed: Midwives that do not have an Android smartphone receive a smartphone after graduation. **DR4.** The native app is stored (a) on a server and can be accessed via internet link, (b) can be transferred from a computer at the university to the smartphone during studies or (c) can be transferred via Bluetooth

from one smartphone to the other, for example usable for midwife colleagues working in nearby rural areas. This requirement was ensured by the Android architecture, making it possible to install the prototype via an APK-file implicitly.

User related requirements

DR5. In the Settings component a language can be chosen. At the moment, the app only supports English, but further language files can be added in case of a rollout to community health workers in a later phase. For being familiar to the midwives, the components were implemented like known apps such as Wikipedia for the Wiki, Facebook for the Forum, Twitter for News and WhatsApp for Messages. **DR6.** The overall simplicity of the application was reached through simple icons on the home screen and the division in one left part for active communication and one right part for passive consumption of content. Subpages are clearly structured into pictures and text. The focus lies on the requested four functionalities for midwives without additional features. **DR7.** Since many users in PNG do not use the internet connection of their devices on a daily basis, the offline-mode is also used in this context and can be switched on manually. This way, all messages or inquiries are saved as drafts, only requiring internet connectivity at one point in time when they should be sent out. Furthermore, this ensures greater transparency and control over costly connections. **DR8.** A first motivation for (a) using the app and (b) motivating the execution of the job itself should be reached by discussing successes in the forum, e.g. a midwife that handled a complicated case. Additionally, news triggered by the educators will include midwives who travel to conferences, special successful cases and awards. To motivate the midwives to use the application on a regular basis and to continuously study and improve oneself, elements of gamification are discussed and might be implemented later.

Environment related requirements

DR9. Synergies should be exploited by (a) reusing current training materials for the Wiki (information flow into the app). (b) Gained data from e.g. the forum can be analysed and thus influences future teaching (backflow from the app to the educators). **DR10.** Promising cooperation was built to support ongoing use of the app. A partnership between the University of Goroka and the most used local telecommunication operator should ensure that the midwives can use the app without having additional internet costs by themselves. Currently they discuss whether the telecommunication operator activates the specific IP address of the app on the server being free of charge. Hence, the midwifery graduates could communicate as much as they want via the app without being charged. This also enhances the motivation to use the app instead of other alternatives such as WhatsApp. **DR11.** With the goal to implement strong networking features in the app, the Messages and Forum components were applied to the infrastructure and functionality of the mobile application. By using the developed services, former students of the Midwifery School can keep in touch with their colleagues and former teachers, regardless physical distance.

7 Conclusion and outlook

The effective use of mobile IS can offer great opportunities to overcome current challenges in developing countries and directly improve the quality of information supply. However, many solutions remain prototypical, presumably due to their design and lack of empirical evidence. To overcome this problem and fill this research gap, we followed a DSR approach within this paper through (a) embedding a triangulation of literature studies, a user survey and on-site observations, (b) working in a cross-cultural and interdisciplinary team and (c) evaluating the design requirements ex-ante by taking the example of an mHealth app to support the work of midwives in Papua New Guinea.

Consequently, we derived justified design requirements obtaining system related, user related and environment related design decision (Q1). In doing so, we determined that not only technical issues and user criteria but further cultural backgrounds have to be taken into account. Although this applies to software in developed nations as well, it is more difficult to register and understand this background. This is due to the fact that the cultural aspects of other developed nations might be more familiar to researchers

from developed nations because of the accessibility through media than the ones detected for example in PNG and the villages that are not reachable for most outsiders and media. The most important insight by conducting our research is that, as IS researcher from outside, we would not have gained such comprehensive design requirements without our visit including the empirical observations on-site and the cross-cultural exchange. Consequently, our contribution to research is a first step towards general knowledge how mHealth applications for developing countries can be designed, and, second, to show an alternative way of doing research to European IS researchers. Additionally, we contribute to the IS research knowledge base by instantiating the suggested methodology by SONNENBERG AND VOM BROCKE (2012) as enhancement of the classic DSR approach.

Our study shows some limitations that create interesting opportunities for future research. The Design Requirements were evaluated ex-ante by Prototyping to justify the consistency and applicability of the requirements (Q2). The next consequential step after DSR is, on the one hand, to evaluate the instantiation of the PNG app to gain insights about the ease of use, the fidelity with real world phenomenon and the impact of the app on the artefact environment (Sonnenberg & vom Brocke 2012), and, on the other hand, implement further instantiation and evaluation in other developing country contexts. Considering the impact on the artefact environment, our research raises further questions that have to be considered in future studies: i.a. how components like messaging and forum functionalities influence the work life of the midwives. OU AND DAVISON (2011; 2015) propose a research model for investigating the significance of social network technology in the workplace that might be adapted to the developing country context. Mutual Trust, as being one element of the research model, is interesting to investigate against the background of the strong tribal cohesion and clan identity in PNG.

In order to refine our work considering the design of mHealth application in developing countries, further construction and evaluation are going to be subject-matter of future research. However, the derivation of the Design Requirements and their ex-ante evaluation already contribute to the knowledge base. It also allows to discuss design objectives and features as initial research, so, other researchers can build upon this rigorously developed knowledge right away, without waiting for the instantiation of the IS prototype itself (Sonnenberg & vom Brocke 2012).

Besides the theoretical implications, the practical impact of the contribution is that it might support software implementing companies or NGOs by the design of systems in developing countries not necessarily in the section of mHealth. Additionally, researchers from other disciplines or behaviourism-oriented IS researchers can build on single Design Requirements such as the User Motivation or Strong Partnership justified in regard to the importance as starting point for a detailed investigation.

In summary, on the one hand, our findings are an initial contribution to research since they fill the existing gap of statistically evident Design Requirements for mHealth applications; on the other hand, it is a first step to investigate the impact of such an application in the working context, and on quality of life in developing countries. Further theoretical and practical studies based on the derived Design Requirements can strengthen evidence in the design and implementation of effective mHealth solutions.

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