



# Human-Computer Interaction for Development (HCI4D): The Southern African Landscape

Judy van Biljon<sup>1</sup>✉  and Karen Renaud<sup>1,2</sup> 

<sup>1</sup> University of South Africa, Johannesburg, South Africa  
vbiljja@unisa.ac.uk

<sup>2</sup> Abertay University, Dundee, Scotland  
k.renaud@abertay.ac.uk

**Abstract.** Human-Computer Interaction for Development (HCI4D) research aims to maximise the usability of interfaces for interacting with technologies designed specifically for *under-served*, *under-resourced*, and *under-represented* populations. In this paper, we provide a snapshot of Southern African HCI4D research against the background of the global HCI4D research landscape. We commenced with a systematic literature review of HCI4D (2010–2017) then surveyed Southern African researchers working in the area. The contribution is to highlight the context-specific themes and challenges that emerged from our investigation.

**Keywords:** HCI4D · Systematic literature review · Southern African snapshot

## 1 Introduction

Research into the social implications of computers in developing countries is the primary goal of IFIP 9.4<sup>1</sup>. There is a specific focus on the experiences relating to information and communications technology (ICT) implementations in developing countries. This resonates with the *raison d'être* of the Human-Computer Interaction for Development (HCI4D) research domain, *viz.* understanding and designing technologies for *under-served*, *under-resourced*, and *under-represented* populations [1]. The global evolution of HCI4D has been described in seminal papers by Ho, Smythe, Kam and Dearden [2], Toyama [3], and Dell and Kumar [1] while Abdelnour-nocera and Densmore [4] presented perspectives and challenges for international development in information and communication technologies (ICTs). These papers highlight the fundamental concerns, trends and challenges, on a global scale. However, the current literature does not address Southern African and situated HCI4D. The research reported here bridges this gap. The purpose of this paper, thus, is to provide an overview of the current status of HCI4D and then focus on Southern Africa, specifically the Southern African Development Community (SADC) states<sup>2</sup>, Uganda and Kenya. Kenya and

<sup>1</sup> [http://www.ifip.org/bulletin/bulltcs/tc9\\_aim.htm](http://www.ifip.org/bulletin/bulltcs/tc9_aim.htm).

<sup>2</sup> <https://www.sadc.int/member-states>.

Uganda have active HCI4D communities involved in AfriCHI therefore; we added those countries to the SADC countries. Henceforth this sample will be referred to as the *African Southern and Eastern (A\_SE) set*.

## 2 Research Design

The mixed-methods research design consisted of three phases. The *First Phase* systematically reviewed HCI4D literature to pinpoint the salient concepts and to prioritize topics to guide the subsequent *Systematic Literature Review* (SLR). The *Second Phase* conducted a SLR of HCI4D literature over the last decade. The *Third Phase* surveyed Southern African HCI researchers to add a Southern African perspective.

### 2.1 Phase One: Identify Concepts and Topics

Information and Communication Technology for Development (ICT4D) has been defined as *the application of any entity that processes or communicates digital data in order to deliver some part of the international development agenda in a developing country* [5]. Human-Computer Interaction for Development (HCI4D) was originally focused on *adapting traditional HCI methods and techniques for designing and deploying solutions for developing nations* [6]. Abdelnour-Nocera and Densmore [4] argue that HCI4D was an outgrowth of HCI that specifically sought to address tensions between local cultures and the assumptions, priorities and values embedded in the extant tools and concepts deployed by this discipline. Therefore, HCI4D lies at the intersection of HCI and ICT4D.

Toyama [3] reviews the historical relationship between HCI and international development and compares their disciplinary approaches. This is useful, in terms of positioning HCI4D as an interdisciplinary field, distinctly shaped by its inheritance from HCI and ICT4D, especially in terms of highlighting its methodological differences. According to Abdelnour-Nocera and Densmore [4], HCI research and literature provides conceptual and methodological tools that are useful in understanding the human dimension of ICT4D. The human element is also pervasive in ICT design, implementation and evaluation, where the focus is on the difference in the performance of technology in different geographies. HCI4D, on the other hand, reports on local experiences, adapting and implementing conceptual and methodological HCI frameworks to make them locally accountable.

The following two studies informed the methodology we adopted, because they, too, reviewed the HCI4D literature. Ho *et al.* [2] presented a conceptual map with the aim of making sense of the emerging HCI4D literature. Dell and Kumar [1] presented an empirical analysis of HCI4D literature (2009–2016). Their findings were based on a survey of 259 HCI4D publications selected from peer-reviewed journals and conference papers that mentioned the keywords ‘*HCI4D*’, ‘*ICTD*’, ‘*low-resource*’, ‘*developing world*’, ‘*developing regions*’, and ‘*development*’. They depicted the evolution of the research domain, with an overview of the (1) geographies covered, (2) technologies targeted, and (3) the epistemological and methodological underpinnings. We adopted the methodology from Dell and Kumar [1] for our review, the methodology categories in our survey is based on Toyama [3] and the analysis of grand challenges on [1–3].

## 2.2 Phase 2: Systematic Literature Review (SLR)

A systematic literature review comprises a systematic search for, and appraisal and synthesis of, research evidence of comprehensive scope with clear inclusion and exclusion criteria [7]. A critical literature review goes beyond a description of the identified articles, to include a measure of analysis and conceptual innovation, typically manifesting as a hypothesis or model [8]. The latter applies to the goal of this study: i.e. to represent the overall state of HCI4D in terms of *where* the research was conducted, *who* was involved and *what* challenges were addressed. The review was conducted on ACM, Springer, Scopus, and Web of Science databases for peer-reviewed conference and journal articles published between 2007 and 2017 using the search string “HCI4D”.

- Step 1.** A total of 239 papers were returned. Removing duplicates left 159 papers.
- Step 2.** Google Scholar returned a further 314 items.
- Step 3.** Combining the results from Steps 1 & 2 gave us a total of 473 papers. Duplicates were removed, leaving 349 papers.
- Step 4.** Panels, workshops, editorials, extended abstracts, forums, books, and book chapters were removed, leaving 213 papers to support in-depth analysis.

A key limitation of this study is that the authors’ country affiliation is operationalized as the location of the institution where the authors worked, instead of where they are originally from. In some cases, it is possible that although some authors were not affiliated with a developing country, they are in fact from a developing country. Another limitation is that the selected search engines covered mostly journal papers; this was mitigated by including 314 Google Scholar papers.

## 2.3 Phase 3: Survey

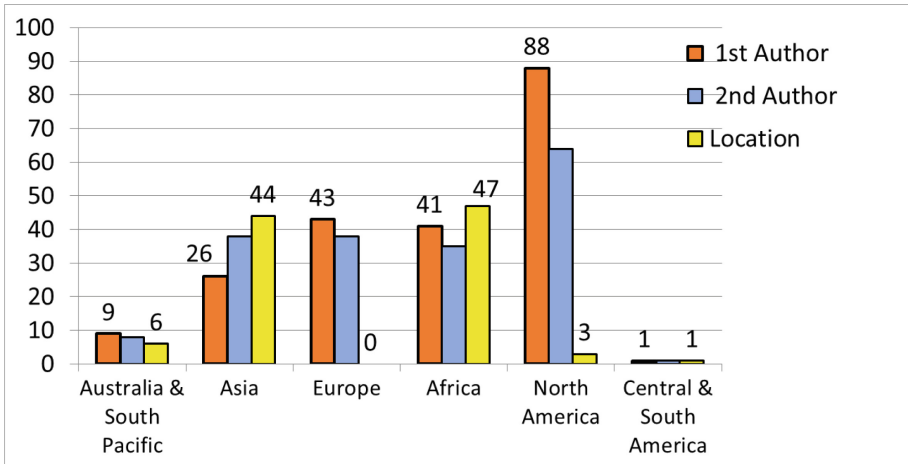
The survey was emailed to the AfriCHI mailing list, AfriCHI being the premier Southern African HCI conference that draws researchers from the global HCI community but especially from SADC countries, as well as Uganda and Kenya. The study received ethical clearance from the School of Computing at the University of South Africa. The survey can be found at [<https://goo.gl/53XBsd>] and we received 20 responses.

# 3 Results

## 3.1 Literature Analysis

**WHERE:** Figure 1 shows where the research was carried out, as well as the location of 1<sup>st</sup> and 2<sup>nd</sup> author institutions. The largest number of first authors came from the USA (88) followed by South Africa (28), the UK (17), India (14) then Australia and Namibia with 9 authors each. The 52 papers from the *A\_SE set* (constituting 24% of the papers) authors’ distribution was as follows: South Africa (25), Kenya (8), Namibia (7), Lesotho (3), Uganda (2) with Congo, Mozambique, Tanzania and Zimbabwe each

with one paper. The remaining 3 papers reported on inter-country comparisons. This reveals discrepancies between the countries where the research was carried out, and the location of the first authors. For example, many studies carried out in India and Kenya were published with first authors from the northern hemisphere. Publication practices, such as publishing in teams (design laboratories) and alphabetising authors, the types of papers (overview or theoretical papers not country based) and the distribution of highly prolific authors, could be distorting this overview to some extent.



**Fig. 1.** Research location, 1<sup>st</sup> and 2<sup>nd</sup> authors, shown in broader geographical areas.

Authorship is a multi-faceted issue and global collaborations can be mutually beneficial. However, this should not occur at the expense of local voices [9] or allow the Global South to become a playground for Western ICT4D scholars [10].

**WHY:** In terms of the focus areas, *Community* was the most prominent, followed by *Health, Theory, Access* and *Education* all at similar frequency levels. Theory development has received more interest since the previous survey, where the frequency rating prioritised Education, Access and Health in declining order with Theory in the 10<sup>th</sup> position [1]. Table 1 categorises the papers we reviewed using categories proposed by Dell and Kumar [1]. The findings confirm that all these user groups are still being investigated in HCI4D research and that the research is geographically distributed. The ‘General’ group comprises papers where the user group is all-inclusive or undefined; this also includes overview and theory development papers.

**HOW:** The research methodologies deployed in the analysed papers were (in order of frequency): Ethnography, Design Science, Participatory Design, Action Research, Case Studies, Mixed Methods, Literature Review, Grounded Theory, Actor-Network and Activity Theory. The methodologies used confirm the HCI4D focus on addressing real world problems, *in-situ* research and practice-led contributions [3]. In terms of technologies used in the research, 58% used mobile phones, 24% used laptops, 7% used other technologies, 2% used DVD or video and 9% did not specify a technology.

**Table 1.** Papers categorized (based on categories by Dell and Kumar [1])

Ground-level users		Examples	Research conducted (Location)
<i>Under-Served</i>	The Elderly	[11–13]	Canada; X*; South Africa (SA)
	Low-income	[14–16]	China, India, SA
	Illiterate, semi-literate	[17–19]	0; India; Pakistan
<i>Under-Resourced</i>	Migrants or Refugees	[20–22]	Palestine; Kenya; Palestine
<i>Under-Represented</i>	Patients	[23–25]	SA; Sweden; SA
	Women	[26–28]	Bangladesh; India; India
	Agricultural Community	[29, 30]	India; Pakistan
<i>Specific Use Scenarios</i>	Mobile phone users	[31–33]	Bangladesh; Morocco; Australia
	Wi-Fi users	[34, 35]	Cuba; India
	Households	[36–38]	SA; India; Kenya
	Pupils or children	[39, 40]	Mexico; India
	University students	[20, 41–43]	USA; China and Australia; Palestine; Malaysia
	Teachers	[44–46]	Indonesia; Indonesia; SA
<b>Human-Access Points</b>			
Healthcare workers		[47–49]	X; Mexico; X
Microfinance		[50, 51]	Azerbaijan; India
Researchers		[52–54]	X; Kenya; X
<b>Collective Entities</b>			
Communities		[55–58]	Australia; SA; SA; India
Organisations		[59, 60]	India; India
Citizens		[61–63]	Bangladesh; SA; Namibia
Rural		[64–66]	Namibia; India; India
<b>Other</b>			
General - No specific group		[1–4]	X; X; Kenya; X

\*Note: X means that the research country was not indicated

### 3.2 Survey Results

We received 20 anonymous responses to the survey; too few to support statistical analyses. However, a number of valuable insights *did* emerge in the categories of *whom*, *why* and *how*.

**WHOM:** Based on the voluntarily divulged email addresses, we observed that most respondents were South Africans or Namibians.

**WHY:** The participants were asked to select all applicable options so the total number of domains selected exceeds 20. The most prevalent focus area was *Education* (18 of 20 participants), followed by *Community* (8), with 7 each in *Government*, *Social Media* and *Health*, 6 in *Theory*, 5 in *Sustainability* and the *Internet of Things*, 4 in *Access*, 3 in *Gender*, *Assistive Technology* and *Politics* each and at least one person working in each of the fields of *Agriculture*, *Business*, *Cybersecurity*, *Transportation* and the *Environment*. The focus on *Education* highlights the challenges with human-capacity development and 21<sup>st</sup> century skills development. Furthermore, there is sustained interest in most of the categories previously identified, with *Government*, *Internet of Things*, *Business* and *Cybersecurity* now added.

**HOW:** The participants were asked to select all applicable options so the total exceeds 20. The deployed *philosophies* were *Interpretive*: 16 (76%); *Post/positivist*: 9 (42.9%); *Critical realist*: 6 (28.5%). In the category, *Other*, there were 4 researchers (19%) and the listed philosophies include ‘decolonist’, post-colonial feminist, African Philosophy, pragmatism and constructivism’. The remaining researchers did not actively use or promote a philosophy.

The *methodologies* (based on Toyama’s categorisation [3]) included *User studies* (needs and context): 15 (75%); *Design & iterative prototyping*: 12 (60%); *Participatory design* 11 (55%); *Evaluation using observation* 10 (50%); *Evaluation using self-reporting* 9 (45); *Evaluation using digital logging including eye tracking* 8 (40%); *Ethnography* 6 (30%); *Other* 5 (25%); *Critical Computing*: 2 (10%). Participants added *Design Science Research*, *Anthropology* and *document analysis* to the list of options provided. Smartphones were the most frequently used technology: 17 (81%) followed by PC or Laptop: 15 (71%) and Basic or feature phone: 11 (53%).

**Table 2.** Mapping challenges identified to survey responses

Ho et al. [2]	Dell and Kumar [1]	Toyama [3]	Corresponding challenges mentioned by Survey Respondents (quotes Ri refers to individual respondents)
Improving <i>HCI Capacity</i> in Developing Regions	How can we further build capacity?		“Acquisition of funding for basic research on development”. (R10); “Lack of researchers in HCI, and availability of viable projects due to limited technology by the community”. (R16);

(continued)

**Table 2.** (continued)

Ho <i>et al.</i> [2]	Dell and Kumar [1]	Toyama [3]	Corresponding challenges mentioned by Survey Respondents (quotes) R1 refers to individual respondents
Reflection around <i>HCI4D</i> practices	How can we broaden the scope of HCI4D?	Technology Alone is Not Enough	“We need to understand the real needs/incentives/ expectations of the recipients first. More often than not, we are “throwing” technology at humans, then analysing the outcomes in the hope that it would have an effect/outcome. We should first ask ourselves - what is required/needed/ practical? It is a fine line, but to me it seems that for many proponents, HCI4D is all about doing the “right thing” in the context of our history as opposed to doing what is really required”. (R4)
	How can we engage with a wider audience?	Technology Sharing and Intermediation	“ <i>Diversity</i> of end users, rapid evolution of technology (with many left behind)”. (R13)
Develop replicable, low-cost approaches and hardware that can be appropriated and adopted by community-based organizations with minimal requirements for external support	How can we design for non-traditional settings?	Hardware and Infrastructure Constraints	“There are pockets of very good use of ICT, but the issues around resources and infrastructure prevent the general use by the majority of the population. Africa is already fallen behind in participating in the knowledge economy due to low computer literacy levels, however we have a real chance to address the situation using mobile”. (R9)
User Interfaces for Illiterate and Semi- Literate Users	How can we improve interactions for diverse users?	Cultural, Linguistic, and Non-Linguistic Adaptation	“Diversity of end users, rapid evolution of technology (with many left behind)”. (R13) “The depth of the multiculturalism”. (R14)
Mechanisms to evaluate designs whereby we can accumulate knowledge that can inform effective and sustainable development interventions			“The ongoing framing of all interactions, HCI methods and designers’ identity by Silicon Valley through materialities, pedagogies and capital”. (R5)  “To adopt an African philosophy of doing in a world westernized and politically tough, where politics means human relationships”. (R20)

## 4 Discussion and Reflection

The findings from the SLR, and the survey, will now be triangulated towards providing a snapshot of the Southern African HCI4D landscape, in terms of the researchers, focus areas, methodologies and challenges. While acknowledging other influences, the ratio between the number of first authors and the number of studies per country provides some indication of the type of collaboration (when authors are ranked by contribution). Our findings indicate variations between authorship patterns: for South Africa and Namibia, the number of first authors correspond with the number of research projects but that was not the case for Kenya. Upon ranking the 56 papers in the *A\_SE set*, according to citation count, we found that the highest ranked paper *not written in collaboration with a Northern-based author*, namely de la Harpe [25], was in position 39 of 56. Furthermore, more than 70% of the publications had foreign authors (previously or currently from the North). There is general agreement that local researchers ought to be spearheading HCI4D research in their own countries, but our findings indicate that the involvement of foreign researchers remain important when publishing research. Therefore, partnerships which involve a measure of mentoring and knowledge transfer may be more beneficial to developing local voices than deliberately limiting international collaboration.

We compared the keyword frequency for the global set (114 papers) with the *A\_SE set* (56 papers) and depicted the results in Figs. 2 and 3, respectively. That excludes the review papers, which are not country based, and inter-country studies. The terms *design*, *mobile*, *ict4d*, *ictd* and *community* dominate both sets. This highlights the importance of community and design-focused research, with mobile phones as the central technology, in HCI4D research (as supported by our survey). The terms *participatory*, *rural* and *health* feature more prominently in Fig. 3. The findings reveal a diverse range of philosophies and methodologies; both the *A\_SE set* and global papers have an action-orientated, design and development focus with due recognition of the user communities. This places HCI4D researchers in a strong position to respond to the calls for practice-led research [67].



Fig. 2. Global papers



Fig. 3. SADC Kenya and Uganda



In terms of the challenges, Table 2 demonstrates a large overlap between the previously-proposed categories [1–3] and our survey responses. This confirms the relevance of the following challenges for Southern driven HCI:

*Capacity building in research leadership.* Collaborations should involve local researchers not merely as facilitators in data capturing but by making a deliberate effort to develop all their capabilities as independent researchers, reviewers and project managers.

*Multiculturalism and an appreciation for diversity,* which requires continued research on interactions and interfaces for diverse user groups considering cultural, linguistic, and non-linguistic adaptations.

*Appropriate methodologies:* HCI4D cannot thoughtlessly appropriate Western-focused HCI tools and approaches without consideration of their appropriateness in the African context. Participatory design is useful in addressing this issue but the process and actual participation of the users, as well as ethical data capturing and governance practices, have to be monitored.

The commitment to socially situated, community-centred research is clear, but Pal [68] warns that the gravity of social good needs to be adequately reflected in the ways HCI researchers approach their investigations. The challenge of broadening the HCI4D scope appears to have been replaced with the challenge of redefining the HCI4D niche. For Southern researchers, this means moving beyond user-centred design, usability and user experience to also consider stakeholders as well as the social, ethical and financial implications of IT systems.

## 5 Conclusion

The paper presents a Southern African perspective on HCI4D research against the backdrop of the global view. The snapshot reveals a diverse and sophisticated research community, with mature, independent research groups in countries like South Africa, Kenya and Namibia and growing and maturing research groups in Uganda. There are also strong international links, which are beneficial to researchers who need some initial mentoring, especially towards high-impact publications. Our findings highlight various application domains of ‘HCI4D’ (with Education being most important in the Southern African landscape) and the evolution and diversification of the methodologies. The challenges in Southern Africa resonate with those previously identified regarding the need to consider the positioning of, and the critical role that HCI4D researchers have to play, in the ICTD field. The validated set of presented challenges provides a point of departure to characterise the challenges inherent in this field of research. All the findings and conclusions should be considered in the context of the study’s limitations as stated earlier. Future studies will benefit from the inclusion of a wider variety of sources to support more detailed analysis and to gather responses from a larger survey sample.

**Acknowledgement.** This paper is based on the research supported by the South African Research Chairs Initiative of the Department of Science and Technology and National Research Foundation of South Africa (Grant No. 98564). We acknowledge the advice and assistance of Mr Sewisha Lehong and Mr Donald Mothisi in analysing the data.

## References

1. Dell, N., Kumar, N.: The ins and outs of HCI for development. In: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI 2016, pp. 2220–2232 (2016)
2. Ho, M.R., Smyth, T.N., Kam, M., Dearden, A.: Human-computer interaction for development: the past, present, and future. *Inf. Technol. Int. Dev.* **5**, 1–18 (2009)
3. Toyama, K.: Human – computer interaction and global development. *Found. Trends Hum.-Comput. Interact.* **4**, 1–79 (2010)
4. Abdelnour-Nocera, J., Densmore, M.: A review of perspectives and challenges for international development in information and communication technologies. *Ann. Int. Commun. Assoc.* **41**, 250–257 (2017)
5. Heeks, R.: *Information and Communication Technology for Development (ICT4D)*. Routledge (2018)
6. Chetty, M., Grinter, R.E.: HCI4D: HCI challenges in the global south. In: CHI 2007 Extended Abstracts on Human Factors in Computing Systems, CHI EA 2007, pp. 2327–2332 (2007)
7. Pickering, C., Grignon, J., Steven, R., Guitart, D., Byrne, J.: Publishing not perishing: how research students transition from novice to knowledgeable using systematic quantitative literature reviews. *Stud. High. Educ.* **40**, 1–14 (2014)
8. Grant, M.J., Booth, A.: A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Info. Libr. J.* **26**, 91–108 (2009)
9. Gitau, S., Plantinga, P., Diga, K.: ICTD research by Africans: origins, interests and impact. In: Fourth International Conference on Information and Communication Technologies and Development (ICTD 2010) (2010)
10. Bai, Y.: Has the Global South become a playground for Western scholars in information and communication technologies for development? *Evid. Three-J. Anal. Scientometr.* **116**, 2139–2153 (2018)
11. Haddad, S., McGrenere, J., Jacova, C.: Interface design for older adults with varying cultural attitudes toward uncertainty. In: Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems - CHI 2014, pp. 1913–1922 (2014)
12. Righi, V., Sayago, S., Blat, J.: When we talk about older people in HCI, who are we talking about? Towards a ‘turn to community’ in the design of technologies for a growing ageing population. *Int. J. Hum Comput. Stud.* **108**, 15–31 (2017)
13. van Biljon, J., Renaud, K.: Validating mobile phone design guidelines: focusing on the elderly in a developing country. In: Proceedings of the Annual Conference of the South African Institute of Computer Scientists and Information Technologists on - SAICSIT 2016, pp. 1–10 (2016)
14. Dhir, A., Kaur, P., Jere, N., Albidewi, I.A.: Understanding mobile phone battery - human interaction for developing world: a perspective of feature phone users in Africa. In: 2012 2nd Baltic Congress on Future Internet Communications, BCFIC 2012, pp. 127–134 (2012)

15. Paruthi, G., Thies, W.: Utilizing DVD players as low-cost offline internet browsers. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 955–958. ACM (2011)
16. Shroff, G., Kam, M.: Towards a design model for women’s empowerment in the developing world. In: Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems - CHI 2011, p. 2867 (2011)
17. Agarwal, S.K., Grover, J., Kumar, A., Puri, M., Singh, M., Remy, C.: Visual conversational interfaces to empower low-literacy users. In: Kotzé, P., Marsden, G., Lindgaard, G., Wesson, J., Winckler, M. (eds.) INTERACT 2013. LNCS, vol. 8120, pp. 729–736. Springer, Heidelberg (2013). [https://doi.org/10.1007/978-3-642-40498-6\\_67](https://doi.org/10.1007/978-3-642-40498-6_67)
18. Raza, A.A., et al.: Viral spread via entertainment and voice-messaging among telephone users in India. In: Proceedings of the Eighth International Conference on Information and Communication Technologies and Development - ICTD 2016, pp. 1–10 (2016)
19. Raza, A., Haq, F.U., Tariq, Z.: Job opportunities through entertainment: virally spread speech-based services for low-literate users. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 2803–2812 (2013)
20. Yerousis, G., Aal, K., von Rekowski, T., Randall, D.W., Rohde, M., Wulf, V.: Computer-enabled project spaces: connecting with palestinian refugees across camp boundaries. In: Proceedings of the ACM CHI 2015 Conference on Human Factors in Computing Systems, pp. 3749–3758 (2015)
21. Wyche, S.P., Grinter, R.E.: This is how we do it in my country. In: Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work - CSCW 2012. ACM (2012)
22. Xu, Y., Holzer, A., Maitland, C., Gillet, D.: Community building with co-located social media. In: Proceedings of the Ninth International Conference on Information and Communication Technologies and Development - ICTD 2017, pp. 1–11 (2017)
23. Hwabamungu, B., Williams, Q.: M-health adoption and sustainability prognosis from a care givers’ and patients’ perspective. In: Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists, pp. 123–131 (2010)
24. Eriksen, S., Georgsson, M., Hofflander, M., Nilsson, L., Lundberg, J.: Health in hand: putting mHealth design in context. In: 2014 IEEE 2nd International Workshop on Usability and Accessibility Focused Requirements Engineering, UsARE 2014 – Proceedings, pp. 36–39 (2014)
25. De la Harpe, R.: The level of participation during the development of a mobile application for home-based healthcare data in a developing context: an actor-network theory perspective: research article. *South African Comput. J.* **54**, 20–33 (2014)
26. Ahmed, S.I., et al.: Protibadi: a platform for fighting sexual harassment in urban Bangladesh. In: Proceedings of the 32nd Annual ACM Conference Human Factors in Computing Systems, pp. 2695–2704 (2014)
27. Karusala, N., Kumar, N.: Women’s safety in public spaces: examining the efficacy of panic buttons in New Delhi. In: CHI, pp. 3340–3351. ACM (2017)
28. Kumar, N., Anderson, R.J.: Mobile phones for maternal health in rural India. In: Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems – CHI 2015, pp. 427–436 (2015)
29. Cuendet, S., Medhi, I., Bali, K., Cutrell, E.: VideoKheti. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems – CHI 2013, p. 2833 (2013)
30. Riaz, W., Durrani, H., Shahid, S., Raza, A.A.: ICT intervention for agriculture development. In: Proceedings of the Ninth International Conference on Information and Communication Technologies and Development – ICTD 2017, pp. 1–5 (2017)