The value of co-creation through Design Science Research in developing a Digital Health Innovation Ecosystem for South Africa

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Structured Abstract

The **purpose** of this paper is to indicate what value was co-created with various stakeholders when Design Science Research as a methodology was applied, to develop a Digital Health Innovation Ecosystem (DHIE) for South Africa.

Design science research as a **methodology** was applied which also involves design thinking. This methodology focuses on the creation of new knowledge and it is a research procedure for producing innovative constructions intended to solve problems faced in the real world. The **value** is to make a contribution to the theory of the discipline in which it is applied and this regard the discipline is Health Informatics.

The **outcome** of the application of co-creation where different stakeholders were involved resulted in the development of a Digital Health Innovation Ecosystem for South Africa. This type of ecosystem has never been developed before with the involvement, feedback and contributions of the various stakeholders in South Africa. The development of the ecosystem went through various iterations/phases based on the methodology of Design Science Research. It was found that the most essential elements in this ecosystem should be the context that encapsulates the co-creation dimensions of social, technological, economic, environment as well as value-based ethics (better known as the STEEPV model) with various stakeholders, as depicted in the different layers of local, regional, national and international dimensions evident in an innovation ecosystem. Under innovation, the importance of applying a specific innovation process (Open

Innovation 2.0) is important where stakeholders and users are involved to co-create. The role of users and stakeholders is very prominent as it was indicated in the workshops to be the essence of customising or localising digital health innovations to fit the needs of the consumer or patient. The greatest challenge and opportunity for preventive health innovation lies in closing the gap between what we know and what we do. This includes attitude and behavioural changes by many different stakeholder groups. This ecosystem development through co-creation stimulated the National System of Innovation in South Africa as the lessons learnt from this development informed organizations, the health industry and government of South Africa. It also contributed to the body of knowledge on co-creation and value creation even though it was applied in the health sector.

Keywords – Value co-creation, Design Science Research Methodology, Digital Health, Innovation, Ecosystems

Paper type – Academic Research Paper

1 Introduction

Co-creation is a concept which normally refers to any type of user or stakeholder who is participating in the ideation and further development of a solution to solve a problem. This "user" is thus viewed as a value creator instead of a source of knowledge (Salminen, Konsti-Laakso, Pallot, Trousse, & Senach, 2011). This presupposes that these stakeholders, given their needs and experiences, are able to co-create and produce innovations that really matter to them as co-producers of knowledge (Evans, Hills, & Orme, 2012). The value literature has predominantly put emphasis on firm conditions needed for successful value co-creation, stressing strong relationships (Jaworski & Kohli, 2006; Prahalad & Ramaswamy, 2004), high quality interactions (Payne, Storbacka, & Frow, 2008) and dialogue (Auh, Bell, McLeod, & Shih, 2007) within innovation contexts.

Co-creation is also related to open innovation processes which takes place in a specific local and institutional context (Bekkers, Edelenbos, & Steijn, 2011). Recognizing the specific environment in which innovation processes take place is referred to by (Castells, 2011, p. 3) as *innovation milieus*. It can, thus, be argued that innovation processes should be studied from an ecological and context specific perspective (Bason, 2010; Bekkers & Homburg, 2007; Osborne & Brown, 2011). It was thus essential to consider the context of South Africa when developing the Digital Health Innovation Ecosystem as well as to identify the appropriate stakeholders to co-create in this ecosystem.

Co-creation has recently been associated with ecosystems that need to adapt to changing contexts and enhance the system's capabilities for responding to new opportunities (Ramaswamy & Gouillart, 2010; Romero & Molina, 2011; Vargo & Lusch, 2011). These ecosystems are constantly adapting while simultaneously creating the

changing context of the ecosystem (e.g., Giddens (1984). This is particularly relevant to the development of the Digital Health Innovation Ecosystem (DHIE) for South Africa as the inputs and contributions from various stakeholders were regarded as essential to co-create an ecosystem that can be of value to the National System of Innovation in South Africa. In order to develop such an ecosystem it was important to use a specific methodology to ensure and guarantee scientific rigour. The next section explains the methodology that was followed and how the value of co-creation played an important role in the developing phases of the ecosystem.

2 The methodology

Design science research as a methodology was applied which also involves design thinking, and a specific process to compliment the co-creation process (Peffers et al., 2006) Design Science Research focuses on the creation of new knowledge and the purpose of design science is "to change existing situations into preferred ones" (Simon, 1996). Design Research is research into or about design, whereas Design Science Research mainly involves research that uses design as a research method or technique (Vaishnavi & Kuechler, 2015). A design mindset is not problem-focused; it is solution focused and action oriented towards creating a preferred future. Design thinking draws upon logic, imagination, intuition, and systemic reasoning, to explore possibilities of what could be, and to create desired outcomes that benefit the end user or customer (Naiman, 2016). DSR is a research procedure for producing innovative constructions intended to solve problems faced in the real world and, by that means, to make a contribution to the theory of the discipline in which it is applied (Lukka, 2003).

Design science addresses *wicked problems* in information systems (IS) (Rittel & Webber, 1984). Wicked problems, as explained by Hevner and Chatterjee (2010) and relate to the ill-defined environmental contexts as well as the creativity and teamwork to produce effective solutions. DSR also addresses *messy* problems. These are characterised by "a large degree of uncertainty as to how the problem should be approached and how to establish and evaluate the set of alternative solutions" Pries-Heje, Baskerville, and Venable (2008, p. 731). This description is applicable to the development of the DHIE for South Africa especially, since there are many ways to develop such an ecosystem and it should be evaluated in different contexts for different purposes to be adaptable and applicable.

The DSR process in addition allows for what open innovation 2.0 refers to as fail fast and scale fast (Salminen et al., 2011). Due to the iterative nature of the DSR process, an artifact, as solution or innovation, is emergent and opportunities exist for it to evolve. The artifact as solution is continuously evaluated through successive iterations, adapted and evolved through implementations and evaluations. Johannesson and Perjons (2012) explain that artifacts are either physical entities (such as a hammer or a car) or they can

be drawings, a set of guidelines or an ICT solution. Johannesson and Perjons (2012) state that the research output in design science is not just the artifact itself, but also the affect the artifact has on the environment to which it has been introduced.

This is what makes design science more than a usability evaluation of software, where the methodology facilitates introducing the artifact in the work environment or presenting it to potential users as was the case with developing the DHIE as an artifact. The DHIE was developed through co-creation with various stakeholders representing industry, Non-profit organizations (NGOs), government officials from the Department of Health in South Africa, academia from both the health and Information Communication Technology for Development (ICT4D) domains, as well as community members who represented a resource constraint community in a rural setting of South Africa.

Hevner, March, Park, and Ram (2004) states that when carrying out Design Science Research it is important that the process is well defined and articulated, especially when developing a specific solution, that there is an explicit phased process to its development and evaluation. Many excellent models of the research process of DSR exist (Hevner, 2007; Lukka, 2003; March & Smith, 1995; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2008; Vaishnavi & Kuechler, 2015) and are reported in high-impact journals. The Design Science Research Process (DSRP) applied in this research is consistent with prior literature (Hevner, 2007; Hevner et al., 2004; March & Storey, 2008) and includes six steps: problem identification; motivation; objectives for a solution; design and development; evaluation and communication. The iterative nature of the DSRP (as introduced by Peffers et al. (2008) and adapted for this paper) is illustrated by the arrows between the various steps as shown in Figure 1. This process model provides a structured approach, from problem identification and statement of objectives, through an iterative process of solution development; testing and communication where co-creation with various stakeholders played a significant role:

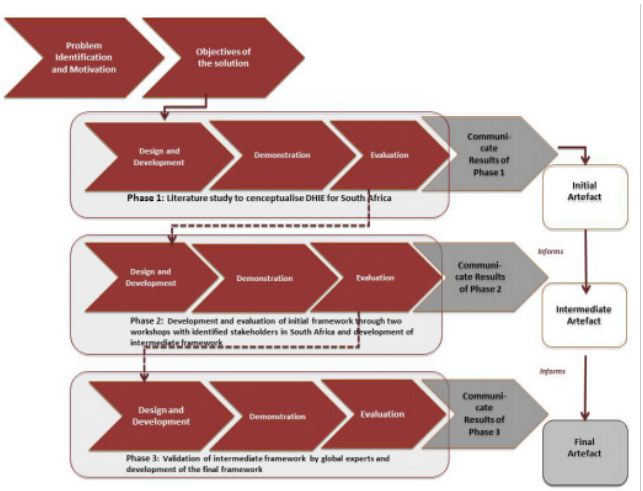

Figure 1: Design Science Research process (adapted from Peffers et al., 2006)

In developing the DHIE as an artifact, pragmatism was the main philosophy to guide the design and development. Interpretivism was also applied to interpret the results from the workshops, which were part of the phase iterations of the design science cycle. Data, theory and method triangulation was also applied for data accuracy. Data collection techniques involved observations, interviews (both one-on-one and focus groups), audio-visual material (photographs, text and video recordings), as well as expert opinions and participants were selecting through purposive sampling and snowball sampling.

3 Developing the DHIE through co-creation

The DHIE was developed in three phases as depicted in Figure 1:

- *Phase 1* involved the literature review on digital health, innovation and digital ecosystems. This involved a review of both national and international literature in order to develop and conceptualise an initial framework for DHIE for South Africa that is representative of all the relevant components that should be considered when conceptualising a DHIE.
- *Phase 2* involved the identification of relevant stakeholders through stakeholder mapping in South Africa that can add value to refining the DHIE from literature and to make it more context specific. This was followed by two workshops where the identified stakeholders co-created a context specific DHIE for South Africa.
- *Phase 3* involved expert consultations to validate and review the conceptualised DHIE prior to its becoming the final ecosystem.

3.1 Phase 1:

Through the application of a systematic literature review the different components for the concepts *Digital Health, Innovation* and *Digital Ecosystems* were identified. These components allowed for the development of an initial DHIE. The purpose of this paper is to focus on the use of co-creation in developing the DHIE through Design Science Research as a methodology, therefore this paper will not emphasise this phase any further.

3.2 Phase 2:

The stakeholder mapping according to Bryson (2011), as well as Eden and Ackermann (2013) was applied. Here the importance of stakeholders is mapped as well as their power, impact, support and attitude. This yielded the digital health stakeholder map for South Africa as depicted in Figure 2:

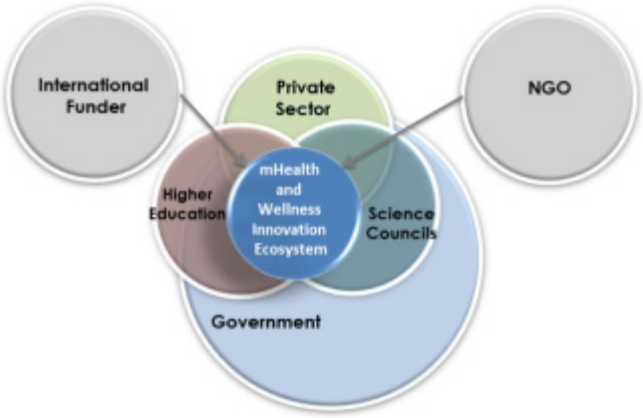

Figure 2: Stakeholder map of stakeholders in South Africa (adapted from Eden and Ackermann (2013)

Once the stakeholders were identified it was decided to apply purposive sampling (Creswell & Plano Clark, 2011), to select four from each group of stakeholders to form part of the two workshops. In the NGO group two people from rural communities were also selected. This allowed for a unique combination of stakeholders who provided valuable feedback and inputs into the Digital Innovation Ecosystem for South Africa. Their feedback offered additional insights into the initial understanding and subsequently expanded the conceptualisation of a successful DHIE.

Twenty Four (24) participants (4 from 7 groups) were identified to be part of two workshops. Workshop 1 involved the contextualisation of the conceptual DHIE from phase 1 by applying the STEEPV (similar to PESTLE and TEEPSE) tool (Miles, 2015). Workshop 2 involved the same participants where they had to share lessons learnt with one another on operational issues in different settings/environments; share challenges on digital health from their specific perspectives; and indicate what they considered to be the most important elements and components in a DHIE for South Africa.

Interviews were all held after the workshops with each participant to verify the understanding of their inputs. Focus group interviews were conducted during the workshops to get a holistic understanding of the participant's feedback. The data was analysed by employing hermeneutics and descriptive statistics techniques to render meaningful interpretations of the collected data as well as to conduct triangulation of results.

3.2.1 Workshop 1 results

The STEEPV (Miles, 2015) tool refines the context. The feedback can inform the proposed DHIE of phase 1, especially from a stakeholder and user perspective, through focusing on finer elements of the context, both on a local, regional, national or

international level by involving all relevant stakeholders. STEEPV areas include: Social, Technological, Economic, Environmental, Political and Value-based issues.

The following procedure was followed during this workshop:

- An overview was provided of the elements and components of a Digital Health Innovation Ecosystem for South Africa as depicted in Phase 1.
- A focus was placed on worldwide challenges facing digital health, and future technological opportunities for digital health.
- Workshop participants identified themselves, their institutions and their focus in the Health space.
- Break-out groups (3 people) for STEEPV brainstorming were formed. The scope was to predict the short-, medium- and long-term drivers, trends and inhibitors for each STEEPV category that will influence digital health. Participants were asked to identify factors and issues under the headings: social, technological, economic, environmental, political and values-based (STEEPV). These form part of the aide-memoire for classifying relevant trends or drivers and inhibitors influencing the topic that was considered (DHIE).
- After these were identified, the groups of 3-5 people had to come up with the 3-5 most important opportunities.
- All these opportunities were finally ranked to be considered when developing or implementing the DHIE.

Valuable inputs and insights into the landscape of digital health were found. The feedback allowed for consensus on what definitions should be applied for digital health and for an innovation ecosystem.

The most important **technological** aspects identified during the workshops were to develop, support and focus on uHealth (Ubiquitous Healthcare) and wearables. **Economic** aspects focused on planning for the increased cost of health in future, as well as policies to support users and stakeholders and governance. In the **environment** the most important issues related to localisation and customisation of systems; climate change and its influence on health; international unstable markets; and the availability of resources coupled with a centralised system of patient care. **Political** aspects related mostly to policy awareness (POPI Act) as well as partnerships, quality assurance mechanisms and regulations. **Social issues** pertinent to digital health ecosystems were found to be continuous quality assurance; incentives for people to take part; healthy lifestyles; better service delivery; cultural influence; respect; trust; language diversity and data privacy.

The most pertinent **value-based** issues were privacy and security of health data; the role of health councils; respect for an older generation; and the use of mHealth as a platform to encourage personalised healthcare.

The following were mentioned when participants were asked to rate the three most important opportunities for digital health ecosystems:

- Industry that should support health research
- Big data sharing can lead to better medicine
- Health tax reduction for healthier people
- Education resources should be used for development, sharing and collaboration
- Data visualisation and analysis should be used to improve health delivery, management and governance
- Dissemination of health information is essential to areas less likely to get access to this information

3.2.2 Workshop 2 results

This workshop focussed on participants to share more lessons learnt with one another on operational issues in different settings/environments; share challenges on digital health from their specific perspectives; and indicate what they considered to be the most important elements and components in a DHIE for South Africa. This allowed for valuable inputs and insights into the landscape of digital health. At the end of the workshop it was agreed that the following factors supported the development of an innovative digital health ecosystem for a developing context like South Africa:

- Resources (allocation, management, availability)
- Governance and democracy (invest in infrastructure, rigorous decision making, and systematic risk assessment)
- Strategy, leadership and flexibility
- Organisational culture of innovation where people and technology interact

This workshop also made it evident that a specific type of innovation model should be considered to play a role in stimulating co-creation and collaboration in order for users and stakeholders to create opportunities for the use of digital health in this ecosystem.

The workshops allowed for valuable contributions and this improved the DHIE even further to result in the intermediate ecosystem. During the second workshop the scope was wider and involved many facets to ensure that all inputs are used to develop this ecosystem. In the end, after Workshop 2, the following can be regarded as the most important components of constituting the DHIE for South Africa:

Context:

Digital health solutions that are sensitive to social, technological, economic, environmental and value-based (STEEPV) aspects at all layers (local, regional, national and international) should consider the following:

- uHealth and wearables will be the future focus in digital health from a technological perspective.

- ICT policies and government programmes should be aligned to and linked with telecommunications regulations and develop a framework for data protection and privacy.
- Inappropriate and unaffordable systems will not work. Socio-technical requirements should be considered where appropriate technologies sensitive to resource constrained environments (context, culture, and politics) and environmental constraints (low literacy, older technologies) are chosen. There should also be a focus on contextualised and appropriate content in solutions that support all cultures.
- Digital health solutions should be adapted to augment the broader localised capabilities in digital health.
- Data security and building coalitions that should include government, other health implementers, technology providers, mobile network operators and other relevant stakeholders like community members.
- Alignment with interoperability standards for mobile health, based on the recent mobile health strategy and reflection on the South African Department of Health's eHealth strategy. These strategies should be updated regularly to accommodate trends and future digital health realities.
- Governance (invest in infrastructure, rigorous decision making, facilitated by data timing, systematic risk assessment where there is strategy and leadership.
- Technical requirements for scalability and taking cognisance of client device neutrality. Data privacy and security have to be guaranteed for uptake and use of digital health systems.
- Allowing for access technology, agnostic support for information and service delivery, and media convergence so that digital content and services are accessible and delivered to end-users, regardless of the type of technologies that they use.

Innovation Lifecycle

- Digital health solutions should be developed locally.
- Innovation opportunities and their uptake are not always organic and the latter is often a facilitated process.
- Local competencies and skills are essential and should be developed, incorporated and supported. Continuous training and updating of skills to use systems are essential.
- Economic sustainability requirements have to be considered for sustainability.
- Creative engagement platforms can help lower the barriers of entrepreneurship.
- Open Innovation embraces a number of new and different ways of working that require skill sets that are not normally seen as critical in healthcare generally and in research in particular. These include excellent communication and

dissemination skills, project leadership and coordination, and excellence in collaboration and teamwork.

- Allowing innovation to take place in an organic manner based on the common interests of various stakeholders can allow for novel outcomes and create new opportunities.
- 'Bridgers' and curators help shape the ecosystem. Salmelin (2015) describes curators as focusing on sustaining and enriching the quality of the innovation for reuse or adaption by 'bridgers' to other disciplines. He describes 'bridgers' as socially well-connected stakeholders, with a broad knowledge base, who are able to link various aspects of the innovation in spontaneous and unusual ways with other stakeholders or innovations.

Users/Stakeholders

- An innovation ecosystem should be based on the common interest of all actors in a quadruple helix (Salmelin, 2015) (government, industry, users or community and universities).
- Resources (allocation, management and availability), people, partners and technology need to work in a flexible system where there is a culture of innovation and support for entrepreneurship possibilities.
- For solutions to work in a digital health space, the technologies and people must be able to adapt to changes and focus on a mind-set where capabilities are important to think differently and opportunities exist for co-creation.

These results allowed for a visualised representation of the co-created DHIE for South Africa as depicted in Figure 3 below:

Figure 3: Intermediate DHIE for South Africa as co-created through the involvement of stakeholders

3.3 Phase 3:

In Phase 3 expert opinions were soughed to evaluate the intermediate DHIE for South Africa. The final DHIE for South Africa were send to 5 experts in Africa and South Africa, all who had to have at least 7 years of experience in working in ICT4D, health systems domain and who has written at least 6 papers on health systems in developing contexts. The Expert reviews are used to evaluate the research outcome (artefact) through criticism of the presented material (Molich & Jeffries, 2003). Their comments and suggestions are subsequently incorporated into the final artefact. The two evaluation frameworks of Prat, Comyn-Wattiau, and Akoka (2014) and Venable, Pries-Heje, and Baskerville (2016) were applied to evaluate an artefact in as part of the process of Design Science Research Methodology (explained in Figure 1). These evaluation frameworks request feedback from experts on the DHIE's goal, structure, activity, evolution, utility, relevance and application. The Venable et al. (2016) framework also focuses on functional purpose.

The feedback from all five were that the goal, utility, relevance and purpose as well as evolution of the artefact is evident from the figure and the explanation but they would like to see more depth when it comes to the application. Based on this feedback it was decided to apply the DHIE for South Africa and to select a specific component of Digital Health namely mHealth to show an instantiation of an implementation. This implementation was done after the development of the DHIE and is not part of the scope of this paper.

The intermediate DHIE for South Africa (Figure 3) as was developed through the DSR methodology process of Peffers et al. (2006) and which went through three phases of development was thus accepted by the experts as the final DHIE for South Africa.

7 Conclusions

The DHIE for South Africa provides the essence of all the elements of digital health, innovation and digital ecosystem which are reflected in the context as well as in the innovation lifecycle. It indicates the importance of the involvement of both stakeholders and users to co-create new innovations within their specific context, whether this occurs at a local, regional, national or international level. It allows for new opportunities and creates new building blocks to improve healthcare in South Africa. The context also encapsulates the STEEPV dimensions of social, technological, economic, environment as well as value-based ethics, as depicted in the different layers of local, regional, national and international dimensions evident in an innovation ecosystem.

The importance of applying a specific innovation process (especially Open Innovation 2.0) is evident where stakeholders and users are involved to co-create and stimulate the National System of Innovation in South Africa. The role of users and stakeholders is very prominent as it was indicated in the workshops to be the essence of customising or localising digital health innovations to fit the needs of the consumer or patient. The users

are therefore all the stakeholders that represent the quadruple helix components of government, industry, NGOs and communities. The greatest challenge and opportunity for preventive health innovation lies in closing the gap between what we know and what we do. This includes attitude and behavioural changes by many different stakeholder groups (e.g. healthcare professionals and providers, private companies, politicians, industry, policy makers and the public), as well as by individuals who are targeted to apply the preventive health solution.

The build-up of digital health in South Africa is not only about improving the availability, access and delivery of healthcare services, but essentially about enhancing a country's strategic capabilities to create, adapt and implement novel digital health solutions within and by the public and private sector. Platforms, technologies and solutions implemented today should remain aware of and be open to the needs of tomorrow.

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