Towards Sustainability and Equality in Digital Development

A case study of the cereal seed value chain in rural Mali

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Abstract. Sustainability assessment and ethical considerations are not commonly included as subtasks in the development of digital systems and services and receive less attention in the design process than business and technical aspects. When developing digital systems/services or platforms for people in resource-constrained environments, it is important to take a wider scope and include more aspects than just the business and technical, and anticipate to unexpected negative effects of the introduction of new technologies. In this study we present a method to assess local concerns in the design of digital services that target poor environments and regions in the world.

Keywords: sustainability, (in)equality, architecture design, ethical principles, resource-constrained environments, decision maps.

1 Digital design for resource-constrained environments

In this ongoing-research-paper we present a design science method [1] that includes assessment of sustainability and ethical values, in the process of *digital development*, i.e. the design and development of digital services for people in poor environments and regions of the world. As a case study, we focus on Mali's cereal seed value chain. This complex ecosystem was until recently operational in non-digital mode. The implementation of a digital trade (web-) platform in 2019 has brought various concerns. Our study aims to provide a design method to improve digital development of platforms

in resource constraint environments and complex dynamic contexts, taking sustainability and equality as central requirements.

1.1 Knowledge gaps in digital development design

Whereas various studies have criticized the lack of sustainability of digital development targeting poor environments in the world [2,3,4,5], other studies show that in digital development projects the concerns of least privileged citizens and the contextual aspects of their local environment are often disregarded, resulting in digital solutions that may exacerbate inequalities [6,7]. It is important that digital development in low resource environments addresses not only technical and economic concerns, and also other concerns (such as sustainability and ethics) become part of decision-making in software architecture design. To date**,** a few studies have proposed practical methods how to *do* Digital Development in practice [7,8,9]. However, suitable instruments for deliberation and proper decision-making about which concerns to address in architecture design are still lacking. To fill this knowledge gap, our ongoing research aims to provide a design science-based method [1] that addresses sustainability and equality issues in digital development. In the case of our research the design question is formulated as:

RQ: How can we design digital services for sustainability and equality in resource constrained environments?

To answer this question, we need to know: What ensures sustainability and equality in the existing workflows? What are the requirements of design for sustainability and equality? And after the case study: can we generalize our findings into a new design framework?

1.2 Theoretical background and framework

In this research we use *decision maps* (DM), borrowed from software engineering, as a theoretical framework. Decision maps guide the design of a software architecture, making sure that the system's purpose is met, and stakeholders' concerns are well addressed, by making them explicit. [10,11]. Decision maps help to frame the concerns of a selected problem and their expected or experienced interdependencies. In doing so, they help understand which ICT solution is suitable to solve the given concerns. Further, if a certain concern is associated with target metrics/indicators, we can use this to assess the extent to which ICT solutions really contribute to the target goals [10,11,12].

2 Methodology and research design

Our research methodology is based on an interdisciplinary approach in which we collect local information from the system's stakeholders through interviews and focus group

discussions. Figure 1 shows an example of a decision map for the current use case. AOPP is the Malian farmer umbrella organization that has commissioned the design and deployment of a seed information system (SIS).

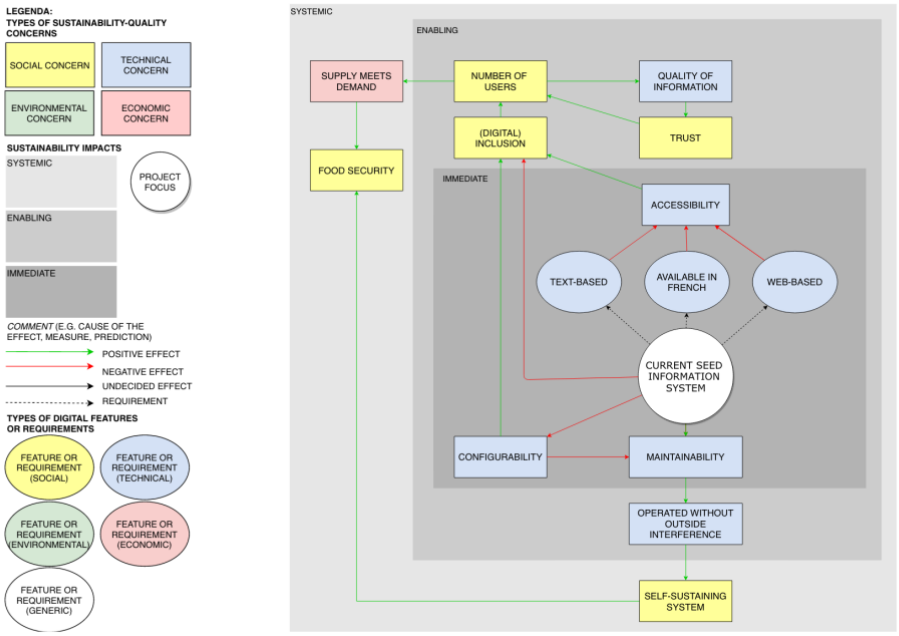

Figure 1: Decision map for the seed information system in Mali, after the first phase.

Decision maps in the design of digital platforms, based on concerns expressed by local stakeholders, is a practical method to structure and formalize these concerns and prioritize them e.g. in terms of sustainability or societal impact. This method is useful for complex contexts in which many dimensions (social, technical, economic, environmental, ethical etc) are at play. It is not a static model, as it visualizes *immediate, enabling and systemic* concerns and impacts of the envisaged digital service or system. The Decision map can be used for the elicitation of concerns that would otherwise remain hidden, in a traditional requirements analysis approach, which focuses only on business profit and technical requirements. In this method, social/ethical aspects and e.g. environmental sustainability are brought to table. These aspects have to be discussed with the users in collaborative and co-creative sessions.

3 Case study: enhancing food value chains in rural Africa with ICTs

For this study we have selected as a case study the cereal seed value chain in Mali. This case is relevant from the societal perspective and illustrates some ethical

considerations. If the research is thorough, a well-designed system can be used in the local case itself (food security in Mali is a pressing issue). Moreover, the case study is expected to provide insights that can be generalized to other contexts.

3.1 Background to the use case

In the concern for food security in countries in sub-Sahara Africa, cereal seed value chains play an important role [13]. Many issues are at play: a need for intensification of agriculture to feed a growing population, concerns about efficiency of local markets, legislation, protection of rights to land use, commercialization of locally bred variations, sustainability, legislation, policy (certification of seeds, control mechanisms). Recently, given the increase in mobile and internet use in Mali, local cooperatives aim to improve access to markets for smallholder farmers through digital trade platforms [14,15,16].

Field research in Mali shows that in low resource environments there is still much digital inequality. Poor or intermittent connectivity, low purchasing power, gender or illiteracy may hamper access to a mobile or the Internet. Since introduction of ICTs is not supposed to increase inequalities or hamper people's current work. Moreover, unexpected, unforeseen effects of the introduction of the system have to be anticipated upon. Sometimes these effects are not found during the design process. This may involve negative effects for people's livelihoods, for the environment, or e.g. effects of increased inequality among different stakeholder groups. Our research is done on the actual process of developing a digital platform for seed trade. Our study consists of three phases, visualized in Figure 2.

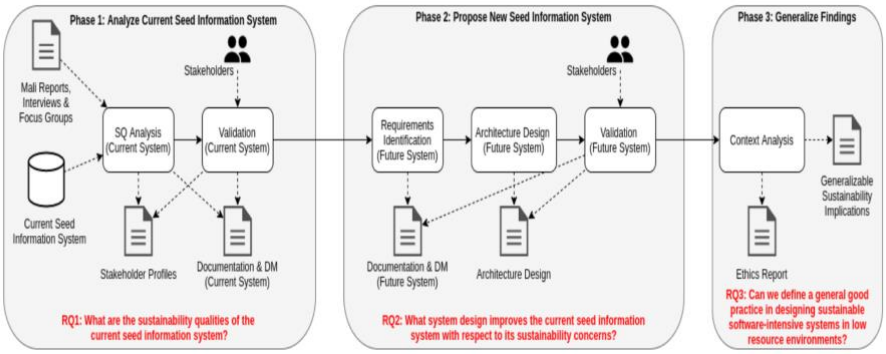

Figure 2 Three phases of this research.

3.2 First phase of the study

First, we aim to understand the sustainability qualities (SQs) of the current workflow [10]. To answer this, we need to understand the context around the seed value chain in Mali and the role of the current system. The tasks in this research phase consist of the

interviews and focus groups and the production of trip reports. The current workflow is studied and analyzed using Decision Maps (DMs). To properly identify the sustainability concerns, the stakeholders of the system are involved. We build stakeholder profiles based on and validated by user interviews. The output of this phase consists of the technical documentation of the current Seed Information System which includes a first versions of a decision map (see Figure 1).

3.3 Second phase of the study

From the first iterations in the field research (phase 1) we have drawn a first version Decision Map in which a number of concerns have been identified related e.g. to language, lack of literacy and infrastructure. By mapping these concerns they are included in the process of decision-making (e.g. to build a speech interface to the seed platform in the local Bambara language, and/or a GSM mobile interface to allow access for users without an internet connection). The question now is: “What system design improves the current seed information system with respect to its stakeholder and sustainability concerns?". To answer this, we identify new requirements and sketch an architecture design of a new platform. Thereafter, the system design is validated by stakeholders. A new Decision Map is constructed to assess the implications of a new, context-sensitive digital platform.

3.4 Third and final phase of the study

In the final phase of the study we assess future implications of the envisaged system, ethical aspects and how to anticipate to unforeseen side effects of the intervention. We then focus on generalizing the findings, asking: “Can we define a general good practice for designing sustainable and beneficial systems in low resource environments?". To address the term “beneficial” we focus on ethical aspects, in casu, how to design information systems that (i) do not compromise the livelihoods and operational goals of the users (ii) do not exacerbate existing inequalities, but helps to reduce them (iii) does not have unintended side-effects e.g. for the environment, or causes other disadvantage for local users. This phase consists of collaboration and extensive dialogue with stakeholders. This research phase has started, but (especially its generalizability) is still work in progress.

4 Discussion: unforeseen side effects of digital development in resource constrained environments

In the last phase of this study (which is ongoing) we will assess future implications, ethical aspects and how to anticipate to unforeseen side effects of the introduction of a digital platform. From our ongoing research and the lessons from the seed value chain use case in rural Mali, both the long-term sustainability of a digital platform as well as unforeseen side-effects have to be addressed. One of the outcomes of the first cycle deployment shows that existing work flows by farmers trading seeds are being compromised by the implementation of the system. Farmers that do have access to the

SIS (e.g. because they do have a Smartphone, and are able to read in French) are privileged by the system, which facilitates their trading and bargaining position. Others are disadvantaged by the system. This access imbalance has impact on the overall trade.
These and other unforeseen negative aspects can be mitigated if a second cycle of testing and evaluation organized, in which the system can be re-assessed by the envisaged users. The process of mapping, categorizing and prioritizing the stakeholders' concerns against the project goals, creates room for reasoning and deliberation about the implications of decisions from the short- (immediate and enabling impact) to the longer term (systemic impact).

5 Conclusion

In this paper we have presented preliminary results how to design digital services for people in resource-constrained environments, while including sustainability assessment and ethical considerations in the design process. We have shown how decision maps are a useful method for the elicitation of "hidden" aspects of digital development. To make sure that the system reduces inequality instead of increasing it, a proper structure for deliberation has to be in place, not only for the system design, but also for the the complete stakeholder ecosystem. How this decentralized, collaborative structure can be included as an integral part of the design phase is subject of our ongoing research.

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