




Knowledge mobilization of human–computer interaction for development research: core issues and domain questions

Judy van Biljon 

School of Computing, University of South Africa, Johannesburg, South Africa

ABSTRACT

Human-computer interaction for development (HCI4D) operates at the intersection of Human-computer interaction (HCI) and information and communication technology for development (ICT4D). The interdisciplinary nature complicates knowledge transfer and articulation between the disciplines contributing to the HCI4D domain. This paper proposes a conceptual framework to highlight the core issues and domain questions in HCI4D towards supporting knowledge mobilization between researchers in HCI4D and the related fields. This paper presents an overview of the HCI4D literature (2007–2017) which investigated the domain questions, including the core issues, focus areas, the phenomena of interest, target users and the research methods. The findings were presented as a conceptual framework which comprises the core issues and salient elements for each of the domain questions. This framework was evaluated and checked against 2017–2019 literature to propose a final HCI4D knowledge mobilization framework (HCI4D_KMF). The contribution lies in knowledge transfer and articulation towards enriching discussions on HCI4D research.

KEYWORDS

HCI4D; ICT4D; ICTD; human–computer interaction; knowledge mobilization

1. Introduction

HCI4D is a research domain aimed at understanding and designing technologies for under-served, under-resourced, and under-represented populations around the world (Dell & Kumar, 2016). It caters for the needs and aspirations of people in developing regions, or for specific social, cultural, and/or infrastructural challenges of developing regions (Ho et al., 2009). Within the wide-ranging definition of the terms *low-resource* and *marginalized* communities as the recipients of development initiatives, HCI4D research has maintained a focus on *design* for better access and *usability* qualified by low-resource settings (Abdelnour-Nocera & Rangaswamy, 2018). Considering the theme of constraints, the focus was on the infrastructural more than the cultural but concerns for social justice and a variety of eco-political agendas was a running theme (Abdelnour-Nocera & Rangaswamy, 2018). HCI4D inherits the *international development* focus from Information and Communication and Development (ICTD) while human–computer interaction (HCI) research and literature provide conceptual and methodological tools to understand the human dimension of ICT4D (Abdelnour-Nocera & Densmore, 2017). Appropriating information and communication technology for the purpose of supporting ICT for development (ICT4D) is by its very nature a complex endeavor, therefore ICT4D researchers need to employ an assortment of perspectives and tools to adequately engage with this complexity (Renken & Heeks, 2018).

CONTACT Judy van Biljon  vbilja@unisa.ac.za

Kweku Osei-Bryson is the accepting Senior Editor for this manuscript.

This article has been republished with minor changes. These changes do not impact the academic content of the article.

© 2020 Commonwealth Secretariat

The interdisciplinary nature of ICT4D (Toyama, 2010; Walsham, 2017) and that of HCI4D (Dell & Kumar, 2016; Toyama, 2010) complicates the matching and aligning of goals, expectations, practices and methodologies across the HCI4D domain. Given the different philosophical and methodological streams to contend with, researchers may be unable to appreciate the value of alternative disciplinary streams (Best, 2010). This can cause isolated streams of progress disconnected from other discourses in the field, hence the maturation of the field and the real-world impact suffers. For example, cases where published usability guidelines for using mobile phones in developing countries were iteratively refined through repeated cycles of heuristic evaluations without evidence of in situ implementation and evaluation (Van Biljon & Renaud, 2016). One of the reasons for the lack of implementation could be found in the different methodological approaches, which broadly include (1) qualitative methods and user studies, (2) design and iterative prototyping, and (3) evaluation (Toyama, 2010). If, for example, the HCI4D research was done from an interpretive position where researchers used qualitative methods and user studies to understand the context and the user requirements for a technology enabled intervention, then a real-life project involving multi- and interdisciplinary research would require that the researchers, once having completed the requirements gathering would proceed with implementation, monitoring and evaluation. This would require a different philosophy and skills set, possibly pragmatism to allow the flexibility needed in action, design or action-design-science research where artefacts are created and evaluated. There are many reasons for this *silos approach* to research including lack of a holistic view, lack of skills etc. but the result is always to diminish the research impact and contribution to making a better world.

The focus on making impact is increasing, Sein et al. (2019) identify four research agendas for ICT4D research, namely theorizing ICT4D; the philosophical bases of ICT4D; expanding ICT4D research to the developed world; and moving from understanding to intervention studies. The latter highlights the need for more action research and action design research studies to create knowledge while solving development problems (Sein et al., 2019).

According to Heeks and Wall (2018) the growing search for causal links between 'ICT' and 'D,' and the political and ethical turns in ICT4D are prompting researchers to engage more with issues of power, rights, and justice. The response to the call of making a better world on different levels by technological, political and ethical innovation requires a holistic view and resonates with Best's recommendation to develop a set of fundamental shared problems and an appreciation for mixed (and when appropriate, shared) methods while ensuring robust evaluation and assessment (Best, 2010). Considering interdisciplinary research Burrell and Toyama (2009) warn that the reader or reviewer's preference and misunderstandings of methods may inadvertently cast baseless doubt on the research quality. In summary, there is a need to traverse ICT4D knowledge sub-domains to progress from understanding the issues and the context to designing evidence-based policy and practice interventions but that requires a mechanism for aligning, connecting and mobilizing the knowledge across sub-domains.

The concept of knowledge mobilization (hereafter referred to as KM) emerged in response to the need to make stronger connections between research, policy and practice (Crilly et al., 2010) and the multiple ways in which these connections can be made (Levin, 2011). Based on a study of KM models in the fields of health care, sociology, political studies and education, Ward et al. (2009) maintain that the quantity and diversity of the knowledge transfer literature make it difficult for researchers and managers to choose which model to use. Furthermore, the KM models remain largely unrefined and untested meaning that their suitability as tools for designing and evaluating interventions is unknown (Ward et al., 2009).

Therefore, the purpose of this paper is to propose a knowledge mobilization framework that aligns the core issues (motor themes) in the HCI4D field with the salient philosophies and methodologies, thereby relating HCI4D to ICT4D on a methodological level and then evaluate the framework in terms of *comprehensiveness*, *transferability* to a region or research domain, *simplicity* and *clarity*. The term *framework* is used in lieu of the term *conceptual model* since the artefact created is informed by the Ward (2017) framework. Acknowledging the continued growth and diversification in the field

this framework is proposed as a non-prescriptive point of departure for verification and further research in the field of HCI4D. The research philosophy is pragmatism, which allows for the triangulation and integration of findings from different research designs including two descriptive literature reviews, a survey and interviews. The literature review section discusses approaches to positioning a research field and identifying the core issues (motor themes) in terms of centrality and density. A discussion of seminal HCI4D overview papers explains the selection of the dimensions of the initial (2007-2017) descriptive literature review. Thereafter, the literature review and analysis is explained. The findings from this literature analysis are synthesized to abstract the conceptual framework on the core issues and domain questions of the HCI4D research field. The use of the framework is illustrated by applying it to the data captured during a survey conducted with Southern African HCI4D researchers. The original framework of the HCI4D research field, as well as the application to the Southern African context, is then evaluated by ICT4D expert researchers and updated accordingly. A second literature review (2017-2019) was done to check if the final HCI4D Knowledge Mobilization Framework (HCI4D_KMF) is up-to-date. The paper concludes by discussing the limitations and contributions of this research.

2. Related work

This paper builds on the concepts of Knowledge Mobilization, Human-Computer Interaction and Human-Computer Interaction for Development. The related definitions and relevant issues are now discussed in the respective sections.

2.1. Knowledge mobilization

The importance of intermediation between communities primarily engaged in research production and those primarily engaged in practice is increasingly acknowledged (Malin & Paralkar, 2017). Funding agencies have provided incentives for knowledge exchange at the interfaces between science and policy or practice, yet that has been met with varying levels of success within academic institutions (Hering, 2016). ICT4D research has a normative orientation, seeking to produce actionable knowledge to influence policy or practice in the service of development goals (Loudon & Rivett, 2013). However, given the interdisciplinary nature of research in ICT4D, the gap is not only between research, policy and practice; there is also a gap between the knowledge bases of the individual researchers and schools of thought (Best, 2010; Van Biljon & Alexander, 2015). The term knowledge mobilization, also referred to as knowledge transfer, knowledge exchange or knowledge translation encompasses the exchange, synthesis and application of tacit knowledge, new ideas or innovations as well as research results and other evidence between academic and practice settings (Ward et al., 2009).

The field of *knowledge mobilization* is grounded in the theories of knowledge transfer and exchange (Phipps & Shapson, 2009) and concerns the multiple ways in which stronger connections can be made between research, policy and practice (Levin, 2011). While the primary interest is in knowledge deriving from formal research, meaningful findings based on widely accepted, systematic and established formal processes of inquiry, knowledge mobilization recognizes that research impact is shaped by the larger social and political context (Levin, 2011). Therefore investments in knowledge mobilization can create value for the institution, researchers, graduate students and research partners (Phipps & Shapson, 2009). The following two studies analyzed the existing KM models:

- Towards scoping and summarizing the knowledge mobilization literature, Ward et al. (2009) conducted a thematic analysis of the literature and identified 28 different models from the fields of health, medicine, sociology and education. Based on the analysis of those models they identified five common components of the knowledge transfer process, namely problem identification and communication; knowledge/research development and selection; analysis of context; knowledge

transfer activities or interventions; and knowledge/research utilization. They also identified three processes namely: a linear process; a cyclical process; or a dynamic multidirectional process (Ward et al., 2009).

- Based on a review of 47 knowledge mobilization models, Ward (2017) proposes a framework to help knowledge mobilizers reflect on, communicate and evaluate their aims and objectives towards increasing clarity and understanding across the field. This can allow researchers to articulate between different philosophical and research design entities. Their framework presents the results from a literature review in the field under investigation in terms of dimensions including the who, why, what, and how dimensions (Ward, 2017). The Ward framework provides a point of departure for structuring the conceptual framework presented in this study.

Considering the field of ICT4D there is an appreciation of the need for interdisciplinary research (Walsham, 2017) and knowledge transfer across disciplinary boundaries (Avgerou, 2017; Renken & Heeks, 2018). Flor (2018) defines Knowledge Management for Development (KM4D) as the undertakings, systems and products that leverage intellectual capital in the pursuit of national, regional or global development goals. Kelly (2018) argues that international development is a data-, information-, and knowledge-intensive industry, where power relations shape KM4D including the data and knowledge constructed yet that power dimension is often overlooked in development impact evaluation practice. He advocates for using Cultural Historical Activity Theory to analyze impact evaluation activities (Kelly, 2018). Despite this evidence of research investigating specific aspects of KM4D no knowledge mobilization tool, model or framework integrating the fields of ICT4D or HCI4D could be found in the academic literature at the time the search was conducted (August 2019).

2.2. Positioning a research field

When positioning a research field, the themes of maturity, core issues and domain questions arise. Bødker (2015) contends that the changing nature of the published papers can be used as an indicator of how a field is maturing and identifies the following waves in the development of a new, human-related research field such as HCI:

- The first wave of papers generally present individual, small-scale studies where researchers report empirical results to lay down founding principles
- The second wave emerges, with reports on the use of the initial results in larger-scale studies, often in organizations where the focus on the individual no longer dominates
- The third wave is introduced when meaning-making papers start appearing, those papers question unwritten assumptions and making recommendations about the way forward.

Therefore, researchers need to build on the existing research in the field for a field to mature and the extent to which that has been done provides an indication of the fields' maturity. Considering the theme of core issues in a field, Reeves (2015) suggest describing those in terms of centrality and density.

As depicted in Figure 1, a theme can be tracked and plotted as the themes evolve through inception starting in 'Quadrant III: Emerging or declining themes'; begin to stabilize in 'Quadrant IV: Basic and transversal themes' then go mainstream in 'Quadrant I: Motor themes' and eventually terminate (back to Quadrant III) or perhaps wane and move to 'Quadrant II: Developed but isolated themes.' The progression of a theme is not predictable; but that discussion is beyond the scope of this study where we are interested in the usefulness of motor themes to describe the core issues and domain questions in HCI4D for supporting knowledge mobilization.

The next section will explain the positioning of HCI4D as a research field also by considering the connection between the domains of HCI, ICT4D and HCI4D.

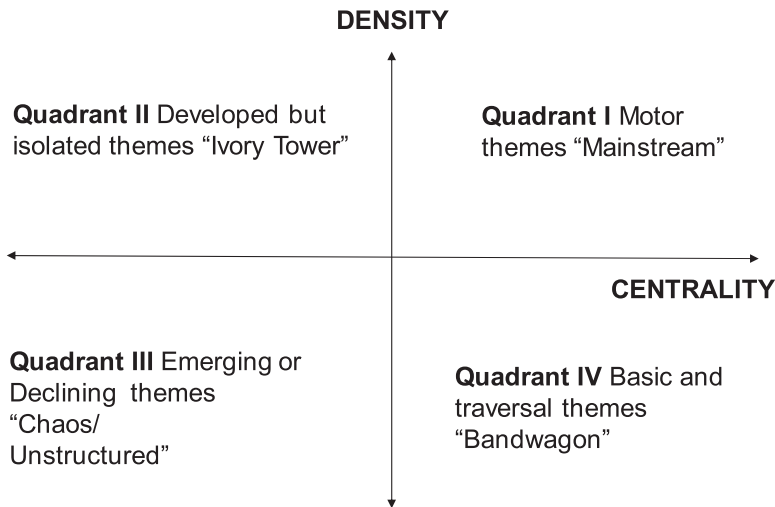


Figure 1. Mapping disciplinary knowledge production as quadrants (Reeves, 2015).

2.3. Positioning HCI4D as a research field

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 (Heeks, 2018). The ICT4D discourse is guided by theories conceptualizing development, theories conceptualizing the use of ICT and theories on the transformative processes linking ICT to development Sein et al. (2019).

Human-computer interaction for development (HCI4D) was originally focused on the adaptation of traditional HCI methods and techniques for designing and deploying solutions for developing nations (also referred to as the Global South) (Chetty & Grinter, 2007). More recently, Abdelnour-Nocera and Densmore (2017) maintained that HCI4D is a response to the fact that HCI as a discipline must alleviate tension created between local cultures and the assumptions, priorities and values embedded in the tools and concepts of this discipline. Toyama (2010) overviews the historical relationship between HCI and international development, and compares their disciplinary approaches. This is useful in terms of differentiating HCI4D from HCI while acknowledging that the HCI4D field is informed by the inheritance from both HCI and ICT4D as parent fields. Oulasvirta and Hornbæk (2016) describe HCI as a hyper-disciplinary field focusing on three main types of problems: empirical, conceptual and constructive, with *problem-solving capacity* (not methodological choice) as the universal criterion for progress. Rogers (2012) describes HCI as an interdiscipline, that signifies the absence of a disciplinary core in HCI, and allows it to be an interdisciplinary space for connecting disciplines rather than a way of ordering knowledge. Walsham (2017) describes ICT4D as interdisciplinary which means that researchers need to contend with different epistemologies and methodologies. HCI4D is a research domain at the intersection of ICT4D and HCI, and thus interdisciplinarity lies at the core of HCI4D research. HCI4D through the connection with HCI deals with human factors while retaining the focus on designing, implementing and evaluating technologies for development. The human element is pervasive in ICT design, implementation and evaluation but the focus is on the difference in the performance of technology in different geographies whereas HCI4D reports on local experiences (Abdelnour-Nocera & Densmore, 2017). The latter means adapting and implementing conceptual and methodological HCI tools and models for understanding the human dimension of ICT4D to make it locally accountable.

Considering ICT4D projects, Qureshi and Xiong (2017) maintain that many well-intended projects fail, due to unrealistic expectations set by development agencies responding to their political

objectives, while information systems research is ripe with well-studied concepts that do little to achieve a better world. Likewise, the '4D' part in HCI4D has been contested, arguing that HCI in developing regions is not always and not only 'for development' (Toyama, 2010). Therefore, many researchers prefer the term ICTD to ICT4D and possibly the term HCID could be introduced to encompass HCI4D projects. Irani et al. (2010) proposed postcolonial computing as an analytical orientation to better understand the challenges of cultural contexts and how designs and methods engage new constituencies, where design and analytical practices face significant challenges. While acknowledging those discourses, the terms HCI4D and ICT4D are well established and will be used in this paper, especially because HCI4D signposts the relationships to the HCI and ICT4D fields.

3. Research methodology

In this section, the research philosophies used to guide the study, the research design used to structure the study and the methods used for data capturing, will be discussed.

3.1. Philosophical assumptions of this study

The purpose of this paper is to propose a conceptual framework to highlight the core issues and domain questions in the HCI4D domain towards supporting knowledge representation and transfer between researchers for *understanding* the socially constructed, research knowledge at the core of the HCI4D domain. This aligns with the interpretive research philosophy, since interpretive research methods depart from the premise that our knowledge of reality, is a social construction by human actors (Walsham, 2006). In that respect, the philosophical orientation of interpretivism, namely understanding socially constructed, subjective research knowledge is applicable. Creswell (2014) argues that interpretivism is divergent, guiding the researcher to explore the expanding complexity of views rather than attempting to limit the findings towards converging into a finite number of categories or ideas. However, towards presenting the understanding, i.e. producing a conceptually coherent model this study needed to converge the findings and therefore another philosophy had to be considered. Pragmatism is not committed to any one system of philosophy and reality, it allows researchers to choose the methods, techniques, and procedures of research that best meet their needs and purposes (Creswell, 2014). Therefore, the philosophical orientation of pragmatism, namely to produce real-world, useful knowledge aimed at improving practice (Mingers, 2004) was selected to guide the development of the model. Furthermore, pragmatism supports a research design combining different research methods as well as modes of analysis and a continuous cycle of abductive reasoning to produce socially useful knowledge (Feilzer, 2010). That applies to this study as discussed in the next section.

3.2. Research design

Mixed methods research is, generally speaking, an approach to knowledge (theory and practice) that attempts to consider multiple viewpoints, perspectives, positions, and standpoints – including the standpoints of both qualitative and quantitative researchers (Johnson et al., 2007, p. 113). Ward et al. (2009) identified five common components of the knowledge transfer process, namely problem identification and communication; knowledge/research development and selection; analysis of context; knowledge transfer activities or interventions; and knowledge/research utilization. These components were used to structure the activities within the multi-method approach, and guided the data capturing events as follows:

- *Problem identification and communication*: The research was triggered by the lack of a coherent model or framework to present the HCI4D field in terms of the core issues and domain questions.

- *Knowledge/research development and selection*: A critical literature review of HCI4D literature over the last 11 years was conducted (as detailed in the next section) to select the relevant literature and then analyze that as a point of departure in identifying the domain questions and core issues.
- *Analysis of context*: The global context was considered by recording and analyzing data on where the research was done geographically and the origin of the researchers.
- *Knowledge transfer activities or interventions*: The knowledge mobilizers framework (Ward, 2017) was applied to structure the findings from the descriptive literature review coherently and to propose the initial HCI4D knowledge mobilizers framework.
- *Knowledge/research utilization*: The HCI4D knowledge mobilizers framework was applied to the findings of a survey on Southern African HCI4D research to develop a contextualized KMF and test the applicability of the framework. The purpose was to provide an accessible, integrated view of the findings that makes it easier to mobilize the knowledge. The initial KMF (Figure 5) and the refined, contextualized KMF (Figure 6) were evaluated during interviews with 8 experts in the field. To account for the dynamic nature of the HCI4D field, a descriptive literature review of 2017–2019 publications was done to confirm the continued validity of the findings.

Triangulation, the idea referring to ‘multiple operationalism,’ in which more than one method is used as part of a validation process (Johnson et al., 2007) was applied to ensure that the findings were the result of the underlying phenomenon or traits and not of the method used. A multi-method research design as used in this study, is distinguished from mixed-methods in the sense that the order and contribution of the quantitative and qualitative components are more flexible (Creswell & Clark, 2017). The initial scoping literature search delivered only three meaning making (third wave) papers, namely Ho et al. (2009), Toyama (2010) and Dell and Kumar (2016). Those were useful in informing the descriptive literature review but offered no guidance on relating the core issues to the domain questions. That confirmed the need for a knowledge mobilization framework as a point of departure in communicating HCI4D meta-knowledge.

The initial literature review was done in 2017 and the initial model was proposed in 2018; HCI4D field is dynamic and an updated review was required to verify the continued validity of the earlier reviews and extract additional information for structuring the findings. Therefore, the 2017–2019 publications were selected using the same procedure, and criteria of the initial descriptive literature review. Alternatively, the 2007–2019 set could have been analyzed but that would mean redoing the study which negates the development history and the evaluation of the initial framework which was based on the first (2007–2017) review. Furthermore, the impact of the more recent (2017–2019) research would be less evident if the data from 2007–2017 and that of 2017–2019 was combined.

3.3. Research methods

The research methods employed include the descriptive literature review, the survey with Southern African HCI4D researchers and the expert reviews to evaluate the model. Each of these will now be discussed in more detail.

3.3.1. Design of the descriptive literature review

A rigorous standalone literature review goes beyond a description of the identified articles to include a degree of analysis and conceptual innovation (Boell & Cecez-Kecmanovic, 2015; Grant & Booth, 2009). The review has to be systematic in following a methodological approach, explicit in explaining the procedures by which it was conducted, comprehensive in its scope of including all relevant material, and hence, reproducible by anyone who follows the prescribed approach in reviewing the literature (Okoli & Schabram, 2010). The expansion of evidence-based practice across sectors has led to an increasing variety of literature review types. Grant and Booth (2009) propose a typology based on an analysis of review types where they identify the 14 most common types of literature reviews, with illustrative examples from health and health information domains. Paré et al. (2015)

provide a typology of nine review types and provide a descriptive insight into the most common literature reviews found in top IS journals. Notably, all these types exhibit a degree of rigor and systematization with the typologies and sophistication of the requirements dynamically increasing. Therefore, some of the earlier studies classified as systematic literature reviews would probably not qualify for that description anymore. Considering the classification of Paré et al. (2015), this study fits under the descriptive literature review type which implies that the scope of the questions are broad, the search study is representative, the nature of the primary sources is empirical, the study selections is explicit and the analysis methods include content analysis or frequency analysis, in this study both methods were included.

Given the methodological rigor, degree of analysis and conceptual innovation required the aim of a systematic literature review is not just to aggregate all existing evidence on a research question. The findings typically manifest in evidence-based guidelines for practitioners (Kitchenham et al., 2009), a hypothesis or a model (Grant & Booth, 2009). The latter resonates with the purpose of this study, namely to *propose a framework representing the field of HCI4D research*. Bramer et al. (2018) propose a systematic search strategy to develop literature searches starting with clear and focused questions. Considering the purpose mentioned, this research question is formulated as: What are the core issues and domain questions in the HCI4D domain? Having defined the question and identified the search term, Bramer et al. (2018) suggest finding articles that can be used as guidance in constructing the research strategy. The following two studies, also having conducted surveys of the HCI4D literature were imperative in informing the search strategy of this study:

- The Ho et al. (2009) study published the result of a literature survey towards presenting a conceptual map for making sense of the emerging HCI4D literature. Their specific aims were to articulate some of the histories that informed the community of researchers; to provide an overview of existing work in HCI4D; discuss the most pertinent issues in the discipline and suggest a set of grand challenges for the ensuing 5–10 years. The following topics were identified: cross-cultural HCI, unique needs, design methods, and empirical studies.
- Dell and Kumar (2016) presented an empirical analysis of HCI4D literature (2009–2016). Their findings were based on a survey of 259 HCI4D publications selected from journals and conference papers that mentioned the keywords ‘HCI4D,’ ‘ICTD,’ ‘low-resource,’ ‘developing world,’ ‘developing regions,’ and ‘development.’ They summarized the evolution of the research, with an overview of the geographies it covers, technologies it targets, epistemological and methodological underpinnings.

The findings from these two overview papers were compared and contrasted with the review on Human–Computer Interaction and Global Development by Toyama (2010) in terms of the core themes and challenges and those were used to inform the categories for the analysis of the papers selected in the descriptive literature review.

The difficulties with refining search terms in interdisciplinary domains have been noted by Pretto and Curró (2017) when they conducted a systematic literature review focusing on common terms in IT-related literature within the three interdisciplinary fields of IT, ICT, and EdTech. They found that the inconsistent usage of the terms in the three interconnected fields causes confusion which makes cross-comparisons problematic (Pretto & Curró, 2017). The same issue arises when considering HCI4D-related terms in the interdisciplinary fields of ICT4D, HCI and HCI4D and that complicated the selection of keywords. Initially the string [‘Human–Computer Interaction’ AND ‘Development’] was proposed. However, some database search engines interpreted the ‘AND’ condition in the strings as ‘OR.’ Furthermore, the term ‘development’ has different connotations which led to many inappropriate selections. Therefore, the term ‘HCI4D’ was used. While acknowledging the value of synonyms and variations in optimizing search strategies to find the best balance between sensitivity and specificity (Bramer et al., 2018), a simple search term like ‘HCI4D’ has value in terms of the replicability of the research.

Cavacini (2015), when investigating the best database for Computer science journals, notes that many studies focus on one or more of the three most important multidisciplinary databases, namely Web of Science, Scopus and Google scholar, he recommends Scopus for indexing the highest number of unique articles. Gasparyan et al. (2016) recommend Scopus and Web of Science as platforms for retrieving and analyzing quality items for most scientific, technical and medical disciplines. Therefore, Scopus and Web of Science were considered necessary and sufficient for covering the relevant literature. Google Scholar was consulted for finding publications not indexed by these platforms.

The methodology is now presented followed by the main results from the literature review.

A descriptive literature review was conducted in January 2018 on the databases Scopus and Web of Science using the search string 'HCI4D' for items published from 2007 to 2017. The review included all publications in English journals and conference proceedings returned in response to the search term. Books were excluded since they were more difficult to access and workshops were excluded due to the variability in format.

- A total of 239 papers which included duplicates were found. Duplicates were then removed to be left with 159 papers.
- A further search for the string 'HCI4D' was done in Google Scholar, which returned 314 items.
- Combining the results from the first search (159) with the results from Google Scholar (314) gave us a total of 473; from this total the duplicates were then removed so 349 items remained for analysis.
- During further analysis 136 papers were removed; these included panels, workshops, editorials, extended abstracts, forums, books, and book chapters.
- A total of 213 English conference or journal papers remained for the in-depth analysis.

The final list is available as, 2007–2017 papers: <https://doi.org/10.25399/UnisaData.12340979.v1>

3.3.2. Extended literature review

In January 2020, a second literature review was done using the same process and criteria specified above but then only for 2017–2019 publications from Scopus and Web of Science. The original set of 295 papers were reduced to 135 by removing duplicates and the publications which were not part of our library subscription and thus had to be bought. The dataset is available as, 2017–2019 papers: <https://doi.org/10.25399/UnisaData.12340730.v1>.

In this case, the analysis was aimed at confirming the relevance of the framework's constructs and adding emerging constructs since 2017. Therefore, the focus was on checking if there were publications in the categories previously identified in response to the domain questions (why, what, who and how) and for publications that warranted the addition of new categories.

3.3.3. Design of the survey

The survey was sent 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 questions on evaluating the framework were part of a larger survey on Southern African HCI4D research, the questions are included as Appendix. There were 20 responses to the survey; identification was optional and from those who chose to provide their email addresses, it could be deduced that all the South African Higher Education Institutions (HEI) offering HCI were presented as well as Namibia and Uganda. The reality is that HCI is not offered at all HEIs and the HCI4D community, being a subset of HCI researchers, is even smaller.

3.3.4. Design of the expert reviews

The survey instrument was designed to assess the relative prevalence or use of the components comprising the framework rather than the framework itself. To ascertain the usefulness, comprehensiveness,

transferability, simplicity and clarity of the framework, it was evaluated by eight ICT4D experts from six different Higher Education Institutions in South Africa. That included four researchers who were double experts, i.e. experts in both ICT4D and HCI4D. The respondents were purposely selected for their expertise in ICT4D, HCI4D or both. They were not involved in any formal or informal relationship with the researchers. Seven of the respondents had doctoral degrees as highest qualification, and one a master's degree. The number of eight reviews was considered adequate since the last two interviews did not add significantly new input thereby indicating data saturation.

4. Research results

This section presents the results according to the *why, what, who and how* dimensions and critically reflects on the findings in terms of previous literature reviews. The selection of the categories was based on the Knowledge Mobilization Framework (Ward, 2017) and the same categories were used in the literature review by Dell and Kumar (2016). This dataset of 2007–2017 papers is available from <https://doi.org/10.25399/UnisaData.12340979.v1>.

4.1. WHERE: geographical distribution of studies

Given the broad view of HCI4D, which covers the technology interactions of marginalized populations, including groups like the elderly, HCI4D research is not confined to specific regions. Furthermore, some studies such as systematic literature reviews are not linked to a specific country and author affiliations (as used to determine the author's country of origin) can change. Despite these limitations, the geographical distribution per continent can provide some insight into where the research has been done during 2007–2017. Figure 2 depicts the publication frequency (number of papers published during this period), most studies (54) were done in Asia. This was followed by Africa (33), Australia (6); North America (5), South America (3), Europe (1) and Eurasia (1). The results for Eurasia and South America could have been influenced by the fact that only English papers were considered.

From observation, the number of studies done per country is not always proportional to the number of first or second authors from that country. This means that much of the research in Asia and Africa is being led by researchers outside those countries. This issue of the Global South being an intellectual playground for ICT4D scholars from the Global North has been raised before. Gitau et al. (2010) highlighted the then almost negligible representation of African researchers in

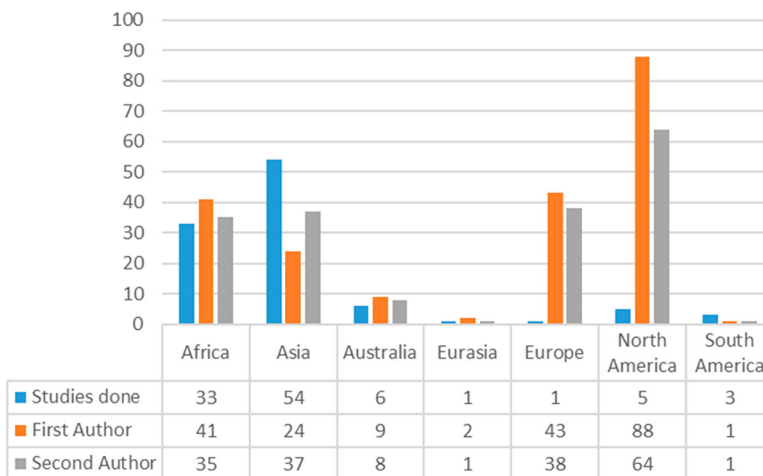


Figure 2. Research location frequency shown in broader geographical areas.

formal academic publications. One of the consequences is that key theories in ICTD could be formed without significant influence by African scholars (Gitau et al., 2010), another consequence is that the indigenous theories from developing countries are not being published. More recently, Bai (2018) studied the role of the Global South countries and the representation of scholars from the Global South in three top-level journals in the area of ICT4D. The study differentiates between core and peripheral countries based on academic knowledge production and found that 21.3% of the countries were simply used as research sites with no indigenous authors publishing in the journals (Bai, 2018). On the other hand, foreign researchers provide much-needed funding (Bai, 2018; Van Biljon & Renaud, 2018) and expertise on how to get published in high-impact journals (Van Biljon & Renaud, 2018). Therefore, the contribution of foreign researchers and the continued need for their involvement should not be underestimated.

4.2. WHO: target users and researcher populations?

Dell and Kumar (2016) provided the most comprehensive framework on HCI4D knowledge available at the time and hence it was used as a point in departure for identifying the analysis categories including the target users and focus areas. They discussed the target users under the categories of *ground-level users* (bottom of the information hierarchy), *human-access points* (individuals who have direct access to the ground-level users); *collective entities* (organizations and communities) and a *general group* (ill-defined and all-inclusive) (Dell & Kumar, 2016). The application of this categorization in our analysis yielded the following:

- Ground-level users: Agricultural community (Farmers) (3), Learners (2); University students (4); Teachers (4); Illiterate, semi-literate (7) Older people (4); Low-income (11); Migrants or Refugees (7); Women (11); Mobile phone users (15); Households (6); Wi-Fi users (2); Patients (4)
- Human-access points: Healthcare workers (19); Microfinance (2); Researchers (12)
- Collective entities: Communities (45); Organizations (13); Citizens (9), Rural (22)
- General: Those papers not matching any of the above (33)

Notably, a paper may involve more than one user population so the number could exceed the number of papers analyzed (213). The findings on the user categorization indicate a substantial

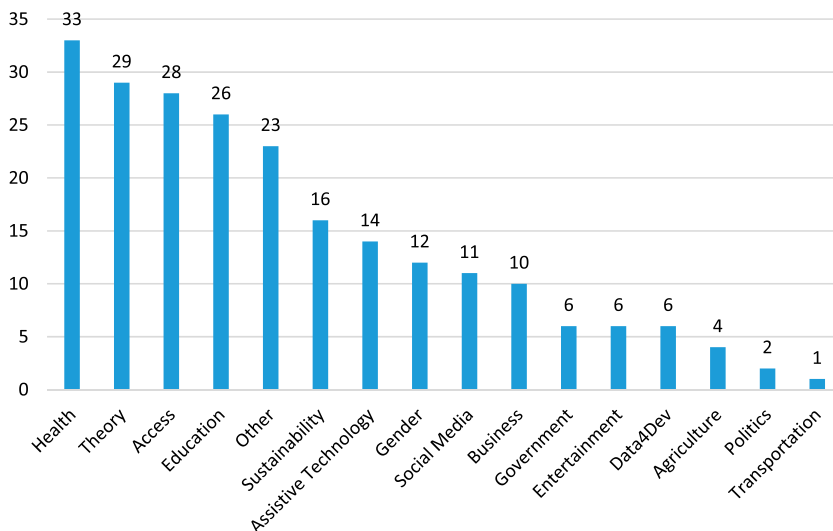


Figure 3. Focus areas: ranking the application domains.

number of papers in each of the categories. This confirms that those categories are relevant in describing the target populations.

4.3. WHY: focus areas

An analysis of the application domains of HCI4D research provides insight into the larger purpose that motivates the researchers (Dell & Kumar, 2016). The work we surveyed covered a wide range of focus areas (see Figure 3). That excludes the 74 papers which stated the application domain as a marginalized *community* or those without any specific domain. It can be observed that the domains of health, education and access, which were previously identified as the most prevalent (Dell & Kumar, 2016) are still well-represented but theory building (including literature reviews) has increased and there is diversification into many new application domains such as Entertainment, Data4Dev, and Transportation. Notably, some papers belong to more than one application domain, for example, the paper on mobile phone (cell phone) charging trials in off-grid Kenya (Wyche & Murphy, 2012) which deals with access and community; therefore the total of the application domains assigned (301) is more than the 213 papers analyzed.

4.4. WHAT: technology and interface

The papers were categorized according to the technologies of Mobile phone (58%), PC/Laptop (24%); DVD/Video (2%); Other (7%); No technology (9%). These categories were not exclusive since a study could involve more than one technology and hence the total number concerning technologies used was 251 where the number of papers analyzed was only 213.

4.5. HOW: research methods

Finally, we analyzed how the research was executed by considering the methodologies used. Previous studies described the methodological approaches as quantitative, qualitative and mixed-methods but did not report on the research design and methods. The histogram of the methodologies found in this research is depicted in Figure 4. The prevalence of design science research and participatory design reflects the constructive (design and implementation) orientation of HCI while the presence of systematic literature reviews and specifically grounded theory is promising in terms of improving the theoretical focus – an aspect in which HCI4D has been lagging (Dell &

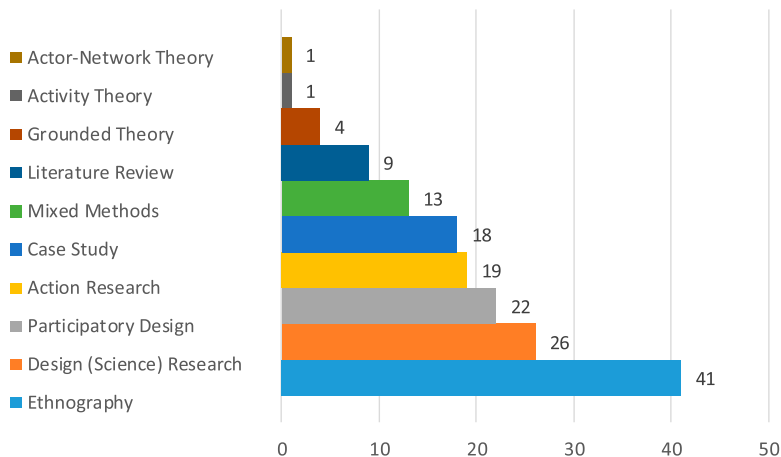


Figure 4. Research methods: comparing the methodologies used in terms of the actual number of studies.

Kumar, 2016). The range of methodologies identified, and the number of mixed-methods studies supports the statement that HCI4D, like HCI, has been able to respect the unique strength of different methodologies and accept diverse epistemological leanings. Only two papers explicitly mentioned the philosophy, namely the papers by Salerno et al. (2015), and Zewge et al. (2015) – and in both cases that was interpretive. However, the focus on *participatory design* and *design science research* suggests pragmatism as a philosophy since the latter is often associated with design-focused research (Hevner, 2007). Critical realism was never mentioned as a philosophy but then, only two papers did explicitly mention a philosophy. The HCI4D focus on real-world problems and commitment to intervention align with the goals of international development. According to Heeks and Wall (2018), critical realism offers two particular types of value for ICT4D research. The first type includes the generic values of critical realism while the second type comprises the goal of realizing international development. The following generic values are associated with critical realism: exposure of context, a contingent causality that reflects real-world ICT4D experiences, legitimization of different stakeholder views and reduction of research bias, and finally support for ICT4D's interventionist approach (Heeks & Wall, 2018).

An analysis of the Mobile for Development Conference papers (2008–2016) revealed that philosophical and theoretical underpinnings were under-reported and the methodologies were not clearly articulated (Van Biljon & Renaud, 2018). However, they contend that the lack of models and frameworks may not necessarily imply a lack of theorization but rather the use of alternative formulations and formats for the contributions – for instance, specifications, standards and guidelines (Van Biljon & Renaud, 2018). Furthermore, in some disciplines like Computer Science, the focus on epistemologies and ontologies are less pronounced and that can affect theorization in multidisciplinary, interdisciplinary or transdisciplinary outputs.

5. Proposing a framework

The findings from this study are summarized in Figure 5. The core constructs are grouped under three clusters namely, *context* which includes constraints, cross-cultural and unique needs, *development* which includes the real-world focus i.e. commitment towards realizing international development goals, in-situ prototyping and sustainability, and *design* which includes user participation, design methods, evaluation methods and technologies. These core constructs originate from the definitions of the term HCI4D as discussed in the literature review and confirmed by the foci of the papers reviewed. Notably, Avgerou (2017), when discussing the central theoretical strands mention foundational theories on *technology*, on *context*, and on socio-economic *development*. In this case, *Design* was used instead of *Technology* to encompass the design of the technology, the intervention and the methodologies related to the technology. The overview of the HCI4D field is summarized by delineating the field in terms of the following dimensions: focus areas (why), the technology and interface (what), the target users and researchers (who) and the research methodologies (how). The recurring themes are based on Toyama (2010) with the addition of *lack of theorization* (Ho et al., 2009); *sustainable development* (Heeks, 2018); *ethical issues* and *participatory design* (Abdelnour-Nocera & Densmore, 2017). Later discourses include user aspirations (Toyama, 2018), choices and capabilities (Kleine, 2009) and postcolonial computing (Irani et al., 2010). According to a more recent study by Bailey and Osei-Bryson (2018), the intersecting concepts of inclusive, sustainable and responsible social innovations in local and global contexts continue to be key focus areas for researchers exploring the development of, access to, and usage of ICTs, by people living in resource-constrained environments. The *context*, *development* and *design* themes are now discussed in more detail.

5.1. Context

This implies an understanding of the unique user needs and culture, expectations and constraints in interacting with the artifact and resonates with the *socially embedded* approach which suggests that

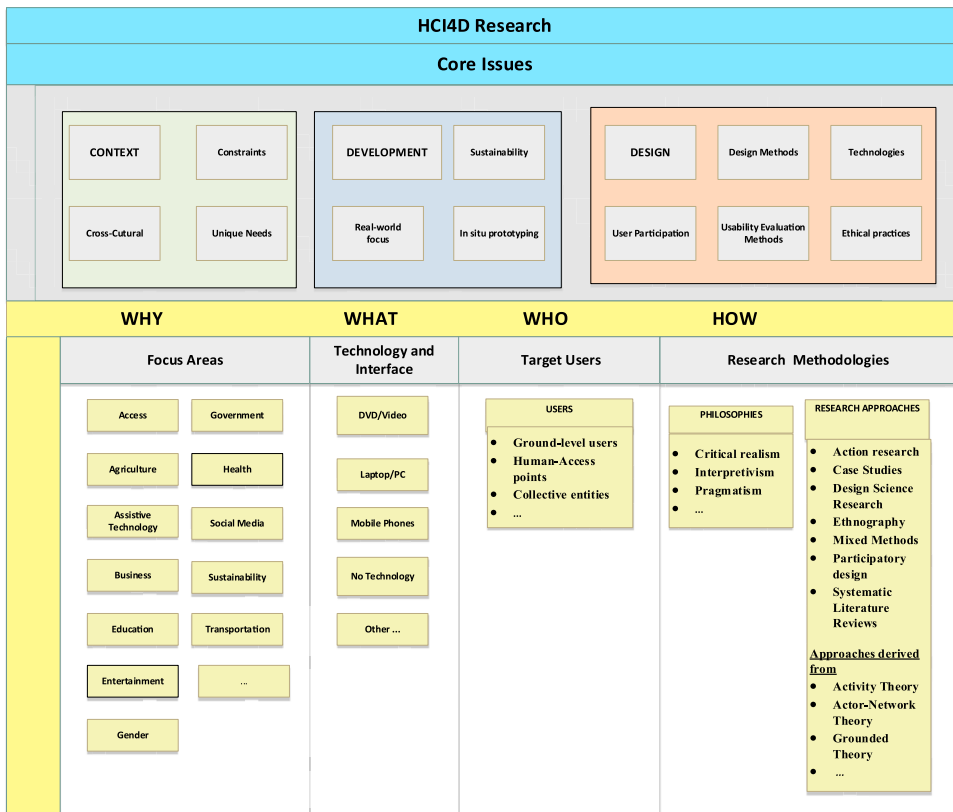


Figure 5. Human-computer interaction for development knowledge mobilization framework (initial).

meaningful impact is only possible when the approach is deeply integrated with the unique needs and practices emerging from the local context (Avgerou, 2008). Contextualization involves two decisions: firstly the choice of conditions and processes in the environment of a focal phenomenon to be studied, and secondly the choice of domains to be researched as the phenomenon’s environment (Avgerou, 2017). In the papers analyzed the individual end-user was mostly the unit of analysis; however, group interactions are considered in some cases. The interpretive philosophy is appropriate for guiding these investigations, which aim to gain in-depth insights about the context. Abstractions such as the Choice framework which operationalizes Sen’s capability approach (Kleine, 2009) have been applied to ensure the validity and rigor of the data capturing. The under-representation of researchers from the countries where the research was conducted (as discussed in section 4.1) is particularly problematic when the goal is to understand and describe the context.

5.2. Development

The fields of ICTD and ICT4D examine the relationship between contemporary ICTs and societal development, that necessitates a deep understanding of both the ICTs and the nature of development (Walsham, 2017). Based on a comparative analysis of development theories in ICTD research from developed and developing countries, (Jonker, 2016) found that Development in ICTD is dominated by ideas from development economics, Keynesian economics, and neoliberal economics (i.e. conventional theories of development – generally), and Sen’s capability approach (focusing on expanding people’s freedoms), new growth theory (focusing on the centrality of the knowledge economy), and the Millenium Development Goals (MDGs) specifically. However, there is a knowledge

gap in the link between ICT intervention and development in the context of developing countries (Sein et al., 2019). Zheng et al. (2018) argue that a broader picture of development should include a better understanding of development processes, their ideological nature, the power structures and driving forces, and the mechanisms through which ICTs may be embedded in and shape these processes. This focus relates to theories conceptualizing development, theories conceptualizing the use of ICT and theories on the transformative processes linking ICT to development (Sein et al., 2019). In this analysis, most papers did not specify any research paradigm. This finding signifies a lack of explicit engagement with research paradigms in HCI4D research. Interpretivism was mentioned twice and that would be appropriate for guiding research into understanding user needs, constraints and the context. However, many HCI4D projects involve ICT related interventions in communities and then the questions of impact and therefore causality arise. Omland and Thapa (2017) propose critical realism as the middle way of universal law (positivism and post-positivism) versus mere understanding (interpretivism) since critical realists argue that the world is socially constructed but not entirely so. Heeks and Wall (2018) concur in supporting ICT4D's interventionist approach for its goal of delivering international development. The real-world focus which necessitates in situ prototyping is fundamental to HCI4D research (Toyama, 2010) and designing for resilience to ensuring sustainability is imperative.

5.3. Design

The aim of iterative design with user participation resonates with the design science research approach which is used to structure the design, implementation and development phases. Based on our literature review, most papers do not explicitly mention the guiding philosophy but given the generally acknowledged commitment to user-centred design and context-awareness, it means reconciling development goals with design constraints and usability. Toyama (2018) highlights the tension between *international development*, which refers to internal traits that require changes in human capital, institutional capacity, mass values, and the *technologist's conception of needs* suggesting solutions that change external context through technological artifacts. Pragmatism provides the flexibility to accommodate data capturing methods compatible with in situ prototyping and evaluation but positivism or interpretivism may be appropriate in guiding parts of usability assessments. Participatory design (or co-design) is a core methodology but user experience and usability constructs including *effectiveness*, *efficiency* and *user satisfaction* are used in the selection of the evaluation methods.

In summary, the keywords *context*, *design* and *development* emerged as core issues when comparing the trends and challenges towards differentiating HCI4D as a research area. The focus on *context*, *design* and *development* is evident in the definition of HCI4D as understanding and designing technologies for under-served, under-resourced, and under-represented populations around the world (Dell & Kumar, 2016) but more specifically in terms of user needs and cross-cultural design (Ho et al., 2009); respecting resource constraints and focusing on practicality when designing digital technology (Toyama, 2010). These core issues are related and any HCI4D paper would probably reference all three. However, if the focus is on the context the research would probably be guided by interpretivism since the aim is to understand the context. A design focus would be guided by pragmatism when the aim is to reconcile design requirements under specific constraints and then interpretivism, positivism (or post-positivism) could guide the evaluating of the artifact. A development focus signals change (Toyama, 2018); change is not an inherent outcome of projects guided by interpretivism, positivism or post-positivism. However, action research and design science research has been linked to pragmatism where those approaches have real-world impact and by implication change, as an outcome. Similarly, Heeks and Wall (2018) highlight the resonance between the generic values associated with critical realism and ICT4D's interventionist approach whereby critical realism has potential value in dealing with the expectations of change. The evaluation of the framework will now be discussed.

6. Evaluation of the conceptual framework

The original framework (depicted in Figure 5) was evaluated in three ways, firstly by applying it to represent survey data from a survey conducted with Southern-African ICT4D researchers, secondly through interviews with experts in the field of ICT4D (four from ICT4D and four from HCI4D, the latter considered as double experts due to their involvement in both HCI and ICT4D). Finally, the components of the framework were evaluated for being up-to-date by considering the findings of a 2017–2019 descriptive literature review.

6.1. Application of the initial knowledge mobilization framework to survey data

The framework was applied to the survey data (on HCI4D researchers in Southern Africa) to see if it was usable and useful. It is important to note that the unit of analysis for developing the original framework was publications (journal and conference papers) while the unit of analysis in the survey was researchers' responses. The group of 20 researchers were disciplinary diverse, having obtained their highest qualification in the fields of Information Systems (28.6%), Computer Science (23.8%), Other (23.8%), Information Technology (19%) and Psychology (4.8). Unfortunately, they were not required to specifically explain their qualification in the category, *Other*.

Figure 6 represents the framework based on the data regarding focus areas, technologies, users and researchers, and research approaches, from the survey. The relevance of all three core issues was confirmed by the fact that all the respondents mentioned those as challenges or suggested related aspects under incentives in response to the open-ended questions (numbers 5 and 6 in Appendix). Arguably, challenges and core issues are not the same, but we found that the respondents provided detailed information on challenges and useful incentives while they were less vocal on identifying the core issues. Therefore, the responses regarding challenges and incentives were included to confirm or reject core issues.

Furthermore, the components under *Context* remained the same. Under *Design* the construct *user participation* was replaced with *user collaboration* to reflect the sentiment that users should be active participants with agency in the design and evaluation process. The domain questions of *why*, *what*, *who* and *how* were applied by considering the relevance of the constructs for this data. As mentioned, there were 20 responses, but the respondents could select more than one option, so the percentages indicate the percentage of the respondents that selected that specific option. For example, the 95% in the bracket next to Education in the HOW (Focus Areas) category means that 19 of the 20 respondents were involved in projects with the aim of improving education within the given context of HCI4D. Considering the WHAT (Technology and Interface) category, 84% of the respondents selected *Smart phones* and 58% selected *Mobile phones*. All the *Smart phones* are *Mobile phones* but the distinction between smart phones and other mobile phones were retained to indicate that there were studies specifically studying older mobile phones. All the focus areas from the general framework were found relevant since they were working in that area and the same applies to the WHAT (technology and interface). Considering the WHO (Researchers) there were no researchers from Information Science and Sociology and therefore those were removed. Obviously, that can change so it is important to remember that the framework provides a snapshot of a specific context. The philosophies proposed in the general framework were all in use, 26% of the respondents selected the option *none of those* and the philosophies *Pragmatism* and *Post-Colonial Feminism* were added. In terms of the research approaches, *Action research*, *Activity theory*, *Actor-network theory* and *Case studies* were not selected and thus removed. It is necessary to distinguish between *case studies* as research methodology and the *practice of studying specific cases*, which would reside under User studies. *Design and interactive prototyping* seem very similar to *Participatory design*, but the latter does not necessarily involve implementation and therefore the distinction remains useful even if many of the respondents used both methodologies. No respondent selected Design Science research but that could be due to the use of different terminologies. Notably, 63% were involved in *Design and*

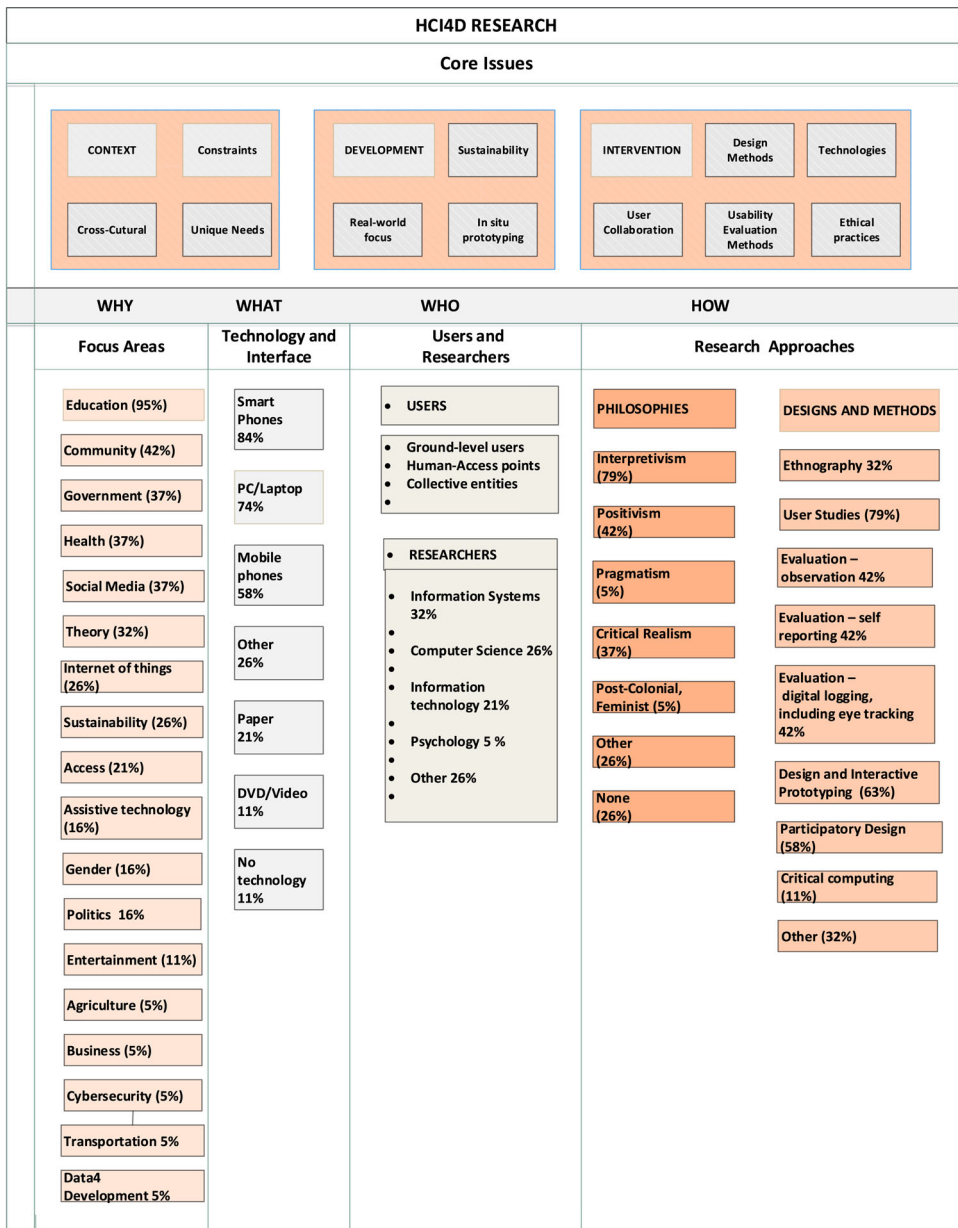


Figure 6. Knowledge mobilization framework applied to Southern African HCI4D researchers.

interactive prototyping. This gap could be an opportunity for those researchers to consider Design Science in extending their research oeuvre and accessing new opportunities. Literature reviews and mixed methods were not selected and hence removed as core methods used by this community.

6.2. Expert evaluation

To ascertain the usefulness, comprehensiveness, transferability, simplicity and clarity of the initial framework (Figure 5) and its potential for representing specific contexts (as demonstrated in Figure 6), it was evaluated by eight ICT4D experts. That included four people who were double experts, i.e.

experts in both ICT4D and HCI4D. The correctness of the framework depended on the survey data and thus that could not be evaluated heuristically. Their responses are now discussed according to their responses to the following interview questions.

Uses of the Framework for HCI4D research: Towards assessing the perceived use and usefulness of the Framework, the respondents were asked to state their view on the use for this framework in terms of HCI4D research. All respondents deemed the framework to be useful in presenting an overview of the HCI4D research done in the past 11 years. Respondents 3 and 5 mentioned that the research could also be useful in identifying gaps in the literature in terms of the focus areas investigated, the technologies and the users involved in the research. Furthermore, the philosophies and research approaches represented could signify epistemological and methodological gaps in the research landscape. Respondent #5 found the focus on HCI4D embedded in the ICT4D research field useful and noted the focus on evaluation as a strength that HCI4D brings to ICT4D. Respondent #3 mentioned the value in overcoming ‘pilotitis’ (isolated, projects of limited scope, duration and impact) by identifying core issues and domain questions that could suggest opportunities and connections towards linking research, practice and policy outcomes thereby improving resilience and sustainability. Respondents #3 and #7 observed that the diagram would be especially useful for post-graduate students trying to identify research questions and contextualize their study.

The HCI4D knowledge mobilization framework is illustrative rather than prescriptive and not presented as an objective perspective through which observers can perceive unbiased reality. The value will be based on the usefulness as perceived by researchers and practitioners interested in HCI4D. However, towards some substantive evaluation of HCI4D_KMF as an information systems artifact, it is necessary to consider the relevant criteria. Pfeiffer and Niehaves (2005) mention criteria for methods and models but none for frameworks. Considering the goal of knowledge mobilization, both sets of criteria were considered applicable. However, in terms of an evaluation with experts, the following were selected as most useful: comprehensiveness, appropriateness (for mobilizing knowledge) and simplicity (economic efficiency) and clarity. The experts were thus asked to comment on the following aspects of the framework:

6.2.1. Comprehensiveness

All the respondents found the framework comprehensive although there is no claim that the model is complete. Respondent #3 mentioned that the USER under the HOW column has not been unpacked for the specific context. Furthermore, users (referring to the users of the technology) could be extended to the users of the research which would include government and industry when considering policy. Respondent #5 suggested that *Tablets* should be added to *Mobile phones*, even though most research was still being done with phones the design evolution was blurring the distinction between phones and tablets. Respondent #3 mentioned that adding definitions of the core issues as defined for the specific context would be useful. Respondents #3 suggested adding *problem solving* as a core concept, while respondent #4 suggested adding *innovation*. Respondents #2, 3, 5 suggested adding a core issue to represent the *contribution*, *innovation*, and *problem solved* aspect. That was resolved by adding the construct *development outcome* in line with the *Development outcomes* category in the ICT4D typology (Qureshi, 2015).

6.2.2. Transferability to other ICT4D application areas or other HCI4D regions

Given the grounding in the set of global HCI4D papers, the respondents (#1, 2, 4–8) argued that the core framework would theoretically be transferable to any other HCI4D research area, but it should be adapted by considering local information as was done for the Southern-African researchers. Respondent #6 argued that it should also be transferable to specific research domains in ICTD such as Health and Education with minor adjustments.

6.2.3. Simplicity

Generally, the framework was considered simple enough for the purpose of presenting an overview of HCI4D research. The only redundancy identified was *Smart Phones* and *Mobile Phones* in the WHAT column. Given the continued technological development, Respondent 1# suggested that *Mobile Phones* be used to represent all phones. Respondent #2 suggested that more of the philosophies and research approaches should be incorporated under *Other* to simplify it, and that *Other should be added to the WHY column*. Respondent #6 argued that further simplification could damage the holistic view.

6.2.4. Clarity

Respondent #3 observed that the representation implied equal weights for all the Core Issue components. However, the researcher's intention was to present the underlined, bolded components (e.g. Context) as the main issue with the other components as sub-issues related to the main issue. Respondent #2 mentioned that the representation did not suggest any relationship between the main or sub-components in the three different blocks. Respondent #2 and Respondent #6 suggested adding a description of the terms, specifically for the core issues.

Additional comments: The following are highlighted since they motivated changes in the diagram, confirmed the correctness of some aspects of the framework or are retained for future resolution. Respondent #1 mentioned that the constructs in the 'Design' block seemed more related to the intervention, i.e. the implementation of the research which involves but also exceeds the design phase. Respondent #7 disagreed, stating that 'Design' is a core and irreplaceable construct. Respondent #4 mentioned the need to include problem solving while Respondent #2 suggested including the contribution to development as an 'innovation' under Design, that was then represented by the *Development outcomes* under Development. Respondent #5 confirmed the importance of research in Education and that it made sense in the developing country context where digital skills development remains relevant discourses in ICT4D, especially given the discourse on the Fourth Industrial Revolution.

6.3. Extended literature review

As noted, the analysis of the 2017–2019 papers was aimed at getting the framework up-to-date by adding new items and it also served to confirm the continued relevance of the core issues and the items listed in response to the domain questions – why, what, who and how? The findings from the 2020 literature review confirmed all the focus areas in [Figure 6](#) (based on finding a minimum of two papers published in the three-year period). Entertainment was the exception, but it was retained since the focus is on comprehensiveness. The following additional focus areas were added to the updated framework ([Figure 8](#)): Environment, Ethics, Games, Finance (including mobile money) and Migrations. The technology and interface categories, target users and research methodologies are more stable, and no categories were considered for addition or removal based on this review. The keywords for these papers were extracted; the terms HCI4D, ICT4D and HCI as well as common English words were removed and then the results for the following categories were combined: education with teaching and learning; privacy with security.

The keyword frequencies (for items above 4) are depicted in [Figure 7](#). While acknowledging the limitations of keyword selection for representing content, it does provide an indication of what the authors considered to be important issues. Clearly, *design* (30) remains a core theme. The terms *mobile*, *rural*, *social*, and *informal* can be related to *context*. In comparison, the term *development* (7) is not mentioned that often but it remains a core purpose of the publications and therefore *context*, *development* and *design* remain the proposed HCI4D *motor themes* (see Quadrant 1 in [Figure 1](#)). The term *mobile* occurred frequently and there may be an argument for that becoming a motor theme, but it was considered as a qualifier, as in *mobile phone* rather than an emerging theme. In

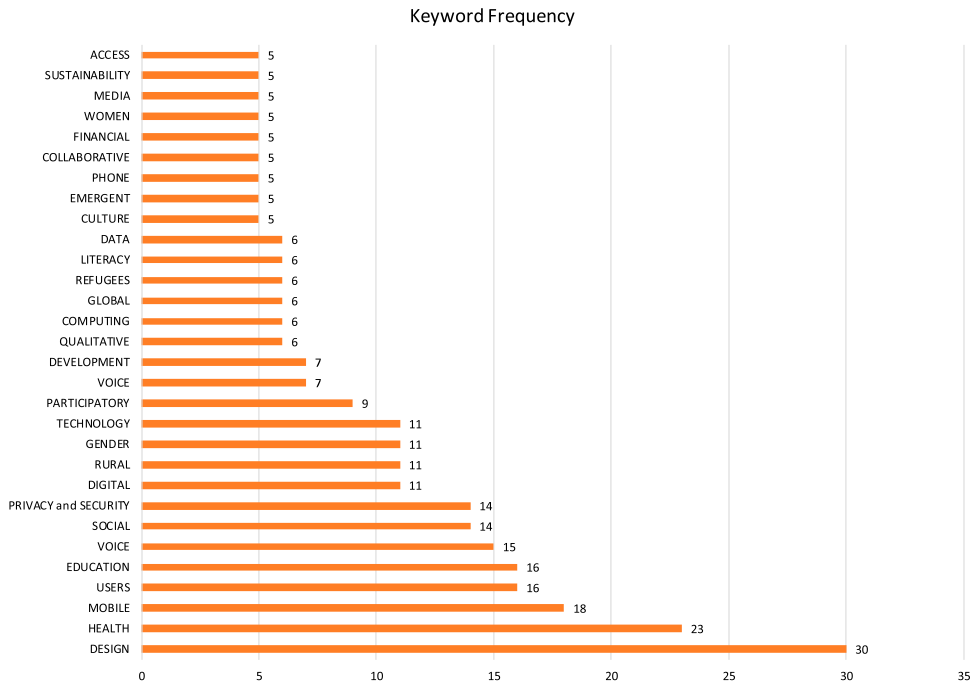


Figure 7. Keyword frequency in literature review 2017–2019.

terms of focus areas, *health and education* remain most prevalent with *voice, social, privacy and security, gender, refugees, data and financial*, emerging as prominent focus areas.

India (25) was prevalent in terms of countries represented with Pakistan (6) and Bangladesh (6) in second place. However, the country names were removed since it is possible that differing titling practices can influence the keywords. Notably, Kou et al. (2018) found strikingly different patterns of titling between studies of Western and non-Western countries, those differences were found in whether and how country names are mentioned in titles and the precision when describing study contexts.

6.4. Final HCI4D framework

Based on the feedback from the expert evaluation and the second literature review the applied framework (Figure 6) was updated to the final *HCI4D Knowledge Mobilization Framework (HCI4D_KMF)* as depicted in Figure 8. There are countless design decisions involved in naming and relating aspects of research methodologies that lie beyond the scope of this paper. However, towards standardization and explanation of the meaning of the methodological components (HOW), the Semantic Web and Research Methodology Wiki (SWARM, 2019) was used as a frame of reference.

6.5. Limitations

This section discusses the trade-offs and consequences of the research design decisions which could have affected the relevance and rigor of the findings. Those are presented by considering the literature reviews, survey, expert evaluation the framework development.

Literature reviews: The choice of the term ‘HCI4D’ for the keyword search limits the results by possibly excluding relevant studies. Furthermore, the term may have been used more in certain regions and thus that could influence the selection of the results. On the other hand, the term provides a clear

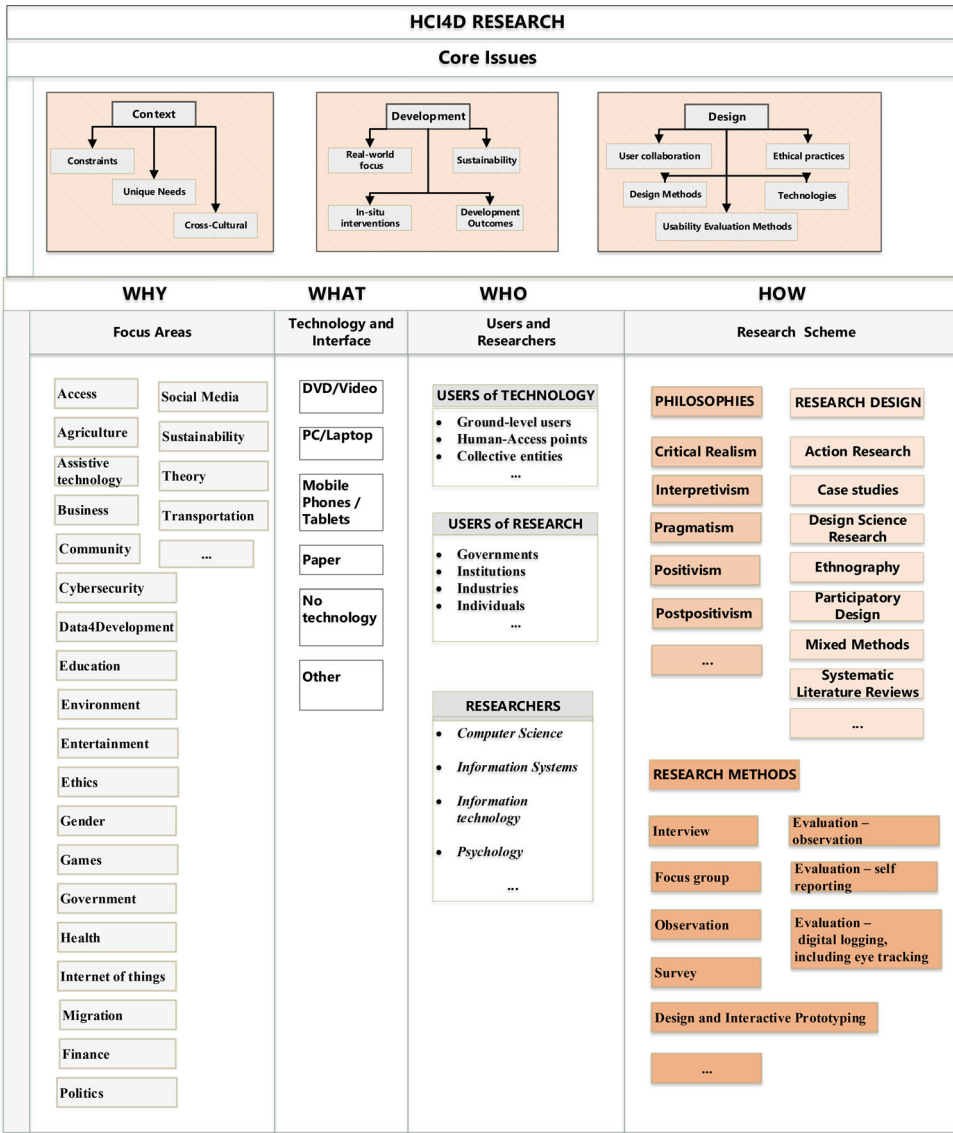


Figure 8. HCI4D knowledge mobilization framework (HCI4D_KMF).

focus as a point of departure. The model was developed over a period of 3 years, starting with the data capturing in 2018 and the publication of the first version at the *GlobDev* Workshop at the end of 2018. In 2019 the survey and expert evaluations were done, and the model was updated accordingly. In 2020, the literature review conducted in 2018 was not up-to-date anymore. The second descriptive literature review was done to cover the 2017–2019 publications. Therefore, the literature is considered in terms of two overlapping sets (2007–2017) and (2017–2019) rather than one comprehensive set of 2017–2019 publications. This can be considered a limitation, but it reflects the development phases. Despite the authors best intentions of following a clear and rigorous literature review process there is subjectivity and human error involved in classifying publications in application areas. However, the triangulation of the findings from four the research activities and the consecutive evaluations should improve the overall rigor of the findings and prevent critical flaws in the framework.

Survey: The small number of 20 respondents is a limitation but that number covers more than 50% of the active researchers in the region (based on HCI4D publications). However, further research in bigger regions with larger numbers of researchers are needed to do a quantitative evaluation of the framework.

Expert evaluation: The framework was evaluated with academic researchers only. That demonstrated acceptance from the academic audience, but the framework needs to be presented to politicians, practitioners and government in future research.

Framework development: Considering the level of detail, the framework could be refined in more detail applying an ICT4D research typology as proposed by Qureshi (2015) which includes the level, unit of analysis and indicators, type, ICT use and development outcomes, this framework included only development outcomes. The motor themes to describe the core issues and domain questions in HCI4D were identified from the literature, their relevance was evaluated during the survey and the expert evaluation and confirmed by the second survey. However, the centrality and density of the core issues were not investigated quantitatively, for example by considering citation counts. Furthermore, the core issues are time and context dependent so the items listed in response to the domain questions may change as the challenges and discourses change over time. The visual presentation of the framework highlights the boundaries and the incompleteness of the knowledge elements. However, any theorization of the HCI4D landscape would have to deal with these complexities. Focusing on the limitations of the representation rather than the potential for integration and synthesis may be one of the reasons for the current lack of a holistic representation. Therefore, this HCI4D_KMF is proposed as a point of departure in positioning HCI4D research as a landscape where different philosophies and methodologies may need to be combined to meet the needs of multi-, inter- and transdisciplinary projects.

6.6. Contributions

First, the paper provides a concise, *high-level overview of HCI4D research* that enables readers to take stock of the current state of HCI4D and how the body of work has developed since 2007. Specifically, this study builds on existing literature by following the idea of a conceptual map (Ho et al., 2009) and then use the dimensions proposed by Dell and Kumar (2016) to structure the systematic literature review conducted. Second, the findings from the extensive literature survey are presented as a *knowledge mobilization framework* (HCI4D_KMF) in response to the fundamental domain questions. That is significant since the response to the fundamental domain questions can form the basis of a theory (Gregor, 2006). The framework is proposed as a point of departure in generalizing and integrating the reflections towards descriptive theorization.

On a practical level, the framework can be used as a point of departure towards a holistic view for multi-disciplinary teams developing theoretical explanations about phenomena in the world where the application domain is the integrated design, development and iterative evaluation of (digital) artifacts for development. ICT4D research can be enriched by the approaches to design, and the body of methodologies, specifically the evaluation methodologies from HCI (and by extension, HCI4D). This could address the issue of *research silos* for both aspiring and seasoned HCI researchers towards an improved understanding of how their work can connect with existing research and methodologies.

Bailey and Osei-Bryson (2018) consider the ability of stakeholders in development initiatives to *collaboratively* and effectively design, implement and evaluate innovations that will be adopted and utilized within specific development contexts and environments as key elements towards sustainable development. This collaboration requires some conceptual agreement on the core issues and the domain questions and thus the proposed HCI4D_KMF could be useful as a point of departure when considering sustainable HCI4D projects. Despite significant differences between HCI and HCI4D, both communities have the capacity for reflection and self-critique (Toyama, 2010) and this study will hopefully build on that tradition. Another contribution is to provide new HCI and ICT4D researchers with a visual overview of the research landscape, particularly those whose primary

domain may be outside of HCI4D research. The references lists are available, the abstracted data for 2007–2017 is available from <https://doi.org/10.25399/UnisaData.12340979.v1> and the methodology has been recorded to make the study more replicable than the previous literature studies in HCI4D.

7. Conclusion

This paper is a response to the challenge of presenting a holistic overview of the HCI4D research domain which is needed for multi, inter- and transdisciplinary research. The findings from a descriptive literature review (2007–2017 papers) were integrated and synthesized to present a knowledge mobilization framework, a theorization to be interrogated and critiqued towards presenting the sub-domains in HCI4D research as well as the salient philosophical and methodological bases. The framework was applied to data gathered on Southern HCI4D researchers to demonstrate the use and usefulness in representing the knowledge about a specific research community. The applied framework was then evaluated by expert reviewers and their input was used to refine the initial framework, a second descriptive literature review (2017–2019 papers) was done to update the model. The refined knowledge mobilization framework is the main contribution of the study. Acknowledging the continued growth and diversification in the field, the HCI4D knowledge mobilization framework is proposed as a non-prescriptive point of departure for verification and further research in studying the use of technology for development.

Acknowledgements

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 number 98564). I acknowledge the feedback from the reviewers and the comments from respondents at the 11th Annual Pre-ICIS SIG GlobDev Workshop, San Francisco, USA, held on 13 December 2018, whose critique and suggestion for future work informed this paper. I also acknowledge the reviewers whose contributions fundamentally transformed this paper.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

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 number 98564].

Notes on contributor

Judy van Biljon is a professor of Information Systems and holds the South African Research Chair's Initiative, Chair in Information and Communication for Development hosted by the School of Computing at the University of South Africa.

ORCID

Judy van Biljon  <http://orcid.org/0000-0002-4646-1641>

References

- Abdelnour-Nocera, J., & Densmore, M. (2017). A review of perspectives and challenges for international development in information and communication technologies. *Annals of the International Communication Association*, 41, 250–257. <https://doi.org/10.1080/23808985.2017.1392252>
- Abdelnour-Nocera, J., & Rangaswamy, N. (2018). Reflecting on the design-culture connection in HCI and HCI4D. *Interactions*, 25, 8–9. <https://doi.org/10.1145/3264381>

- Avgerou, C. (2008). Information systems in developing countries: A critical research review. *Journal of Information Technology*, 23, 133–146.
- Avgerou, C. (2017). Theoretical framing of ICT4D research. In *IFIP advances in information and communication technology* (Vol. 504, pp. 10–23). Springer. https://doi.org/10.1007/978-3-319-59111-7_2
- Bai, Y. (2018). Has the global south become a playground for western scholars in information and communication technologies. *Scientometrics*, 116, 2139–2153. <https://doi.org/10.1007/s11192-018-2839-y>
- Bailey, A., & Osei-Bryson, K.-M. (2018). Contextual reflections on innovations in an interconnected world: Theoretical lenses and practical considerations in ICT4D. *Information Technology for Development*, 1102, 423–428. <https://doi.org/10.1080/02681102.2018.1499202>
- Best, M. L. M. (2010). Understanding our knowledge gaps: Or, do we have an ICT4D field? And do we want one? *Information Technologies & International Development*, 6, 49–52. <http://itidjournal.org/index.php/itid/article/download/622/262>
- Bødker, S. (2015). Third-wave HCI, 10 years later -participation and sharing. *Interactions*, 22, 24–31. <https://doi.org/10.1145/2804405>
- Boell, S. K., & Cecez-Kecmanovic, D. (2015). On being 'systematic' in literature reviews. In *Formulating research methods for information systems* (Vol. 2, pp. 48–78). https://doi.org/10.1057/9781137509888_3
- Bramer, W. M., de Jonge, G. B., Rethlefsen, M. L., Mast, F., & Kleijnen, J. (2018). A systematic approach to searching: An efficient and complete method to develop literature searches. *Journal of the Medical Library Association*, 106, 531–541. <https://doi.org/10.5195/jmla.2018.283>
- Burrell, J., & Toyama, K. (2009). What constitutes good ICTD research? *Information Technologies and International Development*, 5, 82–94. <https://doi.org/10.1038/nm1110-1198>
- Cavacini, A. (2015). What is the best database for computer science journal articles? *Scientometrics*, 102, 2059–2071. <https://doi.org/10.1007/s11192-014-1506-1>
- Chetty, M., & Grinter, R. E. (2007). HCI4D: HCI challenges in the global south. *CHI '07 extended abstracts on human factors in computing systems (CHI EA '07)* (pp. 2327–2332). Association for Computing Machinery.
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Sage.
- Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research* (2nd ed.). SAGE.
- Crilly, T., Jashapara, A., & Ferlie, E. (2010). *Knowledge mobilisation: A scoping review of the literature report for the National Institute for Health Research Service Delivery and organisation programme – SDO project (08/1801/220) research*.
- Dell, N., & Kumar, N. (2016). The ins and outs of HCI for development. *Proceedings of the 2016 CHI conference on human factors in computing systems – CHI '16* (pp. 2220–2232). <https://doi.org/10.1145/2858036.2858081>
- Feilzer, M. Y. (2010). Doing mixed methods research pragmatically: Implications for the rediscovery of pragmatism as a research paradigm. *Journal of Mixed Methods Research*, 4, 6–16. <https://doi.org/10.1177/1558689809349691>
- Flor, A. G. (2018). Knowledge management for development (KM4D). In *Encyclopedia of information science and technology* (pp. 5077–5084). IGI Global.
- Gasparyan, A. Y., Yessirkepov, M., Voronov, A. A., Trukhachev, V. I., Kostyukova, E. I., Gerasimov, A. N., & Kitas, G. D. (2016). Specialist bibliographic databases. *Korean Academy of Medical Sciences*, 31, 660–673. <https://doi.org/10.3346/jkms.2016.31.5.660>
- Gitau, S., Plantinga, P., & Diga, K. (2010). *ICTD research by Africans: Origins, interests and impact*. Fourth international conference on information and communication technologies and development (ICTD 2010), London, 12–16 December 2010.
- Grant, M. J., & Booth, A. (2009). A typology of reviews: An analysis of 14 review types and associated methodologies. *Health Information and Libraries Journal*, 26, 91–108. <https://doi.org/10.1111/j.1471-1842.2009.00848.x>
- Gregor, S. (2006). The nature of theory in information systems. *MIS Quarterly: Management Information Systems*, 30, 611–642. <https://doi.org/10.2307/25148742>
- Heeks, R. (2018). *Information and communication technology for development (ICT4D)*. Routledge. <https://doi.org/10.4324/9781315652603>
- Heeks, R., & Wall, P. J. (2018). Critical realism and ICT4D research. *The Electronic Journal of Information Systems in Developing Countries*, 84(6), Article e12051. <https://doi.org/10.1002/isd2.12051>
- Hering, J. G. (2016). Do we need 'more research' or better implementation through knowledge brokering? *Sustainability Science*, 11, 363–369. <https://doi.org/10.1007/s11625-015-0314-8>
- Hevner, A. R. (2007). A three cycle view of design science research. *Scandinavian Journal of Information Systems*, 19(2), 4.
- Ho, M. R., Smyth, T. N., Kam, M., & Dearden, A. (2009). Human-computer Interaction for development: The past, present, and future. *Information Technologies & International Development*, 5, 1–18.
- Irani, L., Vertesi, J., Dourish, P., Philip, K., & Grinter, R. E. (2010). Postcolonial computing: A lens on design and development. *Proceedings of the 28th international conference on human factors in computing systems – CHI '10* (p. 1311). <https://doi.org/10.1145/1753326.1753522>
- Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research*, 1, 112–133. <https://doi.org/10.1177/1558689806298224>
- Jonker, J. W. (2016). *A comparative analysis of development theories in ICTD research from developed and developing countries*. Master of Arts (Socio-Informatics), Faculty of Arts and Social Sciences, Stellenbosch University. <http://ir.nrf.ac.za/handle/10907/910>

- Kelly, P. R. (2018). An activity theory study of data, knowledge, and power in the design of an international development NGO impact evaluation. *Information Systems Journal*, 28, 465–488. <https://doi.org/10.1111/isj.12187>
- Kitchenham, B., Pearl Brereton, O., Budgen, D., Turner, M., Bailey, J., & Linkman, S. (2009). Systematic literature reviews in software engineering – a systematic literature review. *Information and Software Technology*, 51, 7–15. <https://doi.org/10.1016/j.infsof.2008.09.009>
- Kleine, D. (2009). ICT4 what? Using the choice framework to operationalise the capability approach to development. 2009 *international conference on information and communication technologies and development (ICTD)* (pp. 108–117). IEEE.
- Kou, Y., Gray, C. M., & Nardi, B. (2018). The politics of titling: The representation of countries in CHI papers. *The Politics of titling: The representation of countries in CHI papers*. ACM. <https://doi.org/10.1145/3170427.3188409>
- Levin, B. (2011). Mobilising research knowledge in education. *London Review of Education*, 9, 15–26. <https://doi.org/10.1080/14748460.2011.550431>
- Loudon, M., & Rivett, U. (2013). Enacting openness in ICT4D research. In *Open development: Networked innovations in international development* (pp. 53–78). MIT Press.
- Malin, J. R., & Paralkar, V. K. (2017). Educational knowledge brokerage and mobilization: The Marshall memo case. *International Journal of Education Policy and Leadership*, 12(7). <https://doi.org/10.22230/ijep.2017v12n7a790>
- Mingers, J. (2004). Realizing information systems: Critical realism as an underpinning philosophy for information systems. *Information and Organization*, 14(2), 87–103.
- Okoli, C., & Schabram, K. (2010). Working papers on information systems a guide to conducting a systematic literature review of information systems research. *Working Papers on Information Systems*, 10. <https://doi.org/10.2139/ssrn.1954824>
- Omland, H. O., & Thapa, D. (2017). Methodological approach for identifying mechanisms in ICT4D: A critical realism perspective. *IFIP AICT*, 504, 182–193. <https://doi.org/10.1007/978-3-319-59111-7>
- Oulasvirta, A., & Hornbæk, K. (2016, May 7–12). HCI research as problem – solving. *CHI'16* (pp. 4956–4967). ACM.
- Paré, G., Trudel, M. C., Jaana, M., & Kitsiou, S. (2015). Synthesizing information systems knowledge: A typology of literature reviews. *Information and Management*, 52, 183–199. <https://doi.org/10.1016/j.im.2014.08.008>
- Pfeiffer, D., & Niehaves, B. (2005). Evaluation of conceptual models – a structuralist approach. *Proceedings of the 13th European conference on information systems, information systems in a rapidly changing economy, ECIS 2005* (pp. 43). <http://aisel.aisnet.org/ecis2005/43>
- Phipps, D. J., & Shapson, S. (2009). Knowledge mobilisation builds local research collaborations for social innovation. *Evidence & Policy: A Journal of Research, Debate and Practice*, 5(3), 211–227.
- Preto, G., & Curró, G. (2017). An approach for doctoral students conducting context-specific review of literature in IT, ICT, and educational technology. *New Review of Academic Librarianship*, 23, 60–83. <https://doi.org/10.1080/13614533.2016.1227861>
- Qureshi, S. (2015). Are we making a better world with information and communication technology for development (ICT4D) research? Findings from the field and theory building. *Information Technology for Development*, 21, 511–522. <https://doi.org/10.1080/02681102.2015.1080428>
- Qureshi, S., & Xiong, J. J. (2017). Understanding the role of information technology in the development of micro-enterprises: Concepts to study in making a better world. *Proceedings of the 50th Hawaii international conference on system sciences* (pp. 2627–2636). University of Nebraska Omaha.
- Reeves, S. (2015). Locating the ‘big hole’ in HCI research. *Interactions*, 22, 53–56. <https://doi.org/10.1145/2785986>
- Renken, J., & Heeks, R. (2018). Social network analysis and ICT4D research: Principles, relevance, and practice. *The Electronic Journal of Information Systems in Developing Countries (EJISDC)*, 84(4), 1–13. <https://doi.org/10.1002/isd.12036>
- Rogers, Y. (2012). HCI theory: Classical, modern and contemporary. *Synthesis Lectures on Human-Centered Informatics*, 5, 1–120.
- Salerno, C., Ouma, S., & Botha, A. (2015). Developing a conceptual model for facilitating the issuing of digital badges in a resource constrained environment. *Proceedings of the 2015 annual research conference on South African Institute of Computer Scientists and Information Technologists – SAICSIT '15* (pp. 1–8). <https://doi.org/10.1145/2815782.2815822>.
- Sein, M. K., Thapa, D., Hatakka, M., & Sæbø, Ø. (2019). A holistic perspective on the theoretical foundations for ICT4D research. *Information Technology for Development*, 25(1), 7–25. <https://doi.org/10.1080/02681102.2018.1503589>
- SWARM. (2019). Sematic web and research methodology wiki. http://eagle.unisa.ac.za/mediawiki/index.php/Semantic_Web_and_Research_Methodology
- Toyama, K. (2010). Human–computer interaction and global development. *Foundations and Trends in Human–Computer Interaction*, 4, 1–79. <https://doi.org/10.1561/11000000021>
- Toyama, K. (2018). From needs to aspirations in information technology for development. *Information Technology for Development*, 24, 15–36. <https://doi.org/10.1080/02681102.2017.1310713>
- Van Biljon, J., & Alexander, T. (2015). A conceptual framework for ICT4D. In J. Steyn & D. van Greunen (Eds.), *ICTs for inclusive communities in developing societies* (pp. 84–106). Cambridge Scholars Publishing.
- Van Biljon, J., & Renaud, K. (2016). Validating mobile phone design guidelines: Focusing on the elderly in a developing country. *Proceedings of the annual conference of the South African Institute of Computer Scientists and Information Technologists* (pp. 1–10). ACM.

- Van Biljon, J., & Renaud, K. (2018). Reflections on the maturity of the mobile communication technology for development (M4D) landscape: 2008-2016. In R. Baguma & J. S. Pettersson (Eds.), *Proceedings of the 6th international conference on M4D mobile communication technology for development* (pp. 7–18). Karlstads universitet.
- Walsham, G. (2006). Doing interpretive research. *European Journal of Information Systems*, 15, 320–330. <https://doi.org/10.1057/palgrave.ejis.3000589>
- Walsham, G. (2017). ICT4D research: Reflections on history and future agenda. *Information Technology for Development*, 1–24. <https://doi.org/10.1080/02681102.2016.1246406>
- Ward, V. (2017). Why, whose, what and how? A framework for knowledge mobilisers. *Evidence & Policy*. <https://doi.org/10.1332/174426416X14634763278725>
- Ward, V., House, A., & Hamer, S. (2009). Developing a framework for transferring knowledge into action: A thematic analysis of the literature. *Journal of Health Services Research & Policy* y, 14, 156–164. <https://doi.org/10.1258/jhsrp.2009.008120>
- Wyche, S. P., & Murphy, L. L. (2012). “Dead China – make” Phones off the grid: Investigating and designing for mobile phone use in rural Africa. *Proceedings of the designing interactive systems conference* (pp. 186–195). <https://doi.org/10.1145/2317956.2317985>
- Zewge, A., Dittrich, Y., & Bekele, R. (2015). Adapting participatory design to design information system with rural Ethiopian community. *AFRICON, 2015* (pp. 1–5). IEEE.
- Zheng, Y., Hatakka, M., Sahay, S., & Andersson, A. (2018). Conceptualizing development in information and communication technology for development (ICT4D). *Information Technology for Development*, 1–14. <https://doi.org/10.1080/02681102.2017.1396020>

Appendix

The responses to the following questions were selected as relevant to the framework evaluation. The full survey can be found at <https://goo.gl/53XBsd>:

	Question in survey	Responses
1	The discipline where you obtained your highest qualification:	Computer Science; Information Systems; Psychology; Information Technology; Other
2	Philosophies used in your research (choose as many as apply):	Interpretive; Positivist or Post-Positivist; Critical realist; None actively taught or promoted; None explicitly used; Other
3	Research methodologies (choose as many as apply):	Ethnography; User studies (needs and context) using qualitative research methods; Participatory design; Design and iterative prototyping; Evaluation – self reporting; Evaluation – digital logging, including eye tracking; Evaluation – observation; Critical computing; Other
4	Technologies on which your research focuses (choose as many as apply):	Mobile phone (Basic of feature phone); Smartphone; PC or Laptop; DVD or Video; Paper Other; None
5	In your opinion, what are the grand challenges of HCI4D in Southern Africa.	Your answer: ...
6	What initiatives do you see as useful in promoting HCI4D in Southern Africa?	Your answer: ...
7	Research domains where you are active (choose as many as apply):	Education; Health; Agriculture Business; Government; Entertainment; Cybersecurity; Transportation; Social Media; Robotics; Sustainability; Gender; Assistive Technology; Environment; Theory; Data4Development; Access; Politics; Community; Internet Of Things; Other