

Don Rodney Junio  
Cecile Koopman (Eds.)

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# Evolving Perspectives on ICTs in Global Souths

11th International Development  
Informatics Association Conference, IDIA 2020  
Macau, China, March 25–27, 2020  
Proceedings



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# Preface

Welcome to the proceedings of the 11th International Development Informatics Association (IDIA 2020) which took place during March 25–27, 2020. The conference was organized under the theme “The more things change...” Following this aphorism, we wanted IDIA 2020 to be a venue for reflection on how scholarship and practice in the Information and Communications Technology for Development (ICT4D) space have evolved over the years noting fundamental shifts and stasis in the way the field is construed not only in, but also for, and by the Global Souths.

For three days, sessions were organized along four themes: (i) ICT4D: taking stock; (ii) Harnessing frontier technologies for sustainable development; (iii) ICT4D discourse, methodologies, and theoretical reflections; and (iv) the evolving global souths. Across these sessions, authors and participants were invited to discuss empirical research that examined (old and new) ways ICT4D projects have made a difference in various measures of outcomes; critically reflect on theoretical and practical formulations on issues around ICT4D; and re-examine formulations and reformulations of the notion of “global south” within the ICT4D discourse among many other topics.

IDIA 2020 received 43 paper submissions from more than 10 countries across 5 continents. Each paper underwent a double-blind peer review by at least three members of our Technical Program Committee (TPC), which consisted of international ICT4D experts. Members of the TPC provided comprehensive reviews, and authors had to submit updated versions of their submission before final decisions were made about the paper’s acceptance. Meta reviewers were also assigned to consolidate reviews on specific papers in cases where there were notable discrepancies between the reports of the different reviewers. After this rigorous review process, 14 papers were accepted and included in this volume representing an overall acceptance rate of 33%.

IDIA 2020 took place against the backdrop of a global health pandemic. When it was no longer tenable to host the conference in-person, the Organizing Committee took the decision to transition the event to a virtual format. Despite the challenges involved in running an event in a setup unfamiliar to many of us, we embraced the new format as it allowed us to reach a wider audience among many other things. More importantly, the virtual format gave us a chance to re-imagine a new system to run a conference.

This brings us back to the theme of the conference on how the more things change the more *seemingly* they stay the same. As demonstrated by our shift to a new conference format and the depth and breadth of scholarship of the papers included in this volume, there is scope to move beyond the aphorism that is our conference theme, to do things differently, to imagine a more empowering role for technology in the context of sustainable development, and to build back better post the ongoing pandemic.

We would like to thank our reviewers, authors, conference participants, and other members of the Organizing Committee who made IDIA 2020 a success.

March 2020

Don Rodney Junio  
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## **ICT4D: Taking Stock**



# The Effect of Digital Community-Based Tourism Platform to Hosts' Livelihood

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**Abstract.** In this paper, we present results of a contextual inquiry study in a Community-Based Tourism (CBT) village. We investigate the influence of an enabling digital service platform for tourism that rural Tanzanians utilise to attract and host guests. Our interviews and observations show that hosting tourists delivers positive short-term livelihood outcomes (income, visitors), but the long-term impact (social, infrastructure) to the communities requires deeper consideration. We recommend that sustainable digital service platforms for CBT should be developed and assessed including their features in addressing long-term impacts on livelihood. We propose the following topics for consideration in future development of digital CBT platforms: the role of surrounding communities, rewards to platform contributors, enabling of indirect economic activities, understanding conflict-of-interest between communities and platform, empowerment all of the users, and monitoring the local performance of the platform for its users.

**Keywords:** Digital platforms · Emerging economies · Sustainable Livelihood Approach

## 1 Introduction

In recent years, the emergence of sharing economy platforms such as Uber [1] and Airbnb [2] have revolutionised the way technologies can be used to earn money [3], allowing individuals to digitally offer services to third parties. In theory, these online platforms can connect and benefit users from different parts of the world. However Uber and other such ride-sharing services have received mixed reception in emerging economies [1, 4]. Even legal matters around the services on the platform are confusing to the end users, e.g., are providers independent contractors using the platform as their billboard or *de-facto* employees of the platform [5, 6], what are the national laws and tax regulations in regard to such services?

Insufficient research has been done with regards to the effects of these platforms in emerging economies [1]. While the potential of improving livelihood for locals seems obvious with a wider access to global markets, socio-economic and political issues on

the ground might hamper beneficial usage. For example, the lack of even small amounts of capital can stop micro-entrepreneurs to get started or establish access to markets to find buyers for the products [7].

A better understanding of mutual effects between the locales and the sharing economies therefore needs to be established [3], to determine the role of such global platforms [8]. Harvey et al. emphasises that HCI researchers have the responsibility to contribute to a fairer economy for all [9]. Soro et al. suggest the creation of localized digital services for under-resourced communities in the global south, as global services inherently promote Western views and values, which may not be compatible with the local contexts [10]. Glöss et al. [8] have adapted the labour relations to the local context, as Hallowulla et al. [11] have demonstrated how values of underprivileged users can be integrated in designs. Consequently ICT4D researchers and practitioners are required to work together to support the appropriation of such platforms with the most beneficial effect for emerging markets [12]. Hence in a quest to establish how ICT4D should respond to *the transforming technology and sustainable development landscape* we need to investigate *substantial impacts on local livelihoods*.

In this paper, we present an investigation into the effect of a global digital community-based tourism (CBT) platform on the local's livelihood and consequent strategies. CBT has gained momentum with an increasing desire of tourists to learn about local cultures while including marginalised communities into new income streams. The Sustainable Livelihood Approach (SLA) [13] provides the overall conceptual framing of our work, informing the discussion on sustainable digital service platforms in the global south [14].

## 2 Related Work

### 2.1 Community-Based Tourism

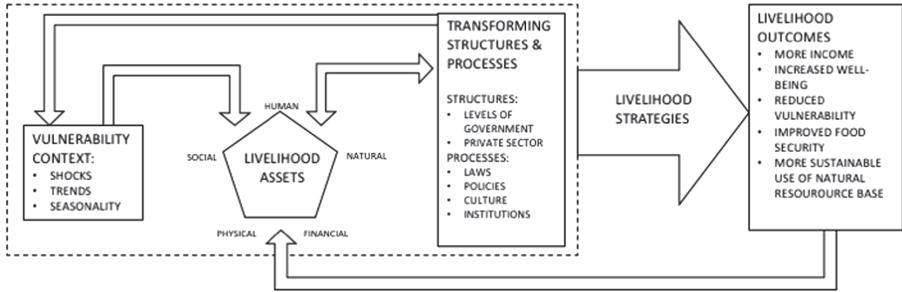
CBT allows for tourists to be accommodated by local communities and be integrated in every-day life. Often, these communities reside in villages or rural areas, in countries such as Kenya [15], the Philippines [16], and Namibia [17]. Rega and Inversini [18] have called upon the ICT4D community to start including CBT in its agenda, as the topic has been largely neglected in the literature.

The effects on host communities have been mixed. On one hand, CBT offers communities hope [19]; ways to turn natural resources, such as beautiful location, into profits [20]; to diversify livelihood strategies by providing local products and services for the tourists [21, 22]; to improve local infrastructures and increase human capacities in tourism business [23]. Authors argue, that the positive sides of CBT far outweigh the negative sides [17, 23]. However, CBT has faced a fair share of criticism, such as insignificant change [15], investors' profit valued higher than effects on the host community [24], increased dependency on donors [15] and disruptions of community dynamics [17, 20, 23].

### 2.2 Sustainable Livelihood Approach

Sustainable Livelihood Approach (SLA) is a tool for analysing “the poor operating in the context of vulnerability” [25], looking beneath the direct income, and widening the

concept to understand other aspects besides the temporary monetary aspects [26]. SLA has been applied to studies of technology adaptation in rural Kenya [27], entrepreneurship in Ghana [28], as well as community-based tourism [21, 22]. Walsham [14] has recommended the usage of the sustainable livelihood framework to link ICT4D research to theory, allowing for generalisability.



**Fig. 1.** The sustainable livelihood framework by DFID [29]

We use the sustainable livelihood framework presented by the British Department for International Development (DFID) [29], depicted in Fig. 1. The sustainable livelihood framework consists of five elements; vulnerability context, livelihood assets, transforming structures and processes, livelihood strategies and livelihood outcomes.

The vulnerability context explains the situation where the poor operate. It consists of shocks, trends and seasonality that affect the livelihood in a positive or negative manner [29]. Transforming structures and processes are external stakeholders and policies that shape the livelihoods of the people [29].

The livelihood assets consist of five different types of capital: human, natural, financial, physical and social capital. These different types of capital refer to the strengths that the people have in earning livelihood [29].

The livelihood strategies refer to the different activities and choices people make in turning their assets in their context into livelihood outcomes [29]. An individual's livelihood strategy may include several different activities. In our study, hosting is only one of the several activities used by the hosts. Livelihood outcomes in itself consist of different desirable goals, such as increased well-being and reduced vulnerability [29]. Obtaining these outcomes is the reason for using the different livelihood strategies.

SLA has been criticised for its lack of immersion in the context [30]. In our research, we have studied the hosts in their own context, and used immersive methods such as contextual inquiry, to counter this issue.

### 3 Research Background

#### 3.1 Research Aim, Scope and Questions

The overall aim of this study is to examine what the role of digitally supported CBT is in hosts' livelihoods? In this paper, we focus on the aspects of SLA that are in the control of

the host: livelihood assets, livelihood strategies, and livelihood outcomes. Vulnerability context affect the livelihood assets that the hosts have, but hosts have little control over them [29]. Transforming structures and processes can be affected by the hosts, but the changes that the hosts can make to, for example, local politics or culture, would require much longer periods of observation and are thus outside of the scope of this paper.

To explain hosting as a part of hosts' livelihoods, we pose three conceptual level research questions that are addressed through practical foci in the contextual inquiry sessions (presented in Subsect. 3.3):

1. How does hosting affect the overall livelihood strategies the hosts have?
2. How does hosting affect the hosts' pursuit of livelihood outcomes?
3. What investments to the livelihood assets does hosting enable the hosts to make?

In a complementary manner, we focus on the digital nature of the CBT platform, as digitality has previously been little discussed in CBT literature.

### 3.2 Research Context

The CBT platform used in this research lists villages and other communities in various countries with emerging economies. According to a 30-min interview with a representative of the digital platform company, the villages have been selected and approved by the company in advance.

Each community has 3–4 host families and a contact person to act as a link between the platform and the families. The contact person might also be one of the hosts. It is also possible that the contact person lives outside of the community in the nearby areas. The host families have been selected by the contact person. The hosts need to have a house that is suitable for hosting tourists, e.g., have basic facilities. When a tourist books a stay in one of the communities, the company gets in touch with the contact person who then allocates one of the host families to host the guests. In February 2018 the cost per night was 40 Euro, which was split between the host, the platform, contact person, and the community. The biggest share of the payment went to the hosting family.

After informing the company about our research plans, Authors 1 & 2 booked a stay in two communities in Tanzania via the platform as tourists. Both communities consisted of about 100 houses, and had primary schools, but no further education. Community 1 was located about 30 km out of popular tourist areas, and there were some hotels even nearby the community. Fishing was an important trade. Community 2 was located next to a major road, but a 3-h drive away from nearest major city. There were no regular hotels or other tourism infrastructure in the community. The community was surrounded by farms.

We informed the contact persons and all the hosts in the villages that we are conducting research, but we asked to be treated as normal tourists visiting the communities via the platform. The contact persons acted as interpreters between English and Swahili while we interviewed the hosts some of who had only rudimentary English skills. Acknowledging our double role as tourist and researcher simultaneously, we recognise that it might have affected the data collection. However, we could not have travelled as researchers only and deprive hosts from their incomes or affect other tourists in their holidays.

### 3.3 Implementation of Study

We conducted a Contextual Inquiry [31] in the field as part of the rapid ethnography methodology framework presented by Millen [32]. A similar approach was used by Wyche et al., observing the mobile phone usage in rural Kenya [33]. We identified the following three topics to focus our observations to on the field:

- How does hosting affect the host's life while they have visitors?
- How are they using the resources from hosting?
- How is the digital platform used in the context?

These topics match the research questions and aims presented in Sect. 3.1. The first focus addresses the livelihood strategy, second focus livelihood outcomes and the investments to livelihood assets, the third focus the digital nature of the platform. We also identified the contact person of each community as the key informant in addition to the pre-determined focus areas as per Millen's instructions [32].

In Community 1, we interviewed the contact person, two of the three hosts individually, and additionally had a group interview with all three hosts present. All hosts, as well as the contact person, were females. In Community 2, we interviewed all three hosts individually. In this village, the contact person was also a host. The contact person was a male, and the other two hosts were female.

The interviews were conducted alongside the daily activities the hosts and the researchers went through as a part of the normal programme for the tourists, and the content of these interviews matched the focus topics identified for the field work. The interviews were recorded and transcribed. The interviews were used as a part of the contextual inquiry to support the data we made from observations. Every evening, a compiled record of the day's activities and observations was recorded. Additionally, Author 2 kept a written diary. Contextual inquiry by two researchers on the field matches Millen's request to use interactive observations [32].

After the fieldwork, all the transcripts from the interviews and the field notes were analysed by using Atlas.ti software (qualitative data analysis) by the two researchers who were on the field. We categorised our findings according to the focus topics. Additionally, categories that did not clearly match any of the foci of the study, such as "cultural exchange between researchers and hosts" and "role of community and gender" emerged in the analysis. In total, we had 20 documents analysed by using 16 categories, and marked down 176 text snippets. Collaborative data analysis by several researchers is the third and final step of rapid ethnography methodology [32].

## 4 Results: Impacts on Livelihood

In this section we present our observations from the field and our interpretations of the data. The section is divided to match the foci of the research presented in Sect. 3.3

### 4.1 The Effects of Hosting to Host's Life During Visits

**Hosting and Other Livelihood Activities.** Preparing visits of tourists entails planning of accommodation, meals and activities. The activities during the visits are done together

with hosts or other community members. The nature of organised activities varies much between villages. The activities offered in the villages of this study included dolphin tours, massages, henna tattoos, crafting jewellery, school visits, saving group visits, snorkelling, tree plantation visits and a visit to a cave.

In the first village hosting was a highly communal activity. If the actual host was busy, another village member was always there to take care of the tourists. For example, the visit to the local cave was done with a member of another host family. The communal aspect of hosting was expressed by the contact person: *I just learnt how people... I mean... How the community and people operate together; most of the time. And how the families come together... I mean, they are not same families but they come together as same families. They share things together. And when there is a problem, they solve it together.* In the second village activities were split, one offering accommodation and another person carrying out the other activities. The hosts ran other business activities, such as selling fish or ice cream, craft jewellery, and farming.

**Tourists as a Source of Additional Income.** Hosting tourists provide the host families and the community with additional income. For example, the dolphin tours and snorkelling conducted by companies was charged extra, with a share for the referring hosts. Massages and henna tattoos were also additional services by one of the hosts offered to tourists against a small fee.

The visits to a school, savings group, tree plantation or to the cave were organized free of charge. However, at the sites visited, we were expected to contribute financially. For example, when visiting the school, we were presented with a possibility to donate money for the school activities. Also, during the visit to the tree plantation, we were asked to buy saplings that we could then plant on the sight. The activity itself did not generate any income for the host.

## 4.2 Usage of Resources Generated by Hosting

Hosting has enabled the host families to invest and save money for the future. In both villages visited, the host families used the money for their children's education and infrastructure improvements. One host in the first village told us proudly that she was now able to pay school fees for all her three children. Equally, the saving group member in the second village mentioned that hosts use the money to pay for the education of their children. "*The aim of the group is to educate women and men how to raise economy by entrepreneurship. And also, to save money to get capital to make business and pay school fees for their children.*"

In addition, all three hosts in the first village said that they had invested the income from hosting to build or renovate their house. One of the host families was able to get electricity to her house, which later enabled her to buy a refrigerator. Another host said that she will save the money to build her own house, since she currently has only the foundation for the house. "*She is now staying at her husband's house. Before <the platform> she had started her own house, so when she gets the money from <the platform>, her plan is to build her own house. So that she would not be so dependent on her husband.*" The third host had already invested some of the income to expand the house by building more rooms.

The income received from hosting has also helped the school in the first village to renovate the school building and pay salaries to teachers. This came up during a group interview with all three hosts in the first village. “*Yeah, they think it (money for the community) is a good thing, because as I told yesterday, some teachers are not getting paid. So, when they (school) get the money, they can pay the teachers*”.

Income received through the platform was also used as a capital for later business establishments. In the first village, one of the hosts said that she is saving the money to open a business in the future. “*Also, they (host family) told me that they have a plan to open their business, but they have not yet told what is the business. Later on, they plan to open their own business from which they can get their own money.*” In the second village, the money was used to support existing business activities, such as farming.

### 4.3 Use of the Digital Platform

We booked our stays in the villages through the platform website with credit card payment. Soon after the confirmation of the booking, we received a written guide for the visit, including a code of conduct, via email. The contact person emailed asking about allergies, and other restrictions to communicate them to the host family. We also received the WhatsApp number of the contact person, which was used in the communication.

The contact person appeared to communicate with the host families mainly via phone and WhatsApp. After the visit, the platform pays the hosts via Tigo Pesa, an SMS money application that allows users to send and receive money.

The platform asks tourists to take photos while in the village, and then to share them online. This had caused issues in the past in the communities, as the tourist had published a video with community members who wished not to appear on the Internet. This appeared to cause some tension between the community members and the host, whom the community interpreted to be responsible for the tourists’ behaviour.

The tourists also publicly rate and give feedback online. The communities were aware of these ratings. They were mentioned several times, and we noticed that some of the issues that were pointed out in the reviews were meanwhile fixed. For example, a tourist had complained how costs were not announced prior to engaging in activities. In turn, we were explicitly informed about the costs.

The nature of the digital platform was unclear for the hosts. The hosts themselves are disconnected from the actual platform, interacting with it only through the contact person. They had not completely understood how the tourists find them, and book stays. The contact persons, who work in between the hosts and the platform in turn understood how the platform worked, “*Yes. They did not really understand how the booking works, they might think that the travellers were all from the university. They did not really understand the booking. So, I told them that the travellers are from different countries and it works like a company. I had to tell them that there are just bookings.*”

## 5 Analysis and Discussion: Influence of Digital CBT Platform on Livelihood

### 5.1 Hosting as a Livelihood Strategy

This Subsection answers the Research Question 1 “How does hosting affect the overall livelihood strategies the hosts have?”

The platform offers the hosts the possibility to earn a larger income than before. The decreased attention to other parts of their livelihood activities during the visit did not appear to have negative long-term effects. The hosts that we met either owned businesses where they had hired help, or had types of jobs where participation every single day was not necessary. In other cases, other community members either entertained the guests or helped with the activities to be carried out.

In both villages, we spent time with other members of the community for times that our hosts were busy. Also, one of the community members who was staying with us, taught us to work with beads to prepare jewellery, that she sold for the other tourists in the area. Although we did not really contribute to her jewellery business, it appears to be possible to integrate hosting of the visitors to at least some of business activities. Our results suggest that from financial standpoint hosting is a positive activity for the hosts.

Tao and Wall have listed several ways that the members of communities involved in CBT can benefit from it [21]. These include direct contacts with the tourists as well as supporting roles. Similarly, we experienced several ways the hosts and the wider communities utilised our presence to benefit the economic activities in wider range than just hosting. We were brought to visit local attractions for a surcharge and we used local services such as kiosks. The hosts and other community members benefited from having a relatively solvent customer presence.

### 5.2 Digital CBT Platform and Livelihood Outcomes

In this Subchapter, the Research Question 2: “How does hosting affect the hosts’ pursuit of livelihood outcomes?” is answered.

Firstly, hosting *increases the amount of income*. The increased income allows hosts to invest into other livelihood assets, which enables more diverse livelihood strategies in the future. The increased income helps hosts to build a financial buffer, reducing risks that they may encounter and improving the hosts’ food security.

Hosting, facilitated by the platform, diversifies the hosts’ livelihood by providing a new way to earn money that is not directly dependent on the same resources as other livelihoods. The vulnerabilities of farming, for example, are not comparable with community-based tourism. The same applies to other forms of small businesses, such as fishing and small-scale selling of general goods that we encountered. The decentralization of the risks *reduces the overall vulnerabilities* of the livelihoods, which is one of the desired livelihood outcomes. Through these reduced vulnerabilities, hosts’ *food security also increases*.

Although the *improvements in the well-being* are more complex, as we need to assume that increased physical and human capital correlate with well-being, our research arrangement (as we were paying customers) makes it slightly difficult to assess the

authenticity of the positive interactions from the hosts. Acknowledging this, it appears that hosting was an activity that at least some of the hosts enjoyed and which brought variety to life in the villages. This is suggested by the high number of mentions to cultural exchange in our data. This could mean, that hosting itself could improve the well-being of a host. Further research on this topic would however be needed.

After a dramatic family emergency, we thought that we should leave the community, and offered this to the host and the contact person. They assured us, that we should stay, and completed the hosting as planned. We were unable to directly confirm their rationale about continuing with the hosting whether it was an economic decision or a cultural decision of hospitality. It appeared that the host and the contact person did not know the options they had regarding changes, or cancellations. It is possible that the platform had policies which could have helped the situation, but if they existed, they remained unknown. This shifted the responsibility to the host who were already in a stressful situation because of the family emergency, which likely affected the host's well-being negatively.

We did not notice any evidence of effects to *more sustainable use of natural resources*.

### 5.3 Investments to Livelihood Assets

In this Subsection, we answer to Research Question 3: "What investments to the livelihood assets does hosting enable the hosts to make?" Through those investments, the hosts can change their livelihoods on the long-term.

Hosting only complements other livelihood activities, as the visiting guests are infrequent. However, the amount of money (*financial capital*) earned from the hosting is relatively high, allowing to invest in mostly *physical capital*, which improves the quality of life and future businesses. These physical capitals include, for example, electricity and larger houses. Hosts further invest in *human capital*. Education improves skills, which expands the possible livelihood strategies that can be used. These investments were articulated by the hosts who appeared to be poorer. It remained unclear, what the better off hosts were investing in.

In addition to physical, human, and financial capital, hosting appeared to affect the *social capital* the hosts had in their communities. One of the hosts explicitly said, that he now is a "big potato" in the community, meaning that he had a good social standing. In his community, we were brought to a school and to a saving group, suggesting to donate, which could be perceived as his influence which can elevate the host's social standing in the community, and thus increase the social capital.

However, hosting might also have negative effects to the hosts' social capital. As explained in the previous subsection, there was a family emergency in the host's family during our stay, which led the host to balance attention between us and the family needs. It appears that situations of this nature might lead to negligence that can negatively affect the long-term relationships within the community or the family.

Additionally, the behaviour of the tourists might lead to further issues within the community. The community perceived that the tourists are the responsibility of the host. The potential misbehaviour by the tourists might result in tensions between the host and the community. The example of the unauthorised publishing of photos was a contentious issue mentioned.

Investments to *natural capital* were not observed.

## 5.4 Digital Services as Enablers

In Sect. 3.1 it was mentioned that we wish to discuss the role of digital services in CBT. In this Subsection, we summarise our learnings to serve as stepping stone for future discussion on the topic. In our research, the main role of the digital services in CBT is an enabler. Without digital tools, the system could not function efficiently.

The platform has two different types of stakeholders in the emerging economies: contact persons and hosts. From the digital point of view, their roles are very different. The contact person acts as a middleman between the hosts and the digital platform. The hosts do not necessarily directly interact with the platform.

The hosts and the contact person communicate via phone. If the host owns a smartphone, messaging applications appear to be popular. However, a smartphone is not a requirement for hosting, as the hosts can communicate with the contact person via phone calls and SMSs.

This policy lowers the technical requirements that are needed from the hosts to start using the platform, and thus makes it more accessible. However, by distancing the hosts from the actual platform, the nature of the digital service remains unknown for the hosts. The hosts were indirectly aware of the ratings that the tourists were able to share online, and it was clear that this concerned them to some extent. The ratings were discussed about several times in both villages. Rating services is a standard feature of the workings of digital platforms, and it is likely, that as the hosts were not familiar with these practices, they were not able to contextualise what this meant in practice. Similar phenomena has been noted by Ahmed et al. with Indian ride-sharing drivers [1].

The most contentious issue mentioned has however been tourists publishing unauthorised media on-line. While on the one hand the platform encourages tourists sharing their experiences in order to boost the business, on the other hand they are equally interested in a good long-term relationship with the communities. Hosts and other community members not directly interacting with the platform, absent from online activities, rights, and controls have no direct influence on the platform.

## 6 Recommendations

### 6.1 Guidance on Developing Digital Platforms for Community-Based Tourism

Soro et al. have expressed their concerns towards global digital platforms as tools in ICT4D [10]. They argue that the global platforms have been designed within a western context, which could be unsuitable for the global south. Although we noticed issues that stem from the global, digital nature of the platform, we argue that these characteristics also enable the existence of CBT platform. Digital platforms are multi-sided markets by nature, and the different types of users (in our case, tourists and the communities) need to operate utilising the same platform in order to create added value [34].

Our results suggest that even though sharing economy on digital platforms has its issues that need to be solved, it also has important potential in improving livelihood in emerging markets. It has already helped hosts to reach some livelihood outcomes. Glöss et al. have stated that HCI as a field should be more active in designing platforms that enable fairer labouring [8]. Therefore, we offer six lessons learned from our research that can be used in developing sharing economy platforms in emerging economies.

- i) *There is a need to emphasise the role of the community.* CBT platforms' influence extends to the community besides the hosts and contact persons. Acknowledgment of this accompanied with a *code-of-conduct* might reduce some of the conflicts within the community as noticed by Kontogeorgopoulos et al. [20]. The share of the profits the community receives via the platform equalises benefits in the community. Although conflicts are still possible, acknowledging possible issues, and discouraging the potentially offensive behaviours from the tourists could also reduce the issues raised by CBT. Furthermore, as much as tourists upload feedback, community members should be enabled and encouraged to equally upload content on the websites, including feedback on tourists.
- ii) *There is an obvious need to reward platform workers.* Ahmed et al. report that one of the biggest issues Indian drivers had with a ride-sharing platform was that they felt that all of their work was not compensated [1]. The CBT platform appears to compensate the hosts to such extent that it is profitable for hosts and communities to plan alongside their other livelihood-sustaining practices. The hosts explicitly expressed their wish to have more visitors, which indicates that they find hosting as a desirable part of their livelihood strategies.
- iii) *Design the systems in a way that allows for expansion of self-created local services.* The hosts and the communities we observed had found ways that the communities could benefit from tourists in the broader community in the form of tours and donations. This contributes to the equalising benefits from tourists introducing possibilities for earnings for community members that do not directly use the digital platform yet and that expands beyond the "hosting".
- iv) *Negotiate and agree on rules and processes between the hosting community and the platform owners.* The issue with undesired sharing of pictures, showed a lack of prior agreements and considerations of local rules and desires. Equally the regulation of exceptional circumstances needs to be negotiated, such as in host's family emergencies, etc. Certain situations might not have been anticipated yet will need to be resolved on an ad hoc basis.
- v) *There is a need to fully empower all the local users of the platform, including secondary users.* Ahmed et al. state that another issue the Indian drivers had was that they did not understand the platform they worked for [1]. Similarly, we found that the hosts did not understand the system they were working with, which led to unrealistic expectations of the number of tourists they could host. It is important that all the users of the platform, including secondary users (in this case, the hosts), understand the system, and preferably have means to impact it. In our case, the hosts could have used some of the features of the platform via SMS, which was a technology available for them.
- vi) *There is a need to maintain the platform from the viewpoint of the users in emerging economies.* The platform we used had specifically been planned with the users in the emerging economies in mind. Still, during our relatively short stay, we noticed issues where the platform did not work optimally for the hosts. We recommend that future development of digital platforms or CBT include even closer engagement with local actors (e.g. via contextual inquiry supported development process) in order to identify issues that users encounter while working with the platform.

## 6.2 Reflections

Our main methodological concern is the contextual inquiry from a foreign researcher's perspective, in the role of tourists, providing biased data which should be enriched by local researchers. While the results indicate that there are issues to be considered in further deployments and operations of sharing platforms and therefore mechanisms for feedback from local communities need to be created alongside.

Another challenge was the role of the contact persons as translators. It was not possible for us to organise professional translating during our field work. Evidently, there was a language barrier between the researchers and the hosts. When we asked the hosts questions through the contact person as a translator, the contact persons often offered us their own answer and interpretation instead of translating the question to the participants. Furthermore, the contact persons had a prior relation to the hosts, which might have affected the responses hosts gave to us in the contact person's presence.

While the Sustainable Livelihoods Approach was a suitable framework for analysing the role of digital CBT platform in the hosts' endeavour to earn living in rural Tanzania, it emphasized the strengths and opportunities that communities or individuals have. However, the identification of different livelihoods that the framework appears to neglect should be considered.

The communities we visited did CBT as a small part of their overall livelihood activities. Lasso and Dahles have stated that resorting to CBT in a larger scale might lead to vulnerabilities, as the old livelihoods might be replaced by tourism [22], suggesting that CBT schemes and platforms should encourage and support co-existence with traditional means of livelihood. Tourism is a volatile business, and the amounts of tourism may be affected by various external factors that the communities cannot influence such as weather or political situation.

However, limiting the number of visitors in the area might be difficult. Blackstock has pointed out that the CBT industry is often ultimately more interested in its profits than empowering of the local communities [24]. It is also questionable whether the local community would be interested in limiting the number of visitors. It was expressed to us that all the visitors at this point were wanted. The tourism brings relatively large sums of money to the village. Communities might be willing to endure the negative sides of the CBT in the hope of a better future as Simons and de Groot have stated [19].

Although our research suggests that the digitally supported CBT might have positive effects on livelihoods of the hosts in short term, the long-term effects are yet unknown. Dependency on a single digital platform that is administrated by a third-party actor poses a risk in the long-term. Also, the negative effects of tourism to community dynamics have been well documented in the literature [15, 17, 20, 23], and may well accumulate during longer periods of time. If correctly used with appropriate advising content for all parties included, digitally facilitated CBT could be a tool for better livelihood in the future.

## 7 Summarising Conclusions

We have inquired with the hosts of Community-Based Tourism (CBT) whose work is facilitated by a digital tourism platform. The hosts' short-term financial gains are

relatively large and important. However, we also noticed questionable effects relating to new livelihood strategies and the regular community alignment and handling of tourists when the amount of tourism increases.

Despite challenges, there is potential to harness global digital platforms as a tool for CBT to create better livelihoods in the emerging economies in the future. Digitalisation brings sharing economy to emerging economies. With the identified guidance on development of digital platforms for CBT, we hope to advance designs that allow users in the global south to take full advantage of the new possibilities in improving their livelihood.

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# ICT and Interactivity in the Classroom: A Case Study of an ICT Intervention in Indian Rural Public Schools

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**Abstract.** Amongst educators, there is a consensus that constructivist forms of learning where teachers and students actively interact to co-create knowledge is valued over instructional forms, which prioritize the transmission of information from teacher to learner. Across the world, ICTs have been applied toward enhancing learning outcomes for school children. This paper analyses an ICT intervention in rural India to assess whether ICT interventions can improve interactions in the classroom towards constructivist learning. Our study of a teacher-focused ICT intervention finds that teachers working in a resource-constrained environment use ICTs as a time and effort saving commodity resulting in little change to classroom interaction. We also find that ICTs are used passively by teachers, without unlocking their interactive potential, as they lack the ICT capacity to do so. Students continue to have minimal say in the pace and outcome of classes. Future design of ICT interventions must strike a balance between addressing teacher's constraints and providing students and teachers features that spark interaction.

**Keywords:** Classroom interactivity · Constructivism · Information and communication technology

## 1 Introduction

The United Nations in its fourth Sustainable Development Goal (SDG4) focuses on efforts to provide quality education at all levels. The role of Information and Communication Technologies (ICTs) in achieving SDG4 is two-fold - as a delivery mechanism providing access to learning resources and to create collaborative learning spaces that offer new ways to learn beyond traditional classroom contexts [1]. Along these lines, there has been several education initiatives in India that focus on empowering public schools with ICTs in the last two decades. ICTs that have entered public schools through such initiatives include desktop computers, laptops, and tablets, multimedia digital content and internet connectivity. We broadly categorize these initiatives as student-focused or teacher-focused, depending on the intended primary users of the ICTs. In this study, we present an ICT intervention where classroom teachers are the intended primary users.

The intervention, *Sampoorna Kali*<sup>1</sup> was devised by EdIndia, which describes itself as a developmental support organization. EdIndia operates educational interventions in over eight states in India. Chief amongst them, *Sampoorna Kali*, aims to create a holistic learning environment in public schools primarily in the state of Karnataka. One of its key components is the Digital Learning Room (DLR) - a set up consisting of a laptop, projector and digital content that strives to usher-in a transformation in how students learn. By enabling access to ICTs in resource constrained public schools and facilitating their use towards holistic learning, EdIndia regards *Sampoorna Kali* as fully aligning with SDG4 of ensuring equitable quality education to all. It adopts a teacher-focused approach where classroom teachers are the primary users of digital devices and content. In this study, we examine the potential of DLR as an ICT intervention to improve interactivity in the classroom and how its teacher-focused approach may influence classroom interactions.

We draw on constructivist literature to identify the role of the teacher in classroom interactions. In India, the National Council of Educational Research and Training (NCERT) lays out guidelines through the National Curriculum Framework (NCF) to make learning less burdensome, more engaging and exploratory [2]. NCF's recommendations accord an active role to teachers in enabling this transformation.

Our findings show that the teacher-focused approach encourages the adoption of ICTs by teachers. Training, repair support and periodic review enable regular use of the DLR and its integration into the learning environment. However, we find that interactions in the DLR are largely authoritative, with the teacher exercising control over the learning process. Despite the promise and potential of digital aids, DLR propagates the status quo of traditional classrooms. Teachers in this context are heavily constrained by the schooling system with administrative responsibilities, sudden transfers and a rigid academic calendar dotted with school events and exams. This restricts their ability to explore the transformative potential of the DLR in improving interactions in the class. Consequently, teachers view DLR primarily as a time and effort saving instrument. We argue that in order to realize the interactive potential of DLR, the intervention needs to engage with teachers and accommodate their needs, constraints, and goals.

The paper is structured as follows: Sect. 2 presents the theoretical framework that informs our study, we review relevant literature on learning, interaction, the role of teachers and how ICTs can be positioned to support and enhance interactions. The section ends with a brief review of recent ICT initiatives in Indian public schools. Section 3 details the methodology of our field study. In Sect. 4, we present our findings from the study, including a description of the context, constraints in the Indian public schooling system, teacher perceptions and use of the DLR. Section 5 engages in a critical analysis of the findings where we discuss the nature of classroom interactions between students and teachers as well as their interaction with ICTs.

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<sup>1</sup> Name of the intervention, organization and that of participants have been changed to preserve anonymity. *Sampoorna Kali* is a pseudonym for the intervention in Kannada which translates to complete learning. Kannada is the state language of the south Indian state of Karnataka.

## 2 Theoretical Framework

### 2.1 Learning, Interaction and the Role of Teachers

In the constructivist pedagogy, knowledge is produced when students relate new information and ideas to their existing beliefs and personal experiences. It rejects the idea of knowledge as a singular objective truth that everybody needs to receive [3]. All knowledge is subjective and situated in context [4]. As a pedagogy that is situated in personal experiences and beliefs, constructivism positions the learner as an active participant in the learning process [5]. Their active participation includes analyzing, investigating, collaborating, sharing, building and generating knowledge based on what they already know [6].

A key characteristic of the learners' active participation is their interactions which contribute to knowledge construction. This includes interactions between students and student-teacher interactions both inside and outside the classroom. Since conceptual growth is shaped by the sharing of multiple perspectives and experiences, interactions within and outside the classroom are central to knowledge construction [7].

In the constructivist approach, the teacher plays a critical role in facilitating interactions in contrast to conventional classrooms where teaching primarily involves disseminating information and delivering instruction. A teacher following the constructivist approach does not assume authority over the process of knowledge creation but rather enables students to become actively involved in the learning process [4]. She helps students connect new insights with their previous learning [5]. In constructivist classrooms, students are encouraged to raise questions, there is little emphasis on textbooks and workbooks and teachers facilitate group learning activities [8].

The NCERT in its National Curriculum Framework recognizes learning as a process of knowledge construction and recommends subject-wise curriculum changes and systemic reforms in schooling, including examination reforms and teacher education. NCF envisions the role of the teacher as follows: "*Allowing children to ask questions that require them to relate what they are learning in school to things happening outside, encouraging children to answer in their own words and from their own experiences, rather than simply memorizing and getting answers right in just one way*" [2].

The constructivist pedagogy accords a critical role to the teacher in enabling and facilitating classroom interactions. This informs our research as we examine the teacher's role in and contribution to interactions in an ICT-enabled classroom.

### 2.2 ICTs and Interaction

Increased interactivity in the classroom is a step towards constructivist learning. Antón [9] for instance, finds that teacher-student interactions lead learners to negotiate meaning and rules during classroom activities. Interactivity in the classroom involves dialogue between participants and objects. Based on a combination of participants and objects, there are various categories of interactions – learner-tutor, learner-learner, tutor-content [10]. ICTs have been used in classrooms to enhance interactivity as Muirhead and Juwah [10] find that multimedia provides an interactive learning environment that caters to diverse learning styles. ICT based systems such as clickers [11], SMS [12], desktop

[13], mobile applications [14] and social media [15] have been introduced to improve interactivity in school classrooms.

Beauchamp and Kennewell [16] argue that more student control over “elements of orchestration” would lead to more dialogue in the classroom. The authors explain orchestration as the use of elements such as ICTs and its affordances by teachers and students towards achieving their goals. They provide an analytical framework to categorize interaction levels within the classroom into five levels - *no interaction, authoritative, dialectic, dialogic* and *synergistic*; based on the elements of orchestration such as learning goals, teacher’s responses, control over the content and overall student influence in classroom proceedings. In this categorization, at lower levels of interactions such as no interaction and authoritative interactions, teachers tend to exert complete control over the pace of the lesson; ICTs are used passively, providing little change to interactivity, i.e., orchestration rests with the teacher.

In dialectic interactivity, the pace of the lesson is determined by software such as in a simulation. A teacher would select content to present based on students’ responses. In dialogic, questions raised by the teacher tend to have a looser structure, orchestration of elements are jointly done by students and teachers. In the synergistic category, students and teachers orchestrate on equal terms, students have ownership of resources. This category requires high levels of ICT capacity of both teachers and students. Thus, while ICTs do improve interactivity in the classroom, the affordances of certain types of ICTs - be it a tablet or an interactive whiteboard, along with control over the orchestration of elements and ICT capacity of participants, determine the degree and nature of interactivity in classrooms through ICTs.

While the framework above provides a means to categorize classroom interaction between students and teachers, we also draw on a second framework by Beauchamp and Kennewell [17] to categorize how ICTs support interactive teaching. In the first of three categories, ICTs are merely providing teachers with additional resources, they are “objects of interaction”. The second category posits ICTs are “participants in interaction” where ICTs can initiate an interaction or respond to an action by the learner. Lastly, ICTs are viewed as “tools for interaction”, leveraged to meet learning goals. We combine the two frameworks to study the nature of interactions in an ICT enabled classroom. The frameworks, therefore, allow gauging the extent to which a teacher-focused ICT intervention enables constructivist pedagogy.

## 2.3 Review of ICT-in-Education Initiatives in India

While there have been several ICT-in-education initiatives in India, in this section, we highlight specific initiatives to throw light on how the education system was problematized and the role accorded to ICTs as a solution to identified problems. Here, ICTs refer to a range of technologies from laptops and PCs to satellite-enabled remote teaching. Based on the intended primary user, we broadly categorize these initiatives into student-focused and teacher-focused.

**Student-Focused Initiatives.** These initiatives prioritize students and envision direct student-access to computers to improve the quality of education. “Hole in the wall” was a popular initiative in the early 2000s, which set up computers in select rural and remote

areas in India for children to freely access computers. The initiative presented itself as an alternative solution to issues plaguing the Indian schooling system, including teachers being reluctant to do their job [18].

Similarly, under the One Laptop Per Child (OLPC) initiative and its variants adopted in India, low-cost laptops were provided to students individually to enable access to computers and digital learning tools. OLPC's design reveals an underlying belief that students benefit from being left to explore and navigate digital content on their own [19]. Azim Premji Foundation's computer-aided learning program (CALP) designed, created and distributed multilingual content (as CDs) for various subjects to public schools in different parts of India. The program's goal was to introduce students to computers and use technology to compensate for teacher-shortage and quality of instruction [20]. What is common across these initiatives is that students are positioned as the primary users of the ICTs provided.

**Teacher-Focused Initiatives.** The design and implementation of these set of initiatives suggest a more active role for the teachers in ICT-enabled education. Some value the role of quality educators imparting lessons remotely while others provide ICT support for teachers within the classroom. In 2000, the Indian government launched a 24-h educational television channel called *DD-Gyan Darshan*, which enjoyed an estimated viewership of about 20 million viewers across 4 million homes [21]. These broadcast educational channels underpin the government's outlook towards ICTs to address the need for accessible and quality education, through centralized mechanisms of broadcasting lessons by a remote teacher.

More recently, in 2014, the Karnataka state government launched the Satellite and Advanced Multimedia Education (SAME) project to address inadequacies in the education system such as the “non-availability of adequately trained teachers, and rampant teacher absenteeism” [22]. The project employed “well-trained” teachers and provided them multimedia educational content to deliver classes at a government studio in the state capital Bangalore, which would be telecast live to rural districts of the state.

Among teacher-focused initiatives, there exists another subset of initiatives that prioritize ICT use by classroom teachers. Project *Shiksha* launched in 2003 by Microsoft not only provided inexpensive software and ICT content to public elementary schools but also trained the teachers of those schools to use ICTs in their classrooms [23]. Unlike *Gyan Darshan* or SAME which enable one or a few remote teachers with ICTs to reach thousands of students through broadcasting technology, this initiative takes ICTs to classroom teachers and supports them to incorporate ICTs into their day-to-day lessons.

Our study analyses one such classroom teacher focused ICT initiative in Karnataka. Given the significance of interactivity in the classroom towards enabling constructivist learning, we analyze the potential for a teacher-focused ICT initiative to improve interactivity in the classroom.

### 3 Methodology

Our sample consisted of 38 schools across two talukas<sup>2</sup> in the southern state of Karnataka. The school sample provided by EdIndia included 31 higher primary schools (HPS) and

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<sup>2</sup> Taluka is an administrative division equivalent to a sub-district.

7 high schools (HS). Out of the nearly 200 schools (at the time of our study) that EdIndia engaged with, EdIndia identified 38 schools based on the maturity of the *Sampoorna Kali* program in those schools, perceived willingness of the school to participate in the study and ease of access to visit the school for fieldwork. Fieldwork included visiting all schools in the sample to interview teachers, administration, students and parents as well as observe DLR based classes.

The extensive fieldwork undertaken over seven months from August 2018 to February 2019, was made possible through the support of a field associate from EdIndia who was hired and paid by EdIndia for undertaking fieldwork on our behalf. The field associate's fluency in Kannada and his familiarity with the schooling context in the region (He has worked as a schoolteacher in private schools) proved beneficial in carrying out the field research.

We crafted an extensive interview protocol, based on our initial interactions with EdIndia office bearers, *Sampoorna Kali* staff members, and an initial field visit to a school. Our field associate then visited the remaining schools and conducted interviews based on this protocol. At each school, 2–3 teachers were interviewed and wherever they were available, headteachers<sup>3</sup> were also interviewed. After each school visit, we would regularly sync-up with our field associate for school-visit updates. This regular communication was critical in addressing any on-field concerns in a timely manner.

We accompanied him on school visits to four schools where we conducted interviews and observed smart classes. Apart from visiting schools, we also interviewed EdIndia facilitators and office bearers who were associated with *Sampoorna Kali* and worked closely with the schools. In total, we had interviewed 109 teachers, 25 head teachers, 7 facilitators<sup>4</sup> from EdIndia and 2 of their office bearers. While most of the interviews with teachers and headteachers were conducted by our field associate, all interviews with EdIndia members were conducted by us.

Reports for each school created by the field associate were coded individually by the first and second authors using the structural coding technique [24] and then merged. In the second round of coding, fresh codes from field notes, interview transcripts and were added to existing codes. All three authors created codes in the second round to arrive at the final categories: 'Changes in pedagogy', 'Changes in learning outcomes and student participation', 'ICT capacity', 'Frequency of use', 'Sessions with motivator', 'Infrastructure and equipment issues' and 'Teachers constraints'. These categories were then thematized to explain the intervention, the context, usage and perception of users.

## 4 Findings

### 4.1 EdIndia and *Sampoorna Kali*

As a catalyst for improving literacy in the country, EdIndia runs several education initiatives geared at promoting enrollment in schools, enabling holistic learning and providing

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<sup>3</sup> Head Teacher is a teacher who doubles as the school's Principal; they shoulder teaching responsibilities while also managing the school's administration.

<sup>4</sup> Facilitators refers to EdIndia employees who worked with schools towards adoption and integration of the *Sampoorna Kali* program.

career guidance for students graduating in rural schools. EdIndia's flagship intervention *Sampoorna Kali* works with public higher primary schools (HPS) (grades 4–7) and high schools (HS) (grades 8–10) in rural Karnataka. The medium of instruction in schools is predominantly Kannada, the official language of the state.

*Sampoorna Kali* seeks to provide schools with resources to enable learning beyond the curriculum. Specifically, it provides a DLR setup, science and math experiment kits, and library books. The intervention also provides training to teachers via a team of facilitators, conducts career guidance, events, and competitions for students.

As part of the DLR setup, the intervention provides target schools with a projector, a laptop, and digital content. Schools are encouraged to convert a classroom into a DLR, purchase speakers, Uninterruptible Power Supply (UPS), projector screen and other equipment through school budgets. Largely, schools do not have internet connectivity and thus digital content is provided as presentations, periodically shared through USB sticks. The digital content slides are based on the prescribed textbook for sciences, social sciences and mathematics along with a collection of prose and poetry for both Kannada and English classes. Each presentation corresponds to a chapter in a textbook with activities, additional images, audio, short video clips sourced from the internet.

The digital content is created by EdIndia facilitators whose main role is to ensure that teachers adopt the DLR and experiment kits into their teaching practice. Facilitators are tasked with school visits where they conduct classes alongside teachers to “change the mindset of teachers”. Each facilitator is responsible for around twenty schools (although that number increases as target schools increase) which they visit twice a month to share the latest presentations, attend to repair requests, review the use of digital aids and engage students in the DLR. Facilitators address technical issues with laptops, projectors, content and train teachers to operate the laptop and navigate presentations.

For office bearers and advisors at EdIndia, the objective of *Sampoorna Kali* is to provide an “alternative means of learning” in public schools, where, often rote learning takes precedence. The DLR along with the science kits and the rest of the intervention amount to such alternate means. They believe that the exposure and student engagement in the learning process through the DLR is invaluable. At the same time, the DLR and the facilitators are deployed to enable teachers “to contextualize content” and to “enhance the quality of the interaction” between the teacher and students. The teacher who is considered the final authority decides how she delivers the content.

EdIndia’s rhetoric suggests that the DLR is a teacher-focused intervention; that teachers are their primary users and that the adoption of “alternative means of learning” provided by the intervention, is at the discretion of the teacher, who engages students in the learning process.

## 4.2 Rural Public Schools in Karnataka

This section will help put into perspective the context within which *Sampoorna Kali* operates. In the region where we undertook our research, we found that students in public schools hailed from families that engaged in farming activities or casual labour. Among the parents we interacted with were farmers, weavers and wage laborers in factories, who typically could not afford private school tuition fee. Parents, therefore, sent their children to the nearest public school which is free of cost.

Schools varied in size from thirty students and three classrooms to schools with over a hundred students and a dozen classrooms. School ownership of ICTs prior to DLR was limited. A few schools had abandoned computer labs or a single computer in disrepair. EdIndia addresses this by providing schools with laptops and projectors. However, schools are also plagued by infrastructure issues such as intermittent electric supply, lack of electrical grounding and in one instance, a collapsed roof. In some schools, when teachers wish to use the laptop to teach, they conduct classes in the office room since it may be the only room in the school with grounding and continuous electric supply. Some schools make do with a bedsheets or wall as a projector screen.

Apart from tackling infrastructural issues, teachers must juggle teaching with administrative responsibilities and training. Teachers are responsible for all day to day administrative work in the school - ensuring smooth operations of mid-day meals, maintenance of water and restroom facilities, updating details of students regularly to the department, distribution of books and uniforms to students. Teachers may also be deputed to undertake census work and scholarship data uploading.

The average number of teachers per school in the region of our study was 3.5 [25]. Between themselves, teachers handle Hindi, English, Kannada, Math, Social, Science and Physical Education for classes 4–7 (in an HPS) with at least one of them handling classes 1–3. When one or more of them are assigned administrative work or training, the pool of available teachers drops further. Teachers, especially in HPS, routinely resort to combining classes<sup>5</sup> to tackle teacher shortages.

The Department of Public Instruction, Government of Karnataka operates primary and secondary public schools across the State. They decide on the number of teachers in each school, the schools' annual budgets. The department mandates compulsory training days for each teacher annually and transfers teachers on a need basis to tackle teacher shortage. The department also frames the syllabus for schools (public and private) affiliated to the state board. To invoke citizen participation in school governance, the department mandates that each school should have a School Development and Monitoring Committee (SDMC) through which parents and residents get involved in the school's administration. In the schools we studied, we found that an active SDMC committee can help raise external funds to meet infrastructural needs.

In addition, civil society actors support schools in a few ways; organizations help build labs, provide human resources to offload administrative burden, equipment such as solar-powered UPS, laptops, computers, content. EdIndia must, therefore, address schools' resource constraints, overburdened teachers, engage with the education department who have considerable say in school operations along with parents and other civil society actors. The constraints described in this section serve to contextualize the use of DLR in the following sections.

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<sup>5</sup> In a combined class, students from different classes (for example, classes 6, 7 and 8) are brought together in one classroom. The teacher tries to engage this combined class by either assigning work for some and teaching the rest or conducts common lessons for this combined class - often choosing topics that would be comprehensible to all the students of the combined class.

### 4.3 DLR Usage

DLR equipment was largely used during school hours by the teacher, facilitator and students to a lesser extent. This section examines how each stakeholder incorporated the DLR into their practice.

**Teacher Use.** While teachers were the intended primary users of the DLR, we found that usage amongst teachers was far from uniform, ranging from non-use where teachers did not incorporate the learning room into their teaching practice to proactive use where teachers created their slides, using content from a variety of sources (Teacher blogs, WhatsApp groups, videos from YouTube). Usage varied across subjects with Math teachers using the room the least because teachers felt that problems are best learnt when solved on the blackboard step by step. This contrasts with Science and Social Science teachers who found images and videos helpful in explaining concepts. Teachers have also found the digital learning equipment useful for administrative work such as uploading of records and school events to ideate and teach students dance steps.

Frequency of use also varied from alternate classes in the DLR to once a week, after every chapter, “whenever necessary” and “only when students do not understand a concept.” Table one below from our field notes describes classroom interactions in a digital learning room where Ramesh, a male HPS teacher with 16 years of teaching experience, uses the room once a week.

**Table 1.** A typical DLR session

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Ramesh sits on a chair in the digital learning room, while the students, over forty in total, sit on the floor with their textbooks and notebooks open in front of them. This is the first class of the day and Ramesh spends the first five minutes of the class to set up the desktop and projector. He navigates to the folder containing the sixth-grade science content and opens a presentation on habitats and ecosystems. Ramesh guides students through the slides while operating the computer positioned in the middle of the room, occasionally he goes to the front of the classroom to write on the blackboard. He instructs students to read specific slides first in unison and then one student at a time. After reading the points on the slide, he raises questions that are answered by a handful of students. The slides contain images and videos some of which Ramesh draws attention to, as students keenly watch. Towards the end of the class, an activity slide with a table to be filled up is presented. Ramesh instructs students to fill up the table in their notebooks, leaving the room for a few minutes. Upon his return, select students present their answers to the class while other students continue to fill up the table peering over each other’s notebooks. The class ends with a summary of the session, with Ramesh going through the slides highlighting specific points in each slide.

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**EdIndia Facilitator Use.** Facilitators work with teachers to conduct classes using digital learning equipment in the DLR. They act as an external source of encouragement to increase adoption amongst teachers. They tend to conduct classes with and without teachers in HPS.<sup>6</sup> Table two highlights classroom interactions in a facilitator conducted class in the absence of a teacher.

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<sup>6</sup> In HS, teachers largely do not allow facilitators to teach, relying on them only for technical support and assistance with conducting events.

**Table 2.** A facilitator lead DLR class

Basappa, the facilitator in charge of the HPS decides to take a combined class due to lack of teachers. He is used to conducting impromptu classes by himself. Students in grades four and five fill up the four benches in the DLR while some students sit on the floor. Basappa consults with the students who collectively decide that they would exercise their Kannada and English reading skills. When Basappa navigates to a list of poems, students voice their opinion as to which poem to read. A student volunteers to read to the class. Basappa explains the meaning of words unfamiliar to the class and engages in discussions with students. Students participate in the discussion drawing on their own experiences. Having finished a poem in both Kannada and English and with 15 min left for lunch time, Basappa splits the class into two groups and asks them to come up with a story of their own, which the students narrate at the end of the class.

**Student Use.** In some schools, students reported that they can engage with the laptop and projector themselves in the absence of a teacher. When the teacher is unavailable due to sudden transfers, administrative obligations or mandatory training, students can use the DLR without supervision, to revise content that was already presented. Largely though, as described in Tables 1 and 2, students do not control the digital learning equipment, save for setting up the DLR and during informal sessions where facilitators and community members teach students typing, paint and video games. However, students have repeatedly expressed that they look forward to DLR classes with images and videos which they thoroughly enjoy.

The digital learning room is therefore largely used by the teacher and a facilitator, with usage varying across subjects and school types. Teachers have differing patterns of usage from non-use to proactive use. We next examine the perceptions of teachers that shape their use of the DLR.

#### 4.4 Teachers' Perceptions on DLR

The degree of variation in the usage of DLR is tied to teachers' perceptions of the DLR. Several teachers expressed their rationale for using the DLR to enhance their teaching practices and to improve student learning outcomes. At the same time, teachers also made clear its shortcomings. Teachers who did use the DLR frequently (once a week), explained that the room allows for efficient use of class time, to cover syllabus faster, thus saving more time for administrative work and to revise. Ramesh describes his motive to use the digital learning room: "*The difference between a digital learning room and a regular class is that it gives us rest. This allows for effective teaching since I don't have to write on the board anymore which saves time.*"

Pavithra, a female HPS teacher with 22 years of service explains changes in her teaching practices after the digital learning room: "*Before the digital learning room, we faced difficulties. Social Science textbooks do not have enough information on cities, countries, older civilizations. We used to gather newspaper clippings for projects about countries and continents. Now, thanks to the digital learning room, we no longer need to spend time on such activities as the slides have plenty of visual information.*"

The remarks indicate that teachers who do adopt the learning room into their practice, view the room as a time and effort saving instrument. Teachers also perceived benefits for students as HPS teachers find that students tend to “participate more” in classroom discussions, they tend to “show greater interest to learn” and can “better recall concepts”. Teachers also expressed that DLR helps students understand concepts with clarity. For instance, a science teacher explained how an animated video depicting the parts of an atom could help students better understand and describe an atom.

However, some teachers also felt that the content presented was not relatable to students’ socio-economic context and since the bulk of videos used English, they required teachers to translate. HS teachers felt that the content was superficial and failed to explain concepts in depth to the level of high schoolers resulting in non-use. Non-use was exacerbated as teachers had to wait for long durations when the laptop or projector broke down as their remote locations slowed down pick up and drop off equipment. Teachers expressed a need for ICT training - for some, this would allow them to use the slides themselves without facilitators, for teachers with an elementary knowledge of computer use, training would allow them to make slides on their own. Thus, the teachers in our sample consisted of those who saw value in the DLR as well as those who did not.

Teachers’ practices were framed by their perceptions of DLR, situated in the constrained school environment. In the next section, we draw on these perceptions, constraints, and practices to examine classroom interaction in the DLR and the relationship between teacher and DLR in shaping that interaction.

## 5 Analysis

Our findings show that DLR use is shaped by multiple factors such as the limited digital infrastructure available, ICT capabilities of teachers, their administrative responsibilities and the presence of a supportive environment at school. This section engages in a critical discussion of the nature of the observed interactions in the DLR and mechanisms to address some issues identified.

### 5.1 Whole-Class Interaction in the DLR

Using the interactivity analysis framework discussed earlier, we examine the “elements of orchestration” in the DLR. The teacher-student interaction described in Table 1 ranges from “none” to “authoritative”. We see that the teacher controls the pace of the class by controlling the slides, unilaterally deciding which slides to skip and which videos to play. While the teacher does initiate dialogue by prompting questions, these are answered by the teacher himself or a handful of students, revealing how little rapport is established. The activity in the slides spark interactions amongst students as well as with the teacher but the activity itself involves recollection of information and thus does not involve constructing knowledge.

Unlike schoolteachers, EdIndia facilitators are unconstrained by pressure to complete the syllabus and to adhere to the curriculum. This allows them to structure their classes such that typical outcomes like memorization are not expected. In Table 2, we see greater participation of students in deciding the pace, goals, and activities in the session

handled by the facilitator. Interactions in this setting ranged between “authoritative” (with the facilitator providing the content) and “dialectic” (students’ inputs were considered while picking a poem to read). Thus, the facilitator-led class provides more control over classroom elements to students leading to more interaction.

This, along with facilitator and community member-led exposure sessions, where students learn typing and gain familiarity with basic software, provides an opportunity for increased student-ICT interaction with guidance. While increased student-ICT interactions are welcomed, the use of the DLR by students in the absence of teachers, may not be desirable [26]. In classes controlled by teachers themselves, DLR alone does tend to increase whole classroom interaction.

## 5.2 Towards an Interactive DLR: Incorporating Teacher Needs and Constraints

We observe that the whole class interaction in the DLR is largely authoritative in nature. For the whole class interaction to become more dialogic (and constructivist, by extension), we now examine the potential of ICTs to contribute to this change. Beauchamp and Kennewell [17] lay out three ways in which ICTs can support interaction as described in Sect. 2. As the “object of interaction”, ICTs provide dynamic forms of display for the teacher to present more difficult ideas with better clarity. ICTs of this kind increase the range of resources at teachers’ disposal. In our study, this is seen in teachers’ belief that DLR helps students “understand the concept easily” and in their usage of DLR - combining the use of blackboard and textbook with video clips, images, and slides.

When ICTs are “participants in the interaction”, ICTs are partners that learners can interact with, as in the case of a simulation or quiz application. As a “tool for interaction”, ICTs provide a medium through which learning goals can be attained. In the context of the DLR, we do not observe such direct interaction or dialogic use of ICTs.

Currently, it would appear that teachers regard the DLR as an object of interaction. Its accomplishment has been in introducing a multimedia setup in the classroom, that triggers excitement among students. However, the DLR is yet to transform into an interactive and dialogic space. A more interactive DLR may be a capital and resource-intensive transformation. The resource limitations notwithstanding, it is also worthwhile to critically analyse DLR’s acceptance and adoption among teachers. Our findings show that the teacher in the Indian public schooling system is tasked not just with teaching; she must juggle administrative tasks, fill in for unavailable teachers and work against the clock to meet a rigid academic schedule. In this context, the cost (time and effort involved) of creating dialogue in a class of forty students appears to be too expensive.

Against this backdrop, our findings show that teachers often turn to the DLR not so much for enhanced interactions but to save time. Going through slides allows them to finish portions faster than if they wrote on the blackboard. Teacher-focused ICT initiatives such as DLR, need to take note of this. The teacher-focused model enables better adoption and integration of ICTs into the classroom. While such preliminary inroads may be gratifying, the adoption of ICTs (like DLR) motivated by time constraints is far from desirable.

Efforts towards an interactive DLR should acknowledge and work with the complexity of the teacher’s position. A simplistic view of a teacher as one who just teaches may not suffice and may be detrimental to the goal of dialogic interactions. Offering

training and support to teachers through facilitators is a step in the right direction. A better understanding of their needs, desires, and constraints may contribute towards more meaningful adoption of ICTs by teachers and consequently, better dialogic interactions in the DLR.

## 6 Conclusion

Through the Digital Learning Room (DLR), EdIndia has introduced ICTs into classrooms in rural public schools. DLR enables access to new avenues for information assimilation through images, audio, and video. By positioning schoolteachers as primary users of DLR, the intervention has managed to integrate ICTs into the classroom, prompting regular use. This lends merit to the teacher-focused approach in the design of ICT interventions. Even as EdIndia's outlook towards education and development aligns with NCF's recommendation of constructivist pedagogy. Our study found that classroom interactions in the DLR have remained minimal and authoritative for the most part, preserving and propagating the status quo from traditional classrooms. However, the DLR is but one component that EdIndia has introduced and *Sampoorna Kali* as a whole requires further study as ICTs are far from the only source to spark interaction towards constructivist learning.

The constraints faced by teachers within the schooling system, including teacher shortages, administrative responsibilities, rigid schedules and syllabus, have led them to adopt the DLR as a time and effort saving instrument. Their constrained position along with their lack of ICT capacity limits teachers from exploring the potential of DLR to improve interactions in the classroom. Efforts like the DLR must engage with this complexity.

Resource constraints must first be addressed by both practitioners and policymakers working in public schooling. A teacher with enough time at her disposal is a precondition for interaction in the classroom. Designers of ICT interventions must be made aware of how ICTs are used in the classroom and strive towards enabling the use of ICT as a tool rather than passive dissemination of pre-loaded content while striking the balance between time-saving goals of teachers and learning for students.

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# **Harnessing Frontier Technologies for Sustainable Development**



# Towards a Human Rights-Based Approach to AI: Case Study of Apprise

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**Abstract.** Frontier technologies such as Big Data and Artificial Intelligence (AI) are hailed to improve decision-making by reducing and even mitigating human biases. The emergence and rapid adoption of these technologies, particularly in optimization of services and provision of key analytics and insights was justified by the widespread benefits of AI to democratize intelligent software for all. Yet, recent studies have brought to light cases where AI has perpetuated existing biases and deepened inequalities, contributing to the further marginalization of specific groups in society. Despite the opportunities that AI offers, it also poses new threats to human freedom, fairness, non-discrimination, privacy, and security; leaving questions regarding the human rights implications of AI unaddressed. This paper proposes the use of international legal frameworks such as the International Bill of International Human Rights (including the Universal Declaration of Human Rights) to assess the human rights impacts of AI system. To ground the discussion, we present a case study to assess the human rights implications of Apprise, a multi-lingual expert system for screening potential victims of human trafficking and forced labor, piloted in Thailand. Drawing on amplification theory, we highlight that AI systems are not deployed in neutral systems, and that pre-existing inequalities and “unfreedoms” can be aggravated if not addressed. We argue for a balanced view of the potential of AI systems, cognizant of both the positive and negative intentions of users of such technologies.

**Keywords:** Amplification theory · Artificial Intelligence · Expert systems · Human trafficking · Forced labor · Human rights

## 1 Introduction

The emergence and rapid adoption of frontier technologies such as Big Data and Artificial Intelligence (AI) has been justified by the widely perceived benefits that these technologies have to democratize intelligent software to all [1, 2]. As our lives become increasingly more mediated by technology, AI has become a big part of them. AI is used for the provision of key analytics and insights for the optimization of services, ranging from online job applications, online banking, to predictive browser searches. These systems are believed to improve decision-making by reducing and even mitigating human

biases [3]. Yet, new studies have brought to light cases where AI has perpetuated existing biases and discrimination, and deepened inequalities, contributing to the further marginalization of vulnerable groups in society [4, 5]. In particular, the use of AI in risk assessment tools in the US criminal justice system has recently discussed and debated. One such tool is COMPAS, a machine learning system used for criminal risk assessment, specifically for forecasting future offenses, to inform sentencing and setting bail. Several studies found that not only are AI risk assessment tools such as COMPAS inaccurate at forecasting criminal offenses, but they are racially biased and characterized by racial profiling [4, 6]. This example shows that, despite the opportunities that AI offers, it also poses new threats to human freedom, fairness and non-discrimination, privacy and security [5].

Due to concerns over the rapid proliferation of AI and its potential impact on human rights, the impact of AI on democracy, rights, and justice is now receiving more attention. Governments, civil society organizations, international organizations and the private sector are developing AI ethical principles and guidelines, from which Fjeld et al. suggest a lack of agreement despite some common themes [7]. Authors like Razo et al. [5] and Donahoe and Metzger [8] take another approach, arguing for existing international human rights law instruments and frameworks to be used to evaluate the human rights impacts of AI systems. These well established and internationally recognized frameworks can be used for “considering, evaluating and ultimately redressing the impacts of artificial intelligence on individuals and society” [8].

This paper analyses Apprise, a multi-lingual expert system designed for screening potential victims of human trafficking and forced labor. Current estimates find that less than 1% of victims of human trafficking and forced labor are successfully identified and subsequently assisted. This low success rate is due to a number of factors including lack of training, lack of privacy in the initial screening phase of victim identification, and communication barriers between frontline responders and workers [9]. Apprise was developed to overcome these issues and is used by governments and civil society organizations across Asia. The paper presents an evaluation of the implications of this AI system, by considering the positive and negative human rights impacts this system has on vulnerable workers. In discussing the findings, we draw on amplification theory highlighting that AI systems are being not deployed in neutral systems and that pre-existing socio-economic conditions, inequalities and “unfreedoms” can be aggravated if not considered in the design, development, and evaluation of AI systems.

## 2 Background

AI is commonly used to tailor and improve our digital experiences, but these AI technologies remain largely unregulated, used unethically and result in the exacerbation of discrimination. To respond to issues of data privacy and fairness, many human rights-based guidelines have surfaced in an attempt to regulate AI. In this section, we will introduce AI and machine bias, describe a capabilities approach to technology, and present current ethical regulations arguing for a human rights-based approach to AI.

## 2.1 Artificial Intelligence and Machine Bias

AI “is an umbrella term that includes a variety of computational techniques and associated processes dedicated to improving the ability of machines to do things requiring intelligence, such as pattern recognition, computer vision and language processing” [5]. Broadly, AI systems can be categorized into expert (knowledge-based), or machine learning systems. The principal difference is that “expert systems aim to emulate the principles used by human experts, whereas machine learning relies on statistical methods to find a decision procedure that works well in practice” [2, p. 8].

Proponents of AI technologies cite their promise to address some of the world’s biggest inequalities and inefficiencies across many sectors of the economy and society, such as healthcare, environment and security [1, 2]. They argue that as AI augments human intelligence, it leads to better-informed decisions and can positively impact society and contribute to: safer living and working conditions [3]; improving access to healthcare; predicting disease outbreaks; optimizing agriculture; predicting natural disasters and mitigating climate change effects; and improving the efficiency and accessibility of government services and resources [4]. More recently, AI has also been implicated in the fight against human trafficking and forced labor [10].

There has been growing acknowledgement of the ‘dark side’ of AI, with considerable attention focused on its impact on conflict, discrimination and insecurity [1, 11]. Examples include the use of AI-powered social media algorithms for spreading disinformation, or *fake news*, in order to promote specific content and the use of chatbots disguised as real users to target certain user groups [4]. Practitioners and researchers also cite the use of AI for surveillance through facial recognition, sentiment analysis, and data mining algorithms that can be used for reducing threats to public security, but also to discriminate against marginalized groups in society [12]. Recent studies have brought to light the harms of AI in perpetuating bias, enabling discriminatory profiling, and driving discrimination against the marginalized – known as algorithmic discrimination or machine bias [4–6, 13]. As noted by Razo et al., “it is important to recognize that AI systems are not being deployed against a blank slate, but rather, against the backdrop of social conditions that have complex pre-existing human rights impacts of their own” [5]. Boyd et al. demonstrated how the use of AI in the job market could result in the marginalization of people who have historically been excluded from certain employment opportunities based on their social networks, which are shaped by race, class, gender, ethnicity, religion and others [13]. The issues raised were lack of transparency and accountability as opaque algorithms are embedded in system designs and can exacerbate potential discrimination with no one to hold accountable [13]. This argument can be extended to the use of AI in criminal justice in forecasting crime for law enforcement or predictive policing and forecasting of risks to inform sentencing.

Predictive policing tools are used to predict and identify places and times with high risks of crime, supporting police deployment optimization [14]. However, as noted by Perry et al., “predictions will only be as good as the data used to make them”, referring to data quality issues for training and testing AI systems, furthermore, “actual decreases in crime require action based on predictions” as “predictive policing is part of an end-to-end process”, referring to the important role AI has within the environment in which it interacts [14].

Toyama's amplification theory explains that technology works as an amplifier of human and institutional intent and capacity [15]. This theory contributes to the view that technology should be perceived as a means to an end and not an end in itself [15]. Existing literature fails to consider the impact of background conditions on the consequences of human rights in introducing AI, this paper will show that AI, as a magnifier of human capacity and intent, needs to have human rights at its core: through the design, identification of data sources, and the impacts and interactions it has in the environment where it is introduced. Without this careful design, AI systems can reinforce systemic bias and discrimination.

## 2.2 Enhancing Human Freedom and Human Rights in AI

Sen describes the expansion of human freedom “as the primary end and the principle means of development” [16], with development referring to “the ability – the substantive freedom – of people to lead the lives they have reason to value and to enhance the real choices they have” and of removing “unfreedoms” such as poverty and inequality [16]. Using the capability approach, Sen defines agency as “the realization of goals and values she has reasons to pursue, whether or not they are connected with her own well-being” [17]. Therefore, agency is not only the achievement of goals, but the freedom to achieve them, constrained by social, political, and economic opportunities, configured by power relations and unjust social structures.

Sen is implicitly concerned with power relations and unjust social structures but doesn't discuss how to understand and interpret these factors. Due to the open-endedness of the Capability Approach, other theories that have strengths in this area can complement it. Critical Theory focuses on determining obstacles to freedom, at a social and individual level, with “a rich theoretical repertoire in relation to the constraints and boundedness of human agency” [18]. Zheng and Stahl draw from Deneulin's [19] concept of social-historical agency that emphasizes an individual's place in socio-historical structures to create the concept of *situated agency*, in which agency is “not only a product of specific socio-historical settings, but also situated in a sometimes invisible or taken-for-granted network of ideology, and participate[s] in the production and reproduction of these socio-historical structures and ideological tenets” [18]. When used naively, participatory approaches to development can serve to reinforce existing hegemonies within a specific context. This points to the relevance of situated agency in enabling researchers to “critically evaluate the design of social arrangement and of the basis of cultural norms as part of the assessment of well-being and agency freedom” [18]. The use of this theoretical approach is key to consider in the early participation of potential users in the design and evaluation of interventions in order to ensure that potential users' ideas and values are implicit in the design and the evaluation of the intervention (rather than for example, with the intentions of the researcher). It also allows participants to reflect on whether the proposed intervention supports or opposes hegemonies within that particular context. Boyd et al. reflect that “racism, sexism, and other forms of bigotry and prejudice are still pervasive in contemporary society, but new technologies have a tendency to obscure the ways in which societal biases are baked into algorithmic decision-making” [13]. They call for normative frameworks towards more accountable and transparent technology to avert algorithmic discrimination [13]

as “Without safeguards, even AI systems built for mundane bureaucratic functions can be repurposed to enact discriminatory policies for control” [20].

The demand for legal and ethical models towards AI is gaining global momentum with a wide cross-section of stakeholders developing AI ethical frameworks. As part of an AI ethics landscape, Fjeld et al. identified 32 AI guidelines, developed by governments, inter-governmental organizations, the private sector, and civil society organizations. Critics of ethics frameworks and normative approaches to AI claim that they are not actionable as organizations have yet to develop accountability mechanisms to ensure compliance with their own principles and reinforce them [21]. Civil society and academia often criticize the lack of transparency in corporation-driven ethics frameworks that are set up to address the black box decision-making, lack of accountability and lack of enforcement mechanisms in AI systems [21].

Another approach to AI ethics concerns regarding discrimination is the technical approach “*Fairness, Accountability and Transparency*” (FAT), a longstanding field of work that aims to address issues of discrimination, injustice and exercise of rights from widespread use of AI through considerations in the design and deployment of such technologies [21]. Although this field of research has been popular within the science and more broadly so in academic domains, it has been criticized because “it does not empower individuals or surrounding institutional mechanisms to challenge the decisions that these systems make” [21].

Razo et al. suggest a third approach to overcome the lack of transparency and accountability of the former two approaches. They note that ethics frameworks are non-legally binding and developed in many cases to serve the best interests of the select minority who created them. The Universal Declaration on Human Rights (UDHR) on the other hand is developed through a transparent and legitimate process, and is the foundation and backbone of over 80 international human rights declarations and treaties, as well as many human rights conventions, bills, and constitutional provisions<sup>1</sup>. These comprehensive, legally binding systems overcome the two main critiques of normative approaches. Canca critiques Razo et al.’s approach, as “an overestimation of what the UDHR is capable of, and an underestimation of what ethics is and does” [22]. Canca notes that the UDHR lacks the specificity required to answer many of the messy questions that AI systems are trying to solve.

This paper argues for a human rights-based approach toward AI, based on the International Bill of Human Rights, which itself consists of: UDHR, the International Covenant on Economic, Social and Cultural Rights (ICESCR), and International Covenant on Civil and Political Rights (ICCPR) and two Optional Protocols [23]. We believe that the frameworks of ICESCR and ICCPR can complement the lack of specificity of UDHR, as they provide a detailed description around each principle. For example, UDHR’s article 23 is the right to desirable work, which ICESCR specifies as the right to just and favorable conditions of work to ensure remuneration with fair ages, as well as safe and healthy working conditions. Therefore, using the International Bill of Human Rights, it is possible to mitigate the criticisms regarding the ambiguity and difficult operationalization of UDHR. This approach understands that “a human rights-respecting AI system

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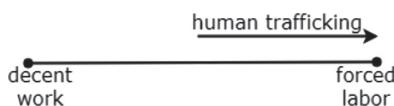
<sup>1</sup> See <https://www.un.org/en/sections/universal-declaration/human-rights-law/>.

is not simply one that does not produce rights-violating outputs, but that it is human rights-respecting through design, development and deployment” [21].

### 2.3 Human Rights, Forced Labor and Human Trafficking

Modern day human trafficking and forced labor practices constitute serious human rights violations under international law [24]. However, many anti-trafficking efforts do not put human rights at their core, hence the need for a human rights-based approach to trafficking “that is normatively based on international human rights standards and that is operationally directed to promoting and protecting human rights” [24]. The promotion and protection of human rights should be central in formulating policies and identifying right holders such as potential victims and trafficking offenders [24].

The International Labor Organization (ILO) defines forced labor as “all work or service which is exacted from any person under the menace of any penalty and for which the said person has not offered himself voluntarily” [25]. Yet, according to Skřivánková, “The reality of forced labor is not a static one, but a continuum of experiences and situations” [26, p. 4]. We use Skřivánková’s framework which plots all labor environments on a single continuum, ranging from ‘decent work’ to ‘forced labor’ (see Fig. 1). This continuum shows that the lived experiences of victims of human trafficking and forced labor can start as consensual and cooperative, but progressively evolve into highly coercive and exploitative situations. They can vary from discrimination and withholding of payment, to more severe forms of exploitation such as hazardous work, harassment and violence [26].



**Fig. 1.** Skřivánková’s continuum of exploitation. Source: adapted from [26].

In some cases, workers’ coercion is through physical violence. However, victims can also be trapped through psychological coercion, such as discrimination and harassment, threats to personal safety, and debt bondage [27]. These patterns of labor exploitation are more difficult to detect and constantly changing [26], adding to the challenge of identifying victims of forced labor and human trafficking.

## 3 Methods

This research uses an inductive approach, drawing on empirical evidence collected over a two-year period in Thailand. We use a critical realist case study approach with data collected in multi-stakeholder engagements to assess the potential for digital technology to support proactive and consistent screening of workers in vulnerable situations. We use the case study approach as a methodology because it allows the in-depth understanding of a “system to generate knowledge and/or to inform policy development, professional

practice and civil or community action” [28], thus allowing the study and context-specific understanding of a particular phenomenon [28]. Case studies can employ diverse qualitative and quantitative research methods to generate data and evidence for purposes of uncovering different aspects of a phenomenon and improving reliability, transferability (external validity), trustworthiness (internal validity) and construct validity of findings [29].

The data used in this case study was collected between April 2017 and May 2019, it corresponds to the innovation process where a tool for AI-assisted screening of potential victims of human trafficking and forced labor built and rolled out in the field. In Sect. 4, we will introduce Apprise<sup>2</sup>, an expert system created using an iterative co-design approach over the course of this period. As at May 2019, this process involved the participation of 998 stakeholders through consultations, observations, interviews, focus groups, and training sessions. These were made up of 199 government representatives, 42 inter-governmental organizations’ (IGOs) representatives, 56 legal consultants, 552 workers from non-governmental organizations (NGOs), and 149 survivors of exploitation. Participants were identified through networking, informal referral systems and fieldwork trips. Transcripts of consultations were translated, transcribed, and thematically analyzed. We used a combination of top down and bottom up analysis techniques, enabling us to analyze through key pre-determined themes, as well as identify emerging themes from participants. More details on stakeholder involvement and data analysis can be found in accounts of research by Thinyane et al. [30, 31].

### 3.1 A Framework for Assessing the Human Rights Impact of AI

As a start, key international legal instruments within the area of human rights and decent work were reviewed for this study. These were the Palermo Protocol, the ILO Forced Labor Convention and its 2014 Protocol, the UN Guiding Principles on Business and Human Rights, the ILO Declaration on Fundamental Principles and Rights at Work, and the International Bill of Human Rights. From that review, the latter was identified as containing the backbone for other conventions, that is, UDHR complemented by ICESCR and ICCPR.

Razo et al.’s two-step method for assessing the human rights impact of AI systems was then followed. Firstly, a baseline was established prior to the introduction of AI; and secondly, the human rights impacts of AI identified. In establishing a baseline, Razo et al. indicates that it is important to anticipate the positive and negative human rights impact in the field or area where AI is being introduced [5]. This baseline evaluation would include considering the availability and effectiveness of institutional mechanisms in place to regulate and address the adverse human rights implications in that field. We used transcripts collected during the initial phase of designing and developing Apprise as a baseline for the current victim screening process. We complemented this data with findings from similar studies highlighting victim screening practices in Thailand [32].

Razo et al. suggest an evaluation of the impact of AI systems on human rights. This assessment would come from three sources. The first source is the quality of training

<sup>2</sup> Note: the authors of this paper are the developers of Apprise, developed by the United Nations University Institute in Macau in partnership with The Mekong Club.

data. Training AI systems on biased or error-ridden data can lead to biased models and discriminatory decision-making. The second source for evaluating the human rights impact of AI is the system design. Kroll et al. argue that the design of AI is key for building accountable algorithms [33]. It is also important to consider the inclusion of a diverse community, especially the end users and beneficiaries in the process of design of AI systems [34]. The third source is analyzing complex interactions of the AI with the environment in which it is introduced, particularly accounting for the system's outputs [20]. We used transcripts of discussions with key stakeholders as source one and three; and the design of Apprise as the second source.

## 4 AI for Proactive and Consistent Screening

This work is situated within a broader study aimed to understand the current challenges of victim-identification and how frontline responders (FLRs, those whose role it is to check labor conditions) and workers in vulnerable situations believe that technology could support them to overcome these challenges. Using the two-step framework described in Sect. 3.1, this section first establishes the baseline of existing approaches to victim-identification, and then describes the AI system that we propose to support proactive and consistent screening of workers in vulnerable situations. A discussion of the human rights implications of the system will follow in Sect. 5.

### 4.1 Existing Approach to Human Trafficking and Forced Labor Victim-Identification

Existing approaches to victim identification were solicited through a series of six focus groups that involved 34 participants in four cities in April 2017 in Thailand, that is, Bangkok, Samut Sakhon, Surat Thani, and Mae Sot. These participants represented a broad range of stakeholders including survivors of human trafficking, local and regional NGOs, inspectors from the Ministry of Justice (Department of Special Investigations) and IGOs with mandates in migration and/or trafficking. Full details of that consultation were reported by Thinyane [30] and the key findings thereto are summarized herein.

The consultations identified two stages in victim identification: initial screening, and then further investigation (should the screening show indications of exploitation). In the initial screening phase, FLRs selected workers for interviews on their working conditions. Different FLRs use different methods to structure their questions, with a significant number going by “gut feeling”. Labor inspectors have a more formal process where a subset of workers were interviewed in a group, away from the supervisor. FLRs described a number of issues that they faced in initial screening, which became the focus of our investigations. These problems included language barriers/communication, screenings being undertaken in uncontrolled environments where victims' privacy could not be guaranteed, lack of training or common understanding of the indicators of human trafficking and forced labor as well as lack of trust between all parties involved (workers, FLRs and translators - where available). Expanding on this, participants routinely referred to cases where FLRs were unaware of the nuanced indications of trafficking and instead looked only for signs of physical violence. In so doing, FLRs effectively

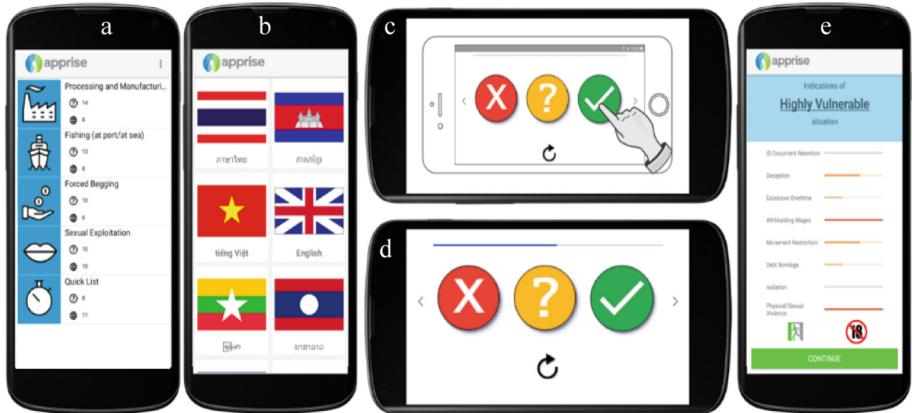
missed cases of exploitation. Stakeholders noted that migrant workers were often most susceptible to labor exploitation and translators had to be present in the initial screening process. There were scheduling and resourcing problems in the field as an FLR would not know which language workers speak, so could not guarantee that they would have a translator with them who could speak the required language. Stakeholders also noted that they could not verify the accuracy of translations in the field and spoke frequently of cases of bribed translators by exploiters seeking to mistranslate workers' responses.

## 4.2 AI-Assisted Screening of Potential Victims

At the end of this consultation, we identified the potential for a mobile phone-based, multilingual, expert system, to support FLRs and workers to communicate during the initial screening phase of victim identification. While this app would be on the FLRs phone, it would ultimately be a tool in the potential victims' hands. It would contain screening questionnaires for different sectors of work (seafood, processing and manufacturing, sexual exploitation, forced begging), with audio questions translated into the most common languages among migrant worker communities in that sector. The app would use an inference engine to allow workers and FLRs to understand the severity of the situation that the worker was in. It would also allow FLRs to understand if the worker signaled that they would like help to exit the situation. The next section presents more information on the design of Apprise, focusing on the expert system and its components. An expert system can broadly consist of a knowledge base, inference engine, and user interface. The remainder of this section describes each of these sections separately.

**Knowledge Base.** We used a modified Delphi approach (also known as mini-Delphi or Estimate-Talk-Estimate Delphi) to develop the knowledge base for Apprise. Delphi is a forecasting method, used to determine consensus among experts on a particular matter [35]. The process typically consists of several rounds of surveys, where experts rank responses against criteria and suggest new or missing responses. After each round, responses were aggregated and sent to participants for further review. This process is repeated until consensus is reached. The traditional Delphi method often avoids in-person meetings to ensure that experts are free to express their personal opinion and to encourage open critique without personality or reputation dominating discussions. Modified Delphi methods include in-person consensus meetings with careful facilitation to support experts to share freely. We held five stakeholder consultation sessions over a period of 11 months (April 2017 to March 2018) and these were used as five rounds of our Delphi process. Through the different consultations we combined the perspectives of legal experts, subject matter experts, and operations experts, with those who had personal experiences of the current patterns of exploitation used by traffickers. The indicators were converted into yes/no worded questions, with each question being assigned a weight, category, and sub-category as defined in *Hard to See, Harder to Count: Survey Guidelines to Estimate Forced Labor of Adults and Children* [36].

**Inference Engine.** We developed an inference engine to calculate the vulnerability of the respondent's work situation, basing it on ILO's *Hard to See Harder to Count* methodology [36]. The engine infers the severity of the work situation as highly vulnerable,



**Fig. 2.** Apprise screenshots: (a) question lists; (b) language selection screen; (c) introductory video; (d) interview; (e) vulnerability screen. Source: authors.

vulnerable, difficult, or no signs of vulnerability. Thai Human Rights lawyers validated the recommendations offered by the system to ensure they were aligned to the respective legal frameworks.

**User Interface.** This section summarizes key design decisions and flow of information within the expert system. A comprehensive discussion of the design and development of the user interface is covered by Thinyane et al. [31].

As depicted from the Apprise screenshots in Fig. 2, after logging in, the FLR selects an appropriate list of questions for the sector of work (Fig. 2(a)). The worker is given the phone and a set of headphones and is presented with a language selection screen (Fig. 2(b)). Once a language is selected, an introductory video is played, describing the purpose of the interview, demonstrating how to use the interface and asking for consent to continue (Fig. 2(c)). If the worker agrees to continue Apprise cycles through each question in the list, playing the audio recording of each question. For each question, users can respond “yes” or “no”, “I don’t know”, or skip forward/backward through the questions in the list (Fig. 2(d)). The last question in each list asks if the worker would like help to exit their work situation. After completing the questions, the system calculates the vulnerability of the worker’s situation. It then asks the worker to confirm if they want to stay (or leave). After storing this response, the worker is asked to hand the phone back to the FLR. The FLR is then provided with a summary of the vulnerability rating (Fig. 2(e)), indicating: the overall rating, the rating per category; the reported age of the worker; and if they would like help to exit their situation. This information is stored on the FLR’s mobile phone. Screening responses are uploaded to the FLR’s account and deleted from the mobile phone upon the FLR’s first point of network connectivity.

Care was paid in designing the interfaces to ensure that the workers’ responses could not be overseen or overheard (when combined with headphones). Firstly, when questions are played, there are no visible signs of what question the worker is responding to. The system also randomly selects between question equivalents, so the order of questions

cannot be memorized. Finally, in the vulnerability rating screen (Fig. 2(e)), the exact questions and responses are not displayed. We iterated through and field-tested different designs for this screen to find an acceptable balance between privacy and specificity.

## 5 Discussion

### 5.1 Human Rights Impact of Apprise

We draw from the International Bill of Human Rights [23], in specific UDHR [37], complemented by the ICESCR and ICCPR, to identify the human rights impacts of the expert system in Apprise. As part of the Bill, ICESPR and ICCPR provide additional specificity, such as UDHR's #4, Freedom from Slavery, for which ICCPR's Article 8 Section a) mentions that "No one shall be required to perform forced or compulsory labor" [23]. As for UDHR's #23, #24 and #25, ICESPR's Article 7 are essential to clarify how the right to desirable work, to rest and leisure, and to adequate living materials. It specifically mentions remuneration, fair wages, health and safety in the workplace, reasonable working hours and rest, as well as the right to a decent living for the workers and their families [23]. Figure 3 provides a critical analysis of the human rights impacts of the introduction of Apprise into the initial screening phase of victim identification based on methodology in Razo et al. [5]. In this image, positive impacts are depicted in light grey circles, indeterminate impacts are illustrated with dark grey circles, and negative impacts illustrated with black circles. We consider the following human rights from UDHR cross-referenced with the Office of the United Nations High Commissioner for Human Rights' *Human Rights and Human Trafficking* report [24]: Right to Equality (UDHR's #1); Freedom from Discrimination (UDHR's #2); Right to Life, Liberty, Personal Security (UDHR's #3); Freedom from Slavery (UDHR's #4); Freedom from Torture and Degrading Treatment (UDHR's #5), Right to Equality before the Law (UDHR's #7), Freedom from Interference with Privacy, Family, Home and Correspondence (UDHR's #12), Right to Freedom Movement in and out of the Country (UDHR's #13); Right to Desirable Work (UDHR's #23); Right to Rest and Leisure (UDHR's #24); Right to Adequate Living (UDHR's #25); Freedom from State or Personal Interference in rights of the Declaration (UDHR's #30).

We first start with the positive impacts of Apprise. As the tool informs the potential victim about the vulnerability of their situation and allows them to ask for help to leave their situation, we believe it positively impacts one's critical agency through the right to liberty and personal security (UDHR's #3). Complemented with ICCPR's Article 11 which states that "No one shall be imprisoned merely on the ground of inability to fulfil a contractual obligation" [23]; this covers the coercive means of exploitation referred to as debt bondage. Apprise also allows the worker to do this in a private, safe, and inclusive way, reducing chances of linguistic or tribal discrimination (UDHR's #2). Yet, it is important to note the potential adverse impacts on the rights of the accused employer when such claims are made as they themselves may feel discriminated against (UDHR's #2). Using ILO's Indicators of Forced Labor, Apprise flags situations of exploitation, allowing the FLR to investigate claims, and informs them how to take action based on the severity of the exploitation identified. This could reduce the perpetuation of abusive and exploitative practices in different sectors, while supporting safer and more dignified



**Fig. 3.** Apprise's Human rights impact assessment on human trafficking and forced labor victim-identification. Source: author.

work – impacting UDHR's #4, #5, #24, #25 and #30, as well as #23.1 on free choice of employment.

The aspects in ICESCR, such as fair wages and reasonable working hours, are all addressed in Apprise's list of questions. Apprise can have a positive impact on workers' privacy during an initial screening interview, allowing them to report details of their working conditions without fear of reprisals or being subject to attacks to their honor and reputation, or interference with privacy, family, home or correspondence (UDHR's #12). In any centralized system, care must be taken to protect data that is collected. In Apprise, the anonymity of respondents is ensured by not collecting any personally identifiable information. This limits the ability for organizations to perform some administrative tasks such as tracking changes in conditions of work (by workplace, by employee). However, the value sensitive design approach that was used in this work prioritized the workers' welfare, privacy and autonomy over any factor.

The human rights impact of Apprise for principles concerning the right to equality (UDHR's #1) and before the law (UDHR's #7) (considering ICCPR's Articles 14, 16 and 26) is still unclear. We also cannot determine the implications for free movement of workers (UDHR's #13). In this case, it is not possible to understand the implications of Apprise in limiting the ability of workers to cross borders and search for job opportunities in countries like Thailand, as a result of law enforcement changes.

This Section has illustrated how the positive impact of the introduction of Apprise can outweigh the potential negative consequences, through a careful design and extended consultation with multiple stakeholders.

## 5.2 Amplification Theory of Technology

Section 4.2 described how we developed Apprise to overcome the common problems faced by FLRs in the initial screening process of victim identification. Through the use of pre-recorded translations of questions that are available in multiple languages and

when played through headphones, the workers and FLRs are able to overcome language problems, lack of training on the key indications of exploitation, privacy and trust in the accuracy of translations. The expert system is able to advise FLRs on the next steps to take, based on the indications of exploitation identified in the screening. However, using Toyama's amplification theory, technology can only work as an amplifier of human and institutional intent and capacity [15]. This means that the introduction of technology (in this case Apprise) cannot be seen as a solution to workers' screening, but as a tool that FLRs and workers will use to do what they originally intended to do.

Consider Fig. 4 which illustrates the impact of positive and negative intentions of workers and FLRs in a matrix. If a worker and a FLR are positively intentioned, then Apprise can be used to overcome the language, training, and privacy issues that are commonly faced, to support an accurate identification. However, in the cases where a FLR or a worker (or both) have negative intentions, then amplification theory holds that Apprise will only serve to amplify those negative intentions. Figure 4 provides examples of a negatively intentioned worker using Apprise to lodge false reports with FLRs; and a FLR using Apprise to alert employers to the details of a confidential report.

		Worker Intentions	
		+	-
FLR Intentions	+	Accurate identification	Lodge false report
	-	Alert employer to details of confidential report	Lodge false report Alert employer to details of confidential report

**Fig. 4.** Intentions of FLRs and Workers. Source: authors.

As the misuse of Apprise has always been a key concern, much attention was paid to the amount and type of data collected and displayed, to limit the impact of unauthorized sharing of responses. We piloted, evaluated and refined the vulnerability screen (Fig. 2(e)) to find a balance between the amount of details shared and the privacy of workers. The screen needed to provide actionable information yet hide the specific responses.

The kinds of technology misuse outlined above are not unique to AI systems, with all innovations in need to be “embedded in a system of accountability. It’s tech in a vacuum if not part of a sound ground game with safeguards, trust, feedback, and engagement” [38]. Introducing a technology into an environment without understanding pre-existing conditions – social, economic, cultural and political – can perpetuate or exacerbate the vulnerability of people in already vulnerable situations. It is also important to survey what mechanisms are in place to keep new systems accountable, particularly their design, use, control and access over the data they produce.

## 6 Conclusion and Further Research

This paper has hopefully demonstrated that the design and deployment of an AI system should not happen in a vacuum. Careful accounting must be undertaken regarding the impact a system can have on users, particularly focusing on the socioeconomic disadvantages and grievances that disproportionately affect certain groups in society.

We used a human rights approach to evaluate the impact of Apprise on the proactive and consistent screening of workers in vulnerable situations. We have demonstrated how internationally established and widely accepted human rights frameworks, such as the Bill of International Human Rights (including UDHR), can be an advantage for the ethical governance of frontier technologies that increasingly become part of our reality. They can also be key for creating algorithms and systems that are accountable, putting human values and freedom at the core of their design and function.

Using this approach, we believe that Apprise has been designed and tested to ultimately support and enhance the agency of potential victims of human trafficking and forced labor. When assessing the impacts of AI in fairness and non-discrimination, we believe that the following principles have been considered in Apprise's development and deployment: non-discrimination and the prevention of bias, representative and high quality data, fairness, equality, inclusiveness in impact, and inclusiveness in design [7].

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# Perceived Factors Influencing Blockchain Adoption in the Asset and Wealth Management Industry in the Western Cape, South Africa

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**Abstract.** Blockchain is an archive of data records known as blocks with key functionalities that include validation, security and preservation. Blockchain has been applied in a wide range of industries, including the financial sector. However, little is known about its adoption and usefulness in industries operating within developing countries. Moreover, while some studies have focused on the financial sector, the Asset Wealth Management (AWM) industry remains relatively unexplored. This preliminary study has identified factors influencing the adoption of blockchain in the AWM industry in the Western Cape province of South Africa. Through a qualitative exploratory study, perceptions of AWM experts were gathered on how blockchain adoption is influenced by the technology's compatibility, complexity and relative advantage. The influence of the South African context was also explored. A preliminary framework is being proposed that will inform an in-depth, longitudinal study on blockchain adoption and use within AWM organizations in South Africa.

**Keywords:** Blockchain · Asset and wealth management · Adoption · Developing countries

## 1 Introduction

The use of third-party intermediaries (e.g. banks) to manage transactions has led to increased costs and decreased efficiency for users of financial services [1]. Blockchain acts as a distributed digital ledger that aims to solve some of the issues presented by traditional financial services and was first used in the cryptocurrency known as Bitcoin [1, 2]. Ever since the introduction of Bitcoin in 2009, there has been an increased interest in blockchain globally [3]. Blockchain is currently perceived as a technology that can disrupt and be implemented within many industry sectors [4].

Developed countries such as the United States, the United Kingdom and Japan are leading the way in terms of research into the applications of blockchain. This has prompted countries such as South Africa to follow suit [1]. There is a need for research on blockchain in developing countries as the enablers, barriers and implications of blockchain may be different in various industries in that context [4].

South Africa, in particular the Western Cape Province, offers a unique context to study the adoption of blockchain from a developing country perspective. According to the PwC's Global FinTech Survey in 2017, the city is seen as the technological hub of the African continent [5].

Blockchain is said to be disruptive [4] and the perceived factors influencing its adoption in the Asset and Wealth Management (AWM) industry, have yet to be explored within a developing country like South Africa. Blockchain will take a few years to be fully implemented into business processes due to complex social factors as well as regulatory standards which are yet to be fully understood [6] in developing countries. Currently there are relatively few papers that specifically explore the factors influencing the adoption of blockchain within organizations [7]. The purpose of this paper is to report on the first phase of a wider study and to explore the factors influencing the adoption of blockchain in the AWM industry in South Africa. This paper proposes a preliminary framework derived from a series of interviews conducted in the Western Cape Province of South Africa. The research question for the study is as follows: What are the factors influencing the adoption of blockchain in the AWM industry in the Western Cape?

## 2 Blockchain in the Context of Developing Countries

The first part of this section is dedicated to defining and discussing blockchain within the context of developing countries. The existing benefits and challenges pertaining to blockchain adoption in that context are also discussed. Lastly, the AWM industry is defined, together with the challenges facing the industry.

### 2.1 Defining Blockchain

Blockchain technology is a public distributed ledger that allows transactions to be stored in its blocks [8]. Blocks contain information such as transaction details (e.g. date of transaction, ID, amount). A block then chains itself to another block and its transactions [9]. The transactions are public and transparent, which encourages people to trust the transactions and the use of blockchain [9]. Additionally, if the block is changed in any way, the hash value will change and it will then lose the block it is chained to. A hash value relates to the previous block that a current block is linked to and stretches to the first block created. This first block is called the “genesis” block [10]. The term “parent block” is used for the previous block that the current block is chained to [10].

Blockchain makes use of a distributed ledger which has a complete transaction history of all the transactions performed [8]. Blockchain allows the verification of transactions to be done by its users as the digital ledger is decentralised over a peer-to-peer network, therefore eliminating the need for third party intermediaries [11]. New blocks must be validated by ‘miners’, who perform what is referred to as ‘Proof-of-Work’ (PoW) in which they receive rewards for their work [8]. Once the block is validated, it becomes immutable, i.e. cannot be changed or altered [12].

## 2.2 Blockchain in Developing Countries

When implementing new technologies like blockchain, it is important to consider the local context [13]. Blockchain offers high value proposition for the developing world [14] and could lead to major economic, political and social change [15]. This is mostly due to the technology's potential to compensate for the lack of less effective legislations and formal institutions that can sometimes be prevalent in some developing countries [14]. In South Africa, blockchain is being implemented in several sectors including health [16], agriculture [17] and financial institutions [18] amongst others. The AWM industry is therefore a relevant use case for this study.

There is a current increase in the rate at which investment technologies like Blockchain and Ethereum are being adopted by financial institutions (e.g. banks) in developing countries like South Africa [19]. However, there are both challenges and benefits associated to the adoption of these technologies. These are further discussed below.

## 2.3 Benefits of Blockchain Adoption in Developing Countries

Blockchain can provide many benefits namely, removal of intermediaries, non-repudiation, automation of manual tasks, improved auditing, streamlined automated processes, quicker execution of use cases, cost reduction and improved trust [20]. Some of these benefits which are particularly relevant to financial institutions in developing countries are discussed below.

**Improved Auditing.** It is often difficult for poor economies from developing countries to effectively deal with corrupt and discriminatory practices [21]. Blockchain can benefit financial institutions from developing countries through traceability [22] and improved internal and external auditing [15]. In effect, the technology enables public auditors to easily conduct real-time audits of relevant registries [15]. This could contribute towards reduced corruption, more efficient economies, and improved transparency during data-exchange within financial institutions [15].

**Cost Reduction.** In using blockchain technologies, financial institutions in developing countries can benefit from administrative and operational cost reductions [15] in various domains. For example, blockchain could be employed to develop solutions that are appropriate for the economics of small transactions. This would allow financial institutions to exploit very low marginal cost economics and help meet the needs of disadvantaged groups and developing countries [22, 23].

**Improved Trust.** Blockchain is known as “the trust protocol” due to its ability to facilitate trust between various parties without the need for an intermediary to verify identities, funds and ensure compliance [24]. As a “trust protocol”, blockchain could allow people from developing countries to transact and interact more freely with each other [15]. Mobile access to banking is prominent in developing countries. Blockchain technologies could therefore piggyback on advantages derived from mobile banking in developing countries with limited banking infrastructure to create a safe and trusted network to hold and transfer money [25].

## 2.4 Challenges of Blockchain Adoption in Developing Countries

In spite of the benefits, blockchain technologies also have some technical challenges and unintended consequences associated to them. From a technical perspective, because each node maintains a complete history of the network transactions, lack of privacy might become an issue for specific use cases in which privacy needs to be maintained. This might also render the addition of new blocks to the network computationally expensive. There can also be regional and cultural challenges (i.e. non-technical) that might influence the adoption of the technology in developing countries. Some of the challenges that are particularly relevant to block-chain adoption in financial institutions in developing countries are listed below.

**High Costs.** While cost reduction is an associated benefit to blockchain adoption and use, institutions can also incur high costs, especially during the early adoption phase. In developing countries, the relevant infrastructure to support the successful adoption and implementation of blockchain technologies might not be available [25] and may be expensive to acquire.

**Lack of Regulatory Framework.** Another challenge to the adoption of blockchain in financial institutions is the lack of a regulatory framework to manage transactions from all parties on the network [26]. If proper governmental regulations are not put in place, the widespread adoption of blockchain in financial institutions will remain hindered [27]. Not only should financial institutions ascertain how they can comply to existing data security and privacy laws, policymakers should also seek to change existing laws to facilitate the use of decentralized models [28].

**Lack of Support from Leadership.** As previously stated, blockchain could help fight corruption through improved auditing. However, this cannot be achieved without political support, leadership and commitment [26]. This is particularly challenging as in developing countries, corruption can stem from top management or leadership level, which might reduce the likelihood of them diffusing or supporting the adoption of technology [29].

## 2.5 Challenges of the AWM Industry

The AWM industry can be defined as a sector of the financial industry, concerned with the management of tangible (money, shares, etc.) and intangible (intellectual property) assets [30]. With the rapid increase in personal wealth in developing countries, the AWM industry is set to double in size by 2025. However, with that growth comes challenges [31], the biggest one being the inability to meet the changing needs of customers [32]. Moreover, the need for automation, better operational efficiency and better customer experiences has become a concern for many AWM service providers [32].

One aspect of the AWM customer experience that has presented itself as a challenge in the financial industry is the slow validation of personal data in the client onboarding process [33]. Strict onboarding requirements such as proof of identification, residency, occupation, etc., have led to a manual process of client onboarding that takes an average

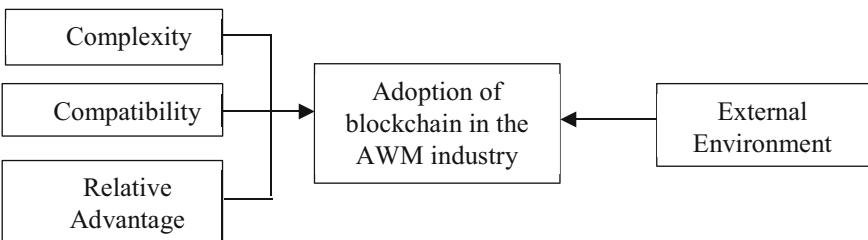
of 21–30 business days to complete [34]. Customer identification is one of the most important aspects of the client onboarding process. However, there is still a lack of digitisation which can reduce the cost and time it takes to acquire new customers [35]. Due to its ability to provide validation, security and preservation, blockchain is being seen a technology that can address these challenges [32, 34].

According to [36] blockchain technology can provide the AWM industry with improved customer data storage, customer experiences, and decreased costs by allowing customers to store and edit personal data freely on a blockchain network that is permissioned to the individual. The safety and validation that a digital ledger provides when storing the data allows blockchain technology to be used to develop tools that can facilitate Know Your Customer (KYC) utilities [31, 33]. These utilities can streamline the process of identifying and verifying customers by removing the need for various organisations involved in the process to constantly verify customer details [31].

The computational logic behind blockchain allows users to design code that can allow transactions between users to be automatically triggered [6]. Through the use of AI technology as well as various other innovative technologies such as blockchain, new business models can be derived to facilitate the automation of wealth management which can allow direct customer interaction with automated investment services [37]. According to Lopez et al. [38], automated wealth management can decrease fees on assets managed from 0.75%–1.50% + to 0.25%–0.50% thus opening the industry to a larger audience. Automated wealth management can allow for the improved operational efficiency and management of investment accounts [39]. As a result, blockchain can account for the better management of customer portfolios [38].

### 3 Theoretical Framework

The theoretical framework employed for this preliminary study (see Fig. 1) was derived from the Diffusion of Innovation (DOI) [39] and the Technology Organisation Environment (TOE) frameworks [40]. These frameworks were chosen based on their successful application in other similar studies (e.g. [41, 42]). The DOI framework helped identify how the relative advantages [43] of blockchain as well as technical compatibility and complexity [41] of the technology were relevant to its adoption in an organization. As previously mentioned, it is important to consider the local context while implementing new technologies like blockchain [13]. The TOE framework was therefore considered



**Fig. 1.** Theoretical framework

since, in addition to technological and organizational variables, it also focuses on environmental factors that might influence adoption [40]. In the following sub-sections, a description of each construct is provided.

DOI posits that the decision to adopt or reject an innovation is based on a potential user's perceptions about that innovation [44]. DOI stipulates five key constructs relative to these perceptions: *Compatibility*, *Relative Advantage*, *Complexity*, *Trialability* and *Observability* [45]. Trialability refers to the extent to which an innovation can be tested for a limited period of time and Observability relates to the extent to which the results derived from using an innovation is visible by others [46]. This study only focused on Compatibility, Relative Advantage and Complexity as, according to past studies, they are particularly relevant to the adoption of technical innovations like Blockchain [47].

*Complexity* can be defined as the extent to which an innovation is perceived to be difficult to use and understand [45]. Past studies found complexity to negatively impact one's intention to use technology [48]. With regards to blockchain, there appears to be a lack of common terms, industry standards and definitions with regards to the technology, which contributes to a limited understanding of the technology by potential users [49]. It is therefore important to better understand how complexity influences adoption.

The ability of an innovation to conform with the existing values, beliefs, habits and experiences (past and present) of the user is known as its *Compatibility* [45]. Therefore, the compatibility of an innovation with a user's lifestyle positively affect its adoption [47]. Agarwal et al. [50] found that users' previous experiences with similar technologies influence adoption. However, the adoption of blockchain is relatively new in developing countries, hence the need to better understand how compatibility can influence adoption.

*Relative Advantage* relates to the extent to which an innovation is perceived to be more beneficial than its predecessor [45]. The relative advantage of an innovation is said to have a positive effect on its adoption [45]. While literature has mentioned some benefits of adopting blockchain in the financial sector in general, it would be interesting to further explore relative advantage of blockchain in AWM sector in a developing country context.

The *External Environment* variable relates to external macro factors that may affect the adoption of an innovation [51]. The adoption of an innovation is influenced by how competitors, regulations and the specific industry characteristics affect the organizations, and these are identified through the external environmental context [51]. As a result, the external environmental context allows for the analysis of both the opportunities and constraints affecting the adoption of blockchain [52].

## 4 Methodology

The study has relied on an interpretivist paradigm to understand perceptions around blockchain adoption [53]. Interpretivism was chosen as it focuses on collecting information as a quest to understand the fundamental meanings which underline the social world [54]. A qualitative research strategy was deemed relevant as it is particularly suited for the understanding of people's perceptions as these cannot be easily translated into quantifiable data [53].

Semi-structured interviews were chosen as the most-suited research method as they rely on open-ended questions and allow for follow-up questions to further explore the

topic under investigation [55]. The interview questions were formulated based on the theoretical framework. In particular, questions around complexity, compatibility, relative advantage of blockchain were formulated to explore how these influenced the adoption of the technology in the AWM sector. Questions were also formulated to understand how the external environment (e.g. work context) in which the respondent operated influenced blockchain adoption.

In contrast to purposive sampling, which involves the deliberate choice of participants based on their characteristics [56], a convenience sampling strategy was employed for the study [57]. This was mostly due to limited access to relevant experts from AWM organizations and time constraints. The target population was defined as experts from the AWM industry sector in the Western Cape, South Africa. Moreover, participants had to be from organizations that were currently using or preparing to adopt blockchain. The study was cross-sectional and data collection took place over a few consecutive weeks within June/July 2018. The sample consisted of six respondents, see Table 1:

**Table 1.** Respondents demographics

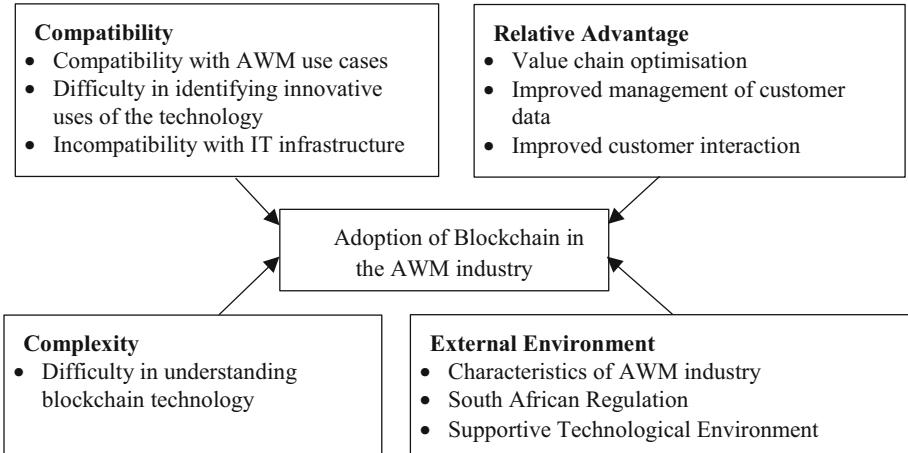
Alias	Position	Qualification	Experience
Adam	Business specialist	BSc, MBA	20 Years
Bob	Lead product manager	Business science degree	>3 Years
Cam	Portfolio manager	Bachelor of commerce	12 Years
Col	Head of enterprise solutions	Bachelor's degree, PGDPM	14 Years
Dave	Strategic assistant to CEO	Bachelor of commerce	8 Years
Eve	CIO	IT, MBA	20 Years

After having transcribed the interviews, analysis was conducted using a thematic approach to data analysis [58]. Thematic analysis was deemed relevant as it can be used deductively, in conjunction with a theoretical framework [58]. Analysis was conducted in line with the six phases of thematic analysis [58]: *Familiarization with the data, Coding, Searching for themes, Reviewing themes, Defining and naming themes, and Writing up*. Ethical approval was obtained prior to data collection. Participation in the study was voluntary and the anonymity of participants was preserved.

## 5 Findings

### 5.1 Compatibility

In the context of the AWM industry (Fig. 2), compatibility of blockchain relates to the technology's ability to align with the requirements of relevant use cases within that industry as well as the existing IT infrastructure. While participants could identify some known blockchain use cases for the AWM sector, they also mentioned that in some cases, there is difficulty in identifying innovative use cases beyond the traditional ways of doing things. Blockchain was also found to be incompatible with legacy IT infrastructure.



**Fig. 2.** Summary of findings

**Compatibility with AWM Use Cases and Business Cases.** Participants explained that the process of tokenising assets and shares using a token assists with ascertaining ownership: “...you now have a digital representation of that [asset], which is immutable and it's decentralized...” [Bob]. Moreover, through a token, assets can be separated and sold in portions, enabling customers to invest in portions of assets such as property. These assets are then recorded using blockchain: “...the record of their holding is recorded in that distributed ledger...” [Col]. Through the use of a smart contract, customers would be able to receive returns on the portions that they have invested in: “...it opens up the possibility of much more fluidly trading these assets and trading fractions of these assets and also opens up an opportunity for people who previously wouldn't have been able to have a share in such large assets” [Bob].

Another use case mentioned by two participants relate to the use of blockchain as an alternate way of generating revenue. Through the use of Initial Coin Offerings (ICO) and crowdfunding on a blockchain platform, AWM organizations may be able to benefit from the increase in speed and volume compared to generating revenue through an Initial Public Offering (IPO). This use case positively influences the adoption of blockchain as asset and wealth managers realize that they can generate more revenue using blockchain.

The idea of using blockchain to create self-sovereign identities within AWM was mentioned by two participants. These participants felt that currently, it is difficult to invest internationally. By using blockchain to create digital identities for customers and asset and wealth managers, the ability to trade over international borders becomes easier as it relies less on central authorities such as banks and regulators: “it drives a consumer view that for my kind of wealth management I would like to invest as seamlessly as possible...” [Eve]. The compatibility of blockchain to support this use case was perceived as having a positive impact on the adoption of blockchain within AWM.

**Difficulty in Understanding Innovative Use of Technology.** Participants mentioned that one of the challenges of the AWM industry is the difficulty in understanding how blockchain technologies could be useful beyond the traditional ways of doing things,

especially in developing countries: “...our challenge is that we’re thinking about asset management in the traditional sense. We need to break that thinking completely to get the best out of this technology. It’s not thinking about your fund mandates or your traditional customer” [Col]. They expressed the need to further explore new use cases, that particularly suit their unique needs.

**Incompatibility with IT Infrastructure.** Blockchain was not found to be compatible with the legacy infrastructure of large AWM organizations, resulting in a barrier to adoption: “We as a business are not agile when it comes to shifting... when you have records for 20 years of business records and 20 years of performance numbers, for example, having that continuity doesn’t help” [Col]. [Dave] also stated that “...the minute you come into a corporate environment you’ll be brought down by their legacy and by their hoops that you need to jump through.”. This implies that the integration of new technologies like blockchain within legacy IT infrastructure is being seen as a challenge and therefore has a negative effect on blockchain adoption.

## 5.2 Complexity

*Complexity* can be defined as the extent to which an innovation is perceived to be difficult to use and understand [45]. In the context of the study, it relates to the perceived *difficulty in understanding the blockchain technology*.

**Difficulty in Understanding the Blockchain Technology.** All participants made statements relative to this theme. The study found that the less the participant was involved within the IT space, the less their understanding of the technology. Participants stated that there was still a lack of understanding outside the IT and innovation sphere within the organisation. For example, participants from non-IT background stated: “I battle to understand it [blockchain]” [Cam] and “...our tax guys and our legal guys kept asking what this thing [blockchain] is...” [Eve].

## 5.3 Relative Advantage

*Relative Advantage* relates to the extent to which an innovation is perceived to be more beneficial than its predecessor [45]. In the context of the study, the aim was to investigate the relative advantage of blockchain to solve challenges or improve the current processes within the AWM industry. The sub-themes pertaining to relative advantage include *Optimised Value Chain*, *Increased liquidity*, *Improved management of customer data* and *Improved customer interaction*.

**Optimized Value Chain.** Within the context of the study, value chain optimisation refers to the removal of inefficiencies within operational processes in the AWM industry. According to participants, the AWM operational process contains many layers, leading to many inefficiencies: “If you look at the value chain in asset and wealth management, there’s so many players, and everybody takes a piece.”. Participants specified that blockchain could optimize the AWM value chain through transactional interdependency.

Transactional interdependency refers to investments and transactions without the need for asset and wealth managers. This could be done with the use of smart contracts as mentioned by Adam, “*...if you think of your automatic buys and sells, all that stuff that the analysts look at in those asset management companies, I think that all that could be written into your smart contracts and automatically executed...*”. Essentially, creating a blockchain product and separating that from the advice and administrative aspect that asset and wealth managers offer, would allow customers to make investments themselves and only pay for the aspects of AWM that they value.

Disintermediation refers to the use of blockchain to collapse the value chain by automating of the various steps within the operational process: “*...a way that you can streamline the value chain more and get rid of intermediaries. So, for example, why do you need a clearing agent? Why do you need a pricing agent? Those are things that you could automate on the blockchain and then you basically get rid of those intermediaries*” [Dave]. Participants saw this as way of improving efficiency by reducing the time and cost involved in validating information across intermediaries: “*people will speak about general efficiencies through the technology and through disintermediation...*” [Bob]. Both transactional interdependency and disintermediation are being perceived as ways to optimize the value chain and derive benefits from blockchain adoption in the AWM industry. However, it is interesting to note that participants seem to perceive that intermediaries (i.e. people) can be replaced by blockchain technologies, even though they fulfill important roles (e.g. pricing and clearing agents).

**Improved Management of Customer Data.** Participants found the process of capturing and retrieving data to be difficult within AWM organizations. Furthermore, they perceived blockchain as a potential solution to this as it could allow for data to be consolidated across the value chain: “*...you can't have a consolidated view of anything from different companies giving you something, but if everyone was on the blockchain you should be able to do that...*” [Dave].

**Improved Customer Interaction.** As noted by participants, there is a definitive shift within the financial services industry to improve customer experiences. It was found that there is potential for blockchain to improve the overall customer experience: *it [blockchain] would improve the customer experience...*” [Adam]. For example, participants mentioned that blockchain is being looked at as a possible solution to improve client interaction by allowing customers to manage their data and their funds through the technology: “*a lot of innovation is going into that space to create a simple product and process, so a customer can basically manage themselves and if you have that full self-service there, the back-office requirement becomes smaller. So, there's more value for the client*” [Eve]. The perceived benefits offered by blockchain to improve customer interaction will have a positive effect on its adoption.

## 5.4 External Environment

Three themes were identified relative to the effect of external environment on blockchain adoption within the AWM industry in the Western Cape: *Characteristics of the AWM industry, South African Regulations, and Supportive National Technological Environment*.

**Characteristics of the AWM Industry.** Participants of the study described the AWM industry as open to collaboration but risk averse. Participants expressed the need to collaborate with Financial Technology (FinTech) organisations in the financial industry to better position the AWM industry for blockchain adoption. They felt that companies that are internal to their group should also act as an external FinTech: “*that’s what gives us great leverage is that we are not an external entity, we’re an internal entity that behaves like an external entity so we can navigate all the internal networks...and you need that so we can leverage both worlds and it serves the group very well.*” In their view, this would allow for further collaboration with external FinTech as the internal FinTech can act as a mediator between the AWM organisation and the external companies: “*then when we don’t have all the skills internally there’s lots of room for us to partner with specialist companies...*”

Participants felt that the AWM industry is risk averse and conservative in nature: “*... [Company X] by its nature is more on the conservative side*”. Participants further qualified the AWM industry in general as not very focused on following trends: “*I just don’t think that from a corporate application stand-point that we’re as progressive as the start-ups...*” [Bob]. They are therefore less inclined to adopt technologies which they perceive as being “hype”.

**South African Regulation.** The regulatory environment within South Africa was identified by participants as a factor affecting the adoption of blockchain in the AWM industry. Participants felt that regulators are willing to partake in the development of the technology, as mentioned by Bon and Eve: “*...South Africa definitely has a favorable stance towards blockchain technology...*” [Bob] “*we’ve got a regulator that understands that they need to stay abreast of things...*” [Eve].

Additionally, the Reserve Bank, the Treasury and the Financial Sector Conduct Authority (FSCA) have come together to create an Intergovernmental FinTech Working Group whose sole purpose is to promote the development of new technologies with the involvement of government and regulators. Therefore, there were participants who saw South Africa’s regulatory environment as that having a positive effect on blockchain adoption. However, some participants also saw regulation as having a negative effect on blockchain adoption: “*you have guys who ... have serious regulatory matters to deal with like fraud etc. But I asked the question do they truly understand technology that’s happening out there...*”. Furthermore, it was perceived that South African regulators are more open to blockchain compared to other countries because they do not understand the threat it could pose to traditional AWM: “*...the only reason our view is different is because I think we know less about blockchain and the threat that it could pose...*”.

**Supportive Technological Environment.** Participants felt that South Africa is ranked highly in terms of its’ technological environment: “*... South Africa is an interesting ecosystem. And once you look underneath the hood, you actually find that they are a lot of projects happening here... So generally speaking, we are quite far ahead*”. Organisations in Cape Town promote the development of blockchain by organising community outreach programs (e.g. hackathons and meetups) to educate and further improve perceptions towards future adoption of the technology. Some of these activities are specifically geared towards the development of blockchain adoption.

## 6 Discussion and Future Studies

The study has identified preliminary findings around the factors influencing the adoption of blockchain in the AWM industry sector in the Western Cape, South Africa. It was interesting to note that while participants were able to articulate known use cases and business cases for blockchain in the AWM industry, they also found it difficult to identify more innovative ways of using the technology beyond what is currently being advocated in the financial sector. Therefore, the next phase of the study will further explore how the AWM industry could further exploit blockchain to better suit their needs within a developing country context.

In spite of the complexity of the technology which non-IT stakeholders found difficult to comprehend, blockchain was found to have relative advantages which positively influence adoption. For instance, the AWM industry seemed to find blockchain's ability to improve customer data management and customer interactions to be particularly useful. This is in line with past studies that stated that financial organizations in developing countries could benefit from elimination of intermediaries [25] and reduced transaction costs [22]. The next phase of the study will further explore the needs of the clients of the AWM industry within the developing country context. This might also help with the identification of innovative use cases for AWM industry in the developing country sector. Participants of the study felt that while leadership and regulators are supportive of the technology, they might not be aware of the implications and challenges to the adoption of blockchain for the AWM industry. Past studies have found that for blockchain to be successfully adopted, the support of regulators is required [27]. They need to know of the cost implications especially around infrastructure [26]. It is therefore crucial for regulators to truly understand the blockchain technology in order to formulate sound policies for the industry. While it is encouraging to note that AWM stakeholders feel supported by South African regulators, the next phase of the study will further explore the extent to which regulators truly understand the technology and how that understanding is achieved.

## 7 Conclusion

There is a need to further understand the adoption and use of the blockchain technology within the context of developing countries. There are some unique factors that affect the adoption and use of the technology within that context and more studies are required to unpack them. This paper described the preliminary findings of a longitudinal study to explore the adoption and use of blockchain within the AWM industry in South Africa. Through a qualitative exploratory study, AWM experts were interviewed, and the findings were analysed using thematic analysis. A preliminary framework proposed highlighted the factors that influence adoption of blockchain within that context. The purpose of the preliminary framework was to highlight key areas that need to be further explored to better understand blockchain adoption within that context. Furthermore, it also allowed for new avenues for research which will lead to a more holistic understanding of blockchain use in the AWM industry in South Africa. It must be noted that a limitation of the study is that only six respondents were interviewed. As a result, definite

conclusions cannot yet be drawn from this small sample. In the second phase on this study, a larger pool of respondents will be identified through purposeful sampling to better understand the factors affecting blockchain adoption as well as the reasons “why” these factors are relevant.

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# Evolving an Efficient and Effective Off-the-Shelf Computing Infrastructure for Rural Communities of South Africa

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**Abstract.** Information Communication Technologies (ICTs) have diffused into almost every area of life for citizens living in the Global North. Data is seen as a key element in the fourth industrial revolution and is the foundation of Information, Knowledge and Wisdom. Knowledge has become the new “make or break” asset and an inability to access the world’s data and technologies that facilitate access, synthesis and interrogation of data places one at a disadvantage. In 2013, the Department of Communications in South Africa announced a new national broadband policy to promote the reduction of a digital divide and support citizens and the economy in digital interactions. Implementation has thus far not been successful. Furthermore, the Broadband policy does not address how South Africans are to access the Internet once available. The Siyakhula Living Lab (SLL) provides an example of a computing infrastructure model for the introduction of ICTs into rural communities. Through the deployment of “broadband islands” and low-cost computing infrastructure to promote both knowledge creation and consumption, access to the proposed ubiquitous Internet connectivity can be unlocked. However, the initial computing infrastructure deployed to the SLL suffers from a single point of failure. In this paper, we discuss alternative computing infrastructure configurations that were tested and deployed within the SLL in order to determine a more appropriate computing infrastructure model for the SLL and potentially other rural South African communities; such that learners, teachers and community members can be active contributors and consumers of data, information, knowledge and wisdom.

**Keywords:** ICT4D computing infrastructure · Broadband islands · Low-cost computing infrastructure

## 1 Introduction

For citizens of the Global North, Information and Communication Technologies (ICTs) have diffused into almost every area of human life; urban cities are becoming virtual playgrounds for technologists to develop and deploy ‘smart’ applications that can enhance the lives of city dwellers [1, 2]. In 2013, IBM reported that 90% of the world’s data had been generated in the last two years, and that 2.5 quintillion bytes of data were being generated daily [3]. Gartner predicts as many as 20.4 billion connected devices in the year 2020 [4]. Data is seen as a key element within the Fourth Industrial Revolution [4]. The notion of a Data-Information-Knowledge-Wisdom hierarchy that details how data leads to information, which in turn leads to knowledge and finally, to wisdom, was first posited by Ackoff in 1989 [5]. In this hierarchical model, Data is the foundation of knowledge and wisdom. Coupled with this, are the notions of knowledge revolution, knowledge society and knowledge economy; all of which grow out of access to vast quantities of data. In this new era, knowledge becomes the new “make or break” asset. An inability to access the world’s data and the technologies that help to unlock, synthesize and interrogate that data therefore place one at a great disadvantage. Upliftment of rural areas and poverty alleviation are a priority for development in South Africa and information and knowledge are key strategic resources for social and economic development. ICTs are important tools in development, assisting in enabling change through economic development [6]. Access to information and by association the data from which it stems is seen as central to technology, the economy, work, space and culture [7].

Most countries in the Global South nonetheless possess nowhere near the same level of access to ICTs. Despite its relatively strong economy and First-World infrastructure in metropolitan areas, South Africa has an average Internet penetration rate of 35.2% (combining access at home, via cellphone, work and elsewhere), as per the 2011 Census (the most recent census conducted in South Africa) [8]. Similarly, only 19.4% of households reported having access to a computer [9]. This is largely due to poor ICT infrastructure in rural areas where a significant portion of approximately 37% of the population [10] live. The South African government has affirmed their commitment to drive the penetration of technology in the country. In 2013, the Department of Communications in South Africa announced a new policy called ‘South Africa Connect: Creating opportunities, ensuring inclusion. South Africa’s Broadband Policy’, as part of its national broadband policy to promote the reduction of the digital divide in South Africa and support South African people and its economy in digital interactions [11]. The implementation of the policy was officially launched at the beginning of 2015 [12]. The policy articulates the government’s aims to provide broadband access to 50% of the population by 2016, 90% by 2020 and 100% by 2030, with a universal average download speed of 100 Mbps by 2030 [11]. There are two key aspects of this policy: it prioritizes the closing of the digital divide; and it emphasizes the goal to create a strong skills base in the technology sector to produce contextually relevant content and applications. However, the policy does not specify how citizens are to access the ubiquitous connectivity once it becomes available; what robust, financially sustainable and easy to maintain computing infrastructure will be available for rural communities?

An example of the introduction of ICTs into rural and marginalized communities is that of the Siyakhula Living Lab (SLL). The SLL is a long-term experiment in connecting the unconnected and has been conducting research into providing sustainable, off-the-shelf and appropriate computing infrastructure in a rural community (targeting schools particularly) of South Africa. The SLL has worked to introduce computing infrastructure, connectivity and digital services. This paper details the experimentation and evolution of the computing infrastructure deployed in the SLL. Over the course of the project, the following requirements were identified as key in providing computing infrastructure within schools: first-line maintenance must be possible by non-IT specialists (either teachers or local community members); IT infrastructure, should be easily healed, as well as robust (more like a mobile phone than the classical desktop); and the price of each end-user device must be as low as possible in order to allow a reasonable number of stations to be available (30 workstations in a school of 800 learners would be less effective than 100 workstations).

The thin client computing model that has been employed in the SLL failed to fully meet all these requirements. As a result, an investigation was conducted into computing infrastructure configurations that could more readily be healed, improve up-time and performance (through the provision of increased hardware resources) as well as ease maintenance. Furthermore, the computing infrastructure should offer a scalable solution in order to readily support a growing number of clients but without significantly increasing the costs. This paper is broadly divided into three parts, the first discusses the SLL, its methodologies and the original computing infrastructure deployed. The second details the various experiments conducted and the third discusses the proposed computing infrastructure model for use in rural communities within South Africa.

## 2 The Siyakhula Living Lab

The SLL is in the rural Eastern Cape province of South Africa and has been operational since 2005 [13]. The site covers a geographic area of approximately 15,254 hectares and had approximately 15,000 people living in villages in the area [17]. Computers and network infrastructure have been deployed to 17 schools across the region and are available for use by the community. Thin-client computers and Internet connectivity are provided through a WiMAX local loop access network and a VSAT connection to the Internet [6]. The SLL is structured such that it is a quadruple helix partnership of academia, industry, government and the community. The purpose of the SLL was twofold: (1) to develop and field-test a distributed, multi-functional community communication platform (now called Teleweaver) to deploy in low income, marginalized communities in South Africa and (2) conduct applied Information Communication Technology for Development (ICT4D) postgraduate research work in the two departments of Computer Science at Rhodes University and the University of Fort Hare, through the support of the Telkom Centres of Excellence (CoEs) programme, producing technically skilled human resources in ICT. The SLL is a multidisciplinary initiative incorporating researchers from Computer Science, Information Systems, Education, African Languages, Communication, Anthropology and Sociology. The research team and local community believe that ICTs in low income and marginalized areas can facilitate: *poverty alleviation; development*

*of local economies; the achievement of basic standards of health, education, access to governmental services and other developmental infrastructure and services; the encouragement of people (through empowering them) to invest in themselves and their communities; and cultural regeneration, including the development and integration of indigenous knowledge systems into a community’s “ways of doing and learning”.*

The word “Siyakhula” means “we are growing” in isiXhosa, the primary language spoken in the SLL community. The name of the project was chosen by the local community and encompasses some of the values underlying the project. In order to ground the research properly in the local context, the SLL employs the ‘living lab methodology’, that is “an approach that deals with user driven innovation of products and services that are introduced, tested and validated in real life environments” [14].

Living labs are, by definition and very nature, research initiatives that require researchers from universities (or research institutions) to partner with local communities in order to effect the desired changes or the creation of desired “products”. As such, the living lab methodology is very closely aligned with participatory action research, where the researchers from an institution work as partners with the communities that they seek to assist in either developing or producing products or services that are needed by those communities. Furthermore, each project or development endeavor undertaken by the researchers and the community can each be seen as a case study – an empirical investigation in a real-world setting [15]. Finally, because of the long-term nature of the Siyakhula Living Lab – more than a decade – it is also a long-term empirical experiment [16].

## 2.1 Mbashe Municipality

The SLL is in several villages in the Mbashe Municipality of the Eastern Cape Province of South Africa (located within the former Transkei Homeland), adjacent to the Dwesa-Cwebe Nature reserve. The natural environment of the area (the reserve and the unspoiled coastline) are assets for the community and have the potential to promote Eco-tourism in the region. In addition, the rich soil and high levels of rainfall make the region lucrative for controlled agricultural intensification and commercial forestry [17]. Despite these natural assets, the municipality and the region are still plagued with remnants of the past. The former Transkei was classified as a Homeland within the South African borders during Apartheid and systematically denied infrastructure and development. As such the region, like many rural areas (and particularly former Homelands) in South Africa is characterized by a lack of (or limited) electricity, telecommunication infrastructure, and poor road networks. Furthermore, service delivery in the area is poor and limited to basic education and health care. Seventeen local schools have been targeted in the SLL and house the computers and IT infrastructure of the SLL within their grounds. Facilities are available to teachers and learners during school operating hours and to the rest of the community after school, in order to support local education and rural life. For more about the SLL please see the following papers [6, 18].

## 2.2 ICT Infrastructure

In order to support the desired outcomes of the SLL (as discussed in Sect. 2), ICT infrastructure consisting of computer networking and information systems was deployed within the community. In order to build a local loop access network, wireless technologies were deployed as there was no fixed line infrastructure in the area which could be used. WiMAX, more specifically the Alvarion BreezeMAX technology, was chosen to build a wireless local access loop or a “broadband island” [19]. The communities access the SLL infrastructure and communications platform via the Digital Access Nodes (DANs) located at the participating local schools. As previously discussed, 17 schools were connected to the SLL ICT infrastructure, having initially begun with 5 [20, 21] and expanding over time [18]; eventually spanning approximately 400 km<sup>2</sup>. The local “broadband island” is connected to the Internet via VSAT links which the various schools and communities share, together with other services such as VoIP and shared local web content (for the purposes of education mainly, but with a view to increasing local services to other areas too, such as health and governance). VSAT was chosen because there is no fixed-line alternative and at the time, VSAT offered greater through-put than the isolated 3G connectivity in the area. It is worth noting, however, that the continued use of WiMAX as the technology used to provision the broadband island is limited. Only a few WiMAX products ever entered the market and as such are still rather expensive when compared with WiFi technologies. Furthermore, there are currently few telecommunication companies operating WiMAX technology on a commercial basis in South Africa, and given that it would seem that WiMAX has “lost” its battle to LTE (many networks in the USA which employed WiMAX have shut them down [22]), there seems very little chance that WiMAX technologies will be deployed on a large scale anywhere in the world. Large scale deployments of LTE, fixed LTE and WiFi networks are more likely. For greater detail about the SLL networking infrastructure please see [2, 6, 18, 20, 23].

Since its inception, the SLL has used a thin client topology as a primary means of computing infrastructure. Furthermore, free and Open Source Software solutions (operating systems and user applications) were chosen as they are cost effective, robust and promote access to knowledge (i.e. users are able to see the source code, understand how software works and modify it (or get members of the SLL team to modify it) in order to better meet their needs). A thin client computer is one which depends primarily on a central server for all its processing activities and software needs in order to collect input from the user (to the applications running on the server) and convey the output (from the application on the server) to the users and data storage facilities. The thin clients are diskless, which means that they have no software installed on them nor are they able to suffer from hard-disk failures. Using Preboot eXecution Environment (PXE) enabled network cards, thin clients can request the necessary software for booting from the central server. A thin client architecture was chosen over thick clients because they are cost effective and more easily sustainable. The “standard PC” was the chosen computing infrastructure over that of the trendier tablet PC, for three reasons. Firstly, there was a historical aspect to that choice. When the SLL began in 2006, the use of smart mobile phones was limited (widespread adoption beginning in the late 2000s), while widespread consumer uptake of tablet PCs began in 2010. Secondly, smart phones

and tablet computers are personal devices, while a more generic desktop computer (even if a thin client) can be more readily thought of as a shared commodity. Thirdly, and finally, we believe that users in rural communities will derive much more benefit from being producers of information and not just consumers of information. High end mobile phones and tablet PCs are devices that essentially promote the consumption of information but do not readily afford production of information – for example, it would be tedious to attempt writing this paper on a tablet PC rather than at a computer with a keyboard, monitor and mouse. As producers of information members of the school and local communities can actively contribute and take part in the digital networked society [24]. It is not to say that this will not change in the future; as technology advances manufacturers might provision new methods in order to support mobile devices being more readily useful in the production of information/knowledge and artifacts.

The choice of software used in the schools is coupled with the choice of running thin client computers; Edubuntu Linux. Firstly, Edubuntu is an operating system aimed at education and the computing infrastructure is in local schools. Edubuntu was developed in collaboration with teachers and technologists from multiple countries. The educational applications are aimed at users aged 6 to 18. Secondly, Edubuntu ships with Linux Terminal Services Project (LTSP) as standard which allows thin clients computers to boot off a central server running the LTSP service. Thirdly, Edubuntu Linux is Open Source Software, which means that source code of the software is available to the user; affording them the opportunity to study and change the software and then redistribute to others. Finally, the Edubuntu Linux operating system, together with several other user applications, such as the LibreOffice Suite and the Firefox web browser, are available in some of the South African local languages, such as isiXhosa [25].

### 2.3 Shortcomings of the ICT Infrastructure

The advantages to thin client computing are numerous and include: 1) being easy to deploy as they require no software installation; 2) provide single sign-on, so any workstation can be used to access accounts and files; 3) afford the opportunity to use older PCs as thin clients or low-cost minimalist hardware both of which reduce the cost of the computing facilities; 4) offer reduced security threats; and 5) they are easier to maintain as only the server needs to be maintained. The disadvantages of this model are that the server typically carries a large computational load, specifically to its CPU, memory and network interface in order to support all the clients, and, most significantly, is a single point of failure within the configuration. This means that if the server fails for whatever reason, the computing infrastructure within the DAN is rendered useless.

From the monitoring graphs that were generated early on in the SLL project, it could be seen that during peak times when the labs were full and the majority of the clients were being utilized, the CPU of the central servers were utilized at 100%. Furthermore, during the same peak time slots, the amount of free memory available was minimal, indicating that each server's memory was also being heavily utilized. Meanwhile, during those same peak time slots, there was increased network activity on the network interfaces, which is to be expected as there would have been a lot of network traffic during those times as the clients were communicating with their central server and the server sending data back to the clients. The graphs indicated that the biggest effect of the increased

load was to the CPU and the available memory. As such, there are two problems that were identified with the thin client computing infrastructure topology used in the SLL, namely, the single point of failure of a server, together with the high demand on the CPU and memory resources of a server when servicing multiple clients. A possible solution to provisioning more computing power (in terms of CPU and memory resources) would be to investigate the usefulness of both cluster and grid like solutions. Furthermore, both computing infrastructure paradigms could be possible solutions to provisioning a more easily healed computing infrastructure and it is possible to build clusters and grids out of refurbished or low-end computers, reducing the overall cost implications.

### 3 Methodology

There is consensus among researchers that Information Systems research has a dual vocation, to make theoretical contributions and address real-world problems of practitioners [26]. Sein et al. [26] propose a research method called “Action Design Research” (ADR) that recognizes information technology artifacts as being “shaped by the interests, values, and assumptions” of the developers, users and funders of the artifacts [26]. ADR is thus defined as “a research method for generating prescriptive design knowledge through building and evaluating ensemble IT artifacts in an organizational setting”. It deals with “two seemingly disparate challenges”:

“1) addressing a problem situation encountered in a specific organizational setting by intervening and evaluating; and 2) constructing and evaluating an IT artifact that addresses the class of problems typified by the encountered situation” [26]. The multi-disciplinary and living lab nature of the SLL are congruent with this understanding of research and development of IT artifacts within the setting of the SLL.

The thin client computing model deployed throughout the SLL DANs suffered from a single point of failure. When the thin client servers failed, the computing infrastructure within a DAN was rendered useless. The single point of failure needed to be eliminated (or the system needed to be more easily healed in the event of a failure), while improving overall hardware utilization and maintaining financially sustainable computing infrastructure that supported the IT needs of the schools and local communities. To begin with, an investigation into the use of ICTs in teaching, learning and education (in general) was conducted by researchers from the universities in order to understand the theories of use of technology in teaching and learning, together with the lessons learned from previous research studies. This was then coupled with a historical investigation of the computing infrastructure already in place in the SLL in order to understand the problems with the then current systems, as well as a survey of six participant SLL schools and 12 teachers (two from each school). The survey included questionnaires and semi-structured interviews investigating the use of technology for teaching and learning purposes within the six schools. Using all of this data, researchers from the universities were able to gain a deeper understanding of the nature of problems being experienced with the SLL computing infrastructure (in addition to the single point of failure, which was the biggest problem). They were also able to establish what teachers wanted to obtain from available computing infrastructure as well as gain understanding from other research projects so that we might be able to learn and apply their lessons in our own context. Consequently,

the initial design for the new computing infrastructure was to replace the single servers with a cluster or grid server.

The use of clusters or grids would help to improve the ease with which the computing infrastructure can be healed and build redundancy and high availability into the system. The purpose was to retain the benefits of thin client computing, while making the infrastructure more easily healed and increase the available computational resources of the computing infrastructure without increasing the overall costs. While thin clients can be acquired relatively cheaply a thin client server can be expensive. It should be noted that a server with a minimum of 4 GB RAM – preferably more – would be needed. The use of recycled desktops or server computers configured as cluster servers offer a cheaper alternative to purchasing new and expensive servers. Four cluster computer options and one grid-like configuration were investigated, built and tested.

The cluster options were: *DNS Round Robin*, *Ubuntu LTSP Cluster*, *Single System Image (SSI)* and *Virtual Desktop*. The grid-like solution was Edubuntu fat/hybrid clients. During initial testing within a test laboratory setting, it was found that: 1) the Ubuntu LTSP cluster solution didn't provide much advantage over a standard DNS Round Robin solution; 2) the Single System Image was not designed to support desktop applications which often create multiple sub-processes, all linked to the parent process; and 3) the Virtual Desktop infrastructure required significantly more memory than other options thus making it more expensive. Consequently, only the DNS Round Robin cluster and the Edubuntu fat/hybrid client grid-like options were tested further and later deployed into school environments within the SLL.

In order to test the performance and user experience of the two computing infrastructure configurations within the laboratory setting, Sikuli was used to simulate user interactions. Sikuli is a visual technology to automate and test GUIs using images (screen-shots) and/or key strokes; programmatically allowing you to control anything from a web page, a Windows/Linux/Mac OS X desktop application, or even an iPhone or Android application running in a simulator. Sikuli is an open source research project developed at the User Interface Design Group at MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) [27, 28]. User interactions with two common desktop applications, Firefox and LibreOffice Writer, were investigated. In the Firefox example, the application was launched, and a local web address entered (local to the cluster server, in order to remove time factors of accessing Internet-based web sites). Once loaded, the simulated user clicks on a link and then scrolls to the bottom of the new page and then closes Firefox. Similarly, for LibreOffice Writer, the application is launched and opens a local file in the user's home directory. The script then scrolls to the bottom of the file, saves the file and then closes the application. These are relatively normal desktop user interactions. Sikuli was installed on each of the server configurations tested (including a standard single server for comparison). Each client interaction was run 50 times (more than 50 iterations did not significantly improve the standard deviation) and the time taken captured in order to calculate averages and standard deviation in an attempt to quantify the user experience in terms of interaction times. Furthermore, each server was monitored in order to assess the load on the CPU and Memory. Tests were conducted using a DNS Round Robin cluster, an Edubuntu Fat/Hybrid client grid-like model and on a standard thin client single server configuration.

The results of the tests showed that memory is a bottle neck in LTSP thin client computing and that clustering the LTSP servers can provide the necessary computing resource requirements in order to serve a growing number of thin clients (see [29] for more details). Furthermore, utilization of LTSP fat/hybrid clients, instead of standard thin clients, further reduces the load on the servers, potentially increasing the life span of the servers and decreasing the rate of failure. For this reason, each of the two alternative configurations was deployed to the real-world setting of a DAN (school) in the SLL, and then compared with a standard server installation, using a powerful Quadcore Xeon with 16 GB of RAM as the single central server at a third DAN (school). In order to assess the performance of each of the server configurations, a Multi Router Traffic Grapher (MRTG) software was used to monitor the load on the various hardware resources for a period of four weeks; specifically, the CPUs, network interfaces, memory, disk utilization and the number of processes running at any given time on each configuration.

The graphs for the DNS Round Robin cluster revealed that separating the LTSP service from that of the file sharing services significantly reduces the load on the file serving node, unsurprisingly. It was also noticeable that the load on the LTSP nodes was greater than the node responsible for file serving and authenticating. However, there was still a considerable amount of network traffic being sent to and from the file serving node (as one would expect). Unfortunately, the DNS Round Robin cluster was unreliable in the real-world setting; two cluster nodes tended to fail to boot. The biggest problem faced with regards to computer hardware in the SLL is that users do not understand that computers are not like a home electric appliance, such as a toaster or a kettle, where you can just switch the device off at the wall, despite explanations from researchers. Furthermore, grid electricity to the SLL is very erratic and often schools in the SLL have long periods (longer than the available UPS could support) without electricity, without warning. Finally, the users struggled to understand the concept of the cluster and that, if possible, they should turn all the servers on. They would often just turn the file server on, and maybe one other LTSP server. Eventually a script was created to automatically power up the full cluster using Wake-On-LAN commands. However, due to power interruptions to the hardware and the associated impact, not all nodes were able to boot properly. That said, despite the issues with some of the nodes on the cluster, the remainder did run and were able to serve clients, providing a more reliable service to the users as compared to a single server when it fails to boot.

The graphs for the Edubuntu Fat/Hybrid clients revealed that the load on the CPU serving 26 Fat/Hybrid clients was not very high, especially when compared with the single server model from the initial configurations in the SLL. The maximum load seen on the original single central servers in a standard configuration was often at 100% for prolonged periods of time, while during the period in which the Edubuntu Fat/Hybrid model was monitored, the largest peak in CPU utilization was 89% over a shorter period and only ever happened once. In terms of memory utilization of the server, results were like those seen in the laboratory experiments, specifically that there was between 3.1 GB and 1.2 GB of free memory on the server (which had a maximum of 4 GB). There was also a lot of activity on the network interface of the server, but that is unsurprising, as the server is still responsible for serving the boot images to the clients, providing user authentication, and serving all the files, folders and root directories of the clients. The

graphs of the Edubuntu Fat/Hybrid server reflect that 4 GB of RAM can adequately serve 26 fat/hybrid clients as the load of providing the Desktop as a Service is delegated to the client hardware, freeing the server to act as a file, DHCP, and authentication server. It is also interesting to note that during the period of monitoring, significantly fewer server related errors were experienced as compared with a standard thin client server.

Lastly, when considering the graphs from a powerful, single server installation, the CPU load peaked at about 130% (the server has a quad core CPU; the CPU reading could go up to 400%), indicating that one of the CPU cores was saturated at 100% and another core was servicing the extra demand; one can see just how resource intensive serving 20 thin clients can be on a single server. This server had 16 GB of memory, and from the memory graph it was ascertained that the server was utilizing a maximum of 4 GB. With more data over time and clients doing more memory intensive work, such as all 20 clients using Firefox, one might see greater dips in the amount of free memory available. The high-end server with its large pool of hardware resources is more than able to serve the 20 thin clients present at the school. However, the single server still represents a single point of failure, and the high-end hardware is expensive, meaning that having a spare server of similar capacity would be very expensive.

## 4 Lessons Learned

The purpose of providing a cluster server solution was to attempt to eliminate the single point of failure and make available more computing resources, especially memory, to the thin client computers at schools in order to improve the overall experience for the end user, without significantly increasing the overall cost of the server. In providing a DNS Round Robin cluster as the “server” to the thin clients, the total memory available to the thin clients increased significantly from 8 GB of RAM in a single server to a shared total of 16 GB (across the four LTSP nodes) as well as another 4 GB in the node serving files; effectively doubling the overall RAM available to provide the various services required by the thin clients. Furthermore, when comparing the average Free Memory of the original single central server to the average Free Memory of the cluster nodes the total average available (Free) memory to the thin clients via the cluster was nearly double (10.6 GB vs 5.7 GB). As such, the cluster was better able to respond to greater demands for memory from the thin client computers as compared to a single server with 8 GB of RAM. Furthermore, the LTSP cluster improved the availability and overall reliability of the LTSP service to the thin clients; if some of the cluster nodes were unable to boot the remaining cluster nodes were still able to serve the incoming requests from the thin clients. As a result, the computing infrastructure remained available to users, albeit in a more degraded state, as the service would be slower when serviced by fewer cluster nodes.

The DNS Round Robin LTSP cluster nonetheless added a level of unanticipated complexity to the computing infrastructure that the end users (teachers, learners and even community members) were unable to adequately navigate through. The idea that several servers, working together, were providing a functionality of one server confused them. As such, they were never sure what servers needed to be turned on in order to access the computing resources, despite being provided documentation and explanation.

Furthermore, the added complexity of the cluster solution made it harder for teachers to self-diagnose computing problems and even more so to effect repairs. In order to reliably provide an LTSP cluster server to a school and its community either more obfuscation needs to happen (placing the cluster in a “black box” so that user interactions are significantly simplified and all layers of complexity are abstracted away from them) or there needs to be a well-trained school technician in order to provide on-site support. The “black box” solution would remove the end user from the server completely, but would be, naturally, only a temporary solution. It would be much better to have locally trained on-site technicians.

Alternatively, to the provision of a cluster server, is to utilize the hardware of the clients on the network more efficiently, in a grid-like configuration. In the standard thin client model, the thin clients are dumb terminals which send the keyboard and mouse events to the server and display the corresponding changes from the server on the monitor. Thus, the only hardware being utilized on the client are the I/O devices, graphics card and network interface. The CPU and the memory of the client are unused. The fat/hybrid client solution allows for the utilization of these hardware resources on the clients. Clients still fetch all their content (operating systems, root device, user files and folders) from the server, but the operating system of the client, together with all the user applications run directly on the client hardware. Thus, the server acts as a file (of various types), DHCP and an authentication server. This significantly lessens the load on the server and makes better use of all the available hardware resources. Unsurprisingly, the fat/hybrid clients deployed in the SLL were typically faster in their response times and interactions than the standard thin clients at the other test sites.

## 5 Proposed Model

Drawing from the findings of the laboratory experiments and the real-world deployments within the SLL, together with feedback elicited from the users, the recommendation is to revise the computing infrastructure model for the SLL to consist of a single Edubuntu LTSP fat/hybrid client server, together with Edubuntu LTSP fat/hybrid clients and a back-up server in order to address the single point of failure. Furthermore, the server (and the back-up) should be configured to offer file sharing services to other non-fat/hybrid clients (such as using SAMBA) in order to facilitate users’ access to their files and folders regardless of the device from which they are operating. In addition, the servers can be configured to provide access to other services like a proxy service in order to conserve Internet bandwidth, distributing it equitably and exercising some control over content. From interactions with the users it was ascertained that the schools and communities required several computing clients in order to facilitate the demands from the various users. Fat/hybrid clients, like thin clients, allow schools to purchase several low-end computers or refurbished computers as the clients and lessen the load on the server. As such the need for a powerful server is mitigated, as the memory and CPU load are spread across the clients. Naturally, it is critical that the clients are at the correct price/performance point. A fat/hybrid client configuration also facilitates ease of maintenance because there is only one computer to maintain; the server. All the clients are still reliant on the server for retrieval of their OS, application software, files, folders and authentication.

In order to provide reliable computing infrastructure, we propose the use of a backup server. The server would not be active until such time as the primary server fails. The server should be configured to boot once a day, preferably at night when the school infrastructure is not in use, to synchronize all the hard-disk changes on the primary server (so that as little data as possible is lost in the event of the primary server failing) as well as update its own operating system. Should the primary server fail, a remote technician could talk a teacher through swapping the failed server for the back-up, and the technician could possibly perform basic remote configuration in order to replace the primary server in functionality. This would improve the availability of the computing infrastructure and provide time for the technician to effect repairs to the primary server, which would then be re-introduced as the new back-up server. Naturally, a fully automated solution is also possible. However, based on the experience accumulated over the years of the SLL being operational, it is important that the automatic solution is not “brittle” and does not introduce additional complexity. It is important to note that the ideal would be to have teachers or community members who are more proactive and take on greater responsibility for the facilities available and so are able to undertake more maintenance related tasks over time, thus requiring less assistance from remote support. One of the tenants of the SLL has been to promote this type of growth among the teachers and community members within the SLL.

Teachers also specified the need for educational based software, that supports their curriculum. While Edubuntu is not specifically designed for the South African curriculum, it does contain a significant proportion of the Free and Open Source Software for education within the image. This means that there is a lot to choose from for the teachers; specifically, there are over 45 different education packages available within the standard Edubuntu installation. Unfortunately, there is no specific list of pre-approved software that supports the South African school curriculum from the Department of Basic Education in South Africa. Teachers will therefore have to make their own choices about what constitutes appropriate software for their classroom activities. The best that the SLL can do for now is to make available as much of the free and open source education-based software as possible to the local SLL teachers. Edubuntu ships with Office productivity software (such as a Word Processor and Spreadsheet applications) together with web browsers for accessing the Internet, facilitating typical community user interactions as well. In addition, other research projects within the SLL have been developing appropriate applications to facilitate local community requirements, such as access to various government departments and services and promoting tourism through facilitating online sales of local arts and crafts. It is important to note that recently, Ubuntu has discontinued the Edubuntu spin-off. However, the same functionality can be achieved through a standard Ubuntu installation, installing both LTSP and all the education packages (it's just no longer being developed as a pre-packaged operating system solution).

In using WiFi networking, laptop computers, tablet PCs and mobile phones can be supported in accessing the network and the computing infrastructure resources available at a school as well as the Internet. Laptop computers can also be configured to boot as fat/hybrid clients on the network. This configuration would thus support laptops with data projectors for use in the classrooms in order to support the integration of ICTs

into teaching and learning activities. In addition, the server can be used to store off-line copies of on-line educational content and resources, such as Wikipedia, Project Gutenberg and the Khan Academy. Computing infrastructure of this nature would allow schools and their surrounding communities to access the proposed Internet resources that the South African government plans to deploy through the implementation of the SA Broadband policy; learners, teachers and community members can be active contributors and consumers of data, information, knowledge and wisdom.

## 6 Conclusion

In order to unlock the proposed ubiquitous access to the Internet as espoused in the National Broadband Policy of South Africa, citizens will need access to useful and sustainable computing infrastructure. By providing robust and reliable computing infrastructure for the proposed networking facilities at schools across the country, where teachers, learners and local community members can access those facilities, we can begin to bridge the digital divide in South Africa. To that end we propose the use of fat/hybrid clients together with a primary and back-up server as the computing infrastructure model for rural South African schools and communities. In this manner, the role of education, namely, to develop higher-order thinking, inquiry, collaborative problem solving and transmit culture, values and lessons of the past while preparing individuals for the world of information and knowledge, is extended to the wider community.

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# **ICT4D Discourse, Methodologies, and Theoretical Reflections**



# After the Smartphone Has Arrived in the Village. How Practices and Proto-Practices Emerged in an ICT4D Project

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**Abstract.** This paper presents a case study of an Information and Communications Technologies for Development (ICT4D) project in rural Bangladesh, and examines the emergence of new practices connected through a theoretical lens. Social Practice Theory and different concepts of place provide a middle-range theory frame for interpretation. Two groups of 100 women living in different remote villages took part in the project and received smartphones and training. The project also established a call center and delivered timely agricultural information by voice, apps and short message service (SMS). A mixed design was used to evaluate the project progress. A baseline survey was completed in the two areas before the project started. After one year, the two groups of women involved in the project and two control groups completed a questionnaire on smartphone use practices. Episodic interviews were also conducted with a subsample of 40 participants. Project participants developed new skills and meanings associated with smartphones, which contributed to enhanced communication practices. The new practices and the emerging proto-practices at a micro-level also resulted in new perceptions of time and place and new locations for personal presence and interaction. The use of Social Practice Theory in conjunction with insights from theories of place provides a transferable framework with which to identify and emphasize what is meaningful to individuals and communities in the relationship between skills, materials and ideas with respect to different social-technical initiatives. In this regard, Social Practice and theories of place provide new insights into the integration of Information and Communications Technologies (ICTs) in development projects.

**Keywords:** Social Practice Theory · Place · Placefulness · Gender and ICTs · Bangladesh

## 1 Introduction

The fact that international development projects are increasingly interested in using mobile technologies for ‘pro-poor’ solutions should not be surprising, given the explosive growth in mobile technology use in the developing world [1]. However, while there is

a growing body of research relating to mobile phones in developing countries, with few exceptions [2], the literature on Bangladesh is almost entirely limited to descriptive surveys about their use and assumed impact, with voice calls and SMS as the two functions of most interest [3]. However instead of mere description, ICT4D projects also require theory-based analysis in order to overcome the simple impact metaphor of technology, and to better grasp the socio-technical processes they activate at the individual and community level [4]. This paper examines whether and how a smartphone project in Bangladesh has been able to foster the emergence of new individual and community practices connected with smartphones. Social Practice Theory (SPT) is used to develop a micro-lens on a local sociotechnical system, in which sociomaterial practices are operationalized in terms of material, skills and images in both physical and virtual settings [5]. Moreover, given the specificity of mobile practices, insights from theories of place allow for reflections on the ‘experience of place’ [6, p. 28], and its effects on feelings and affects associated with connectivity [7].

## 2 Social Practice Theory

SPT, as presented by Shove and colleagues [8], has been used for the analysis of stability and in innovation of everyday life, especially with regard to the individual dimensions of sustainability. Shove and Pantzar [5] consider social practices as composed of a mix of *materials*: objects, technological devices embedded in particular situations and relations that endure across time and space; *skills*: operational capability, know-how; and *images*: meanings attached to a specific performance. The level of integration of these three elements can be used to distinguish between practices and proto-practices. Practices assume an active integration of the three components. In proto-practices, the three elements are not connected either because some elements are missing or disconnected ‘I know how to operate the mobile phone but I have no idea that a help service may exist’, or because they are no longer connected due to changes in their components.

In this paper, we focus on providing further nuance to SPT and we link the insights of SPT to concepts of place. We suggest that SPT can also be fruitfully employed to analyze the appropriation of smartphones in the village, in a new experience of ‘disembodied mobility’ [9, p. 561]. In this ‘placefulness’, mobile practices involve social-technical innovations that interact with and modify everyday mundane behavior [10–12].

## 3 The Complexities of Place

In studies of mobile phones, there has been particular interest in how mobile phones affect both physical and virtual senses of place. Mobile phone experiences in social-technical settings are considered to be different from those carried out in bounded physical locations with fixed technology such as personal computers or telecentres [13, 14].

However, ‘place’ is a complex thing. Drawing upon insights of geographers influenced by the seminal work of Hagerstrand [15], and later usefully synthesized by Giddens [16], concepts of place and mobility have influenced the study of the mobile phone and its effects [17–23]. Post-Cartesian time and space, which frame place and movement, are

in a state of relational production, dependent on such factors as time of day, seasonality, negotiations between people and objects, culture and of course, the particular social formation in which people live [16, 23–25]. The following number of place concepts are relevant:

1. Place as fixed points (e.g. a map of people's houses).
2. Place as locale, the 'settings of interaction' [16, p. 118], where daily life passages take place. For example, the village courtyard as a meeting place for men at one time of day, for threshing grain by women at another. Nowadays, this locale also has virtual overtones that mix geo-location at either end and the virtual.
3. Place as a response embedded with meaning, a 'sense of place', thus the idea of 'my home', 'my village', but also now 'my Facebook' [26–28]. As well, the concepts of settings of interaction as described above and 'sense of place' imply group-oriented, rather than individual forms of action via the phone [28].
4. 'Placefulness' or positive placelessness. This contrasts with negative ideas about placelessness, as a kind of disempowerment or homelessness [29]. Strong connections that exist virtually [4, p. 85] as hybrid assemblages of humans and artifacts, stretching relationally through post-Cartesian time and space [27] provide 'geo-imaginary' agency [30] within much larger global technological trends [31].
5. Gendered place affecting all the above. This structuring factor accords with ideas from feminist geography with its insights into place-based social reproduction under patriarchy in particular cultural and structural conditions [32–35].

Of these, the first three are more commonly discussed in ICT literature, while the fourth and fifth are of particular relevance here. Indeed, the constraints upon women are particularly relevant for research in ICT4D, since women are generally underprivileged, along with their dependents [4, 36, 37].

## 4 The Project in Context

Bangladesh has a population of approximately 160 million, of which around 80% live in villages in vulnerable regions prone to floods, cyclones or earthquakes, with consequent negative impacts on food security and livelihoods [37]. In this context, ICTs can be important tools for dealing with everyday needs and emergencies. Non-governmental organizations (NGOs) and government now view mobile phones as a tool for an information and knowledge-driven society [38], although the challenge is how to achieve this beyond aspirational discourse [39]. According to the Bangladesh Telecommunication Regulatory Commission, as at December 2015 there were 133 million mobile phone subscribers. Anecdotally, the majority of people have basic mobile phones (known as button, China, or touchphones), although smartphones with varying levels of advanced functionality are being adopted as prices drop. According to one report, 82% of adult males own a mobile phone, in contrast to 55% of women, and 34% of men access mobile Internet services in contrast to 13% of women [40].

A review of the literature on mobile phone adoption in Bangladesh in rural areas suggests that phones have impacted the lives of rural women in at least five areas, namely:

social security; social status; economic mobility; disaster and emergency response; and bridging the digital divide. However, recent studies are few in number. Studies note that access to mobile phones has the potential to contribute to increased pro-poor outcomes such as material affluence, improved health, education and livelihood outcomes, and reductions in travel times and isolation [37]. Gender is seen as central to discussions about improving life opportunities (including ICTs) in Bangladesh, because women are overwhelmingly poor and disadvantaged compared to men with respect to their rights, economic status and access to information [41].

## 5 Description and Aims of the PROTIC Project

PROTIC (Participatory Research and Ownership with Technology, Information and Change), is a collaboration between Monash University, Australia, and Oxfam, a major International NGO, through its affiliates in Australia and Bangladesh. It has been a five-year project (2015–19) to develop and implement an interactive smartphone-based information system capable of providing specialist localized agricultural information to women. While there are other examples of call center and SMS projects in the ICT4D context, the degree of participatory engagement (known as *gonogobeshona* in Bengali) in building knowledge and skills has provided a strongly sensitizing theory and practice frame for people-centred development research [42–44].

The project has been working in the far north-west of Bangladesh (Area1), and in the southern mangroves region (Area2), chosen because they represent different ecological systems. One hundred women in each project village were provided with smartphones. A community information service was established, providing messages by voice and text, with the ability to call agricultural experts in a call center for more information. Local NGOs provided training in the use of the smartphones and apps. Monthly meetings were held to provide community-based feedback and on-site training to reinforce messages has been provided. For example, training in animal vaccination and use of particular vaccines has been provided, allowing for mass inoculation of ducks in the village. This would not otherwise happen due to staff shortages in veterinary services. As well as this, there have been small-scale research projects conducted by local university students with the villages for the project in conjunction with local NGOs. As such, it has acted to highlight the potential for *gonogobeshona* with local communities to the universities and NGOs.

## 6 Method

A mixed methods approach was used. Survey data (2015 Baseline and 2016 follow-up surveys) and episodic interviews [45], have been used to examine the stability or changes in practices. Further insights, emerging from qualitative observation and analysis of secondary data are summarized in the discussion and conclusions section.

### 6.1 Baseline Survey

Questions concerning the ownership and use of mobile phones were included in a broad Baseline survey, conducted by Oxfam in 2015, in the two areas where PROTIC was to be

implemented. The survey, in Bengali with English-language coding, included questions on income, occupation, and health status at the household level. Other sections collected information on ownership mobile usage (i.e. material and skill components), and their use of mobile phones. Data was collected by trained interviewers.

The Baseline survey was distributed to 649 participants ( $N = 160$  in Area1;  $N = 489$  in Area2). The mean age and gender of respondents was: Area1 40.87 (SD 15.31), 39.4% men and 60.6% women; Area2 38.00 (SD 13.86), 36.2% men and 63.8% women. The data was checked for differences based on gender and no significant difference as regards mobile phone use was found, except that women contacted friends more frequently, whereas men were more likely to use the phone for calling abroad (probably India). Most respondents in both areas were housewives or farmers (>80%) and married (>85%). With respect to education, in Area1 and Area2 respectively, 42.9% and 37.9% were illiterate or could only sign their name, 25% and 19.4% could read and write or completed up to class 5, 22.4% and 22.6% completed up to class level 9. The remaining 9.6% and 20.1% had higher levels of education.

## 6.2 2016 Survey

To monitor the early effects of the project, a Bangla-language survey was administered in July 2016. The first section of the survey included open questions on the perception of what a smartphone is (the image component of practices), the second section collected information on frequency of use of smartphones (material and skill components), and the third section focused on practices and purposes of using smartphones. Data was collected by trained interviewers in conjunction with village intermediaries.

Respondents were from the two areas included in the Baseline, and included respondents involved in the project (PRgroup1 and PRgroup2) and two control groups (Control1 and Control2) with similar conditions that were chosen to check against any natural spread of smartphones or general improvement in information resources and practices. A total of 388 women from the four groups completed the survey. The main characteristics of the four samples are similar in terms of age, marital status and occupation. The women were mostly aged around 30 years, married (>88%) and the majority were housewives or carrying out agriculture (>80%). Overall, participants from project groups have slightly higher levels of education than participants from control groups. More than 70% of participants from project villages and more than 50% of participants from control villages stated they were at least able to read and write.

Quantitative data was analysed using SPSS. Chi square tests with the analysis of standardized residuals were used to identify significant differences among the four villages. Free-text answers to the question ‘What is a smartphone?’ (translated from Bangla into English) were submitted to content analysis to identify themes relevant to the investigation of the image component of practices.

## 6.3 Episodic Interviews

Episodic interviews were conducted at the end of 2016 and at the start of 2018. In order to reflect the diversity of the community on social and economic grounds, a purposive

sample was constructed with the assistance of local NGOs. Twenty women in each project group (40 in total) took part in each round.

The interviews covered areas of everyday life and technology. They were translated, transcribed and coded by experienced bilingual researchers using NVivo software for hermeneutic discourse analysis [46].

## 7 Results

Taken together, the results provide an overview of changes fostered by the project. The basic facets—access to materiality, skills and image—of smartphone practices are described. Evidence of new practices concerning family, livelihood, citizenship, micro-economics and sense of place are then presented.

### 7.1 Access

The Baseline survey showed that just prior to the start of the project the large majority of respondents had at least one mobile phone: 89.4% in Area1; 87.5% in Area2. Of these, the great majority of respondents who used the mobile phone used only a button phone: 92.8% in Area1, 93.1% in Area2. One year into the project, the situation remained constant in the control groups, whereas smartphones provided by the project are now used in PRgroup1 (93.8%) and PRgroup2 (96.7%).

### 7.2 Skills

At the time the Baseline survey was conducted, the vast majority of respondents knew how to use a button phone (87.2% in Area1, 87.4% in Area2) and some advanced skills were already present, especially in Area2, including the capacity to use mobile phones for music, movies and photos.

One year after the start of the project, the use of mobile phones for taking and exchanging photos and videos increased significantly in the project villages compared to the control villages. Participants from project villages were also watching more videos, playing more games and using calculation tools, even though these tools were already present in the button phone. From the point of view of understandings of place, the smartphone has had the clear effect of providing tools in a fixed point (the village, the home), as well as new locales for social activity and placefulness (for example, posts on Facebook, or virtual infotainment).

It is worth noting how the women developed their skills. In the interviews, there is only occasional mention of the initial training provided by the local NGOs. Time and again, however, the women mention some form of peer learning, from other PROTIC participants, their husbands, their children, and sometimes their neighbors. Here, the collective, rather than individual orientation of the women can be noted.

In the first round of interviews many women mentioned apps, even though several were hesitant about describing them and clearly lacked confidence in using them. By the second round of interviews, the women were more confident, both in talking about the smartphone apps they could use, and also in discussing new apps they had

identified. These apps included ShareIt, Discover Shyamnagar and Bangla Geeta (for religious information), taking advantage of new and positive local sense established via the smartphone. In 2016, only one woman who described herself as a businesswoman, talked about using bKash, so that she could pay bills using the smartphone. By the end of 2017, bKash was in common use, demonstrating a new placeful locale for financial interaction.

### 7.3 Image

In SPT, an image is the understanding, representation, awareness of the multiple possibilities offered by a technology [8]. To explore this, the survey used an open question ‘What is a smartphone?’

The Baseline survey had almost no responses because very few respondents had any experience of smartphones. The same result is found in the control groups in 2016. As expected, in 2016, the PROTIC groups provided interesting insights. In the following, italicized words are typical associations given to smartphone. It is a kind of *modern, good, developed mobile phone*, it is an *expensive mobile* that allows one to *communicate abroad*. *Call* is the most frequent practice associated with the smartphone. *Activity* and *functions* include to *receive* and *share information* on *agriculture*, and multimedia: *pictures, music and video*. It is linked to the *Internet*, mainly represented by *Facebook*, and to *news*, to the *world* and to new *apps*. A further group of words suggests that it is useful to *solve problems* and to *save time*. In terms of ideas about place, here we see a strong sense that the smartphone offers new sense of placeful experience, and social meanings and positive experiences via different media for new forms of interaction beyond fixed-point location.

Likewise, the in-depth interviews confirmed that the image is anchored around improved communication and information. Moreover, a number of new images emerged, coherent with the goal of the project. In the first round of interviews, the smartphone was linked to improve social positioning in the family and community by 12 interviewees—affecting their interpretation of locale and sense of place and community. Moreover, it was linked with individual empowerment in terms of learning opportunity (six respondents), and improved agency (six respondents). By the second round of interviews, the image of the smartphone is clearly that of an information seeking tool, but to some extent it has been expanded to being seen as a shared family or community tool, affected its use in locale such as the village, and beyond into the realm of ICT communications.

The most important job is talking with my sick husband and to know his condition. I can take care of my daughter’s education using the mobile phone. I also can get helpful information about cooking by searching in Google through this mobile phone. All these activities I do for my family. I can help my neighbours by this mobile phone as well.

Constraining social influences also appear to come into play, with many women reporting that they need to limit the range of potential activities, or to make calls from home.

Yes, my friends. I mostly communicate to them by sending texts or commenting on their posts in Facebook. But I did not talk to my male friends much, it may hurt my husband or he may not like that.

Although the activity is placeless, this is one indication at least that extended places—new settings for interaction—are not always viewed as a positive form of placefulness. Within the traditional setting, social pressures can constrain use.

## 7.4 Practices

The 2016 survey data and the episodic interviews confirm the emergence of new mobile practices for respondents involved in the project, who extended the range of purposes of phone calls to include business calls, calls to veterinarians, doctors, the local NGO, and the project call center. Although the number of new practices may be limited, they are perceived as important by the participants. New practices fall into four groups: family, livelihood, business and citizenship practices.

### Family Practices

Communication practices continue to be complex, subject to traditional deference to the husband and his family. Smartphones can change this relationship to a certain degree by providing new locales for activity and virtual placefulness. This can include feeling privately connected with one's own parents in other places through a virtual connection on one's own device as well as connection with non-family males on family related matters.

In the Baseline survey and in the 2016 survey, the main use of the phones is to make phone calls for family communication. Respondents from both project and control groups report that they make or receive calls from their spouse and children once or more than once a day. Phone calls with relatives are slightly less frequent (several times a week). However, the qualitative data shows that smartphones provide a new setting or locale for interaction.

My communication network developed more. Earlier I rarely used my husband's phone. But now I can call anyone. It is also helping my family. I can talk to the teachers of my children. I can communicate to my parents in India. Earlier I was not comfortable to talk with them on my husband's phone.

A sense of feeling comfort implicitly refers to greater technical affordance, but it can also relate to a sense of positive and private placefulness, and reflects an increase in the sense of self-confidence and agency:

I think if you can spend some time by yourself then you will learn more. Just think, a woman like me was never comfortable using a buttonphone but I am now using the smartphone efficiently.

The episodic interviews also provide evidence that the range of calls was growing, particularly in relation to obtaining medical advice and activities associated with their children's education.

My husband visited the doctor in India a few months before. Last week I sent a recording to my brother to talk to the doctor as a follow up visit. After listening to the video, the doctor wanted to talk to my husband. My brother called me on my phone by using WhatsApp from doctor's chamber.... My brother sent the medicine... It is saving our huge effort and money and all these are possible because of technology.

As can be seen, the women are adopting new strategies to both find telephone numbers, through the use of apps such as Discover Shyamnagar, and for actually making calls, for example using WhatsApp.

Questionnaires also show an increase in the reported use of SMS in the PROTIC villages. Interviews and field observation, however, suggest the need to consider this result with care, since the use of SMS is often mediated by younger people who can more easily read messages. This gives a new role to young members of the family, and stresses the importance of young people as support for relatives.

### **Livelihood Practices**

At the time the Baseline survey was conducted, the great majority of respondents did not receive agricultural information using their phones. Personal phone calls were used to get information by just of respondents, 2.8% in Area1, 6.9% in Area2, although they were considered potentially useful by 9.9% in Area1, and by 20.3% in Area2. The call center, as a significant virtual setting of activity, was identified as potentially the best way to get information about agriculture by 15.5% of respondents in Area1, and 5.8% in Area2, however they were used by just 1.4% in Area1, 3.6% in Area2.

Such a proto-practice, as identified by the Baseline survey, quickly became a practice in the project villages. Indeed, the data shows significant differences in livelihood practices between control and project villages in 2016, with respondents from project villages seeking information related to seeds, equipment, weather, cultivation, fertilizer, irrigation, weeding, harvesting, storage and market prices. Here, the smartphone and its affordances have a direct impact on fixed location activity in the village and settings of interaction, whether in the village, the paddy field, fish ponds or in the local market. The accounts provided in the interviews suggest that there has been a positive response to the call center—a virtual locale—and other informational opportunities in a relatively short time. As a villager from PROTIC-Village2 reported:

My experience is really good. Earlier we were really helpless, and could not save our domestic animals from different diseases. If they got sick we had to go to the doctor physically to inform them, it took a long time and most of the time we had lost them before the doctor came. But now we can call the doctor for the quick support. This kind of communication is saving time, travel cost and effort.

Similarly, an interviewee from PROTIC-Village1 said that:

In the case of agriculture if we can get the market price of vegetables, fish and other items then I can set the same price and bargain with the buyers. You do not need to go to market as I am giving them the fresh thing in the same price. It will save their transport cost also.

These quotes add to the idea that a new placefulness is developing, that is, that various types of communication and activity are no longer dependent on people being in each other's presence, and that time-space compression has taken place [19, 20, 43]. Thus, the villagers emphasize the immediacy of activities, leading not only to faster responses to problems, but also a reduction in their feelings of isolation.

### **Business Practices**

The use of the mobile phone for personal business—which is closely related to livelihood practices—was reported in the Baseline survey by 14.3% of respondents in Area1 and by 30.8% in Area2. In terms of business practices, one year after the start of PROTIC, analysis shows significant differences between the project and control groups, particularly with regard to the intention to use mobile phones for getting information on market prices and for buying/selling products.

Data from the interviews suggests that the project has fostered the development of the household business unit, with women serving as a home-based hub that coordinates the activities of children and men in the field, at the market and in other working environments. Settings of interaction—the locale—have increased through the project physical and virtual sense. Location-based business interaction is enhanced by peaceful communication. For example, a woman in PROTIC-Village1 commented:

This phone is saving my time, money and effort. Earlier I need to go to the market to buy the materials. But now I just call the shopkeeper in the market and they send me the materials. I pay them through bKash. Earlier it took 50 BDT to go to the market but now I am paying it through bKash and it is taking 20 BDT and saving 30 BDT. I can also utilize this time in my tailoring business.

### **Citizenship Practices**

The Baseline data suggests that mobile-based citizenship practices were extremely limited before the project was implemented. Official information from government, NGOs and other sources was received by 1.3%, 1.9%, and 3.8% of respondents in Area1, and by 2.5%, 8.8%, and 1.4% in Area2. In the 2016 survey, the situation had changed dramatically. Percentages of participants who used their mobile phone to call any call center, union parishad (local government), or another local officer were 79.6% for PRgroup1 and 62.0% PRgroup2, compared with 39.8% Control1 and 29.0% Control2.

The episodic interviews provide further evidence that participants feel more entitled, to bring their voice (or the voice of other community members) to the authorities:

I communicate with many people. I use the app Discover Shyamnagar to get useful contact numbers. For example, I am a community member of the Forestry Department. If I see someone doing any harm to the forest then I can directly call the Forestry Department. Earlier I need to go physically for any kind of communication. But this mobile is saving my time and I can communicate more easily.

This effect is strongest with people who are already seen as community activists. The research shows that peaceful political activity occurs.

## 8 Discussion and Conclusions

Overall, the results present changes in ICT practices as seen through the SPT lens, and an impact on sense of place commencing soon after the implementation of the PROTIC project. In the project villages there has been a change in the perception and practice of material agency with the smartphone, and movements in skills, and image components of practices linked to new and overwhelmingly positive senses of place. New skills concerning visual functions have been acquired resulting in new locales for presences with new means of communication. SPT demonstrates these different pathways in the appropriation of the smartphone.

In the first proto-practice pathway, the stability of practices is preserved and the new material artifact (the smartphone) takes the place of the buttonphone. Although aware of more advanced functions, the participants do not appropriate them for everyday mundane tasks and prefer to use verbal communication (for example, calls) over apps (Facebook, Messenger). There is little impact or refinement on senses of place.

In the second practice pathway, the smartphone introduces new place-based and virtually-connected affordances which contribute to capacity building, for example, by using services to obtain agricultural information. The idea of receiving useful information was already present in the villages, but only the new artifact connected to a placeful call center provided this affordance, quickly becoming the means to transform the proto-practice into a new everyday practice for receiving information.

A third practice-based pathway is connected with the emergence of ideas and images of different types, which were not present before, and which require more time to be connected into new practices. This is the case, for example, with the placeful citizenship practices that developed.

Additionally, a sense of placefulness (the fourth interpretation of place) in the sense that activities can take place anywhere is emerging, and this is linked to the collapse of time and geographic restrictions upon physical movement. However, its impact is clearly restrained by strongly gendered social and cultural traditions and practices (such as fear for personal and family reputation) that limit more open communication. While the research reported upon here only hints at this issue, more recent research to be published demonstrates how strong is the salience of gender-based regulation.

In some cases, in order to become practices, some components changed in ways that were not expected. For example, although skills and knowledge were in place, the smartphones and their placefulness did not reach their full potential because of gendered social constraints. However, to some extent, seeing the smartphone as a shared resource helped the women in having smartphones accepted. It remains to be seen, however, whether that component may cause future problems, for example, with regard to different types of digital abuse, as smartphones are designed for individual, rather than shared, communal use. When phones are shared, physical and virtual privacy is contested, problems may all-too-easily occur [47].

The women involved in PROTIC are aware that it is possible to access relevant information using a smartphone and that they had the necessary skills to do so. There is a vision of the smartphone as a tool capable of supporting almost any information need in whatever sense of place. However, this appropriation must be kept in perspective: the primary method of communication is through talk, particularly face-to-face talk, as well

as more conventional record-keeping such as notebooks, as more recent research results are now showing [28].

The results demonstrate that there are emerging practices that affect daily life and self-perception. The impact is stronger on personal and livelihood practices, although business practices have also emerged. At this stage, communication is still overwhelmingly verbal in form, and advanced uses of smartphones, which include accessing the Internet and using problem solving tools, are still at level of ‘proto-practices’ for the majority of women, even though they touch upon the different and positively viewed new senses of place. With a few interesting exceptions, they have not yet taken the next step of connecting skills and images to create new, locally meaningful sets of online practices.

There are, however, other limitations to these findings, particularly as they represent a case study of some villages in one country. This focus has been upon women, and the gendered nature of their experience with the constraints of a hierarchical, patronage-driven, gendered and risk-averse culture [48]. Careful further research is needed to explore this issue as it effects responses beyond aspirational discourse [49].

The broader implication is that SPT and theories of place, certainly for women and probably for men, provide a framework for identifying what is meaningful to in their communities, at least in Bangladesh. Being able to capture and understand nascent perceptions and experiences with mobile phones helps to identify the relationship between skills, materials and ideas when undertaking ICT sociotechnical initiatives. These insights could first, help to develop more nuanced research and development of products and services, and second, help governments and NGOs in tailoring policy development, advocacy and decision-making as to how technologies are to be introduced to communities, potentially resulting in more sustainable ICT4D projects in Bangladesh. The same framework could also be applied in other countries and contexts, possibly resulting in a useful body of knowledge for research and sensitive ICT4D projects and programs.

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# Mapping the Factors Influencing the Sustainability of Public Access Computing in Africa to the ACE Framework: A Systematic Literature Review

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**Abstract.** Information and communication technology (ICT) has been widely used in attempts to address the diverse range of socio-economic challenges in Africa. Included in these initiatives is the establishment of public access computing (PAC) venues. PAC venues are spaces where the general public has access to computers and/or the Internet and are established to address ICT access in underserved and marginalized communities. Despite the good intentions of such interventions, the success and sustainability of PAC initiatives remain a challenge. A systematic literature review (SLR) was performed to determine the common challenges faced by PAC initiatives in Africa as well as the recommendations based on PAC success stories. These challenges and recommendations are subsequently evaluated against the Access, Capacity, and Environment (ACE) framework for PAC developed by Gomez. It is shown that the recommendations for PAC in Africa do not necessarily correspond to the identified challenges. In addition, a number of challenges and recommendations are identified that are not represented in the ACE framework. It is suggested that the ACE framework is extended to incorporate these factors in order to make it more relevant for PAC in Africa.

**Keywords:** Public Access Computing (PAC) · Telecentres · Public libraries · Cybercafés · ACE framework · Information and communication technology for development (ICT4D)

## 1 Introduction

In Africa, where poverty and economic disparity remain rife, access to information and communication technology (ICT) is a key mechanism for providing access to information, for knowledge transfer, for learning, and for socio-economic advancement [1–3]. In an attempt to address ICT access in underserved and marginalized communities in developing countries, Public Access Computing (PAC) venues have been introduced as spaces where the general public can have access to computers and/or the Internet either for free or at a cost, and include the implementation of telecentres, internet cafés, and

public libraries [2, 3]. Based on the belief that public access venues incorporating ICTs can bridge the digital divide, PAC initiatives feature prominently amongst interventions used by governments and non-governmental organizations (NGOs) in Africa to bridge the digital divide [2]. However, despite the good intentions of such interventions, their success and sustainability remains a challenge [4, 5].

This study focuses on the sustainability of PAC in Africa. While numerous studies have been undertaken on PAC in developing countries, e.g. Gomez [6], it is believed that the African context and conditions hold particular challenges and benefits related to public access, that are not necessarily the same as in other regions of the world. This study is therefore concerned with the following research question:

- What influences the sustainability of PAC initiatives in Africa?

A systematic literature review (SLR) was conducted to investigate the best practices, recommendations, challenges and lessons learned related to PAC in Africa. The findings were mapped to the existing ACE framework for the sustainability of PAC [7] to ascertain how well the ACE framework reflects the African PAC situation. Also, recommendations made in the literature about PAC in Africa were compared to the challenges that were identified.

Admittedly, Africa is a very diverse continent. Hence, in addition to investigating whether PAC in Africa has characteristics that are different from PAC in the developing world, this SLR may be able to highlight intra-continental differences and disparities with regard to PAC in different regions or countries within Africa.

The rest of the paper is organized as follows. In the next section, background is provided on key concepts such as PAC, its constituents, as well as Gomez's ACE framework for PAC. Thereafter, the research methodology is explained. This is followed by a presentation and discussion of the findings of the SLR.

## 2 Background

The concepts of PAC, the sustainability of PAC as well as the ACE framework are introduced in the sub-sections that follow.

### 2.1 Public Access Computing (PAC)

PAC refers to the provision of access to information and technology resources to the public, “irrespective of their geographic location, age, socio-economic status, education, gender, religion, nationality, culture, or race” [8]. PAC initiatives are generally interventions that are used to extend the reach of ICT to those that do not have access to computers or the Internet [9], and they include access to computers, the Internet, information, and games [3, 8]. Inadequate infrastructure and high communication costs in Africa, have led to the development of various PAC venues in Africa [10]. These venues often link communities to the Internet, which is an important medium for information and knowledge sharing [10].

While PAC venues by definition include any form of public access provision, including WIFI hotspots, the concept generally refers to the implementation of telecentres, cybercafés (also commonly referred to as internet cafés), and public libraries [3]. Although these three types of venues all focus on the provision of ICT access to the public, they primarily differ in terms of intent. Unlike libraries and telecentres that focus primarily on social and economic development, the focus of cybercafés is primarily on profit generation [11, 12]. Other differences between telecentres, cybercafés, and public libraries, are generally related to financing, services offered, and ownership [13]. The choice of PAC used is often determined by convenience and quality, customer service, and trust in the venue [14]. The following section provides more details on each type of venue.

**Telecentres.** Viewed as one of the fore-runners of ICT4D initiatives, telecentres have been established primarily to promote inclusivity [15]. Telecentres are viewed as an effective means to reach large portions of the population and to provide Internet access in rural areas where provision of dedicated ICT services by the private sector is not profitable [15, 16]. The intention of telecentres is to make ICT accessible to rural communities by bringing ICT facilities closer to rural communities [17].

Telecentres vary in their service offering, size, and focus. Simplistically, telecentres involve the erection of “buildings” with access to computers, the Internet and other digital services; however, services can also extend to colour printing, scanning, video conferencing, laminating, the facilitation of distance education, training, the provision of telephones, photocopying, faxing and document design [18, 19]. Internet services are generally free but a fee is often charged for additional services [18].

Despite some challenges, telecentres have been found to benefit many communities by improving their quality of life [15]. Furthermore, they have been found to improve literacy skills, encourage social interaction, improve social skills, break down social barriers, simplify lives, increase income, bring services closer to communities, improve knowledge, and reduce crime by occupying individuals that would otherwise be involved in criminal activities and motivating them to stay away from criminal activities [17, 18, 20, 21]. They have also been found to be a key communication mechanism with government on matters that affect society and are used to assist government with the provision of government services such as the application for identity documents, pension, and grants [20].

Even though some researchers advocate the running of telecentres as a business, subsidies and institutional support remain essential in many cases if they are to meet their objectives of uplifting the very poor [15]. Overall, telecentres have been found to be an effective means of meeting developmental objectives in terms of improving the well-being of the poor, and therefore remain a relevant solution [15].

**Cyber/Internet Cafés.** Cybercafés have become a widely adopted model for internet access and diffusion with a rapid growth of cybercafés in Africa in the 2000s [10]. Cybercafés, also referred to as internet cafés, are generally small businesses that have been set up to provide access to computers and related services in a social, coffee shop-type environment [22]. Usually used by the advantaged and educated who typically have

a disposable income, cybercafés generally provide reasonably priced internet services including access to computers and the internet at varied rates and connection speeds [13].

While similar to telecentres, the focus is not primarily on the development or upliftment of communities, but rather on offering a service to make profit [22]. Despite the profit-making objective, people in marginalised communities are often willing to pay for the services [2]. This is largely because cybercafés have been found to be more affordable than accessing the internet from home or from mobile phones [10]. The rapid growth of cybercafés in Africa has resulted in job creation, increased government revenue, improved internet access, greater entrepreneurship, and a greater involvement of women in ICT [10]. Studies in Kenya suggest that cybercafés can provide effective informal work centres that can be used to generate earnings for the poor [23]. Telecentres have remained the most common public source of the Internet [24].

**Public Libraries.** Public libraries, which traditionally provide public access to books and printed material, have over the past years extended their public services to include free access to computers and the Internet [22]. Established and funded by governments, these PAC venues are generally the cheapest venues [24]. Despite some advancements, public libraries have been found to lag behind telecentres and cybercafés in terms of ICT service offerings [6]. Since ICT is not the key focus of public libraries, public library assistants often lack the requisite ICT skills to assist patrons [2].

## 2.2 The Sustainability of PAC

“An innovation, no matter how well designed, would be perceived as useless if it is not adopted” [25]. The sustainability of PAC may be defined as the ability of PAC venues to maintain a level of service that fosters continued adoption and use; that is, it implies longevity [26]. While research indicates that mobile phones have decreased the need for PAC venues, it is argued that they are still required as they serve different purposes [27]. Due to the high data costs, mobile phones are generally used for calls and text messaging rather than being used for accessing the Internet in marginalised communities [28]. Connectivity, specifically with high bandwidth applications such as gaming and Skype, is also generally faster and more reliable at cybercafés [28]. Many PAC venues also provide the added benefit of a social setting, additional services such as printing and scanning, and a support system in the form of tutorial support from staff and peers [28, 29]. This suggests that PAC initiatives still have a place in today’s world, and that a focus on the sustainability of PAC remains relevant.

Dimensions that impact the sustainability of PAC initiatives include financial, political, technical, social, and institutional viability [14, 30]. For a PAC to be financially sustainable, not only is it expected to charge for services, it must also be able to continuously attract users over a period of time regardless of the price being charged [30]. The time taken to reach financial sustainability will, however, vary depending on the availability of funds in the community. In poor areas, donor funding may be required for a longer (if not indefinite) period of time for the initiative to be sustainable [31]. Political and institutional sustainability require that governments and institutes ensure that they

create and support environments that sustain PAC initiatives [8, 31]. Social sustainability is achieved by continued community involvement and support, while technical sustainability is achieved by the ability of technology to remain relevant, useful, and usable over a period of time [14, 32].

To define what sustainability looks like in an African context, there is a need to understand what practices foster long-term usage, and what inhibits the successful implementation and longevity of PAC. Etta and Parvyn-Wamahiu [33] has listed the following impediments to telecentre (and consequentially PAC) usage: the cost of services; the cost of equipment, maintenance and supplies; inadequate physical facilities; poor management; operating hours; poor publicity; and literacy and language. According to Coward, Gomez, and Ambikar [34], factors that impact and influence PAC access and usage (and subsequently sustainability) are related to access to technology, capacity to use infrastructure and services, as well as environmental factors.

### 2.3 The ACE Framework

Gomez [7] has developed the ACE framework to analyze PAC initiatives. Due to its comprehensiveness and appropriateness to this study, the ACE framework will be taken as a point of departure when investigating PAC sustainability. The ACE framework defines dimensions and associated variables that can be used to analyse PAC initiatives [7]. The framework is depicted in Table 1.

Based on the tried and tested Real Access framework that was developed to understand the factors impacting access to ICT, the ACE framework focuses specifically on PAC [7]. It considers dynamic variables that impact PAC and suggests three interrelated dimensions that are required to ensure the robustness of PAC landscapes, namely access, capacity and environment [7]. Dimensions consist of a set of variables, which are in turn made up of indicators. The focus on PAC coupled with the consideration of dynamic variables makes the framework appropriate for this study. The framework is used as a guideline to determine the factors impacting PAC sustainability and to vet findings.

## 3 Research Methodology

This section presents the research strategy, namely a systematic literature review (SLR). The SLR research method adopted in this paper is based on the eight-step guideline recommended by Okoli and Schabram [35]. This method was selected because not only does it draw from a multitude of other popular SLR guidelines, it has also been adapted for ICT research. In addition, the method addresses the requirements of a robust SLR process, namely: explicitness, comprehensiveness, and reproducibility [35]. The method, which is depicted in Fig. 1, has been simplified and adapted to reflect the scope and depth of analysis required in this paper.

The search protocol includes the identification of keywords and sources. The following combination of search terms was selected after initial search attempts proved that this combination provides the most meaningful results: “Africa” AND “public access ICT” OR “telecentre” OR “cybercafé” OR “internet café” OR “public library” OR “connectivity”.

**Table 1.** The ACE framework [7]

Schematic representation of ACE framework		
1. Access	2. Capacity	3. Environment
<p><b>1.1 Physical Access to venue</b></p> <ul style="list-style-type: none"> <li>• Location of venue</li> <li>• Venue distribution (urban/non-urban)</li> <li>• Basic infrastructure (space)</li> <li>• Hours of operation</li> </ul> <p><b>1.2 Suitability of venue</b></p> <ul style="list-style-type: none"> <li>• Universal access (differences between serving rich and poor)</li> <li>• Venue meets local needs and conditions</li> <li>• Physical safety of venue, people, and materials</li> <li>• Venue as a place people want to go</li> </ul> <p><b>1.3 Affordability of venue</b></p> <ul style="list-style-type: none"> <li>• Cost in relation to daily needs</li> <li>• Financial sustainability of venue</li> <li>• Sustainability of ICT</li> <li>• Competent services (including ICTs)</li> </ul> <p><b>1.4 Technology access</b></p> <p><b>1.4.1 Infrastructure</b></p> <ul style="list-style-type: none"> <li>• Availability of technology (hardware, software, internet)</li> <li>• Basic infrastructure (e.g. electricity)</li> <li>• Appropriateness of technology</li> <li>• Physical access to technology</li> </ul> <p><b>1.4.2 Affordability and use</b></p> <ul style="list-style-type: none"> <li>• Cost in relation to daily needs</li> <li>• Financial sustainability of technology</li> </ul>	<p><b>2.1 Human capacity and training</b></p> <p><b>2.1.1. Staff</b></p> <ul style="list-style-type: none"> <li>• Level of operator training</li> <li>• Digital literacy</li> <li>• Operators' attitude to support information needs</li> </ul> <p><b>2.1.2. Users</b></p> <ul style="list-style-type: none"> <li>• Perception of venue</li> <li>• Venue offers ICT training</li> <li>• Digital literacy of users</li> <li>• Programs for underserved populations</li> <li>• Trust in the venue</li> </ul> <p><b>2.2 Meeting local needs: relevant content and services</b></p> <p><b>2.2.1 Local needs</b></p> <ul style="list-style-type: none"> <li>• Local needs are met (resources, skills, and operator capacity)</li> <li>• Locally relevant content (meeting local needs)</li> <li>• Produced in local languages</li> </ul> <p><b>2.2.2 Local services</b></p> <ul style="list-style-type: none"> <li>• Sharing between venues</li> <li>• Urban/non-urban distribution</li> </ul> <p><b>2.3 Social appropriation</b></p> <p><b>2.3.1 Venues</b></p> <ul style="list-style-type: none"> <li>• Space for collaboration</li> <li>• Integration into culture</li> <li>• Adapt venue to suit local needs (including ICTs)</li> </ul> <p><b>2.3.2 Technology in venue</b></p> <ul style="list-style-type: none"> <li>• Space for collaboration</li> <li>• Integration into culture</li> </ul>	<p><b>3.1 Socio-cultural factors</b></p> <ul style="list-style-type: none"> <li>• Gender discrimination</li> <li>• Age discrimination</li> <li>• Education discrimination</li> <li>• Religion discrimination</li> <li>• Socioeconomic discrimination</li> <li>• Ethnicity discrimination</li> </ul> <p><b>3.2 Political will, legal and regulatory framework</b></p> <ul style="list-style-type: none"> <li>• National and regional economic policies support for venues</li> <li>• Political will of venues</li> <li>• Long term government strategies to support PACs</li> <li>• International policies to support venue networks</li> <li>• Use/censorship of material (including ICT)</li> <li>• Legal and regulatory framework particular to ICT</li> </ul> <p><b>3.3 Popular support</b></p> <ul style="list-style-type: none"> <li>• Popular support to improve venues</li> <li>• Involved community stakeholders</li> <li>• Champion for the cause</li> </ul>

Research relating to the following have been excluded: Access resulting from the use of mobile phones, and research focusing on schools and academic institutions that restrict access to students or groups of individuals.



**Fig. 1.** SLR process

The following journals were included in the literature search: Electronic Journal of Information Systems in Developing Countries (EJISDC); Information Technologies and International Development (ITID); and Information Technology for Development (ITD). In addition, the following databases were consulted: IEEE Xplore and Google Scholar. The search period was the full years 2000–2017.

Literature screening was done in two iterations. Iteration 1 included a review of each article and its classification of relevance based on the title of the article and the abstract. Where there was still doubt, the article was skimmed for relevance. Articles were classified as either relevant, reference (not directly relevant, but perhaps useful for providing background or reference information) or not relevant. During iteration 1, duplicates were eliminated. Iteration 2 of the screening involved a more in-depth analysis of the articles deemed “Relevant”. Iteration 2 provided the final list of articles used to achieve the objectives of this paper.

The final list of articles were analysed as follows. To understand what sustainability looks like for African PAC, the research on African PAC initiatives was analysed by looking at the challenges faced with PAC implementations, lessons learned from PAC implementations, and recommendations and best practices following PAC initiatives. For the mentioned aspects, recurring or emergent themes were identified (rather than deductively using the ACE framework as a means of analysis). This was done to ensure that all information pertinent to this paper was included and not jaded or restricted by the ACE framework. Emergent requirements for the sustainability of PAC in Africa could hence be identified. This was done not only to provide insight into the applicability of the ACE framework for Africa, but also to highlight factors that are important for PAC in Africa.

## 4 Descriptive Review of Search Results

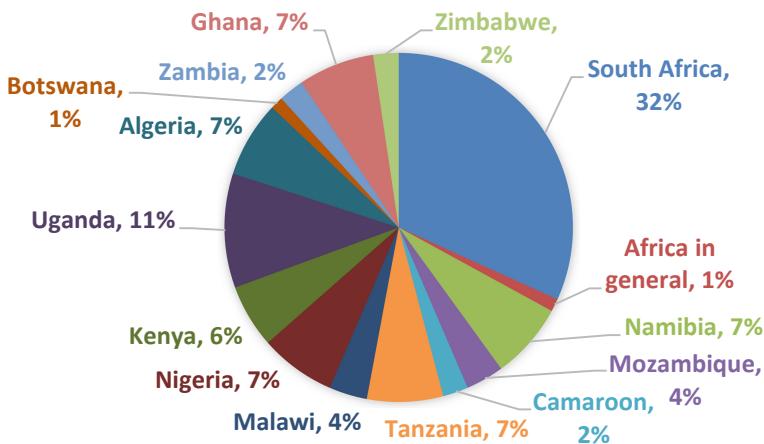
The initial search led to the identification of 740 potential documents. After the removal of duplicated articles, the two levels of screening led to the search results shown in Table 2:

According to Table 2, the two databases produced the majority of the relevant documents, followed by the journals ITD, EJISDC and ITID in that order.

**Country Classification.** Geographically, the results show that research has focused on only 13 of the 54 countries in Africa, indicating a large gap in research on PAC for the majority of Africa. Of the countries researched, almost a third of the research focuses on South African PAC initiatives. These statistical numbers are displayed in Fig. 2. “Africa in general” refers to research on Africa that does not explicitly list the African countries used in the research.

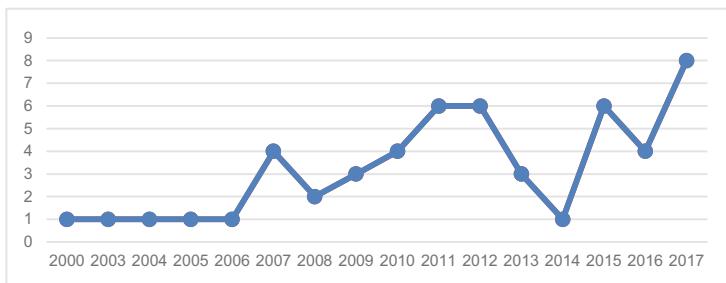
**Table 2.** Search results after two iterations of screening

Source	Iteration 1 relevant	Iteration 2 relevant	Percentage after iteration 2
Google Scholar	31	15	29%
IEEE	23	13	25%
ITD	17	12	23%
EJISDC	14	8	15%
ITID	13	4	8%
<b>Total</b>	<b>98</b>	<b>52</b>	<b>100%</b>

**Fig. 2.** Articles per country (%)

**PAC Types.** Regarding PAC types, telecentres are the most prevalent topic of research (44% of studies), followed by internet/cyber cafés (27%), public access computing as a collective, which generally includes telecentres, internet/cyber cafés, and public libraries (23%) and other access initiatives such as digital doorways, and container laboratories (6%). Literature that solely focused on public libraries could not be found within the scope of the sources selected.

**PAC Research and the ICT4D Value Chain.** Research regarding PAC in Africa has been found to align with Heeks' ICT4D value chain. According to Heeks [36], the focus of ICT research should have been on the “impact” of ICT4D initiatives from the mid-2000s to the mid-2010s, shifting to “sustainability” post-2015. By focusing on PAC implementation challenges, and recommendations, this paper analyses articles that focus on impact and/or sustainability. The research distribution (based on the year published), depicted in Fig. 3, clearly indicates an increase in literature that focuses on impact and/or sustainability post-2006.



**Fig. 3.** Articles focusing on impact and sustainability

It was not possible to separate between the notions of “impact” and “sustainability” when classifying the articles in Fig. 3 as many of the identified articles focused on both.

**Discussion.** The search process after Iteration 2 resulted in the identification of 52 relevant articles. These were largely from Google Scholar, IEEE, and ITD, and focused largely on South African PAC initiatives, indicating an uneven distribution of research on PAC across African countries. The PAC research, however, has been found to have kept abreast of the research focus of ICT4D initiatives, implying that the interest and focus of PAC research is where it should be if it is to attract continued interest and funding.

## 5 Analysis of Findings

This section presents the analysis of the selected articles. The data is initially grouped according to emergent recurring themes without attempting to map it to the ACE framework. This is done to ensure that all information pertinent to this paper is included and that thinking is not restricted by the ACE framework. The data is then evaluated against the ACE framework. The ACE framework has been used as a guideline for grouping information into meaningful categories that are applicable to PAC evaluations. While every effort was made to remain true to the meaning of the variables and indicators of the ACE framework, the determination of the fit of the data is subject to the authors’ interpretation of the data. Using a bottom-up approach, findings; referred to as “recurring themes”; are mapped to the ACE indicators. The emergent “recurring themes” that cannot be mapped to the ACE framework are identified. These themes hold implications for extending the ACE framework to make it more representative of PAC particularly in an African context.

The findings are separated into two sets of analyses, namely challenges and lessons learned on the one hand, and best practices and recommendations on the other. This is because issues are often duplicated across the sets of the analyses as best practices and recommendations are generally a response to challenges and lessons learned. For the sake of brevity as well as a planned comparison of the two sets in the next section, challenges and lessons learned will be referred to as “Challenges” going forward, and best practices and recommendations will be referred to as “Recommendations”. The findings are detailed in the sections that follow.

## 5.1 Findings: Challenges

When searching for recurring themes related to challenges in the 52 articles, 34 unique challenge themes were identified. The number of times a challenge was mentioned was counted, as well as the number of articles in which it was found. Challenges mentioned most frequently were “Cost for user (use and transport)” (22 times), “Poor/unreliable connectivity” (18 times) and “Poor infrastructure” (17 times).

The challenges identified were subsequently mapped to the three ACE dimensions and associated variables. Table 3 gives a summary of the number of challenges mapping to each ACE variable. At the bottom of the table, the challenges are shown that do not map to the ACE framework. Note that some challenges mapped to more than one ACE variable and may therefore be duplicated in the table.

**Table 3.** Challenges statistics

ACE dimension	Factors impacting PAC / ACE variables	Number of times mentioned	Number of articles presented in
Access	Physical access to venues	13	11
	Suitability of venue	9	8
	Affordability of venue	39	29
	Technology access	42	28
Capacity	Human capacity and training	57	29
	Meeting local needs, relevant content and services	14	14
	Social appropriation	1	1
	Socio-cultural factors	7	7
Environment	Political will, legal and regulatory frameworks	23	15
	Popular support	6	5
Challenges that do not map to ACE	Management	13	12
	Lack of community awareness or understanding of benefits	13	13
	Cybersecurity	5	4

## 5.2 Findings: Recommendations

In the search for recurring themes related to recommendations, 31 unique recommendation themes were identified. Recommendations mentioned the most often were “Training (equipment maintenance, usage, basic computer literacy, management)” (16 times), “Skilled and accessible support” (12 times), “Create awareness campaigns/marketing” (11 times) and “Understand context/local needs” (11 times).

Similar to the challenges, the recommendations identified were subsequently mapped to the three ACE dimensions and associated variables.

Table 4 provides a summary of the number of recommendations mapping to each ACE variable. At the bottom of the table, the recommendations are shown that do not map to the ACE framework.

**Table 4.** Recommendations statistics

<b>ACE dimension</b>	<b>Factors impacting PAC / ACE variables</b>	<b>Number of times mentioned</b>	<b>Number of articles presented in</b>
Access	Physical access to venues	20	16
	Suitability of venue	7	6
	Affordability of venue	8	8
	Technology access	3	3
Capacity	Human capacity and training	41	22
	Meeting local needs, relevant content and services	31	19
	Social appropriation	4	4
	Socio-cultural factors	19	15
Environment	Political will, legal and regulatory frameworks	31	16
	Popular support	20	16
Recommendations that do not map to ACE	Management	11	9
	Service offering	6	5
	Create awareness campaigns/marketing	11	11
	Become self-sufficient	2	2

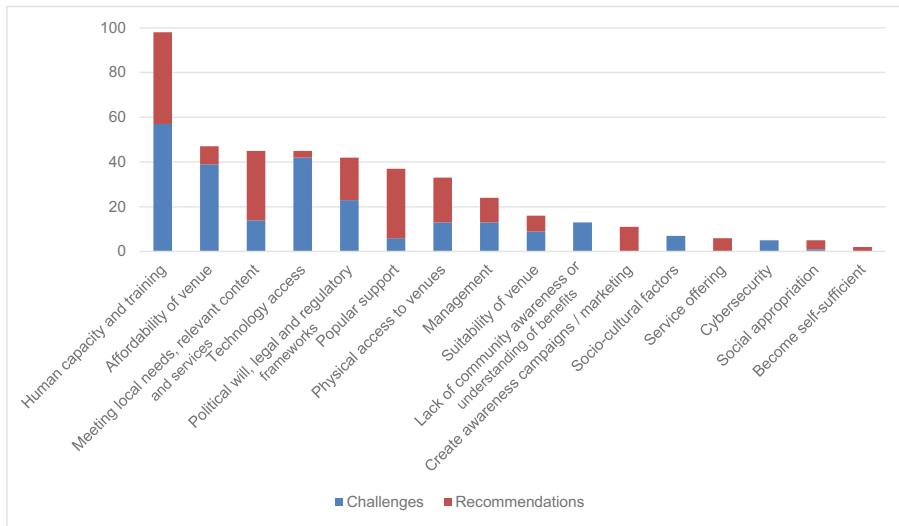
## 6 Discussion of Findings

Two aspects of the findings that were of particular interest are discussed below. The first is the match between mentioned/discussed challenges and the recommendations made. The second is the recurrent themes of challenges and recommendations that did not map to the ACE framework.

### 6.1 Comparing Challenges to Recommendations

Figure 4 compares the number of mentions of each challenge (as mapped to the ACE framework variable) with the number of mentions of the related recommendations.

Contrary to the expectation that the number of challenges discussed would largely correspond to the number of recommendations discussed (based on the premise that recommendations are made to meet challenges), other than in the case of “Human capacity and training”, this does not seem to be the case. Significant differences appear in “Affordability of Venue”, “Meeting local needs, relevant content and services”, “Technology access”, and “Popular support”. This indicates that while there are many challenges related to “Affordability of Venue”, and “Technology access”, these may not be addressed sufficiently in literature. Conversely, the level of discussion on recommendations for “Meeting local needs, relevant content and services” and “Popular support” are largely not warranted. There are also several factors that do not have challenges associated with recommendations. This may be due to the different words used to classify information, for example, “Lack of community awareness or understanding of benefits” and “Create awareness campaigns/marketing” may be reflected separately, but they address the same



**Fig. 4.** Comparison of challenges and recommendations for each ACE variable

issue. While other factors, such as, “Socio-cultural factors” may be addressed by other recommendations, such as “Service offering”, there is no focus on recommendations for “Cybersecurity”.

The general mismatch between the discussed challenges and recommendations give the impression that in the literature, the authors make recommendations that are not aligned with the actual challenges experienced. This is a cause for concern.

## 6.2 Items that Do not Map to the ACE Framework

The bottom rows of Table 3 indicate the challenges that do not map to the ACE framework. Similarly, the bottoms rows of Table 4 indicate the recommendations that do not map to the ACE framework. The item “management” is relatively frequently discussed as part of challenges as well as recommendations. The same is true for “community awareness”. “Cybersecurity” is mentioned 5 times as a challenge but has no corresponding recommendations in the literature studied. While the space limitations of this paper do not allow for a more detailed unpacking and discussion of these topics, the study makes it clear that they are important considerations in an African context and that they warrant further attention.

## 7 Conclusion

This paper sets out to define what PAC sustainability is within an African context. To address this question, the paper considered the influences on the sustainability of PAC initiatives in Africa, and the applicability of a PAC framework, namely the ACE framework, as a point of departure for the evaluation of PAC sustainability in Africa.

Africa may have its own characteristics that are not currently captured in existing PAC frameworks, while its internal diversity also needs to remain recognized.

A systematic literature review was undertaken that focused on African PAC studies, to identify recurrent themes in terms of challenges as well as recommendations. These themes were mapped against the ACE framework. While the majority of the themes could fit within the ACE framework, a handful of challenges and recommendations were found that could not be mapped to the ACE framework. These topics, in particular project management and the creation of community awareness around PAC, indicate that the African context has its own particular PAC concerns that need to be addressed in order for PAC initiatives in Africa to be sustainable. The other cause for concern that was identified in the SLR, was that the most discussed challenges in the papers reviewed do not necessarily match with the most discussed recommendations. Themes such as the affordability of venues and technology access have been identified as challenges that are not sufficiently addressed.

An encouraging finding of the study is the increased focus of the included articles on the notions of impact and sustainability, as per the ICT4D value chain [36].

This study contributes to current knowledge by exposing some of the factors relevant to PAC in Africa that are currently disregarded or not receiving sufficient research attention. It is hoped that the uncovering of these factors will lead to them being better addressed, thereby contributing towards improving the sustainability of PAC in Africa. The study further exposes the fact that PAC research has to date focused on only 13 of the 54 African countries, with an overwhelming domination of South African based PAC research. There is hence a need for future research in African countries whose voices are not currently heard in the PAC research discourse.

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# Technology Stewardship Training for Agricultural Communities of Practice: Establishing a Participatory Action Research Program in Sri Lanka

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**Abstract.** This paper reports on a technology stewardship training program to promote ICT leadership development with agricultural extension practitioners in Sri Lanka. Technology stewardship is an approach adapted from the communities of practice literature that recognizes the importance, practically and ethically, of guiding change from within a community. The technology steward's role in development is not to impose ICT solutions on a community of practice but instead to empower members as part of a "change through choice" strategy, with the end goal of improving the informational capabilities of the community. Researchers assessed the training program using a multimethod approach with a single embedded case study. Data were collected using a pre-course survey, formal course evaluation, classroom observation, and semi-structured interviews with participants. Findings from this study show a positive response to technology stewardship training among agricultural extension practitioners in the course, that learning objectives of the course are achievable when offered as an in-service training program, that self-confidence with ICT is improved, and that some participants applied their learning in a post-course activity. This study contributes to a better understanding of the role of social learning to foster change in ICT practices among communities of practice in agricultural extension services, and in contributing to effective use of ICT for development more broadly.

**Keywords:** ICT4D · Leadership education · Technology stewardship · Communities of practice · Information communication technologies · Informational capabilities · Choice framework · Capabilities approach · Agricultural extension · Sri Lanka

## 1 Introduction

Digital media and technology hold tremendous potential to improve lives in both developed and developing country contexts. Despite the possibilities, there remain ongoing challenges for many communities to transform their access to and use of digital technologies into enhanced informational capabilities for improving education, health, employment opportunities, governance, as well as civic and cultural life [1–3]. Models of development based on social intermediaries show promise as an approach that emphasizes community empowerment through enhanced informational capabilities [4, 5]. “Informational capabilities” is an inclusive concept that includes four related competencies: technology skills, communication skills, information literacy, and content creation/curation [6].

In this paper, we report on the results of a technology stewardship training program introduced in Sri Lanka for agricultural extension practitioners serving as social intermediaries [7]. Training serves as a foundation and common framework for an ongoing action research study that will compare within and across cohorts of technology stewards going forward. It is therefore important to evaluate the suitability and effectiveness of training as a contribution to this community intermediary strategy. Results from a cohort of trainees that completed the course in 2018 are presented, including a qualitative description of a case example that illustrates stewardship in practice following the training.

## 2 Technology Stewards as Community Intermediaries

Social intermediaries can play a crucial role in promoting effective use of information communication technologies (ICTs) in agriculture, especially when they are embedded in the local community. For example, Gigler’s study of rural poor in Bolivia looked closely at the role of intermediaries in ICT programs, concluding that the presence of an effective and local intermediary organization is the essential factor for enabling poor people to enhance their well-being through the use of ICTs [6]. Intermediaries help local communities to interpret, appropriate, and enact ICTs to their local sociocultural context; to make the use of ICT meaningful to their everyday lives; and to enable people to enhance their informational capabilities, which ultimately translate into improvements in their human and social capabilities [6, p. 406].

The nature of the intermediary relationship is important insofar as Gigler’s research has found that “the intermediary organization (ICT program) is the variable that exerts the strongest influence on people’s informational capabilities” [6, p. 399]. For Gigler, this is a primary outcome of any ICT project, which describes an inclusive measure that includes the four related skill sets, namely: ICT use, communication, information literacy, and content creation. Intermediaries are a vital link in enhancing information capabilities in combination with ICTs that are responsive to community needs and aspirations.

The communities of practice approach conceives of the intermediary role in relational terms as a leadership practice that “mobilize(s) people to work together in pursuit of some shared enterprise” [8]. The term “leadership” in this context is taken to be a communicative practice that emphasizes building commitments among members toward

the achievement of shared goals as articulated by the community of practice [9]. With respect to digital ICTs, the emphasis is on cultivating a “digital habitat” for a community of practice to which the individual belongs:

Technology stewards are people with enough experience of the working of a community to understand its technology needs, and enough experience with or interest in technology to take leadership in addressing those needs. Stewarding typically includes selecting and configuring technology, as well as supporting its use in the practice of the community [10, p. 25].

An important aspect of the technology stewardship approach is its origin from within the communities of practice literature. Wenger, McDermott & Snyder define a community of practice as “groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis” [11, p. 4]. This type of social learning situation is important to consider because the impetus for using digital technology is often situated with respect to crosscutting professional, civic, or cultural concerns rooted in social networks that do not follow formal organizational and/or geographical lines.

The aim of enhancing the informational capabilities through technology stewardship is a development strategy consonant with Amartya Sen’s capabilities approach [12]. The capabilities approach (CA) is a paradigm for human development that calls for creating conditions to enable individuals to achieve greater degrees of freedom and self-determination in how they live their lives through “achieved functionings” that include competencies such as the ability to seek out, evaluate, and act on information about health, employment, education, government services, and so forth. While not always sufficient on their own to achieve desired ends, informational capabilities are nonetheless necessary for individual and community empowerment [13].

In seeking to achieve this end, the technology steward’s role is therefore not to impose ICT solutions on a community of practice but instead to empower members to make reasoned decisions about changing social practices in relation to ICT. Kleine’s “Choice Framework,” which also draws on the capabilities approach, lends itself to technology stewardship insofar as it emphasizes empowerment along four dimensions of choice. According to the capabilities approach, “the primary development outcome is choice itself” with development outcomes linked to the types of choices that individuals make depending on “what life they value” [5, p. 45]. Viewed through this lens, the change leadership role of a technology steward can be provisionally categorized into the following four distinct but overlapping areas of responsibility with respect to ICT:

- Make the community aware of the existence of choice (i.e., other ways of doing things are possible).
- Help the community to develop a clear sense of choice (i.e., how the community might take advantage of choices available to them).
- Facilitate and support the effective use of choice (i.e., assist with trying a new technology practice or deploying unfamiliar digital tools).

- Recognize and sustain the achievement of choice (i.e., report on the outcome of new deployments, analyze and understand points of failure, and acquire resources to build on success).

Along these lines, a number of training programs have been introduced in recent years intended to promote the use of social media for agricultural development [14, 15], including the Food and Agriculture Organization (FAO) online course titled “Social Media for Development” that features a module on technology stewardship [16]. The FAO course offers guidance on a number of important points such as differences between hosted versus installed software, proprietary versus open source licenses, and some basic pointers on supporting users.

While it is a useful introduction, the FAO course does not cover the full spectrum of technology stewardship role and its implications for leading change with a community of practice. For instance, it does not address community engagement processes in any detail, it overlooks the difficulty in articulating objectives related to ICT use, and it does not discuss the importance of evaluating ICT use or how to establish criteria for assessing the outcome of an ICT trial or pilot with a community. Moreover, based on a review of published studies, there is limited understanding of the effectiveness of technology stewardship as a specific type of intermediary strategy within an ICT4D context. This paper reports on the first comprehensive study to operationalize the technology stewardship approach through an action research design. The initial step in this process has been to develop and evaluate a baseline training program.

In order to lead a successful “change through choice” initiative, the technology steward should first be trained in a community-minded model encompassing a social and technical skill set. Within an agricultural and rural development context, this emphasis on change leadership shares features with the “New Extensionist” view of engagement [17], while providing a foundation for our own research and education efforts in Sri Lanka and elsewhere.

### 3 The Joint Education and Training Initiative (JETI)

Since 2012, the authors have been involved in a series of collaborative research projects with the initial goal of establishing a technology stewardship training program that will serve as the foundation for more extensive action research with community-based social intermediaries [18–22]. This work has coalesced around a Joint Education and Training Initiative (JETI) that launched an introductory course in technology stewardship in 2016 through a partnership with the University of Alberta, the University of Guelph, the University of Peradeniya (Sri Lanka), the Wayamba University of Sri Lanka, and more recently the University of the West Indies. This classroom-based course has now run successfully twice in Sri Lanka and twice in Trinidad, with elements of it also being introduced in Canadian-based projects with nonprofit community groups. A total of 80 participants from Sri Lanka and Trinidad have completed the course so far, and future offerings will be made available for extension practitioners and advisors through the Postgraduate Institute of Agriculture (PGIA) at the University of Peradeniya in Sri Lanka.

The current version of the course is based on a model described in Wenger, White and Smith [10], with adaptations made for a sector-specific audience; in this case, agricultural extension officers and advisors who are the primary focus of the JETI at this time. This version of the course uses sector-relevant language and examples from an agricultural setting, while adding activities in the areas of community engagement and evaluation of ICT in use [23].

The course is conducted over two-days covering four sessions. Each session includes a mix of short lectures, hands-on activities, and group discussion. The sessions are arranged as follows:

- Session 1: Principles and practices of technology stewardship.
- Session 2: Engaging your community and creating a campaign.
- Session 3: Choosing an ICT platform and rapid prototyping.
- Session 4: Planning and managing a campaign.

Participants working in small groups are directed through a set of activities using a course workbook to conduct an analysis of a community of practice and its challenges, and to identify a priority concern for immediate action. This is followed by a set of procedures described in the workbook that results in a structured goal statement to be used to inform and evaluate an ICT-based pilot study (“campaign”) with the community of practice. While these activities are introduced to participants in a classroom setting, the method is intended to be carried into the field setting and conducted with community members as a form of participatory action research.

Participants complete the final classroom session by drafting an individual action plan (IAP) in which they select a set of activities to be completed with a community of practice outside the classroom as an optional capping project. The IAP suggests a number of options to participants based on the four training sessions, ranging from conducting a community engagement activity, completing a rapid prototyping exercise, to designing a campaign and evaluation plan. This final step in the course is where participants have an opportunity to apply the principles and practices of technology stewardship with their communities and provides the research team with valuable insights about how this role can foster innovative and effective ICT use.

## 4 Evaluation Methodology

The larger study, which also includes two cohorts in the Caribbean, is based on an action research design with an embedded case study [24]. Individual participants in each course are considered a single cohort, but each member of the cohort is given freedom to act in accordance with the needs and interests of their own community of practice. The study is therefore designed around multiple units of analysis, namely: (1) the experience and impact of the training program at the cohort level; (2) the experience and impact of training at the individual participant level; (3) the impact on the community of practice to which the technology steward belongs. For this article, we are reporting on the Sri Lanka 2018 cohort and drawing out an individual case from that cohort.

Kirkpatrick’s model [25] has been used to assess the technology stewardship course at the cohort and individual levels. This model is widely accepted and used for evaluating

organizational, community, as well as ICT related training programs [26–28]. The model takes into account different styles of training and considers both short and long-term effects by comprising four levels of evaluation, namely: reaction, learning, behaviour, and results.

*Level 1 Reaction:* Learner's reaction to the training course focuses on their experience of the training course and the satisfaction with the learning experience. It is the most immediate outcome of a training program. An anonymized course evaluation based on the Universal Student Ratings of Instruction (USRI) instrument from the University of Alberta was used to assess learner response to the course.

*Level 2 Learning:* Learning can be assessed based on the degree to which learners appeared to understand the course material and the extent to which stated learning objectives for the course were achieved. Participants were given individual and group assignments to complete in class, generating a range of learning artifacts in the process. Participants shared their artifacts in class discussions and were also invited and encouraged to take and post photos of their workbooks to a private WhatsApp group to create portfolios of their learning.

*Level 3 Behaviour:* This level addresses the question of whether the training has influenced the behaviour of the participants, and how they intend to apply the skills and techniques in their professional practice. It may also be reflected changes in attitudes and perceptions about their role as extension officers and advisors attributed to the training experience. Intent to act on the training was identified in the individual action plans, while data on behavioural and attitudinal factors was gathered through follow-up interviews conducted with participants several weeks after completion of the course.

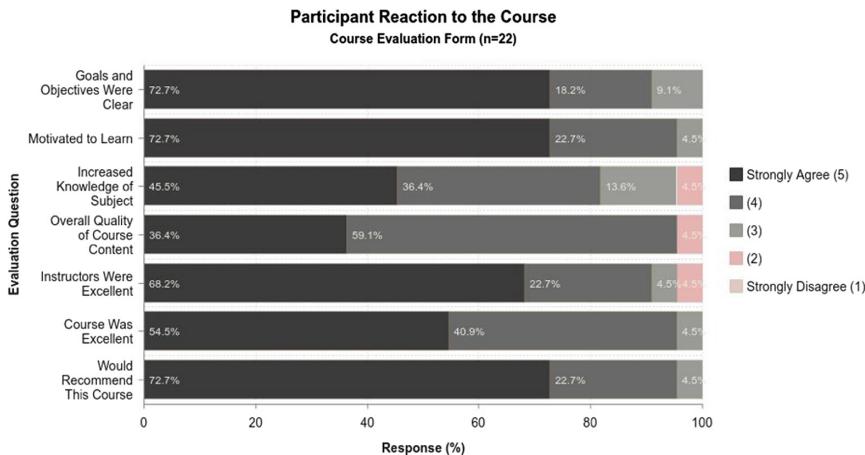
*Level 4 Result:* This level considers the extent to which the training program contribute to program-level or community objectives. It is too early to establish definitive long term results linked to the training program, but we are able to draw some preliminary insights based on capping project reports provided by participants to consider how the actions of a trained technology steward in a community of practice contributed to some form of “choice enhancement” with respect to ICT.

## 5 General Findings

Overall, the training program has been well received in both countries where it has been offered, indicating a strong initial response. A course syllabus was included with invitations sent to various public, private and non-profit organizations in agricultural extension and advisor services (EAS). Courses were initially limited to 16 seats, but interest in the training led the team to open up additional seats (25 in Sri Lanka, 20 in Trinidad). Attendance was consistent while participants completed the two days of classroom sessions.

Kirkpatrick Level 1 (reaction) was measured by responses to the course evaluation were positive. Overall results show that the quality of the course was rated “excellent”

by most participants, that the course material added to their knowledge, the quality of instruction was rated highly, and that most participants were motivated to take additional courses related to the subject. Figure 1 provides a summary of course evaluation results from the Sri Lanka 2018 cohort. (Results from the two courses in Trinidad were similar).



**Fig. 1.** Participant responses from the course evaluation survey.

Kirkpatrick Level 2 (learning). For this study we assessed two facets of learning: (1) Learning of discrete skills and techniques based on the extent to which participants appear to achieve the learning objectives in each of the sessions; (2) the extent to which the overall learning objective was met based on the ability of each group of participants to integrate course activities into a hypothetical campaign plan in the classroom setting.

Based on classroom observations and artifacts produced and shared by the groups, the training material and activities appear to support the learning objectives. Participants had been organized into small groups, each with 4–6 members. Each group was able to draw on the course material to identify and select a community of practice, to create a campaign objective based on a problem tree analysis, and to identify and match an appropriate ICT tool set for a hypothetical campaign. Table 1 summarizes the campaign ideas developed by participants in the Sri Lanka 2018 cohort.

In keeping with the stewardship principle “keep it simple” [10, p. 149], all of the groups opted for a “use what you have” technology acquisition strategy, identifying ICT requirements and platforms suitable for their first campaign. Other possible technology acquisition strategies are presented in the course, including free/commercial platforms, patching pieces together through application programming interface (API) integration, and build custom applications. It should be emphasized that the introductory nature of the course means that the training material focuses on low cost and other “use what you have” choices as a preferred starting point for technology stewardship efforts.

Kirkpatrick Level 3 (behaviour). All of the participants completed an IAP, with most indicating their intent to undertake a capping project; however, follow up interviews conducted with participants revealed a number of challenges and obstacles to completing

**Table 1.** Outcome of campaign planning activities carried out in the classroom

Community of practice	Priority action	Campaign objective	Identified ICT needs
Beekeepers in Kandy District	Instructional project	Introduce new beehive box	Group messaging; video tutorials
“Para Team” members of Hatton Plantations (tea cultivation)	Organize and schedule meeting among members	Improve awareness of and attendance at training events	Individual/group messaging; photo sharing
Small scale coconut growers in Dankotuwa ASC Division	Access to expertise (Q&A)	Reduce cost and improve timeliness of responses to questions from growers	Individual/group messaging; photo sharing
Organic vegetable farmers in Ipalogama DS Division	Attendance at meetings; access to expertise and information	Improve awareness of gov’t employment opportunities; increase attendance at training programs	Microblogging

the capping project including lack of resources and difficulties gaining administrative approval. Despite these challenges, several participants from each of the cohorts did succeed in completing all or some portion of their capping projects and provided the research team with a report showing evidence of their efforts. Table 2 summarizes the completed capping projects from the Sri Lanka 2018 cohort.

Kirkpatrick Level 4 (results). “Results” in this study refer to engagement efforts leading to some enhancement of “choice” as prescribed in the choice framework described above. The following case provides details from a capping project report submitted by Pradeep, a course participant who is an Extension Officer with the Advisory & Extension Division of the Tea Research Institute in Talawakelle, Sri Lanka.

## 6 Case Example: Stewarding with the TRI Talawakelle Techno Park in Sri Lanka

Pradeep participated in the technology stewardship course held at the University of Peradeniya in November 2018. He submitted a 9-page capping project report to the research facilitators in December, which was recognized with a certificate of advanced standing. He identified a community of practice in his report as the advisory and extension division officials from the Talawakelle Techno Park:

*The advisory and extension division of the TRISL (Tea Research Institute of Sri Lanka) is the main source of technology dissemination to tea industry of Sri Lanka. [The] Tea Technopark is a demonstration plot maintain[ed] by advisory and extension division of TRISL to show the cultivation practices of tea with new innovation for the regular visitors and training groups.*

**Table 2.** Summary of completed capping projects led by participants.

Community of practice	Campaign objective	ICT platform/tools	Technology steward
Seed paddy producers from Galle District	Sharing agriculture related information	Text messaging (SMS)	Agriculture extension officer
Advisory/Extension staff of the Tea Research Institute	Scheduling maintenance activities of the Tea Techno-Park	Google Services (email, shared calendar, group chat, photo sharing)	Extension officer
Ipalogama Divisional Secretariat in the North-Central Province	Evaluating effectiveness of a Twitter-based SMS service for rural development	Twitter-to-SMS messaging	Science and technology officer
New recruits of tea factory-based extension officers from Matara District	Testing the effectiveness of voice messages for a forthcoming extension campaign	Google services (email, Google Forms, voice messaging)	Tea extension officer
Extension Officers from the Sugarcane Research Institute	Sharing information related to pest and disease problems in sugarcane	Viber messenger app	Technology transfer officer
Facebook users interested in Sri Lankan agriculture	Conduct an issues awareness competition among the user community	Facebook	Community member

A persistent challenge for the Techno Park is scheduling and monitoring required maintenance activities, which are currently managed by a single individual. A complicating factor is that advisory and extension officers within the division are engaged in various other scheduled and on-call activities during their working hours, making it difficult to muster and coordinate group effort in support of maintenance at the Techno Park:

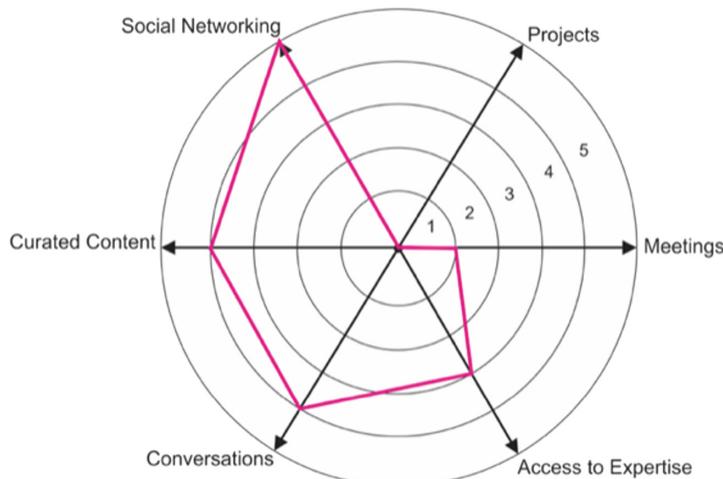
*Sharing the responsibilities of the Tea Technopark maintenance activities among officials is the best solution to overcome this problem. But, [to] nominate officers in [a] dynamic manner become again as an issue.*

The community assessment conducted by Pradeep led to the conclusion that assigning maintenance activities on a shared basis among the extension officers might address some of the current workload concerns. However, this would prove difficult in part because of the varied schedules and duties of the extension officers in the division. Some means of coordinating group effort would be needed if this approach is to be

workable. Using a community assessment method introduced in the course, Pradeep established that an ICT-related solution would be appropriate to attempt:

*With respect to stage of maturity [this] communit[y] of practice [is] stable and adaptive but willing to try new ideas if they provide benefits. This community of [practice] has high level of tolerance for new ICT choices. The advisory and extension division officers regularly access to Smartphone and Desktop computer with internet and daily they check official emails.*

Following the community engagement methods presented in the course, Pradeep was able to identify the main factors that affected the poor monitoring of the Technopark and then translate them into a set of information and communication related actions. Figure 2 depicts the spidergram method introduced in the course and used by Pradeep with his community of practice.



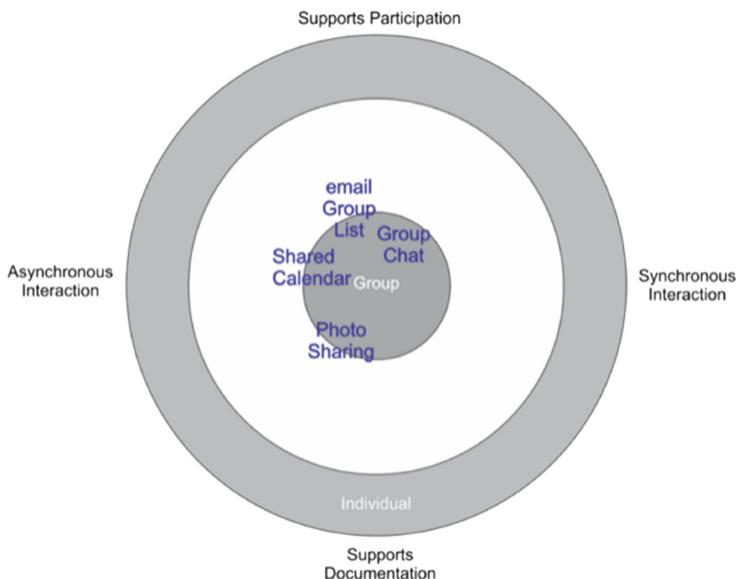
**Fig. 2.** The steward's spidergram ranking actions by priority.

Having completed these preliminary steps, Pradeep was able to articulate a campaign goal in order to inform the choice of ICT and to guide in its implementation and evaluation:

*The goal of the campaign is to improve the maintenance of the TRI Tea Techno park area by using ICT to [support] social networking for sharing the responsibilities... between the officials of TRI Talawakelle advisory and extension division officials.*

Continuing with the planning process introduced in the course, Pradeep created a use case diagram depicting the anticipated set of interactions between members of the community of practice in relation to the campaign goal. The use case diagram then provides the basis for choosing ICT tools that align with the intended community dynamics of the campaign. Wenger, White and Smith [10, p. 56] refer to these dynamics as the “three

inherent polarities” of rhythms (synchronous vs. asynchronous exchanges), interactions (participation vs. documentation), and identities (individual vs. group). The technology steward uses a “tools landscape diagram” to plot the ICT tools along these three polarities (see Fig. 3). In this case, Pradeep recognized the need to choose ICT tools that support group effort while providing a balance of support in the other two dimensions.



**Fig. 3.** A tools landscape diagram created by Pradeep during his capstone project planning

Having settled on the appropriate ICT tools for the campaign, Pradeep then turned to examine the various ICT platforms that include those tools. The technology stewardship course introduces participants to a number of technology acquisition strategies, but typically emphasizes a “use what you have” approach for new stewardship projects.

By default, this strategy typically means choosing from one of several commercial social media (CSM) platforms familiar to community members. CSM offer user-friendly, low cost platforms with advanced features and can provide real benefits to a community of practice. It must also be acknowledged, however, that they entail serious concerns related to privacy and data residency [29]. As such, CSM might be viewed as an intermediary strategy to create an “on-ramp” for community members to migrate to other types of platforms later.

In this case, Pradeep compared several CSM platforms using guidelines provided in the course material:

*Based on the fit for purpose, integration, performance, pricing, vendor and security evaluation Google platform has been selected as the most suitable platform among others.*

A key element of campaign planning is deciding on the timeline and making community members aware of the initiative and its goal:

*This campaign will be launched after the divisional meeting on 4th December 2018 (the purpose of the campaign will be explained on the divisional meeting) and it will continue for a two week period. Promotion for this campaign will plan to done by email invitations and during the Divisional meeting.*

Evaluation planning is vital to campaign design in order to assess outcomes against the intended goal. The training course provides an evaluation planning guide that encourages technology stewards to consider a set of four key metrics, identify sources of data and methods for collecting data, and the timing of data collection. Pradeep provided the research facilitators with his evaluation plan for the campaign, using a format that is described in the course workbook. As a final step, Pradeep planned for a debriefing meeting with the community members following the campaign:

*Results will be discussed with the community of practice during next divisional meeting of Talawakelle Advisory and Extension Division.*

The post-campaign debrief is an essential step in the community engagement with respect to the choice of ICT. It is during this stage that the technology steward recognizes the achievement of choice with community members, celebrates points of success, identifies ongoing challenges, and receives feedback essential to the next iteration of action.

Pradeep completed the planning and submitted his capping project report to the research facilitators in December 2018. He then launched the campaign with his community of practice, using an email group list, a shared Google calendar, group chat and photo-sharing. In a brief follow up report in July 2019, Pradeep indicated that the results of the campaign have been mixed. Several of the extension officers continue to use the Google calendar in scheduling work programs of Tea Technopark, and their daily schedules. Some of the senior staff members initially used the Google calendar together with a diary, but preferred the latter, which they have been using for a longer time. This is an important result in as much as it speaks to the principle of choice and the technology steward's need to respect decisions by members of a community of practice to choose to continue with established practices over new methods.

Pradeep's experience brings to light the difficulty of drawing firm conclusions, one way or the other, about the long term impact of technology stewardship training on the informational capabilities of a community of practice. Nevertheless, what is encouraging is that this capping project report, similar to the others from our cohorts, does show promise with respect to the influence of training on the following four key responsibilities of a technology steward:

- This case example demonstrates a successful effort to make community members *aware of choice*, by assisting them to articulate current challenges related to Techno Park maintenance and suggesting that ICT might provide a way to improve the coordination of group action;

- It shows how the technology steward introduced *a sense of choice* to community by explaining how specific ICT tools could be introduced to enhance current practices related to the techno park maintenance;
- It shows how the technology steward encouraged the *use of choice* by planning a relatively simple campaign with “a use what you have” strategy with a CSM platform (in this case, Google);
- It shows how the technology steward planned for *recognizing and sustaining the achievement of choice* through ongoing community engagement and post-campaign debriefing.

## 7 Conclusion

The technology stewardship training program integrates a social intermediary approach from the communities of practice literature with an ICT4D-informed framework guided normatively by Gigler’s informational capabilities and Kleine’s Choice Framework. The goal of the program is to build capacity for change leadership among agricultural extension and advisory service officers in developing country contexts. Change leadership as expressed in the technology stewardship model should be a community-minded and exploratory approach that aims to improve the informational capabilities of communities of practice through enhanced choice. A trained technology steward can contribute to this goal by engaging with their community to make members more aware of the existence of choice, to help them develop a clear sense of choice, to facilitate and support the use of choice, and to recognize and help sustain the achievement of choice with respect to ICT-related practices.

The creation, implementation, and evaluation of the training program has been an essential step in the operationalization of the technology stewardship approach for agricultural communities of practice. Cohorts trained in a common set of skills and techniques provide a baseline by which to carry out more extensive participatory action research on community-based leadership in ICT. The next step in the project will be to revise the training materials based on results of the evaluation, and to introduce the course into professional development programming at the Postgraduate Institute of Agriculture at the University of Peradeniya. Cohorts of trainees will then be enrolled in a longer term participatory action research project to better understand technology stewardship as a leadership practice.

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# **The Evolving Global Souths**



# Towards a Resilience Framework for Integrating and Using Mobile Technologies in South African Public Rural Schools: Theoretical Considerations

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**Abstract.** South Africa has seen research and development (R&D) efforts in Information and Communication Technologies for Development (ICT4D) to provide rural schools with mobile technologies for improving the quality of teaching and learning. The challenge however is that most of the interventions fail when the project team withdraws from the beneficiary schools. The failure of the ICT initiatives in public rural schools has led to studies that aim to understand the problems related to the sustainability of these interventions, however, despite all that, ICT initiatives continue to fail in these schools. While sustainability studies have historically focused on the ICT initiatives and factors impacting on their sustainability, in contrast, this study focuses on building resilience of the education system in a way that enables the school to thrive when using ICTs. Using a Design Science Research Method, the overall study seeks to identify existing sustainability and resilience frameworks for purposes of developing a resilience framework and guidelines for South African rural schools. This conceptual paper presents the theoretical building blocks for such a resilience framework.

**Keywords:** Resilience · Sustainability · Rural communities · ICTs · ICT4D · ICT4E

## 1 Introduction

This paper aims to address the importance of building resilience at a school level as a measure for tackling challenges inherent in the introduction of mobile technologies in South African rural schools. The introduction of Information Communication and Technologies (ICTs) in South African rural schools is part of a broader need to provide educational resources to resource constrained environments. The provision of these mobile technologies was intended to create multiple benefits, including the provision of learning resources to enhance learner participation [1] and create an enabling environment that will prepare learners to take part in the knowledge economy by, for example,

equipping the learners with 21st century learning skills [2–4]. These skills are particularly essential for creating an enabling self-learning environment in a school context.

The motivation for undertaking this study emanates from the failure of Information and Communication Technology for Education (ICT4E) initiatives, which have proven to be unsustainable in most rural schools. Despite the noble intentions of introducing mobile technologies at rural schools, such projects usually become unsustainable following the withdrawal of project teams [5, 6]. The issue of sustainability has been lingering on for long periods of time now. For this reason, research studies were undertaken to explore and understand factors impacting the sustainability of ICT interventions at schools, particularly those located in the rural areas. Despite continued research on the sustainability of these projects, serious challenges resulting in the failure of ICT initiatives at rural schools still persist. On a positive note, a particular limitation associated with previous sustainability studies has been identified; focus was previously directed towards the sustainability of the initiative and not on the education system being practiced at school level. To date, very few (if any) of these studies have looked at whether resilience can provide insights and enable schools to thrive when using mobile technologies. There appears to be a strong relationship between sustainability and resilience when identifying existing and relevant theory for developing the resilience framework that is relevant for South African rural schools. It is for this reason that we have elected to take a resilience stance in this paper.

What makes this study unique is the attention given to community resilience. In this study, community resilience is central to the development of both the theoretical contemplation and the development of the actual framework. The attention given to the community emanates from the perspective that a school is part of a bigger system (i.e., a community), which is viewed as a key role player when building the resilience of the school. It is envisaged that the resilience framework that will be developed in this study will have community resilience as one of the essential building blocks. It is worth noting that while many studies have been conducted to understand sustainability challenges of ICT4D interventions in rural schools, very limited work considering the role of community resilience as part of a community's ability to sustain such interventions has been undertaken. Heeks [7] is one of the few scholars in the Information Systems (IS) discipline that has focused on the resilience of members of communities. While the exploration of the notion of resilience is not new, previous studies were carried out in fields of ecology [8], sustainability [9, 10], decision making and support [11], and enterprise development and information systems [12]. Albeit, limited research has been undertaken in IS with a specific focus on resilience of education within a rural community setting, particularly with respect to the exploration of humans as a subject. In a response to this need, a study has been scoped with the aim to develop a resilience framework integrating and using mobile technologies in rural South African public schools. This paper forms part of an overarching study, and is aimed at presenting the theoretical building blocks that are relevant for developing a resilience framework. The research question for the overarching study is: "*What constitutes the components of a resilience framework for rural public schools in South Africa that will guide the integration and use of mobile technologies?*" This paper contributes to the overarching study by providing theoretical considerations that will be used to build the resilience framework for rural

South African schools. Another contribution of the study is to explore existing resilience frameworks that will be used to build the envisaged artefact.

This paper seeks to answer the following two research questions:

- What existing resilience approaches can be adapted into a framework and guidelines for building resilience in rural South African public schools?
- What can existing community resilience body of knowledge contribute towards a resilience framework for rural South African public schools?

This paper is structured as follows. First, a background section is presented that contextualizes the notions of sustainability as well as resilience in the IS as well as ICT4D domain. Following this, the research plan for the overarching project is presented, with an indication of where this study fits in. Thereafter, existing theoretical bodies of knowledge that respond to the two above-mentioned research questions are discussed. The paper concludes with a reflection on how the existing theories can contribute towards a preliminary resilience framework for rural South African public schools for purposes of guiding the integration and use of mobile technologies.

## 2 Background

The term resilience is used to imply different things in different contexts, and due to its recent overuse, some have coined it a buzzword. The use of the word resilience underpins elements such as stability [13] equilibrium [14], withstanding shock and developing functional structures [15]. There is a lack of clarity on the philosophical stance on resilience [16]. Often the term is used without taking cognizance of the social dynamics and complexities whereby things are reduced to technically defined frameworks that are ‘based on unchallenged assumptions of society’ [7]. For the purpose of this study, a resilience definition has been adopted from Heeks [7], which states that “resilience is the ability of vulnerable systems – countries, regions, communities, value chains, organisations – to withstand, recover from, adapt to, and potentially transform amid change and uncertainty.” The reason for adopting this definition is that it includes elements that are essential for building community resilience. The adopted definition also contains the term “system” and in this context it is conceptualised based on Checkland [17] adopted from Turpin [18] which states that “a system is a complex whole, the functioning of which depends on its parts and the interactions of these parts.” This definition of a system indicates elements of inter-dependency between different components within the system itself. However, according to Daellenbach and McNickle [19] the interdependency (between the different components of the system) “does not deny the importance of the individual elementary parts”, which also calls for recognizing the importance of the individual parts and their relationship to the other components that make up the system.

Resilience, unlike sustainability, takes a different focus and perspective. Resilience takes a Systems Thinking perspective that all complex systems are, by nature and definition composed of numerous interacting parts that are sometimes dependent on each other. Using this perspective, the rural school in this case is viewed and perceived in

relation to the complex system in which it is found. In this case, the complex system is the community which is composed of households, citizens, businesses, interests groups, and cultural groups, political and other structures that are critical for making the community thrive.

The limitation that comes with sustainability is that the focus has mainly been on the sustainability of the project or initiative and not the sustainability of the change that is brought by the initiative. Resilience takes a holistic approach in a sense that the sustainability of the change brought by the initiative is dependent on how the different structures of the community embrace and support it.

### 3 Research Methodology

Since a Systems Thinking approach was adopted for this study, it was essential to use a research methodology that will be able to deal with complexity in a systematic way. Design Science Research Methodology (DSRM) was therefore chosen for this study. This methodology originates from engineering and architecture, and it is concerned with the science of design such as physical artefacts as structures. DSRM was developed as a problem-solving research paradigm that can be incorporated in research to answer questions that are relevant to people and how their problems can be solved [20].

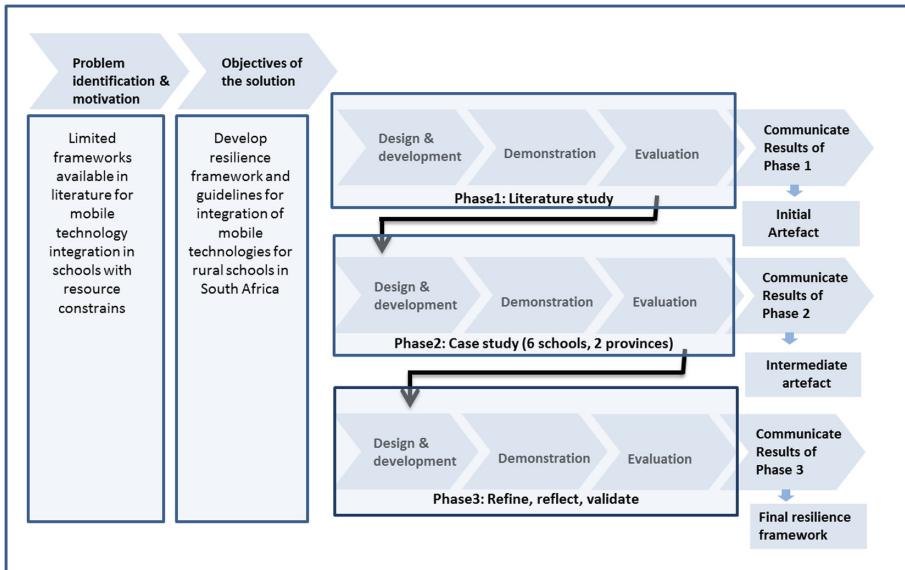
#### 3.1 Design Science Research Methodology

DSRM [21] was selected as a suitable methodology for the overarching study of which this paper forms part. Since the overarching study is conducted in the IS domain where the focus is placed on factors such as humans, organisations and technology, DSRM is well suited to studying the application of IS in a community context that comprises all these factors. In the bigger research study, DSRM is used for the purpose of building an artefact, which is the resilience framework for the introduction of mobile technologies in rural South African schools. In this way, DSRM is regarded as the building block of IS research, and is concerned with the development of new artefacts of products through which IS can be used [22].

Figure 1 illustrates the manner in which DSR guides the research study that this paper is part of. This paper is aligned with the second column in Fig. 1, namely “Develop resilience framework and guidelines for integration of mobile technologies for rural schools in South Africa”.

### 4 Theoretical Building Blocks Towards a Resilience Framework

The purpose of this paper is to consider relevant theory that will be used to develop the resilience framework. The study also identified two existing frameworks with elements will be used when developing the proposed framework. In this section, the existing resilience framework are explored and are explained based on how they provide theoretical contribution to the development of the resilience framework and guidelines for the integration of mobile technologies in rural South African schools. Firstly, the use of



**Fig. 1.** Design science research methodology used in this study

resilience in IS will be discussed, then the Resilience Assessment Benchmarking and Impact Toolkit (RABIT) framework developed by Heeks [7] and the six foundations for building community resilience by Lerch [23] will be explored. This section also highlights what each of the components of the framework and the foundations contribute to the attempted framework.

#### 4.1 The Resilience Assessment Benchmarking and Impact Toolkit (RABIT)

For the purpose of this study, the RABIT framework developed by Heeks [7] coupled with a personal and community resilience perspective will be used for grounding and conceptualising resilience in this study. It is of great importance that the RABIT framework be explored in the context of community resilience as the study seeks to position an initiative in a school in a manner that recognizes the community context.

Heeks [7] and his colleagues at Manchester University developed the RABIT framework for purposes of practical application of resilience in systems and contexts of all kinds. When developing the toolkit, Heeks [7] started by firstly defining resilience as “the ability of vulnerable systems – countries, regions, communities, value chains, organisations – to withstand, recover from, adapt to, and potentially transform amid change and uncertainty.” Unlike most definitions that only focus on recovering from adversity, this definition, provides a broader scope for conceptualising resilience. The reason for broadening this scope is that resilience will play an important role in the realisation of development outcomes [24].

The toolkit by Heeks [7] has identified nine attributes of resilience, which are divided into primary foundations of resilience (three attributes) and enablers of resilience (six attributes). The three primary attributes of resilience are robustness, self-organisation, and learning ability.

**Robustness.** Robustness is regarded as “the ability of the system to maintain its characteristics and performance in the face of external fluctuations, including shocks [25]. In this case, robustness refers to the integrity and preparedness of the system to absorb shock. Heeks and Ospina [16] acknowledge the following illustrative markers of robustness: “physical preparedness, institutional capacity, and multilevel governance”. These attributes are essential, from a systems perspective, when looking at a school as a system and how these attributes can be applied when creating a resilient institution, in this case a school.

**Self-organisation.** Self-organisation as a primary attribute of resilience refers to the system’s ability to self-correct in case of external disruption [26]. In resilience, external measures for enabling the shocked system to recuperate is often mentioned. However, in this case, self-organisation is seen as a means through which the system can self-restore without external interventions. Self-organisation reflects the system’s ability to self-correct in case of external disruption [26]. The notion of self-organisation also includes the state of preparedness of the system to absorb shock. Thus, this means that the level through which the system may be ready to reorganise itself is highly dependent on how well is the system being organised prepared for disaster. Self-organisation is perceived as a thread that holds the system together thus creating a dependency between the various components of the system. According to Folke, Carpenter, Walker, Scheffer, Chapin and Johan [13] self-organisation (of a system) is not only collectively illustrated by the internal workings of the system but also by the enablers of those processes such as social capital and trust. The indicators of a strong sense of self-organisation are collaboration and consensus, the use of social media and the contribution of the system towards trust building [13]. Self-organisation in an education system is the ability of the schools to organise themselves within a broader social system comprising of the wider community, business, and other institutions in society. Markers are collaboration and consensus, the use of social media and the contribution of the system towards trust building [13]. Social capital is also a critical indicator of self-organisation as it emphasises the notion of collective identity and understanding the strength of the system in relation to the relationships between the different components of the system.

**Learning.** The third primary attribute of resilience is learning, which mirrors a system component as well as a human dimension retrospectively. From a systems perspective, learning is understood as the capacity of the system to generate feedback that can guide the designer to experiment and innovate [13]. It is important that a management information system provides feedback about its own efficiency and effectiveness. The reporting enables an early detection or identification of flaws and hazards in a system and creates a pre-emptive environment that may even prevent disaster. This attribute is crucial as it has a human element in it and that element can play a vital role in strengthening preventative measures from learning from past experiences. Heeks and Ospina [16] have listed capacity building, new and traditional knowledge and reflective thinking as markers of this attribute.

Other than the above-listed attributes, Heeks and Ospina [16] have listed six secondary attributes of resilience in a system. Unlike the primary attributes, the six are what they coin enabling attributes or enablers of resilience. The six secondary attributes are: redundancy, rapidity, scale, diversity and flexibility, equality, and alignment.

**Redundancy.** Redundancy is the extent to which components within a system are substitutable or are ready to interchange in the event of collapse or loss of quality of one or more of the components that make up a system [27]. In the same way, [16] identified functional overlaps and interdependency, and resource substitutability and sparseness as markers of redundancy in a system. Redundancy as an attribute will play an important role in assessing the school in relation to other units of the community i.e. churches, interests groups, business and other government programs and departments in the communities. The practical use of redundancy at the school would be having complementary technologies which can serve the same purpose or used to fulfil the teaching and learning practice when the other technology fails (i.e. replacing tablets with laptops or *vice versa*).

**Rapidity.** Rapidity is concerned with the management of assets in a broader system, especially taken the interdependence of various units due to the redundancy in the system. According to [28], rapidity means how rapidly assets can be accessed and organized to achieve goals in a way that ensures efficiency. Rapidity is fundamental in ensuring the system's ability to respond to external stressors in a timely manner [28]. In this research study, rapidity is viewed in the context of a school that has never had any technology which then organises itself by integrating mobile technology to make teaching and learning much more efficient and effective while at the same time equipping the learners with 21st century skills. According to [29], rapidity is the “capacity to meet priorities and achieve goals in a timely manner in order to contain losses, recover functionality and avoid future disruption”. Although this view of rapidity has been adopted from an Engineering discipline, its elements are applicable in IS and in this study since it is concerned with how resources are mobilised to meet end goals.

**Scale.** Scale is closely related to rapidity. While rapidity is concerned with the management of assets in a broader system and how these can be accessed to achieve goals, scale is concerned with the resources that a system can access within itself or from the outside to meet the challenges it may encounter [13]. The resilience or the ability to withstand or bounce back from the shock is strongly dependent on the availability of these resources when they are needed. Heeks and Ospina [16] suggested the following markers for scale: multi-level networks, resource access and partnerships, and cross-level interactions.

**Diversity and Flexibility.** This attribute has two elements. Whereas diversity refers to institutional assets, flexibility is concerned with actions. According to [13], diversity is the variety of institutional assets (including knowledge, skills and capabilities) that can be accessed to deal with short as well as long term challenges. Flexibility in this case is understood from the perspective that the more diverse the system is, the more it is likely to be resilient as the diversity of the (system's) elements may help with ensuring continuity when the system is stressed. Diversity can also serve as “the basis for innovation, learning and adaptation to slower, ongoing change” [30].

Flexibility refers to the system's elasticity, which is the ability to undertake different sets of measures with the immediate available resource; therefore, not only does flexibility offer fitting solutions to problems, it also capitalizes on opportunities arising from external changes [13].

**Equality.** Equality is the last attribute of the RABIT toolkit and this element plays a crucial part in how the system is governed and operated. It can be argued that equality takes a socio-psychological stance since it is concerned with inclusivity and equal opportunity. The equality in the system gives every player the opportunity to act without encroaching on the rights of other players and thus ultimately strengthening the resilience of the system.

The RABIT framework has significance in the development of the resilience framework and guideline for the integration of mobile technologies in rural schools. What makes the framework significant are its elements that speak directly to rural schools that the proposed work seeks to transform.

## 4.2 Community Resilience

Unlike resilience in its broader sense, community resilience has to some degree a well-defined perspective. As it stands, community resilience is understood to be a form of resilience that is concerned with the community and looks at what needs to happen for a community to thrive. In a community perspective, resilience is generally understood to be the ability of the community to withstand, mitigate, or adapt to outside pressures and shocks [31]. This definition also creates a contestation of what constitutes a community. According to [32], a community is “a group of people living in the same place or having a particular characteristic in common.” The word community in this case becomes encompassing; it includes “the geospatial qualities of community, important to programming and intervention implementation and the capacity building component critical to sustainable development” [31]. Lerch [23] defines a community as a “place-based group of people who have some meaningful capacity to influence their basic common needs given their particular social and political context.” This definition of community has an element of agency thus making it possible to position resilience in it, particularly since it is inclusive. For the purpose of this research study, the six foundations for building community resilience by Lerch [23] will be used. The reason for selecting these foundations is that they fit well with the RABIT toolkit by Heeks [7]. Lerch [23] has identified two preconditions for a community to be resilient, namely: “the responsibility for resilience building and the power to decide how it is done must ultimately rest with community members” and “the process of resilience building must equitably address both the particular situation of the community and the broader challenges facing society.” These pre-conditions are essential and are also aligned with the RABIT toolkit developed by Heeks [7] and Heeks and Ospina [16].

The following section of the paper unpacks the concept of resilience in terms of how it is used in IS and other disciplines. This will be done by firstly defining resilience for the purposes of coming up with a working definition, especially since there is no universally agreed upon definition of resilience. This will be followed by a brief discussion on the use of resilience in IS and ICT4D. The Resilience Assessment Benchmarking

and Impact Toolkit (RABIT) as the adopted framework suitable for use in resource constrained environments will then be introduced and explained in more detail. The RABIT framework is one of the critical components for this study since it contains essential elements that will be used in the development of an initial framework for this study. Lastly, personal and community resilience will be introduced and unpacked. The reason for introducing community resilience in this study is to combine it with the RABIT framework for purposes of developing a resilience framework and guideline that will be used when implementing mobile technologies in communities with constrained resources. This holistic approach to resilience is essential as it positions the school in a broader social system and looks at the relationship and dependencies of various elements of the system.

### 4.3 The Six Foundations of Building Community Resilience

The six foundations for building community resilience is informed by recent academic deliberations on resilience, sustainability advocacy, and grassroots activism, as well as Post Carbon Institute's prior work [23]. The foundations were established on the basis that "in resilience science, a community and the ecosystem it makes use of are together considered a unified socio-ecological system." Heeks [7] and Heeks and Ospina [16] are also of the view that an attempt cannot be made to understand the community without having to look at its ecosystem. In addition, adaptability seems to be a key component in the community resilience school of thought since it is seen as the element that assists with coping during disaster management. The six foundations of building community resilience, which are listed by Lerch [23] are: people, systems thinking, adaptability, transformability, sustainability, and courage. The section that follows explains these six foundations in terms of how they fit into community resilience. The reason for incorporating the six foundations in the RABIT framework is that the elements talk directly to the Heeks [7] framework and both of these are suitable for developing a framework that is suitable for rural South African communities.

**People.** People make up a community, and there will never be a community without people. People are therefore essential elements in building community resilience. According to Lerch [23], communities are products of human relationships and therefore what the community will become in the future is strongly influenced by the interactions, negotiations and the relationship of its people. The emphasis of the role played by people in building community resilience indicates the importance of social capital, which refers to "the ability and willingness of community members to participate in actions directed to community objectives, and to the processes of engagement, that is, individuals acting alone and collectively in community organizations, groups, and networks" [33]. Building resilience in communities is dependent on how people interact with each other, and the types of relationships that exist among the people [34]. Relationships in communities and decisions on what needs to be done and how it needs to be done involves political and economic processes; that is, the power of the desire of the people is channelled around these institutions. As Lerch [23] argues, when building community resilience, the political and economic processes cannot be ignored because they have an influence on decisions of what needs to be done, for what reason and for whose benefit. People

and the institutions they belong to therefore play an important role and these cannot be ignored when building community resilience.

**Systems Thinking.** Communities are complex systems; they are made up of many components and are subject to internal and external forces. According to [23], “communities are thoroughly integrated sub-systems of a single global socio-ecological system” and it is practically impossible to understand the communities without the components that comprise it. According to [19], when using systems thinking, a phenomena to be explained is viewed as a part of the larger sum, a system, and it is also explained in terms of its role in that system. System thinking therefore becomes a methodological approach for understanding how the parts of the system are related to each other and how each of the components influence the bigger structure or a larger system. Communities are complex systems in their own way; they are also made up of components that are constantly evolving while interacting with each other at the same time. Therefore, systems thinking assist in the understanding of the complex crises of the system [23, 35]. The relationships and influences occurring amongst the various components in the system can easily be unpacked using systems thinking as a suitable methodology to deal with complex systems.

**Adaptability.** When complex systems are resilient towards forces of disruption, it is mostly because they have the capacity to adapt to changing environments [23]. In a community resilience perspective, resilience is generally understood as the ability of the community to withstand, mitigate, or adapt to outside pressures and shocks [31]. Adaptability is a crucial stage towards becoming resilient. In community resilience literature, adaptive capacity is understood as the capacity of communities to cope with, adapt to, and shape the nature of environmental, economic, and social change [36, 37]. Adaptive capacity in resilience is generally preceded by learning [7] and communicating what has been learned to inform the actions required to become resilient. In community resilience, adaptability is preceded by individuals, stakeholders, or communities learning from and responding to changes precipitated by some hazardous event [38]. Although this is a process that normally involves social learning, it can also have a measurable outcome. Although different authors have different ways of using adaptability to explain resilience, they mostly include the following to explain adaptability: “creative problem solving, coping with uncertainty, learning new tasks and skills, adapting to teamwork and collaboration, changing procedures and developing new procedures, and adapting across cultures” [31]. It is for the above-mentioned reasons that adaptability has become a crucial element in building community resilience.

**Transformability.** Transformability and adaptability have similar characteristics yet they differ in principle. Communities generally adapt when the circumstances require them to [23]. However, if there are circumstances that hinder transformation, the challenge or disaster may progress faster than the efforts to cope with it, which will ultimately hamper the chances of being resilient.

According to Lerch [23], building resilience attempts to adapt and manage the basic function and structure of a system in the face of disruption, which ultimately means that transformation happens in the midst of the challenge or disaster. Transformational

efforts are purposefully disruptive to the system, and it is also important that the need to transform may result from both the external or internal forces. Transformation may also force part of the system to transform, but it may also require the whole system to transform. The level of resilience required will in one way or the other determine which elements of the system need to transform and to what extent.

**Sustainability.** Resilience and sustainability are often used interchangeably. Sustainability and resilience are distinct concepts that complement each other [23]. While resilience assists in the understanding of the complexity of how socio-ecological systems work and how adaptability happens, sustainability assists with the understanding of the complexity of the relationships we have with the natural world and what happens if the relationships go wrong [23]. Berkes, JColding and Folke [36] described sustainability as “the use of environment and resources to meet the needs of the present without compromising the ability of the future generation to meet their own needs.” Although this definition comes from an ecology point of view, central to it is the considerate use of resources that is also essential in building community resilience. Sustainability and community resilience fosters a need to think about individual action in relation to common goals that benefit greater society.

**Courage.** Courage is the sixth foundation of building resilience, according to Lerch [23]. This is quite a distinctive element of the foundation. None of the literature consulted during the review made mention of courage. Although reference has been to social and psychological wellbeing [35, 37, 38], no specific mention of the courage has surfaced in the literature. Lerch [23] has argued that building community resilience does not take knowledge and skill like solving engineering problems, instead it is a social undertaking process that involves many and diverse groups of people. To undertake such a strong task as building community reliance requires a large degree of courage [23]. In this context (of building community resilience), courage is viewed as the ability to do what is deemed difficult yet continue to do it for the benefit of the whole community.

The above conceptualisation of resilience and the RABIT framework coupled with community resilience provides a good perspective on what is essential for building resilience of rural schools in a way that enables these schools to embrace and benefit from using mobile technologies. The intended outcome here is to use these for a development of a framework and guidelines that can be used for building resilience for rural South African schools.

## 5 Discussion

Table 1 indicates how the various components of the RABIT framework and the foundations for building community resilience will be used for the development of the resilience framework and guidelines for use when integrating mobile technologies in rural South African schools. The reason for merging the components in that fashion is to make sure that the scope of focus is clearly defined, the system and its context is well understood and the approach is representative.

**Table 1.** Proposed resilience framework

RABIT framework	Foundations of building community resilience	Contribution made by the merged components
Robustness	Systems thinking	Taking a systems thinking view to preparing to deal with shock
Self-organisation	Adaptability	Ability to self-restore without external interventions, and generate feedback for better understanding of the systems capabilities and learn and innovate from previous shocks
Learning		
Redundancy	Transformability	System components are substitutable or can be redundant in state of chaos and re-organized in the midst of disaster
Rapidity	Sustainability	Ease of access and organization of assets to ensure efficiency that is sustainable
Scale		Assets available for use within or outside the system
Diversity and flexibility		Availability of resources to deal with short and long term challenges while also taking different sets of measures with the immediate available resource
Equality	People	Inclusiveness and representation and understanding the important role played by individuals and groups that are part of the system
	Courage	

## 6 Conclusion

The introduction of mobile technologies in rural South African schools remains a challenge and the studies that have been conducted in the Information Systems domain have only focused on sustainability and sustained benefit. The problem with such studies is that even though the focus was on sustainability, which is an essential element of resilience, the focus was often on the sustainability of the project. Resilience is therefore an approach that needs to be taken into consideration when addressing the challenges accompanied by the introduction of mobile technologies in rural schools. The reason why resilience is appropriate for this exercise is that it takes a holistic view of the community and views a school as a subset in a bigger context, which is the community. The community resilience perspective provides a guideline through which resilience can be studied in a community and indicates what elements should be considered when building the resilience of the community. This study contributes to current state of the

art by synthesizing existing theory into a proposed resilience framework for use when integrating mobile technologies in rural South African schools.

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# Appropriating Digital Citizen Engagement in Resource Constrained Local Government Service Delivery: A Case Study in South Africa

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**Abstract.** South Africa is currently plagued with destructive civic protests associated with a lack of service delivery and deteriorating local government operations. Digital Citizen Engagement (DCE) has globally been promoted as a game changer in these circumstances, as it is identified as essential in facilitating a two-way communication and evidence-based engagement between government and citizens. However, programmes in resource constrained municipalities struggle to align and integrate ICTs with existing service delivery operations. The paper proposes a framework to support the appropriation of DCE in local government in South Africa. Adaptive Structuration Theory is applied to contextualize the study, using a pragmatist qualitative approach. The findings illustrate a holistic process needed and deduce that appropriation of DCE in a local municipality is a gradual process of complex learning which depends on the strength of the civil society context, the effectiveness of the enablers of social accountability, and inevitably political change.

**Keywords:** Citizen engagement · Social accountability · e-Government · Open government · Alignment

## 1 Introduction

Despite efforts towards post-apartheid transformation in the social and political landscape of South Africa, service delivery has worsened for many citizens, especially in marginalized contexts of the country. This is clearly evident with the growing number of destructive protests, as citizens feel disempowered and are unaware of how to effectively exercise their rights [1, 2]. During the Apartheid era, public services were a privilege only to those who could afford it. The right to basic services only became part of the Constitution after the Apartheid Era, enabling *all* citizens to have access to basic needs (Constitution of the Republic of South Africa Act 108 of 1996). However, the provision of basic services to resource-constrained communities took substantially longer than envisioned [3], and consequently service delivery needs are still not accessible to communities at large.

Local municipalities in South Africa (especially in marginalised contexts) continue to fail to meet the constitutional command, due to government's top-down approach

that underlines that local government is a vehicle for service delivery only, rather than simultaneously emphasising that it is a vehicle for participation [3, 4]. Many of the service delivery challenges that exist today relate to two main information and communication aspects: 1) lack of effective communication and collaboration between citizens and government, and 2) lack of evidence to hold government accountable for the services it provides. A facet of citizen engagement that incorporates the use of Information and Communication Technologies (ICTs) to support such communication flow is referred to as Digital Citizen Engagement (DCE) [5]. DCE enables and amplifies citizen engagement through information access, enabled participation by citizens, collaboration between stakeholders, and empowerment through joint decision-making. Despite the opportunities that exist for DCE, the reality of implementing such innovations in resource constrained local governments remain a barrier for many initiatives [6]. The key to successful adoption and implementation of these ICT initiatives emanates from an alignment of processes, departments and employees as well as external stakeholders with a strategic plan of local government. The research study proposes a guiding framework to support the alignment and integration (through appropriation) of DCE in local government in South Africa. The following research question guides the study: *How can digital citizen engagement be appropriated and integrated in the service delivery processes of resource-constrained local government in South Africa?*

To set the background for the study, a literature review is first presented. This is followed by a description of the theoretical framework that guided the study and the research methodology applied to the empirical setting. The findings and discussion are subsequently presented. Finally, the research study is summarized and it is concluded that the appropriation of DCE in a local municipality is a gradual process of complex learning which depends on the strength of the civil society context, the effectiveness of the enablers of social accountability, and inevitably political change.

## 2 Literature Review

After coming into power in 1994, the newly elected democratic government inherited overwhelming municipal service backlogs that were found mostly in rural, impoverished regions in South Africa [7]. Municipalities in marginalized areas were deprived of the means to meet the needs of citizens [8]. The key operational challenges still currently being faced include lack of capacity [8, 9]; lack of implemented policies [10], and the inability to clear backlogs [1, 8]. This is particularly pertinent in B3 type municipalities, characterized as having small populations with a fair proportion residing in urban areas and rural areas. They form the majority of municipalities in South Africa, and are the focus of the research study, given the urgency for change and progress.

The current communication problems being faced by municipalities are due to lack of sustainability of a positive disposition internally and externally. Internally, among others, there is lack of consistency in holding regular departmental meetings to steer service delivery [4]. Externally the local government is unable to efficiently and timeously communicate with various stakeholders, therefore affecting the impact of the message and intended consequences regarding service delivery issues, progress, successes, and failures [4]. Bridging the gap of communication requires ensuring that citizen engagement exists, and capacity and motivation for government responsiveness are improved.

The Municipal Structures Act of South Africa states that citizens have a right to decision-making processes of a municipality, to be informed of decisions of the council and disclosure of state affairs of the municipality (Municipal Structures Act No. 117 of 1998). The primary purpose of citizen engagement and citizen participation is to improve developmental outcomes in decision making [11]. The growing interest of citizens in socio-economic development is reflected in their increased need to participate in decision making, hence citizen engagement [5]. Citizen engagement facilitates *social accountability*, where citizens become capable of holding government accountable for the services provided, lobbying for responsiveness to their needs [12]. Social accountability can be viewed as an interaction of five elements to achieve its objectives: *state action*, *citizen action*, *information*, *citizen-state interface*, and *civic mobilization* [13]. Each of these elements are affected by certain contextual drivers that determine the outcome of citizen engagement and social accountability. Grandvoynnet et al. [13] indicates that through an iterative activation and amplification of information, citizen-state interface and through civic mobilization, accountability can move from a spiral of weak accountability to strong accountability and vice versa, depending on the effectiveness of enablers of those three elements.

*State action* encompasses approaches that support accountability and government responsiveness to citizens' requests and demands. The state should be able to determine the effectiveness of citizen engagement, through access to information, and a supporting platform/interface for citizens to communicate. There is a need for *two-way communication*, as citizens can either supply information or provide feedback to the state and vice versa [5, 13]. DCE through the use of ICTs, plays a strategic role not only in enabling two-way communication between government and citizens, but also providing a platform for the collection of evidence-based data to engage with government. Nonetheless, like any citizen engagement initiative, the effect is not always immediate but rather transitions over a period of time through different levels of engagement. Here citizen engagement sequentially facilitated by ICT over time along the four dimensions of *Information provision* (usually one-way from government), *Participation* (two-way communication between local government and citizens), *Collaboration* (collaboration between stakeholder groups on issues observed from ICT data and information), and *Empowerment* (citizens and government to contribute to joint decision-making – Multi-stakeholder coalition building) [14]. Ultimately the goal of citizen engagement is to reach level 3 and/or level 4 (collaboration and empowerment) – however, technology does not operate in isolation, but is reliant on the dynamics/challenges of the context. Technology does not bring about change in itself. In other words, technology to support social accountability and government responsiveness cannot make up for the lack of human intent and capability. It can actually lead to creating more inequalities between groups in a local municipality, depending on who has access to the technology, capacity to effectively use it for its intended purpose, and the motivation to use it [15]. Addressing or mitigating identified constraints, relies on multi-stakeholder partnerships between government, citizens, civil society and the private sector, in order to support the operation of digital citizen engagement. This is not a clear-cut exercise, but a *learning process* over time, in efforts to align innovation with existing processes in local government and citizen participation and engagement.

The use of innovative ICTs by local government brings about changes in their traditional processes and transforms the way in which they operate [6]. The key to the successful adoption and implementation of these innovative ICTs requires the alignment of processes, departments and employees, and citizen engagement processes, with the strategic plan of an e-governance initiative. An organization will efficiently distribute its resources if its methods and projects are aligned with its objectives and goals. It assists in maintaining strategic goals, which in turn lead to better decision making [16]. Engagement is often linked with alignment. In local government, there is a need for a balance in the two aspects for improved results, and enhanced service delivery [16]. Therefore, alignment activities for DCE initiatives require that key stakeholders be engaged at every stage. Resource-constrained municipalities have been seen to exclude key stakeholders in the alignment process, which is one of the many reasons innovation adoption has not been successful. Alignment practice is beyond aligning innovative technology with local government; it entails aligning innovative ICTs with civil society and citizen practices of engagement. Alignment requires change, either to enhance existing activities or introduce new processes. The field of Business Process Re-engineering (BPR) provides a foundation to contextualize the process of aligning digital citizen engagement with local government practice [17].

While most of the issues with alignment and implementation are related to non-technical problems, they still pose a threat to the confidence of stakeholders and the credibility of their related responsibilities or roles. Lack of adoption or inclusion of the people (both government and citizens) that are associated with the processes of citizen engagement and service delivery is one of the causes for failure [18]. DCE initiatives that are adopted in local government tend to focus more on the technology than the people that will be affected by the change [14]. Three main factors borrowed from BPR literature and practice that similarly influence the adoption of digital citizen engagement include: 1) *Organizational Culture* encompassing values, traditions and beliefs that do not easily change, 2) *Capacity* in resource constrained local government where low digital literacy and lack of skills impact on ICT implementation and workflow change, and 3) *Change management* and *leadership* to drive transformation in the organization, understanding the potential of innovation and establishing the appropriate way to distribute people and resources. While the above factors are not an exhaustive list of challenges in the DCE space, they allude to the key aspects that influence alignment and adoption. It is eminent that DCE implementers are aware of these factors, and employ processes to either mitigate these influences or provide supportive structures to enable success factors in the alignment process. This research study investigates these factors and the process of alignment in the context of a resource constrained municipality in South Africa.

### 3 Theoretical Framework

The research proposes Adaptive Structuration Theory (AST) as its base theory in studying organizational change that occurs due to the implementation of technologies [19]. Like any e-governance initiative, digital citizen engagement implementation brings about change in local governments processes and structures. AST aims to uncover technology structures and the social interactions in which they are used. In this study, changes in

processes (requiring communication across municipal departments and between local government and citizens) are linked to problems ingrained in a social structure [20]. Adaptive Structuration Theory assists in understanding how a user-defined, user-driven technology is adopted in organizations. This is important in alignment, as users are a determinant of successful adoption of a system. For this research, the focus will be on the critical users who are the municipality and the citizens. According to AST, structuration is the act of bringing processes, resources, and other structures into appropriation (element: *Social Interaction*) [21, 22]. Appropriation is the alignment of structures that impact digital citizen engagement with the processes, resources, and other structures (elements: *structure of advanced information technology, group's internal system, other sources of structure*). The outcomes of appropriation are to elaborate the current structures or enable new structures (elements: *emergent sources of structure, decision outcomes, new social structures*).

In order to thoroughly investigate organizational change brought about by technology, there is a need for all the aspects in the theory structure to be examined [21]. This theory was made to support the social interaction of Group Decision System (GDS) systems. The approach used is too complex and is modified to guide the development of the alignment framework within a Digital Citizen Engagement context. The original structure, however, provides a guideline of the structures and analysis themes to focus on, in a digital citizen engagement context. Therefore, theory outlines factors as a point of reference [20, 21]. These factors are listed and described as structures that guide the planning and alignment of the DCE initiatives at the local government level. These structures govern the way they interact with the Advanced Information Technology (AIT), which impacts on the adoption and alignment of technology [20]. The following assumptions for this study are adopted from Sedera and Zakaria [23]: 1) This theory assists in defining the knowledge base of the system, 2) It assists in encapsulating the interactions of the municipal employees and citizens with the system, 3) The theory increases the knowledge of the system, 4) It accommodates the inclusion of various stakeholders of the system, 5) There are two users of this study which are the government and the citizens - however, this research focus is on building government responsiveness, which is often neglected, 6) Lastly, it assists in assessing the relationship between the system structures and its success.

## 4 Research Methodology

The research applies a philosophical approach of pragmatism, where the epistemology focuses on discovering knowledge and truth through experience and observation to explain the actions and interactions of the actors involved [24]. Pragmatism is premised on abductive reasoning, where a logical connection between theory and empirical data are developed in an iterative fashion. Morgan [25] describes this as "...an active process of inquiry that creates a continual back-and-forth movement between beliefs and actions". The research strategy is a longitudinal case study of a Category B3 municipality in the Eastern Cape of South Africa, over the 2 years of implementing a digital citizen engagement initiative. The investigative process assisted in revealing the key processes and factors that supported or hindered the alignment of digital citizen engagement at local government level (how and why), and aided in explaining how the proposed

framework operated within the context [26]. The digital citizen engagement initiative is the MobiSAM project – an initiative that aims to facilitate two-way communication between government and citizens. It accomplishes this by providing an ICT platform for direct citizen reporting on service delivery, collating and visualizing reported problems, facilitating evidence-based engagement, and supporting feedback from government on reported issues. MobiSAM has been implemented in two phases. The first phase (phase 1.0) was implemented in the local municipality in 2012 – however, challenges that emerged originated from a lack of local government buy-in and responsiveness. The second phase (phase 2.0) of the project built on the lessons learned from the previous phase. Phase 2.0 started in April 2016 with a focus on developing government responsiveness and capacity, and expanding citizen reach and engagement – the research study was initiated at that stage, and conducted as a longitudinal study as the new phase unfolded, understanding the dynamics of the research problem. The project evolved through various stages, which the researchers used to extract information related to the research study, using different qualitative tools for data collection:

*Participant Observation:* Guided by a frame of observation questions related to the dynamics of the local government context and its stakeholders, the researchers participated in or attended local government meetings (management meetings, special council meetings, public forums, and provincial initiative meetings (Masiphatisane), civil society meetings and workshops, and MobiSAM project workshops and meetings (needs assessment, strategy formulation workshops, training workshops, and process assessment).

*Interviews:* Both semi-structured and unstructured interviews were conducted, to gain an understanding of the context – at times ‘on-the-go’ given the dynamic nature of the context. Interviews were conducted with municipal staff (technicians, service department clerks, communications officers, ICT managers, service department managers, and ward councilors), civil society representatives, and citizens.

*Focus Groups:* Focus groups provided a space to prompt for stakeholders’ shared views on the project, with the aim of further understanding ‘how’ and ‘why’ specific factors supported or hindered the alignment of the initiative. Four focus groups were conducted in the municipality with staff from the: 1) Communications Department, 2) Engineering and Infrastructure Services Department, 3) Electricity Department, and 4) Fire Department.

*Document Analysis:* project and municipal documents were reviewed to identify and understand themes that influence DCE alignment and integration. Documentation of preceding project evaluations and activities, such as the Baseline Study, Needs Assessment, Process Assessment and DCE Strategy formulated. Municipal documents were also analyzed, such as the council meeting documents, the communication strategy and communication policy documents.

Data analysis applied abductive reasoning throughout the longitudinal study, using analysis approach of Explanation Building [26], and open and closed thematic analysis. The approach builds an explanation of the case over time, developing causal links in an iterative manner. The iterative process unfolded as follows: re-examine the components

of Adaptive Structuration Theory; compare the qualitative findings and reflection of project implementation processes that incorporate DCE alignment against the Adaptive Structuration Theory model; and contextualize AST in the local government case study in South Africa to develop a framework for DCE alignment. The iterative nature of the alignment process itself, required consistent revaluation as new factors emerged from the process in a complex social political environment. Contextualization became fundamental in the theorizing process to make sense of the phenomenon that unfolded in the context – which Avgerou and Davison et al. [27, 28] also support for indigenous theory development.

The proposed DCE alignment framework that was developed is explained in the subsequent section. This research paper focuses on describing the proposed framework that emerged from the empirical investigation. The detail of the analysis process and unique methodological experience are elaborated on in a future publication.

## 5 Findings and Discussion

The structures that are present in Adaptive Structuration theory were used as a point of reference in examining the local government context. It divides its structures into three sections, which are Drivers, the Appropriation Process, and Emergent Outcomes. Figure 1 illustrates a proposed framework that emerged from the empirical investigation. The drivers that can either positively or negatively impact the appropriation process assist in realizing essential factors that hinder or support the alignment process. Over time, the nature of these drivers is also influenced by an iterative appropriation process, depending on effectiveness (hence the blue and green arrows). The emergent outcomes are the factors generated from the appropriation process. These can also be negative or positive depending on the effectiveness of the appropriation process, which in turn feeds back into the iterative appropriation process over time in developing an enabling environment for digital citizen engagement. The bi-directional arrows between the alignment process and Citizen-State Socialization illustrate that they feed into each other. To efficiently align DCE initiatives it is important to involve stakeholders and for there to be constructive engagement.

### 5.1 The Appropriation Process

The appropriation process is the act of alignment that impacts DCE, using resources, factors, and processes [29]. The appropriation process encompasses two sub-components: which are 1) Integration and Alignment, and 2) Citizen-State Socialization. The integration and alignment process were adapted from generic business re-engineering process by Vakola and Rezgui [30], while Citizen-State Socialization is a vital aspect that emerged from the empirical study, in relation to the way in which citizens and the local government engage to effect the alignment process.

**The Integration and Alignment Process.** The integration and alignment process consist of six stages. The MobiSAM project processes were organic and unraveled appropriate practice in the context of digital citizen engagement. As the project reached post-strategy formulation, alignment became paramount, reflecting between context relevance

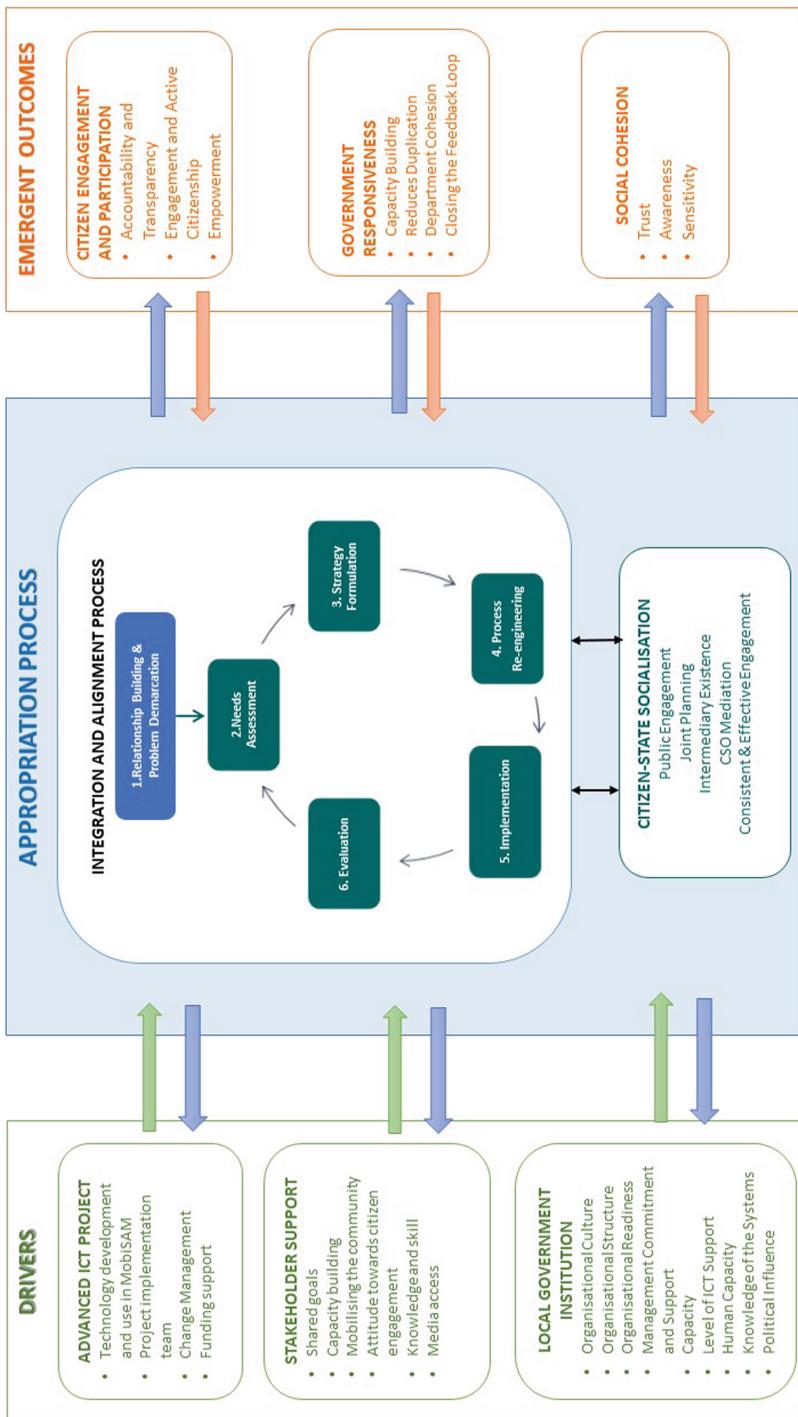


Fig. 1. Digital citizen engagement (DCE) alignment framework

and theory. Given the complex dynamic structure and culture of local government, it is an iterative process because the context is always evolving. Lessons from each stage were employed and adapted in subsequent iterations until the process of alignment was fully engaged.

The iterative process alleviated risk and increased the ability to adjust to unpredictable outcomes. Correspondingly, resource constrained municipalities lack the capacity to adopt technology initially, therefore, implementing in-piece stages assisted with gradual adoption. Relationship building and problem demarcation are not included in the iteration process as it was a once off process that established the context and found an entry point into the project. The other five stages are iterative as each cycle leads to the desired outcome and improves the process.

1. *Relationship Building and Problem Demarcation:* Focused on attaining buy-in from stakeholders in exclusive spaces and understanding the context for or against citizen engagement in the local municipality. The baseline study contributed significantly to this stage, paving the way for a tailored alignment process for the particular local government context.
2. *Needs Assessment:* This process built on the findings of the Baseline Study, but entailed engaging more directly with municipal staff and civil society to determine their information and communications needs for DCE. This process can be repeated as demand driven needs emerge throughout the course of the project.
3. *Strategy Formulation:* This stage focused on developing a strategy with stakeholders from government and citizens, for the integration of the MobiSAM platform in service delivery reporting and citizen engagement. Obtaining mutual buy-in was fundamental to implementing the initiative effectively.
4. *Process Re-engineering:* Once a strategy was agreed upon for the operation of MobiSAM, project implementers had to engage with government staff to explain the change required, and the implications of change in existing processes. Change management was not a straight forward exercise, and political and cultural influences led to some staff excluding themselves from the change processes [10].
5. *Evaluate Processes:* This is the last stage of the cycle, which focused on assessing successful aspects of the project, and identifying areas in need of improvement. This was exceptionally beneficial for an iterative driven approach, as each stage would be a learning opportunity with room for improvement. Assessment of the project at this stage focused on process assessment and short-term outcomes assessment.

**Citizen-State Socialization.** It is widely recognized that institutionalized spaces (government institutions) for citizen-state interaction in South Africa are not vibrant local democratic spaces [2]. They do not allow for ample engagement, which has led to an increased lack of trust and despondency by citizens, as well as the reluctance of government to engage with citizens. Citizen-State Socialization considers how the two stakeholder groups learn to conduct themselves in joint engagements, in a way that is acceptable [31]. Through engagement, stakeholders learn how to behave in group settings in a way that is progressive for service delivery in the community. This was an uneasy process in the MobiSAM project, as different mindsets tended to conflict at first.

Group structural elements (group member relations, differentiation features, and group resources) that influenced citizen-state socialization had to be investigated, in order to determine the best possible way for stakeholders to interact [18]. Here, the MobiSAM project team had to facilitate effective dialogue and build joint relationships between citizens and government towards realizing the value of the DCE initiative. Socialization was developed over time through government initiated public forums and civil society workshops/meetings, and MobiSAM project activities such as needs assessment workshops, strategy workshops, and training sessions. Joint planning and involvement of citizens and/or CSOs in the creation of key documents, such as the communication strategy and policy assisted the resource-constrained local municipality in evidence-based planning, targeting issues that are affecting the community.

## 5.2 Drivers

The appropriation drivers for digital citizen engagement are categorized into advanced technology, local government institutions, and stakeholder support (citizens and CSOs). Advanced technology focuses on the technology development and use. As Toyama and Geek [15] argued, technology is only an amplifier of underlying factors, such as, organizational culture, willingness, and human resource capacity. Therefore, technology can have a positive or negative effect depending on the impact of these factors. Other inputs emerged from local government institutional function and stakeholder support. Local government institution drivers consider the organization's external and internal environment and how it impacts alignment, while stakeholder support focuses on the level of support from other organizations, citizens, and CSOs. The framework in Fig. 1 also illustrates that drivers do not only influence or contribute to the appropriation process; the drivers or external environment factors are also influenced by the appropriation process – hence the bi-directional arrows. Essentially, the aim is to gradually develop an enabling environment/context for citizen engagement, which a suitable dynamic combination of integration, alignment and citizen-state socialization can work towards achieving.

**The Advanced Technology.** Advanced Information Technologies (AIT) are tools and techniques that enable engagement between various parties in the municipality, in the development, implementation, and integration of the digital citizen engagement initiative. Factors that emerged from the case study included the approach for technology development and use, project funding model, and the project implementation team's role (team, capacity, leadership).

**Stakeholder Support.** The stakeholders that were key to DCE alignment in this case study were citizens, CSOs and local media. These stakeholders needed to be identified and engaged with, in order to be able to identify what encourages or affects their use of technology. The more the stakeholders' opinions and views were aligned with the project, the more they were willing to use the system – and hence support the alignment process. The factors that influenced the alignment process included: shared goals between CSOs, local media, and citizen activists in the municipality; capacity building and civic education driven processes; and the attitude towards citizen engagement.

**Local Government Institutions.** This input largely impacts the alignment process. It could be noted that some of the alignment factors in this input are generated from the appropriation process, in particular, the integration and alignment process. In local government, issues around weak leadership, vacancies in critical positions, poor financial management, lack of transparency and accountability, and communication with communities were seen as the standard factors that affect service provision, and were quite prevalent in the local case study. Key aspects that emerged as influencing factors in the case study included organizational culture and readiness for change, management commitment and support, human capacity, political influence, inter-organizational relations, and the level of ICT support.

### 5.3 Emergent Outcomes

Emergent outcomes are generated from the appropriation process. The results depend on whether the drivers acted as an opportunity or constraint in the alignment process, which makes outcomes less predictable. The emergent outcomes of the alignment process are linked to the goals of digital citizen engagement, and citizen engagement in general. Building up these factors were also shown to feed back into the process of integration and alignment, and negotiated spaces for engagement between citizens and government in the MobiSAM project. However, where these factors experienced challenges, the negotiated process for digital citizen engagement became divided (conflicted), and the sustainability of the MobiSAM project began to rely on external funding and volunteered support from the local academic institution, which has been challenging to sustain.

**Citizen Engagement and Participation.** Citizen engagement and participation can increase with the new innovative platforms that are being created to facilitate communication. The citizens should have a platform to hold the municipality accountable for resolving issues as the system provides evidence-based information. The factors that are generated from citizen engagement and participation include: accountability and transparency; engagement and active citizenship; and empowerment.

**Government Responsiveness.** Government responsiveness is an important factor generated by the appropriation process. It is a determining factor in closing the feedback loop in citizen engagement. The outcomes from the appropriation process in Municipality A, which are related to government responsiveness in the MobiSAM project were capacity building, reduced duplication, and departmental cohesion. These outputs have only been partially realized from the appropriation process, as influencing factors and drivers that continue to negatively influence the process.

**Social Cohesion.** Social Cohesion is a broad concept that covers several components, such as, a sense of belonging, social exclusion, citizen engagement and trust [32]. Social cohesion unifies a society. As an outcome, it provides an overview of transformation that occurred in the social space of government-citizen engagement, building trust, awareness, and sensitivity. Knowledge of increased engagement in the MobiSAM project increased levels of trust between Municipality A and citizens, civil society and local media. The partnerships developed between MobiSAM and civil society, enabled active

dialogue between local government and citizens, creating greater awareness of service delivery issues. For example, MobiSAM workshops sensitized CSOs to the reality of the challenges in the municipality, and sensitized government to the desperate needs of citizens to be heard.

## 6 Recommendations and Implications for Practice

The Digital Citizen Engagement (DCE) Alignment framework presents as case for understanding the intricacies of introducing and enabling [digital] citizen engagement in local municipalities. The research was conducted in a resource constrained municipality, nonetheless, a number of the challenges are not unique to this particular case study, as literature reiterates. This framework provides a breakdown of the drivers and outcomes that influence and are influenced by the appropriation process for adapting citizen engagement supported by innovative technology. Understanding those key drivers and emergent outcomes sensitizes stakeholders to the reality of contextual factors that need to be nurtured to support negotiated spaces of engagement between citizens and government. Furthermore, understanding the need for iterative development of citizen engagement and social accountability is fundamental, as highlighted by Grandvoynet et al. [13], in challenging contexts where power dynamics are at play [33]. Stakeholders that are aware of the drivers and desired emergent outcomes can work towards nurturing positives influences and outcomes. In addition to this, the appropriation process for digital citizen engagement should be respected as an iterative long-term process towards developing an enabling environment for citizen engagement. Too many e-government projects fail, before they even begin, because of rushed desires for results. It is a process that requires invested patience, with clear awareness of the components identified in the framework in Fig. 1.

## 7 Conclusion

There is growing frustration by South African citizens, emanating from inadequate basic service delivery by local government. Municipality A, like many local government organisations in South Africa, continues to face a variety of challenges that have impacted its capacity to provide basic services. Recently with the rise in communication-related challenges, innovative ICTs have been implemented in an attempt to facilitate communication and engagement between citizens and government around service delivery. However, ICTs are merely enablers of change and not a panacea for government service delivery [15]. Appropriating ICTs in the context of service delivery operations and citizen engagement is a complex process characterised by uncertainty due to socio-political challenges [10]. Using Adaptive Structuration Theory and a pragmatist approach in the empirical setting, a guiding framework to support the alignment and integration (through appropriation) of digital citizen engagement in local government in South Africa was proposed. Municipality A is used as a single case study, as it representative of many municipalities in South Africa, and literature has continued to highlight the same challenges experienced across different municipalities [1, 2]. The proposed

framework provides a holistic view of the factors that positively or negatively influence the appropriation process, as well as the influence of the appropriation process on these same inputs. What is clearly evident is that DCE operates in a dynamic context that requires iterative operational activities over a long period to sustain activities. These iterative activities, framed by citizen-state socialisation gradually contribute to improved citizen engagement and participation, increased government responsiveness, and social cohesion. Stakeholders in DCE need to acknowledge this gradual process as a learning journey that is not smooth, but gradually improves. The length of time this will occur will depend on the strength of the civil society context, the effectiveness of the enablers of social accountability, and inevitably political change.

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# Tacit Knowledge Explicitation and Sharing Through Social Networks by the South African Healthcare Practitioners

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**Abstract.** Drawing from the social capital concept, this study evaluated how trust, social cognitive and social ties influence the explicitation and sharing of tacit knowledge through social networks by South African public healthcare practitioners. A model underpinned by the social capital concept was proposed and quantitatively tested with data collected from four South African public hospitals. A total of 146 healthcare practitioners responded to the survey. The results confirmed that social cognitive and trust had direct strong effects whilst social ties had moderate effect on the explicitation and sharing of tacit knowledge by South African public healthcare practitioners. The findings of this study are valuable for they elucidate factors that influence the explicitation and sharing of tacit knowledge at public hospitals through social networks. The explicitation and sharing of tacit knowledge through social networks is valuable at South African public hospitals because it provides an interface for archiving organizational experiences.

**Keywords:** Knowledge sharing · Social capital · South African public health sector · Tacit knowledge explicitation

## 1 Introduction

Retention of tacit knowledge within the South African public healthcare sector community of practice is a challenging task. This becomes a major problem when employees resign from public healthcare organizations, in particular when they migrate to overseas countries. Organizational tacit knowledge brain drain results in the repeating of past operational mistakes [1]. Davenport and Prusak [2] emphasized that the value of knowledge embedded in employees is only realized when they leave an organization. Thus, tacit knowledge has to be explicitated, preserved and shared as a way for conserving organizational memory, a process described as externalization [3]. Unlike explicit organizational knowledge archived in databases and hardcopies, sharing of tacit knowledge is difficult because of its nature. The nature of tacit knowledge is that it is based on personal experience, is not formalized and is difficult to communicate [4]. Nonaka [3] regards tacit knowledge as a worldview of an individual that is a product of both continuous skills development and cognition. In the context of public healthcare, valuable tacit

skills include the practical acumen of carrying out, for example, a heart surgery. This contrasts explicit knowledge, which is codified and archived information [3, 4]. Explicit knowledge can be retrieved and referenced, for example, a handbook on how to perform heart surgery in a library. Challenges that hinder the explicitation and sharing of tacit knowledge were reported to be language, time, value and distance [5]. The assertion that we know more than we can tell [4], have implications on decoding, valuing and sharing of tacit knowledge. Additionally, people have tacit knowledge overload, which makes it difficult for them to determine the value of what they know and the significance of what they know [6]. Owing to these challenges, explicitation and sharing of tacit knowledge through formal channels have been reported to be rigid in the Chinese healthcare [7]. For this reason, Chinese medical practitioners have called for the explicitation and sharing of tacit knowledge through informal channels such as social networks. The significance of using social networks as an interface for the explicitation and sharing of tacit knowledge have been highlighted [3]. Nonaka [3] has likened todays' social networks to a "field" that provides a medium on which a self-organizing team meets, interacts and shares ideas.

The explicitation and sharing of tacit knowledge through social networks calls for cooperation and mutual understanding amongst healthcare practitioners. This can be achieved if the healthcare practitioners have trust, sympathy and shared vision [8]. In the context of South Africa, trust and sympathy are fundamental due to the historic segregation of citizens according to racial, tribal, and economic divides. The historic segregation makes tacit knowledge explicitation and sharing difficult amongst healthcare practitioners. Hence, the shared interest of giving quality health in the country can be achieved if the healthcare practitioners share knowledge and experiences.

The factors that encourage the explicitation and sharing of tacit knowledge amongst South African healthcare practitioners can be explained by the social capital concept. This concept is characterized by trust, social ties and social cognitive [5, 9, 10], and has thus been adopted for this research study. Social capital entails the exchange of information and resources, establishment of community networks for the benefit of a community with a shared value [9]. In the context of the South African public healthcare sector, this study seeks to unravel how social capital constructs, which are trust, social ties and social cognitive, influence the explicitation and sharing of tacit knowledge through social networks by South African healthcare practitioners.

## 2 The Significance of Social Capital, Online Social Networks, and Tacit Knowledge Sharing in South Africa

This section discusses how the concept of social capital and the use of social networks can mitigate tacit knowledge explicitation and sharing by the South African healthcare practitioners. The explicitation and sharing of tacit knowledge is valuable when the public healthcare faces challenges that include brain drain; skills gap due to resignation and migration of practitioners [11, 12]; racial, social and economic divides at work; and the integration of immigrating foreign practitioners [13]. These challenges call for the preservation of organizational tacit memory.

The migration of South Africa practitioners has resulted in skills gap, which ultimately leads to the institutional memory and delivery of services in public hospitals being compromised. The situation deteriorated when some of the experienced practitioners moved from public to private hospitals [14]. Push factors that drive practitioners to migrate or to move to private practice are well documented [12]. Owing to the brain drain and the replacement of experienced practitioners by junior practitioners in public hospitals [15], the South African government [16] now requires public hospitals to create environments that promote mentorship, and tacit knowledge explication and sharing. Tacit knowledge explication and sharing is fundamental amongst practitioners because “procedural and casual knowledge is not only acquired by personal experience, but from collective discussion around other’s experiences...” [17, p. 147]. To establish and grow informal environments for tacit knowledge explication and sharing, technologies such as online social networks have proven to work [18].

While the migration of medical practitioners in South Africa is common, practitioners from different parts of the continent also flow into the country [19, 20]. Although the cohort of immigrant practitioners bring with them some expertise, they encounter challenges adapting to new working conditions and environment [13]. For the immigrant practitioners to achieve smooth and successful acclimatization, adaptation strategies are required. The social capital concept can be employed as copying, bonding and bridging strategy to facilitate the integration of immigrant practitioners into the healthcare practice networks. To explicitate and share their tacit knowledge, which will result in the growth of the social capital of the South African healthcare system, online social networks could be used as platforms for embracing the immigrating practitioners.

South Africa is a country divided along racial, social, tribal and economic lines, and these are visible in all facets of life, including the work place. Such divides create closed and exclusionary social capital networks amongst the workers, which makes it difficult to explicitate and share tacit knowledge [10]. Despite the divides, healthcare practitioners share a common goal with respect to the provision of healthcare. Hence, the parameters of social capital that include trust, social cognitive, sense of belonging and reciprocity [9] are fundamental in strengthening bonding amongst practitioners in order to achieve a common goal that provides room for tacit knowledge explication and sharing. In that respect, Barron and Padarath [14] have noted that an environment that is politically and ideologically neutral but promotes work ethics should be able to support the sharing of knowledge by healthcare practitioners in South Africa. Social networks are tools that can provide the envisioned environment because they are recognized as tools that can break collectivist in-group culture, which is usually a closed community [21]. Panahi et al. [8] have found that, unlike face-to-face interactions, social networks promote unique interaction that enable people to befriend and trust the unknown, usually outside their cultural groups. This is congruent with research that established that social networking sites provide interfaces that enable people to create bonds and bridges with the unknown [21]. To this end, irrespective of race, social economic status or nationality, social networks provide a platform for discussing, sharing and acquiring tacit knowledge.

### 3 Theoretical Framework

The concept of social capital underpins this study. Social capital refers to resources that are found in, available through, and derived from a social unit through networking relationships [22]. The social capital concept encourages social relations amongst individuals through communicating, trust and shared vision [23]. The constructs adopted for this study are trust, social cognitive and social ties.

#### 3.1 Trust

Trust is the degree to which an individual has confidence in other individuals, and it acts as an enabler or barrier to information sharing [24]. Trust motivates people to share knowledge and reduces information sharing barriers [23]. In a healthcare setting, Zhang et al. [25] has alluded one of the qualities of trust being the reputation of a healthcare practitioner. If healthcare practitioners have trust amongst themselves, they build symbiotic relationships that enable them to have frank discussions and share tacit experiences [23]. Regardless of whether ties are strong or weak, the absence of trust amongst healthcare practitioners prohibits the sharing tacit knowledge [26]. With respect to online social networking communities, trust refers to the acceptable conditions that allow knowledge to be shared on a platform with integrity, completeness and reliability [27]. Individuals who find an online community trustworthy would typically accept it and make contributions [28]. Trust can be achieved on an online social networking platform as long as the healthcare professionals are caring, integral and competent. Thus, in this study, it is hypothesized that: Trust positively influences tacit knowledge explicitation and sharing through social networks by the South African public healthcare practitioners (Hypothesis 1).

#### 3.2 Social Cognitive

The social cognitive dimension is fundamental in driving mutual understanding amongst healthcare practitioners when sharing resources that are sources of knowledge [22]. Shared vision and shared language form part of the social cognitive dimension [29].

Shared vision is concerned with co-worker goals, concerns and purpose [29, 30]. Shared vision is fundamental to continuous learning of an organization since it provides a sense of common direction, unity and focus. Therefore, healthcare practitioners would understand a shared vision if it is communicated through a shared language.

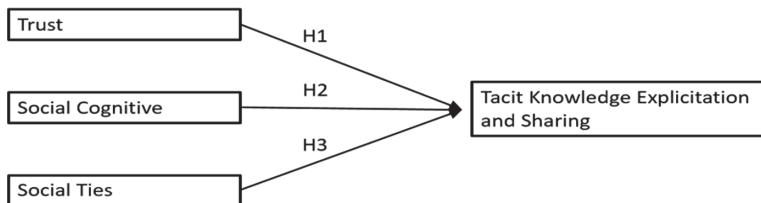
Shared language is how individuals share and discuss information, ask questions and conduct collective activities [31]. Shared language is an invaluable factor as it improves communication, sharing of knowledge, learning and understanding among the practitioners. The healthcare field ascribes significant value and importance to accuracy and precision; hence, the use of unshared language may result in disastrous medical consequences. Thus, this study hypothesizes that: Social cognitive positively influences tacit knowledge explicitation and sharing through social networks by the South African public healthcare practitioners (Hypothesis 2).

### 3.3 Social Ties

Granovetter [32] conceptualized the social network dimension of social capital into the strength of ties. The factors that determine the strength of ties are emotional intensity, reciprocity, trust, proximity and the intimacy amongst individuals [33, 34]. Therefore, collaboration amongst healthcare practitioners is a reflection of strong ties.

In the context of online tacit knowledge sharing, ties are strong if an online platform enables the practitioners to communicate, comment, ‘like’ and interact [25]. Individuals with strong ties share knowledge and experiences on the pretext that they are providing their acquaintances with valuable knowledge or information [35]. Stronger ties drive acquaintances to share knowledge and experiences because they feel that they are welcome and are happy to share knowledge. Thus, this study hypothesizes that: Social ties positively influence tacit knowledge explication and sharing through social networks by the South African public healthcare practitioners (Hypothesis 3).

The proposed hypothesis are conceptualized into a model presented in Fig. 1, showing relationships amongst the constructs that inform the sharing of tacit knowledge by healthcare practitioners.



**Fig. 1.** Proposed research model

## 4 Research Methodology

The following subsections present the questionnaire operationalization, the sample and the data analysis methods employed in this study.

### 4.1 Questionnaire Operationalization

The questionnaire consisted of two parts. The first part covered the biography details of the participants. The second part consisted of 20 questions related to the four components of the conceptual model, which are trust, social cognitive, social ties, and tacit knowledge explication and sharing. Table 1 presents the operationalization of the data collection tool.

Six items adapted from past studies measured Trust. The items focused on benevolence, integrity and competency [29, 36, 37]. Social Cognitive was measured with six items, which focused on shared vision and shared language. Shared language items focused on the use of common language, communication patterns and narratives

**Table 1.** Operationalization of data collection tool

Construct	Item	Wording	Reference
Trust	Trust1	I trust that social network members would act in my best interest	[29, 36, 37]
	Trust2	I trust that social network members have interest in my well-being not just their own	
	Trust3	I trust that social network members are honest	
	Trust4	I trust that social network members are committed	
	Trust5	I trust that social network members are honest and competent	
	Trust6	I trust that social network members are truthful with their expertise	
Social cognitive	SharedLang1	I will share knowledge on social network if members have a shared language	[30, 31]
	SharedLang2	I will share knowledge on social networks if members have an understandable communication pattern	
	SharedLang3	I will share knowledge on social networks if other members share understandable narratives and reading resources	
	SharedVis1	I will share knowledge on social networks if we share a goal	[28–30]
	SharedVis2	I will share knowledge on social networks if members share the concerns about the health of our community	
	SharedVis3	I will share knowledge on social networks if members are all committed to the same purpose	

(continued)

**Table 1.** (continued)

Construct	Item	Wording	Reference
Social ties	SocialTie1	I will share knowledge with colleagues who I always communicate with outside social networks	[33, 38]
	SocialTie2	I will share knowledge with social network members if I feel comfortable	
	SocialTie3	I will share knowledge with social network members if I know them for some period of time	
	SocialTie4	I will share knowledge with social network members if they return favors	
Tacit knowledge explication and sharing	ShareTacitKnow1	I will share ideas on social networks	[29, 37]
	ShareTacitKnow2	I will contribute knowledge on social networks	
	ShareTacitKnow3	I will contribute knowledge for others to benefit	
	ShareTacitKnow4	I will share new ideas on social networks	

[30, 31]. Shared vision items focused on co-worker goals, concerns and purpose [29, 30]. Four items adapted from past studies measured Social ties. The items focused on proximity, intimacy, reciprocity and length of a relationship [33, 38]. Four items adapted from past studies measured Tacit knowledge explication and sharing. The items focused on willingness to share new ideas, contributing and sharing experiences for the benefit of others [29, 37].

The questions were closed-ended and used a five-point Likert scale rating. The Likert scale ranged from 1 “strongly disagree” to 5 “strongly agree”. A team of three researchers pre-reviewed and revised the questionnaire. Furthermore, the questionnaire was pilot-tested with a sample of 10 healthcare practitioners at a medical school in Pretoria, South Africa. Feedback received during pilot testing was used to refine the questionnaire.

## 4.2 Sampling

The data was cluster sampled from respondents that comprised medical doctors and nurses from four hospitals in two provinces of South Africa. In the Gauteng Province, data was collected from one academic hospital in Johannesburg and one provincial hospital in Pretoria. In the Eastern Cape Province, data was collected from one provincial

hospital in the Buffalo City and another provincial hospital in the city of Port Elizabeth. Participation in the study was voluntary. From each hospital, the entire population was given a chance to respond to the questionnaire. The survey was distributed through emails obtained from hospital administrators. In total, 146 questionnaires were completed and returned. The categories of respondents were 54.8% nurses, 26.7% general doctors, 17.8% specialists and 0.7% did not identify themselves.

The proportions of responses per hospital relative to the total responses ( $N = 146$ ) were as follows: In the Gauteng Province, the responses were 30.1% at an academic hospital in Johannesburg and 29.5% at a provincial hospital in Pretoria. In the Eastern Cape Province, the responses were 21.9% at a provincial hospital in Buffalo City and 18.5% at a provincial hospital in Port Elizabeth.

### 4.3 Data Analysis

The IBM SPSS 25.0 statistical package was used for analysis. The data from all the hospitals was combined, checked for missing data, and a test of normality was carried. Descriptive statistics was carried out and the data was checked for reliability using Cronbach's alpha at cut off point of ( $\alpha > 0.7$ ). To verify the validity of the factors, Factor analysis was carried using the Principal Component Analysis. The correlation between the independent factors of the model (i.e., social trust, social cognitive, and social ties) and the dependent factor tacit knowledge sharing were tested using the Spearman correlation.

## 5 Results

The results presented in this section are for descriptive analysis, model validation (factor analysis) and correlation testing.

### 5.1 Descriptive Statistics

The scope of social capital factors that influence tacit knowledge explicitation and sharing through social networks by the South African healthcare practitioners were examined. Table 2 shows weighted frequencies, mean and standard deviation of responses per range scale.

The results show that the respondents had varied views on trusting tacit knowledge explicitated and shared through social networks. Frequencies across all items of Trust were fairly distributed with 35% disagreeing, 37% neutral and 28% agreeing that they will trust tacit knowledge explicitated and shared through social networks. This indicates a lack of confidence on tacit knowledge explicitated and shared on social networks as indicated by the overall mean score of 2.86, which is low on a Likert scale range of 1 to 5 and standard deviation of 0.813.

With respect to Social Cognitive factors, a substantial majority of the participants (72.2%) were positive that a shared vision and a shared language facilitate tacit knowledge explication and sharing on social networks. The results suggest that if practitioners have a common vision and shared language, they will share tacit knowledge. The overall mean score of 3.75 with a standard deviation of 0.847 confirmed the frequency distributions.

In terms of Social ties, the majority of the respondents (54%) agreed that Social Ties influences tacit knowledge explication and sharing on social networks. The results suggest that healthcare practitioners seem to be content with tacit knowledge explication and sharing on social networks if ties are derived by reciprocity, intimacy and emotional connection. The mean score of 3.41 with a standard deviation of 0.821 confirmed these results.

Overall, the results showed that 58% of the participants agreed that they would explicitate and share tacit knowledge on online social networks. Also, the results show that 21% of the participants disagreed to explicitate and share tacit knowledge on online social networks. The overall mean score 3.45 and standard deviation of 1.008 of the Knowledge Sharing construct supported the frequency distributions.

**Table 2.** Response rate per construct (weighted averages)

	Disagree (1–2)	Neutral 3	Agreed (4–5)	Mean	Std. deviation
Trust frequency (%)	51 (35%)	54 (37%)	41 (28%)	2.86	0.813
Social cognitive frequency (%)	16 (11%)	25 (17%)	105 (72%)	3.75	0.847
Social tie frequency (%)	30 (21%)	37 (25%)	79 (54%)	3.41	0.821
ShareTacitKnow frequency (%)	31 (21%)	31 (21%)	84 (58%)	3.45	1.008

## 5.2 Factor Analysis

Principal Factoring and Orthogonal Varimax rotation were used, and Table 3 presents the results. The KMO measure for sampling adequacy was 0.914, which is above the cut-off value of 0.60 [39] and thus confirming the adequacy of the data. The Bartlett's test of sphericity (Chi-square = 2470.92) was significant ( $p < 0.05$ ), indicating no scope for dimensionality and confirming an underlying relationship amongst the variables [40].

Using Eigen value cut-off of 1.0, there were four factors in the initial solution with a total variance of 75.22% as confirmed by the scree plot. This suggested that four latent factors are associated with the sharing of tacit knowledge through social networks. The four latent factors were returned for data analysis and all item loadings were above the recommended cut-off point of 0.4. Thus, factor analysis confirmed that the

items/indicators represented the content domain of the underlying model as expected. The constructs are Social Cognitive (1), Trust (2), Tacit Knowledge Explication and Sharing (3) and Social Ties (4) as presented in Table 3.

All the factors were reliable, with high scores of Cronbach's Alpha coefficients above 0.7. The Alpha coefficients were as follows: Social Cognitive (0.975), Trust (0.890), Knowledge Sharing (0.925) and Social Ties (0.789). The Cronbach alpha value of the social cognitive factor, which comprised items Shared language and Shared vision, was 0.957, which indicates a high level of internal consistency towards measuring knowledge sharing. However, a Cronbach's alpha value of more than 0.950 could be an indication of redundancy of the items [41].

**Table 3.** Factor analysis (rotated factor matrix)

	Factors			
	1	2	3	4
SharedVis2	.843			
SharedLang3	.816			
SharedLang2	.810			
SharedVis1	.793			
SharedVis3	.791			
SharedLang1	.786			
Trust3		.778		
Trust4		.762		
Trust2		.746		
Trust1		.701		
Trust5		.673		
Trust6		.645		
ShareTacitKnow2			.817	
ShareTacitKnow4			.769	
ShareTacitKnow3			.739	
ShareTacitKnow1			.704	
SocialTie3				.822
SocialTie2				.601
SocialTie1				.595
SocialTie4				.494

### 5.3 Correlation

The association between the dependent construct Tacit Knowledge Explicitation and Sharing (ShareTacitKnow) and the independent constructs Trust, SocialTies and SocialCognitive were tested using the Spearman Correlation test. The non-parametric test was carried out because the Shapiro Wilkinson test results were significant ( $p <= 0.05$ ), which means all the four constructs of the model were not normally distributed.

Table 4 presents the results and shows significant correlations ( $p < 0.01$ , two tailed) between the dependent variable and the independent variables. The thresholds for Spearman correlation ( $r$ ) values are regarded as weak ( $r < 0.3$ ), moderate ( $0.3 < r < 0.5$ ) and strong ( $r > 0.5$ ) [42]. The strong correlation between Trust and Tacit Knowledge Explicitation and Sharing is evidenced by  $r$  value of 0.538 and  $p < 0.01$ . The results support the hypothesis (H1), which states that: Trust positively influences Tacit Knowledge Explicitation and Sharing through social networks by the South African public healthcare practitioners. Additionally, the correlation between Social Ties and Tacit Knowledge Explicitation and Sharing (ShareTacitKnow) was  $r = 0.366$ ,  $p < 0.01$ , which is moderate. The results support hypothesis (H2), Social cognitive positively influences Tacit Knowledge Explicitation and Sharing through social networks by the South African public healthcare practitioners. Lastly, the correlation between Social Cognitive and Tacit Knowledge Explicitation and Sharing (ShareTacitKnow) was  $r = 0.600$ ,  $p < 0.01$ , which is strong. The results support hypothesis (H3), Social ties positively influences Tacit Knowledge Explicitation and Sharing through social networks by the South African public healthcare practitioners.

**Table 4.** Correlation results

	ShareTacitKnow	Trust	SocialTies	SocialCognitive
ShareTacitKnow	1.000	.538**	.366**	.600**
Trust	.538**	1.000	.285**	.439**
SocialTies	.366**	.285**	1.000	.470**
SocialCognitive	.600**	.439**	.470**	1.000

## 6 Discussion

The results of this study confirmed that Trust positively influences tacit knowledge explicitation and sharing through social networks by the South African public healthcare practitioners (H1). The results suggest that healthcare practitioners are viewed as trustworthy if they have the best interest of others at heart, are honest, committed to their work, have expertise and are truthful. The results correspond to the findings of previous studies [8, 24, 28]. The implication is that the healthcare practitioners who have trust would embrace and participate on tacit knowledge explicitation and sharing on social

networks. Also, the healthcare practitioners who have trust would seek for information from the same platform.

Even though the results supported the hypothesis, descriptive results revealed that there seemed to be some healthcare practitioners who do not trust tacit knowledge explicitation and sharing through online social networks. Lack of trust could be due to the fact that sharing of knowledge on open platforms may contradict the medical code of conduct that is strict with respect to privacy [43]. The implications of not having trust are that, those who do not have trust, would act as barriers to tacit knowledge explicitation and sharing on social networks. They may not participate or they may not make important contributions.

There were respondents who were neutral, not declaring whether they trust tacit knowledge explicitated and shared on social networks. The respondents' lack of commitment could be because of the lack of policies that regulate knowledge sharing on social networks at some medical facilities [8]. If there is no support from the hospitals, some healthcare workers may assume the wait and see attitude.

The results confirmed that Social Cognitive positively influences tacit knowledge explicitation and sharing through social networks by the South African public healthcare practitioners (H2). The majority of respondents agreed that shared vision and shared language influence tacit knowledge explicitation and sharing on social networks. The results acknowledge that healthcare practitioners seem to have a shared vision and are willing to explicitate and share tacit knowledge on social networks. A shared vision commits healthcare practitioners to a common purpose and gives them a sense of belonging. A sense of common purpose is important because South Africa is a country that is polarized [10]. Therefore, the results seem to suggest that shared vision has the power to break exclusionary social capital networks, which in turn encourages tacit knowledge explicitation and sharing by practitioners.

The results further confirm that a shared language facilitates tacit knowledge explicitation and sharing by healthcare practitioners. The findings concur with previous research that reported that shared language guides how health practitioners communicate, seek information and interact in an endeavor to achieve the shared vision, which influences their willingness to share knowledge [31]. Sharing a common language ensures efficient tacit knowledge explicitation and sharing, and reduces misunderstandings.

Social ties had a positive influence on tacit knowledge explicitation and sharing through social networks by the South African public healthcare practitioners (H3). Healthcare practitioners would explicitate and share tacit knowledge if social ties are underpinned by reciprocity, intimacy and emotional connection. This suggest that practitioners would explicitate and share tacit knowledge on social networks with those close to them as well as those who reciprocate favors. These results strengthen prior research, which found that co-workers are most likely to explicitate and share tacit knowledge with members of a social network if they feel comfortable, have a sense of belonging and are viewed as being like-minded [8]. In the same vein, results reported herein contradict research that established that, on social networks, people tend to share knowledge with people whom they do not know or have weak ties [35]. The contradiction could be due to the nature of the medical field that is underpinned by the provision of expert services where one cannot trust information published in unverified sources. Therefore,

healthcare practitioners would explicitate and share tacit knowledge with those who are experts or those with whom they have strong ties.

## 7 Limitations

The small sample size, in terms of the public hospitals selected and the participants who responded to the survey is a limitation to the generalization of the findings of this study. Also, the study did not analyze the effects of moderating variables since it was focused on the overall perspectives of the respondents irrespective of gender or work rank. Data were collected from three provincial hospitals and one academic hospital as discussed in sampling Sect. 4.2. The participants from various hospitals across South Africa gives some credence in that the experiences and views of practitioners from both provincial and academic hospitals were represented. Despite some of the limitations outlined above, the study contributed to the understanding of tacit knowledge sharing in the public health sector in South Africa.

## 8 Conclusion

This research hypothesized that social capital constructs: trust, social cognitive and social ties positively influence tacit knowledge explication and sharing through social networks by the South African public healthcare practitioners. The study quantitatively analyzed data collected from 146 respondents at 4 public hospitals in South Africa. The results of the study confirmed that the constructs of social capital positively influence tacit knowledge explication and sharing through social networks by South African public healthcare practitioners. Despite the results being generally supportive of the proposed hypothesis, the results also revealed that some practitioners were skeptical with trusting explicitated and shared tacit knowledge on social networks. The implication is that some practitioners would contemptuously take tacit knowledge explicitated and shared through social networks, and would not seek for or contribute tacit knowledge through social networks. The results of this study are valuable as they inform the strategic implementation of knowledge sharing through social networks at public hospitals in particular and private hospitals in general. This study calls for hospitals to implement the sharing of tacit knowledge through policy and provide implementation procedures.

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# Development Tendency of Double-Layer Digital Divide in Mainland China: A Longitudinal Study Based on Perspective of Group Segmentation

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**Abstract.** This research makes a longitudinal analysis of a development tendency of a double-layer digital divide (access and usage) in mainland China by using data from CGSS (Chinese General Social Survey) over the period of 2005 to 2015. Results indicate that the double-layer digital divide is narrowed in mainland China from 2005 to 2015 overall, while varies among different groups. Firstly, the access gap between the western region and others in China is further widened. Secondly, although there is still a significant double-layer digital divide between male and female, the probability gap of accessing the Internet between them is gradually declining. Thirdly, communist party members have higher probability of accessing the Internet compared with those non-communist, while there is no significant difference on the usage of the Internet between communist members and non-communist. Finally, the double-layer digital divide between the young and the elderly shows the opposite tendency. As time goes by, digital divide among the young with different characteristics tends to be narrowed, while that among the elderly tends to be widened. Theoretical and practical implications are discussed.

**Keywords:** Digital divide · Group segmentation · Age · Education

## 1 Introduction

This study starts from the emergence of a new form of inequality: digital divide. In recent years, investigations about digital divide in developing countries have become the frontier and hotspot in the field of international digital divide research [1] since Information and Communication Technologies (ICTs) are playing a significant role in modern society, and increasingly becoming an unavoidable topic for most countries, especially developing ones around the world [2]. The digital divide has also been viewed as an important indicator of social equality and development potential [3].

As the largest developing country in the world, China's digital divide circumstance is directly related to the digital equality of nearly one fifth of the world's populations and many related studies also enable us to understand the overall situation of China's digital divide to a certain extent. However, through reviewing the concept, it is found that

digital divide exists not only between different geographical regions and countries, but also among different groups of population [4]. After more than 40 years of development since “opening-up” in 1978, social classes and groups in China are becoming diverse [5]. The access and use of ICTs among various groups also reflects the current situation of differentiation. Thus, for describing the complex digital society more objectively, it is necessary to analyze the digital divide phenomenon among different groups in China’s process of digitalization, which is also beneficial for further researches related to this topic [6].

This study investigates the development trend of digital divide in China based on a group segmentation perspective, and explores differences in the access and use of ICTs among various groups of population, especially those with different age and educational background. The purpose of this study is to deepen the understanding of digital divide in mainland China, and promote social development as well as provide theoretical references for other developing countries.

## 2 Literature Review

### 2.1 What is Digital Divide

The concept of “digital divide” first appeared in 1989 in an article entitled “Digital Divide” published in The Time Educational Supplement, and the topic of digital divide aroused wide-spread attention in academic circles right after. However, the phenomenon of information inequality concerned with the digital divide theory had drawn great attention early since 1970s. During the decades of 1970s to 1990s, the theory “Knowledge Gap” proposed by many scholars and the related publications laid the foundation for the early researches on digital divide [7].

In all kinds of literature, there are many terms that are similar to “digital divide”, such as digital gap, digital division, digital inequality and digital disparity [8]. It proves that digital divide is a multidimensional and multilayered concept [9]. After reviewing the digital divide studies around the world over 23 years, research has classified all scholars who defined the digital divide into 4 groups [10], which also represents the four main aspects of the digital divide that researchers focus on. The first group of researchers emphasize a distinction among those who use ICTs and those who do not. The scholars from second group extend the concept of digital divide to the level of users’ usage and skills, namely the so-called second-layer digital divide, and they look at the differences of their usage of the digital medium. The third group concentrates on the division existing in information resources and knowledge. Compared with those from advanced countries, scholars from developing countries, such as China, are more representative in the third set, and they mainly focus on the gap in knowledge and resources. Furthermore, the fourth group introduces the theories of social differentiation, social exclusion and others from the perspective of sociology to analyze the digital divide and the digital unfairness caused by structural factors.

These definitions are not mutually exclusive and each of them is a supplement to others. With the comprehensive consideration of all the scholars’ opinions, this paper proposes that the digital divide has three layers: the first-layer (access), the second-layer (use and skill) and the third-layer (disparity stems from structural factors). From the

outset, the access gap focuses on the differences between those who have access to or use the ICTs (Information Haves) and those who do not (Information Have-nots). The use and skill gap look at the differences in the netizens' usage of the medium. The third-layer gap concentrates on the deep structural factors contributing to digital divide, such as politics, culture and social capital. Unlike material access, personal use and skills, there are many factors involved in the third-layer gap that needed to be analyzed from multiple angles. However, the measurement indicators of these factors are beyond the capacity of a paper, therefore, this study will only focus on the first two layers.

## 2.2 Current Situation and Development Trend of Digital Divide

Starting from the mid-1990s, numerous proofs demonstrate that the first two layers of digital divide exist not only in different countries over the world, but also in different regions and demographic groups within a country. For example, a report on the 15-year development trend of the digital divide released by ITU in 2015 shows that there is a high level of inequality of access to ICTs in different countries worldwide. In developed and developing countries, 82% and 35% of the population respectively have access to the Internet, while this figure is only 10% in the least developed countries [11]. In addition, the related report released by the World Bank in 2016 also indicates that, even though the number of people accessing the Internet is increasing all over the world, rural communities, disabled or illiterate people and elderly are among the last to benefit [12]. Moreover, many scholars have also conducted relevant researches on the development trend of digital divide in different countries all over the world. For example, the research conducted by Lun and Jian-Hua point out that the development trend of the digital divide varied among Hong Kong, the United States and other parts of the world from 1996–2008 [13].

China's government classifies the provinces into eastern, central, western and north-east region according to the economic development situation [14]. This type of classification of the regions reflects the economic development of these four regions scientifically, which indicates that the provinces in the same region have a higher similarity in terms of economic development and infrastructure construction. Therefore, this method has been widely employed by Chinese scholars in the digital divide research, which yields many valuable conclusions. For example, Li-Ping points out that there is a huge Internet gap within China's regions [15]; Ming-Feng holds that most provinces and autonomous regions in China are still in the primary stage of Internet application, and the degree of Internet popularization in small and medium-sized cities needs to be improved urgently [16].

Scholars have also examined the current situation of the digital divide between urban and rural areas. For example, there is an obvious digital divide among different regions and different cities in China domestically, and rural areas are in an unequal position in information compared with urban areas [17]. Li and Ranieri's research [18] show that students from rural schools scored lower on all the Internet quality indicators (such as digital access, Internet use and self-efficacy) and are therefore more disadvantaged in Internet usage than their urban counterparts.

## 2.3 Factors Affecting the Digital Divide

In digital divide, researchers attach great importance to factors such as geographic location, ethnic, income, gender, age and education. A quantitative study [1] categorizes factors affecting the digital divide into two groups: the first is macroscopic factors, such as the overall level of infrastructure construction and economic development, which were the main factors that caused access gap between countries and different regions within a country; the second is various demographic factors, such as income, gender, age and education, which belong to the micro factors related to the digital usage gap.

The connection between these factors and all layers of digital divide is well researched by previous scholars. At the macro level, Quibria [19] analyzed relevant data from 19 countries and found that factors such as economy and infrastructure construction were the main causes that led to the digital divide. Besides, due to the relatively high level of economic and ICT development in eastern and urban areas of China, Jiangxi, Guizhou, Gansu, Anhui, Tibet, Yunnan and other central and western provinces are lagging, not only in the access gap but also in various indicators of Internet users' usage behavior [20]. In terms of mobile Internet access, there are few empirical studies in China at present. However, according to the report released by the China Internet Network Information Center (CNNIC) in 2019 [21], the number of Internet users in China is 854 million, of which 99.1% use mobile phones to access the Internet. These data reflect that there are still more than 550 million people without access to the Internet and mobile Internet in China.

Among micro factors, firstly, income has been widely verified as one of the important reasons that affect the digital divide [22]. It may be assumed that income is a micro factor and very important to access gap, but, in order to clearly demonstrate the congruent relationship between gaps and factors in the two layers, this study will investigate the relation between personal income and the second-layer gap, while the economic development circumstance in different regions of China is related to the access gap. Secondly, in terms of gender, Cooper's study [23] points out that females are rather technophobic and male are much better users of digital devices, while Hilbert [24] puts forwards that under specific conditions, women are more active users of digital tools than men. These researches revealed that the studies about the relationship between gender and digital divide are still inconclusive so far. Therefore, based on this condition, together with the situation that there are few studies focused on the relations between gender and digital divide in China, this research will adopt the gender factor to explore the development trend of the double-layer digital divide in mainland China. Thirdly, age and educational level are also two important factors that affect the digital divide [25, 26], many scholars have taken these two factors as the criteria and selected different groups of people as research objects in order to carry out the research. For example, the proportion of the elderly who have access to and use the Internet is increasing year by year, and age is associated not with just access, but also with Internet usage and pattern of connection [27]; people with higher education level will actively use the Internet. Moreover, because of the special cultural background and social characteristics of China, ethnic is rarely adopted as a factor by Chinese scholars.

Usage of the Internet is not only affected by physical factors, but also by users' psychological factors; self-efficacy is the most mentioned factor that affects the digital

divide in related literature [28]. Many studies prove that there is a significant positive relationship between students' use of Internet and their Internet self-efficacy, and peoples' self-perception of their own social status has been found to positively correlate with their self-efficacy [29, 30].

In China, working for the government and the Communism Party is considered as a symbol of high social status, and people with higher social status are more likely to have long-term psychological advantages. Accordingly, an individual's party identity seems to have connection with the use of ICTs in China while many studies take the identity of Party members as an independent variable to conduct relevant research in the field of social science [31, 32]. Thus, this study regards an individual's party identity as an indicator of self-efficacy.

Three vital points can be extracted from the literature review: first of all, the concept of digital divide is quite complex and dynamic, that is, the digital divide cannot be analyzed from a single and static perspective and the assertion cannot be made from a binary perspective between haves and have-nots, or users and non-users. Secondly, Chinese scholars generally take the perspective of regional quartering and urban-rural comparison to examine the overall situation of digital divide in mainland China. Thirdly, factors affecting the digital divide can be classified into a macro and micro level and that macro factors mainly affect the material gap while micro factors mainly affect the usage gap [33].

Limitations of existent literature can be also summarized. First, many domestic researches in China examined the digital divide only from a general perspective instead of analyzing it at all levels respectively. Secondly, many of the studies can hardly help us recognize the digital divide among different groups. Thirdly, some of the researchers in the digital divide field adopt a cross-sectional method in their works, that is, they mainly use static data in a certain period to analyze the dynamic process of the digital divide development, and make a simple comparison of the current situation. It is not suitable to apply their conclusions in the "trend" analysis of the digital divide.

### 3 Research Questions

In order to refine research questions, there was still some fundamental information that needed to be clarified so that all the researchers could reach a basic consensus with the scope of this study and the reasons for proposing the research questions.

Firstly, although the digital divide is divided into three layers, there is a progressive relationship among them. "Use" is based on "access", in other words, discussion about different usage of the Internet is under the premise of having access to them.

Secondly, although scholars have summarized main factors affecting different-layer digital divide respectively, these factors are not completely independent, micro-level factors can also affect the first-layer digital divide. Therefore, it is necessary to combine micro-level factors with macro-level ones to analyze the basic access gap for conducting the research which is based on segmentation perspective.

Thirdly, there is a lot of literature about the micro factors that affect the digital use gap. However, this paper is mainly based on literature published by Kai [34], where he pointed out that young people guide the elderly to use the Internet, which implied that

all the elderly lag behind the young. The internal situation of the elderly is worth further discussion since people with higher educational or economic level continue learning even as they get old. This study also focuses on the interaction effect between different factors, which is helpful to explore the trend of digital divide in China. Accordingly, the research questions have been formulated as follows:

*Question 1:* What is the development tendency of the first-layer digital divide among different regions and between urban and rural dwellers in China?

*Question 2:* What is the development tendency of the first-layer digital divide among different groups (microscopic variables: demographic variables) in China?

*Question 3:* What is the development tendency of the second-layer digital divide among different groups (microscopic variables: demographic variables) in China?

## 4 Method

### 4.1 Data Source

This research selected four groups of data (2005, 2010, 2013 and 2015) from the Chinese General Social Survey (CGSS) database released by Renmin University of China as a data source. The reasons of selection are as follows; CGSS programme is the earliest nationwide, comprehensive and continuous academic investigation project in China. There are more than a thousand articles published in academia based on CGSS, which can demonstrate the authority and reliability of its data. Furthermore, the multi-dimension data from same database in different years can help us to investigate the topic of digital divide in China from a macro and micro perspective comprehensively and provide insights into the dynamic development of the digital divide in mainland China.

### 4.2 Variables Selection

Independent variables in this study include macro and micro ones. Macro variables mean factors that include region and habitation, while micro demographic factors include gender, income, party, age and education. Occupation was excluded because of too many missing values in the original database. The research used “whether use Internet or not” as measurement index of first-layer digital divide and “whether regarded internet as the main information source” as a second-layer digital divide. Table 1 illustrates variables and their related questions.

### 4.3 Data Process

Some variables needed to be processed before analysis. For example, the variable “city” was recorded into a four-category variable named “region” according to the division of China’s four major regions (east, central, west and north-east). Also, since the absolute value of annual income is much higher than others, this study took the logarithm of it into a regression model and all dependent variables were recorded as virtual variables. In terms of variable “whether use the Internet or not”, if interviewees said “never use

**Table 1.** Correspondence of variables in database.

Variables	Related questions
<i>Independent variables</i>	
Gender	Recorded by interviewer
Age	Which year were you born?
Income	How much was your yearly income last year?
Party	Are you the communist or not?
Social status identification	Which social level do you think you belong to?
Education	What was the highest education level you finish so far?
Urban/Rural	Recorded by interviewer
City	Recorded by interviewer
<i>Dependent variables</i>	
Whether use internet or not	How often do you use the internet in daily life?
Whether regarded internet as the main information source	Which media is your main information source?

the Internet”, it would be “0” (never use the Internet); otherwise, it would be “1” (use the Internet). In terms of variable “whether regard the Internet as the main information source”, if interviewees said “the internet is the main information source”, it would be “1” and if other types of media were selected, it would be “0”. After data cleaning, the distribution of samples is shown in Table 2. After data cleaning, this research used SPSS to conduct binary logistic regression analysis.

**Table 2.** Distribution of sample data from 2005 to 2015.

	2005	2010	2013	2015
<i>Total</i>	10372	11783	11438	10968
<i>Gender</i>				
Male	4919	5677	5756	5134
Female	5453	6106	5682	5834
<i>Age</i>	M = 44	M = 47	M = 48	M = 50
<i>Education</i>				
Junior level	6944	7590	7261	7109
Middle level	2378	2263	2180	1970
High level	1039	1813	1860	1773
<i>Ln(income)</i>	M = 8.22	M = 8.21	M = 8.51	M = 8.22

(continued)

**Table 2.** (*continued*)

	2005	2010	2013	2015
<i>Party</i>				
Communist	1120	1461	1161	1133
Non-Communist	9252	11767	10211	9788
<i>Social status identification</i>	M = 3.67	M = 4.06	M = 4.31	M = 4.20
<i>Urban/Rural</i>				
Urban	6098	7222	5618	6470
Rural	4274	4561	5736	4498
<i>Region</i>				
Eastern	4224	4351	4161	3993
Central	2577	2967	2905	2810
Western	2653	3060	2862	2716
North-east	918	1505	1510	1449

#### 4.4 Analysis Method

This research adopts a “thick-description analysis” method proposed by De-Huan [35] in order to analyze the tendency of digital divide among different groups in China. Independent variables are transformed into non-linear forms in the process of building a logistic regression model, which can provide insights into the relationships among variables in a multi-dimensional way, showing the complex causal relationship.

### 5 Results

#### 5.1 The Overall Development Tendency of China’s Digital Divide

Results are introduced logically coincided with the sequence of research questions proposed above. Table 3 shows the overall development tendency of Internet access and usage gaps in mainland China from 2005 to 2015.

**Table 3.** Overall trend of Internet access and usage gaps in China from 2005 to 2015.

	2005	2010	2013	2015
The % of using internet	17.4%	34.3%	43.1%	46.7%
The % of regarding internet as main information source	—	13.2%	19.4%	26.6%

Overall, the proportion of people accessing the Internet rose from 17.4% in 2005 to 46.7% in 2015 and the rate of people using the Internet as main source of information

rose from 13.2% in 2010 to 26.6% in 2015. Research Question 1 could thus be answered as follows: the proportion of China's population accessing and using the Internet is continuously increasing, and China's dual digital divide is showing an overall narrowing tendency.

## 5.2 Development Tendency of the First-Layer Digital Divide

Table 4 shows the results of a logistic regression of China's Internet access gap from 2005 to 2015. From a macro perspective, the probability of Internet access in the Eastern region is always higher than that in the other three regions after controlling other variables. The Internet access gap among different regions in China is nonetheless further widened. One-way ANOVA analysis reflected a significant difference in Internet access among different regions in mainland China from 2005 to 2015. Specifically, the percentage of people accessing Internet in eastern, central, western and north-eastern regions rose from 24.4%, 13%, 12.8% and 10.6% to 60.2%, 39.8%, 34.8% and 45.4% respectively from 2005 to 2015. An LSD test found that the proportion of Internet access in the eastern region was the highest and that there was no significant difference among other three regions in 2005, while the proportion of accessing the Internet in the western region was significantly lower than other three regions in 2015.

**Table 4.** Logistic regression model of China's Internet access gap from 2005 to 2015.

	2005		2010		2013		2015	
	Beta	exp(B)	Beta	exp(B)	Beta	exp(B)	Beta	exp(B)
Male	.393***	1.482	.341***	1.407	.245***	1.278	0.206**	1.229
Sin(edu)	−.630	.532	−3.5***	.029	−2.6***	.076	−2.12***	.12
Age	−.21***	.812	−.25***	.775	−.59***	.553	−0.23***	.794
Age^2			.001**	1.001	.008***	1.008	0.001	1.001
Age^3	.000	1			.000**	1		
Age^4	.000	1					0.000	1
Ln(income)	.192***	1.212	.072***	1.075	.100***	1.105	0.10***	1.101
Central	−.5***	.607	−.62***	.535	−.52***	.596	−0.766***	.465
Western	−.64***	.526	−1.3***	.278	−1.2***	.313	−0.906***	.404
Northeast	−.91***	.401	−.33***	.716	−.79***	.452	−0.614***	.541
Urban	4.08***	59.10	−2.19**	.112	−5.69**	.003	4.785**	119.7
Communist	.486***	1.627	.731***	2.078	.791***	2.207	0.587***	1.799
Social status identification	−.417***	.659	.160***	1.174	.150***	1.162	0.083***	1.086
Age * Urban			.116**	1.123	.407**	1.502	−0.203*	.817
Age^2 * Urban			−.001*	.999	−.008**	.992	0.003*	1.003
Age^3 * Urban					.000*	1		
Age^4 * Urban							0.000*	1

(continued)

**Table 4.** (continued)

	2005		2010		2013		2015	
	Beta	exp(B)	Beta	exp(B)	Beta	exp(B)	Beta	exp(B)
Urban *sin(edu)			1.223*	3.397	.823*	2.277		
Age* Urban *Sin(edu)	-.120**	.887						
Age^3* Urban *Sin(edu)	.000**	1						
Age^4*City*Sin(edu)	.000	1						
n	3.196		7.933		13.558		8.635	
R square	.315		.42		.474		.469	

\*p<.05, \*\* p<.01, \*\*\*p<.001

From a micro perspective, demographic characteristics including party, gender and income had a significant impact on accessing the Internet. What's more, the tendency of first-layer digital divide between urban and rural dwellers varied from people with different ages and education levels. Firstly, youth urban dwellers (aged 18–30 years) with high education level are early adopters of Internet in China. In 2005, the percentage of this group accessing the Internet reached 92%, far higher than the overall 17.4%.

Secondly, the accessing gap between youths in urban and rural areas in China is gradually narrowed. The proportion of Internet access among youths (aged 18–25 years) in rural areas was 17.3% in 2005, while that in urban areas was 75.5%. Chi-square test shows a significant difference between the two groups (Pearson Chi-square = 307.846, P = .000). The proportion of youth rural and urban dwellers accessing the Internet rose to 90% and 98% respectively in 2015. Although there is still a significant difference (Pearson Chi-Square = 54.662, P = .000), the probability gap of accessing the Internet is narrowed (Fig. 1).



**Fig. 1.** The interaction effect between age and habitation in logistic regression model of accessing the Internet in 2010, 2013 and 2015. The probability gap between youths living in urban and rural areas is narrowed, that between the elderly is on the opposite.

The accessing gap between elder (aged over 55 years) urban and rural dwellers is however widened. The proportion of elder rural dwellers (0.28%) was significantly lower than that of elder urban dwellers (6.29%) in 2005 (Pearson chi-square = 61.276, P = .000), and 4.66% and 28.4% respectively in 2015, the gap is further widened (Pearson Chi-Square = 433.26, P = .000) (Fig. 1).

### 5.3 Development Tendency of the Second-Layer Digital Divide

Table 5 shows the Logistic regression analysis results of the development trend of the second-layer digital divide among different groups in China. The probability of using the Internet as the main source of information increases by 0.08 times for every unit of increase in the logarithm of income in 2010, which is similar to that in 2015. Although there is an obvious digital usage gap among people with different income, it does not show a trend of expansion. Males were 1.5 and 1.244 times more likely than females to use the Internet as the main source of information in 2010 and 2015 respectively. The proportion of men using the Internet as their main source of information was 30%, which was 5% higher than that of women in 2015. Moreover, there is no significant difference between the proportion of Chinese communist and non-communist party members using the Internet as the main information source from 2010 to 2015.

**Table 5.** Logistic regression model of Internet usage gap in China from 2010 to 2015.

	2010		2013		2015	
	B	exp(B)	B	exp(B)	B	exp(B)
Age	−1.352**	.259	−.062	.939	.876	2.402
Age^2	.028*	1.029	.000	1.000	−.015	.985
Age^3	.000*	1.000			.000	1.000
Age^4			.000	1.000		
1/age					261.797	
Edu	−14.949*	.000				
Edu^2	3.708*	40.786				
Sin(edu)			.661	1.938	53.556**	
Age*edu	1.357*	3.884				
Age^2*edu	−.032*	.969				
Age^3*edu	.000*	1.000				
Age*edu^2	−.314*	.731				
Age^2*edu^2	.007*	1.007				
Age^3*edu^2	.000*	1.000				
Age*sin(edu)			−.138*	.871		

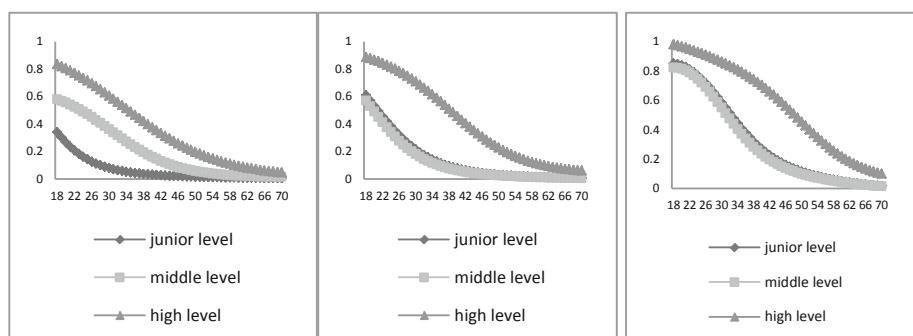
(continued)

**Table 5.** (continued)

	2010		2013		2015	
	B	exp(B)	B	exp(B)	B	exp(B)
Age^3*sin(edu)			.000*	1.000		
Age^4*sin(edu)			.000*	1.000		
Age*sin(edu)					−2.146**	.117
1/age*sin(edu)					−503.959*	.000
Age^2*sin(edu)					.034**	1.035
Age^3*sin(edu)					.000	1.000
Communist	−.024	.977	.238*	1.269	.163	1.177
Ln(income)	.076***	1.079	.095***	1.100	.092***	1.097
Social status identification	.095***	1.100	.070**	1.072	.077**	1.081
Male	.403***	1.497	.162*	1.175	.218**	1.244
n	13.728		2.427		−22.710	
R square	.251		0.304		.385	

\*p<.05, \*\* p<.01, \*\*\*p<.001

Overall, youths have a higher probability of getting information from the Internet compared to the elderly. In 2010, youths with middle and primary education were less likely to get information from the Internet than those with high educational level, but the probability gap was gradually narrowed in the five years that followed. While the usage gap among the elderly with different education levels is further widened, the probability of the elderly with high education level getting information from the Internet rose gradually (Fig. 2).



**Fig. 2.** The interaction effect between age and education in logistic regression model of regarding the Internet as main information source in 2010, 2013 and 2015. The probability gap among youths with different education level is narrowed, that among the elderly is on the opposite.

## 6 Discussion

The research finds that overall, the accessing gap in China has shown a narrowing trend in the past ten years, mainly as a result of the rapid growth in GDP and the falling price of intelligent hardware. However, the process of reform and opening-up since 1978 spreads from the eastern coastal areas to others, resulting in an obvious difference in the economic development and technical facilities amongst the four regions in mainland China. Due to accumulated advantages in economic development, the eastern region always earns the highest proportion of ICTs access. The accessing gap between western region and others is widened gradually mainly because of the limitation of economic development and natural environment.

Different tendency of digital divide in different groups appears to be divided according to demographic factors, which are also worth further discussion. The probability of accessing and using the Internet for male is higher than that for women. However, compared to the past, the digital divide between male and female is narrowed, showing that the digital disadvantage of females in mainland China has changed to some extent.

There is also an obvious digital divide among people with different income, which would result from the ceiling effect of income on digital divide. Technological improvement causes the falling price of digital hardware, enabling ordinary people to afford digital devices such as smart phones.

After controlling other factors, the membership of communist party proved to be an important factor affecting the digital divide in China. Results show that the probability of communist party members accessing the Internet is much higher than that of those who are not, and the accessing gap between them shows an expanding trend. However, there is no significant difference in the usage divide. The research believes that communist party members in China have higher economic and social advantage of accessing the Internet. However, the usage gap is not determined by material factors but by personal skills. Membership of a communist party does not mean higher digital skills, so the usage gap between communist members and others is not obvious.

This research further investigated the factors of age and education, showing that the development tendency among people with different education background and age is complex. Firstly, the accessing gap between youths in urban and rural areas is narrowed gradually, while that among the elderly in urban and rural areas is quite the opposite. Secondly, the usage gap among youths with different education level is narrowed, while that among the elderly showed an expanding tendency; the probability of getting information from the Internet of the high-education elderly is higher than those with lower education level.

The different overlaps between the innovation diffusion of the Internet and the life course of different generations may explain this phenomenon. Youths are so-called digital natives, whose early life course coincides completely with the early development of the Internet, so they are quite familiar with information technologies. The double-layer digital divide among youths is therefore narrowed. For the elderly, they get in touch with the Internet after entering the second half of their life course. Whether they can adapt themselves to the digital era and acquire corresponding skills depends more on their own learning ability. As the education background is an important indicator of learning

ability, the usage gap among the elderly with different education background will show an expanding trend as time goes by.

## 7 Conclusion

This research analyzed the development tendency of a double-layer digital divide among people with different characteristics (including region, habitation, gender, income, party, age and education) based on a longitudinal and comprehensive perspective. Results revealed that digital divide cannot be conducted from a macro or micro perspective singly. Due to different social situations in various countries, adopting the perspective of group segmentation is of great significance for deepening the understanding of this phenomenon.

At present, different countries, especially developing countries, are facing fierce digital divide problems. Conclusions of this research can provide theoretical value to relevant researchers in developing countries like China. In addition, the more the elderly tends to access the Internet and the phenomenon of social aging becomes increasingly obvious in China, the more necessary it will be for scholars to investigate the digital differentiation within the elderly in the future.

It is undeniable that this study also has some limitations. Due to the characteristic of the database, this study only used “whether the Internet is used as a source of information” as an indicator of second-layer digital divide. Studies can therefore adopt other indicators to provide a more comprehensive explanation. Furthermore, the level of regional and demographic variables was different. While the high-level variables may affect the low-level variables in the regression model, scholars can alternatively adopt a hierarchical linear model to solve this problem in the future.

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# When the King Turns Jester: A Carnivalesque Analysis of Police Outreach on Social Media in Kerala

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**Abstract.** As bureaucratic organizations enter social media spaces for public outreach, the organization of their communication assumes forms more suited to the needs, requirements and tastes of a digital society. Successfully interacting with new media users requires that the organization shed bureaucratic formality and appropriate a social media personality, with its language and viral digital artefacts. The study examines the digital approach of the Kerala Police in its use of memes based on popular Malayalam cinema, a sub-literacy that the bureaucracy shares with the public. Using a mix of interpretive examination of memes and interviews with the police, we use a carnivalesque frame to highlight ways in which the Kerala Police subverts the negative discourses related to police identity and police-public interaction through comic memes. We propose that the choice of a means of outreach that has a greater affective impact on the middle-classes, rather than the poor, offers insight into a specific moment in state-citizen relations where a bureaucratic organization's use of technology becomes the means of defining its approachability. This case also highlights the prerogative institutions have in creating solid online presences to deal with new forms of informational attacks that are enabled by viral social media.

**Keywords:** Bureaucratic communication · Social media communication · Police · Humour · Cinema · Facebook · Meme · Carnivalesque

## 1 Introduction

Public agencies are part of the ecosystem of technology and development in which being techno-savvy and interacting with the public directly on social media is a means of signaling a modern institution. Bureaucratic communication on social media can be a path to transforming or redefining the organizational identity or, more directly, a way to enhance its organizational performance through effective outreach. The adoption of social media in the public sector has been proposed as a paradigm shift towards greater citizen engagement and participation, through responsive accountability and open collaboration [1]. A large body of work on the use of social media by organizations in public service, both in politics and policy, shows that the primary driver of online

engagement is to impact the affective sensibilities of viewers with the end goal of image management [2].

Humorous content is an important part of such affective sensibilities [3], though with the necessary precondition that there be a shared cognitive environment - the inside jokes must be understood by parties involved [4]. With the increasing popularity of social media, memes have become a means of shared cultural experience, used in a variety of communicative environments to signify affiliation, to parody, or offer social commentary [5].

While memes began as an informal, personal form of exchange, they have grown over time to be used by a range of stakeholders including religious organizations [6], advertisers [7], professional organizations [8] and politicians [9]. Meme creators include both engaged stakeholders or ‘active publics’ who advocate for or against an organization, and members of the ‘aroused publics’ who create memes as a response to a specific individual or product [7]. In this work, we examine the creation of memes by ‘active publics’, i.e. representatives of the Kerala Police (KP), a public safety bureaucracy seeking to use social media as a means of outreach. Specifically, we examine the use of comedic, often self-deprecating memes, which use images from popular cinema as a means of popular outreach. We frame the use of satirical memes by KP from a carnivalesque perspective, building on Mikhail Bakhtin’s notion of the Carnival as a means of a satirical challenge to social hierarchy and systems.

Unlike studies in the past that have used the carnivalesque to examine the attack on an institution from the outside, we propose that social media use in the Kerala Police case offers an interesting take on how a subversive discourse can be employed from within a bureaucracy. The choice of carnivalesque output for the police, comic memes based on popular Malayalam cinema, has roots in a long tradition of social commentary both in film itself, and in the reproduction of film in public events such as festivals or cultural gatherings, as well as other media including television and social media. The idea is frequently used in outsider politics, where a political actor offers a mockery of the existing system to present themselves as a challenger to the status quo. Here, we propose that Kerala police turns the carnivalesque on its head, in that the establishment and the jester are one and the same.

## 2 Related Work

Our work builds on four areas of rich work on carnivalesque theory, bureaucratic communication on social media, memes in social media communication, and traditions of satire and cinema in the state of Kerala. An examination of literature in these fields provides a lens and a framework for our study.

### 2.1 Bureaucratic Communication on Social Media

Recent work shows that government communication on social media enables citizens’ participation and collaboration with the government, as well as build more openness about its activities [10]. Public institutions have also adopted these new channels of communication and use social media for various purposes, one of which is to overcome

the barriers to communication often encountered in the public sector [11]. Meijer and Torenvlied [12] examine the new forms of digital bureaucratic communication by analyzing the adaptations in the three characteristic features of bureaucratic model of government communication: centralization, formalization and boundary creation identified based on Weber's [13] foundational work on bureaucratic organizational structure.

Though social media use has stoked concerns about online disinformation and polarization, it is also generally argued, and increasingly common that public institutions interact with the public directly and that social media can improve communication, citizen engagement, transparency, and trust [14, 15]. Social media use can make government processes appear citizen-centric by engaging with or even potentially gauging public opinion [16–18].

Studying Twitter use by police, Grimmelikhuijsen & Meijer find that a direct channel of communication to showcase their work helps police to reinforce their legitimacy [19]. This is a means of citizen reassurance since the public's relationship with the police is greatly impacted by public opinion, which is a wicked problem since the police has the power of legitimate force over the citizens [20]. In contrast, sousveillance from citizens does little to reinforce trust [21], as social media allows the citizens to impact this public opinion about the police through showcasing their personal experiences.

## 2.2 Conceptualizing the Carnival

Humorous content is an important part of making affective appeals to people online [3], though a shared cognitive environment is necessary for its effectiveness [4]. Humor is at the heart of the carnivalesque environment - the carnival offers a unique space for challenging orders that may otherwise be untouchable through formal orders of power since it does so behind the mask of humor. In the carnivalesque setting, political issues are discussed with the use of outsider status in presenting oneself [22]. The components of the carnival are the site of the carnival - a part of the public sphere where the satirical action takes place, and the protagonist, or "fool", through which the action is delivered. It is characterized by (1) a populist and critical inversion of official words and hierarchies; (2) hierarchical norms, positions and prohibition on activities being suspended; (3) an atmosphere of creative disrespect and degradation; (4) social formations that are temporarily recontextualized to expose their fictive foundations [23]. The carnival allows a window of opportunity in which there is a relaxation of conventional norms on public behavior and a reversal of hegemonic social roles [24].

While much work on the carnivalesque actor has focused on antagonistic politics, there is a small body of work that looks at tension with modern bureaucracies. Examples include mothers organizing against genetic engineering [25], activists engaging with big business [26], or even nation-states responding to international bureaucracies [27]. Here, in the case of the KP, as the establishment, it mocks itself, performing an alternative model of engagement. Indeed, their use of self-directed jokes derived from popular cinema, a middle-class persuasion in Kerala, turns on its head Guy Debord's [28] argument that states that unjust institutions working towards the satisfaction of the powerful cannot have a sense of humor.

### 2.3 Meme Manipulation

With its roots in the Greek word ‘mimema’ meaning imitated, the notion of an internet meme has been appropriated out of a genetic meme. The internet meme refers to short media objects such as images or brief moving pictures that are edited for use in a different context. Memes are rhetorical artifacts that fundamentally operate through reaction. They are predicated on a shared cultural experience, used in a variety of communicative environments to signify affiliation to parody, offer social commentary and in effect shape collective belief and actions [5]. A meme is only as good as the inside joke it is able to signify, thus depends on the subcultural literacies of communities it calls to [29]. While memes began as an informal, personal form of exchange, they have grown over time to be used by a range of stakeholders from religious organizations [6], advertisers [7], professional organizations [8] to politicians [9].

Memes circulated in a top-down manner, especially from politicians, can be a method of disarming critics and relieving tension [30]. Their public, performative nature is inherently carnivalesque. Memes blur boundaries between interpersonal and mass, professional and amateur, bottom-up and top-down communications’ [5]. In using memes to communicate, KP presents itself in a style that is associated with young, informal communication, and in using widely recognized artifacts from popular culture, it humanizes itself as one with the rest of the citizenry.

Meme creators include both engaged stakeholders or ‘active publics’ who advocate for or against an organization, and members of the ‘aroused publics’ who create memes as a response to a specific individual or product [8]. In this work, we examine the creation of memes by ‘active publics’, i.e. representatives of a Kerala Police (KP), a public safety bureaucracy seeking to use social media as a means of outreach.

### 2.4 Tradition of Satire and Cinema Culture

The choice for the carnivalesque style may hark at social commentary and satire aimed at institutions in a strong and socially conscious record in post-Independence Malayalam cinema, though the culture of satirical opposition through public performance has a longer political history. The 18<sup>th</sup>-century poet, Kunjan Nambiar is widely referenced for his carnivalesque style - using satirical verses that ridiculed the kings and the high priests of the day, at a time when sovereigns and the religious elite were supreme [33]. The state boasts the highest number of cartoonists, television satire shows, and widely consumed satire theatre, not just in centers of urban elites, but also among poor and rural geographies [33]. The wide consumption of arts and cinema has meant that much of the public discourse is shaped by cinema [35], which has been central to the state’s attempts to define itself in various ways against its national and regional “others” [34].

## 3 Methodology

We use qualitative methods, including interviews and observations, to study the actors in the chain of content creation for the KP, and conduct interpretive analysis of individual memes. A central character in the memes is the “police mama” (police uncle) - an

approachable, witty police officer. We studied the memes first, and then conducted 25 semi-structured interviews of the KP social media team, commanding officers, public administrators, and PR executives, and satirists. Informal coding of the themes was conducted after batches of interviews, and the interview questions were updated based on what emerged as the major overarching themes. Interviews were largely conducted in Malayalam, translated verbatim, and the entire transcripts were coded iteratively for themes at the end of the primary research process.

The research team was very familiar with Mayalalam cinema; thus, the memes were accessible for analysis. As polysemic units of cultural text, their multilayered nature enables symbolic representations, referencing cultural aspects that can be employed in dog-whistling to groups who ‘get’ the joke. Rhetorical criticism of the memetic units as employed by Silvestri [36] allows us to best tie the content and ideas presented in the meme to the cultural, social discourses in the state. We studied each of the memes for the symbolic arrangement of the image and text, and contextualize them to the original source, usually a scene from a film. Between August 2011 and September 2019, the Kerala Police Facebook page published 664 images on their timeline, spanning content related to events, achievements, hotlines, legal awareness messages, greetings, and finally memes. All except the memes were largely informational in intent. We selected all 34 meme images, typically multi-panel series of screenshots from a Malayalam film, and conducted a close reading. Four purposes of messaging emerged following deep reading and thematic coding of the memes – (1) pushing page popularity; (2) awareness creation; (3) countering misinformation; and (4) advertising initiatives. We then reclassified these under conceptual headings – (1) image management, (2) legitimacy signaling, (3) relationship building, and (4) awareness. The paper discusses representative memes that can be critically analyzed for the visual and textual style of the messaging.

### **3.1 Structure of Kerala Police Social Media Communications and Audience**

External social media communication undertaken by the KP is through their verified Kerala Police Facebook Page, Instagram account and a Twitter account handled by a social media cell. The social media cell members were selected through an ‘entrance exam’ after inviting applications from all the police personnel in the police departments of the state. The entrance exam assessed the candidates’ knowledge of criminal law, skills in creating memes using cinema and their tact in defending the department using humor. After the candidates were selected, they were given social media management training at Cyberdome, a public-private partnership police initiative that deals with cybercrime prevention and security. The four-member social media team works round-the-clock, monitoring the social media platforms, receiving messages from users which need to be processed internally and channeled to the correct police departments, gathering intelligence, responding to comments and messages by users and creating engaging content. The dissemination of information from the page is centralized as the Inspector General of the Police department signs off on content that is published.

The KP page had over a million followers, 88% of whom were male. The core community of followers were males in the age groups of 18-34, which accounted for almost 70% of their following. Over 90% of list their primary language as English, versus 6% Malayalam. A third of the fan base was international – from places in the

Middle East, which have large populations of Keralite migrants. While these are not definitive indicators of class (and the KPs messaging is largely in Malayalam), these suggest that the consuming audience of the Facebook content is not from the poorer classes of Keralites.

## 4 Results

*“When the king wanted to communicate something, his man would come to the market, beat the drum and make an announcement. It was fine because people were in the marketplace. Now, where are the people? People are on social media. You can’t sit in the ivory tower and expect people to come to the notice-board for information. No one will come. You have to engage with them and take suggestions.”*

Pradeep, Public Administrator, Kozhikode, Kerala

The KP is marred in perceptions of unwarranted violence and corruption, further exacerbated by the sousveillance culture that has published much video/photographic evidence of police brutality or misuse of authority. This, in and of itself, is arguably not new, but in the past, the police did not have the same response prerogative. Pradeep’s quote points at the current moment in media consumption and the need for communication it has created. Alongside citizens posts of negative content on experiences with the police, popular media continues to project police as corrupt, incompetent, and brutal. By keeping a well-maintained online presence, KP engaged in a direct PR exercise, attempting to flood the same platform with counter-stories that reshape perceptions, but also, using the connective affordances of social media, to form new relationships.

### 4.1 Reimagining the Police-Public Relationship

*“The Kerala police, their social media page has been successful in changing people’s perception of the police. Actually, they haven’t done any work for it – they continue to beat up and kill people, kill them with their vehicles, do all of these things. but they have created an atmosphere where you can go joke with them.”*

Fathima, Journalist, Ernakulam, Kerala

To present a ‘relaxed’ citizen-police interaction, away from the typically tense and power-imbalanced engagements involving police, this meme (Fig. 1) calls the public to digital action while portraying a collaborative, laidback relationship. Images from iconic Malayalam films *Nadodikattu* (1987) and *Chitram* (1988) are used. *Nadodikkattu*, a satirical comedy about unemployment in 80s Kerala, enjoys a cult status with lines from the film commonly known across the state. The scene here is recreated as a conversation between Kerala Police and the New York Police Department (NYPD).

In the first panel, a scene from the film in which the comic duo dream about a luxurious life in the future is used. Here, the KP superimposes lines as though the duo are musing ‘how standing with the public, hand in hand, joking about with and guiding

them, is such fun.' In the second panel the KP Facebook page says, 'In the coming year, the number of our Facebook followers would reach 1 million' to which NYPD Facebook page responds, 'No way that's going to happen'. In the third panel, Kerala Police Facebook page addresses the social media audience to say, 'What do you say... if we put our minds to it, can we not make it happen?' The last panel is a riff on a widely known line from the *Chitram*.



**Fig. 1.** Meme of scenes from two iconic films presented as a conversation between New York Police Department and Kerala Police on who can pull together more followers.

In multiple memes, the KP social media cell creates an 'opposing' team, another bureaucratic authority, for example, the Bengaluru Police Department, or as in this case, the NYPD, to use a sense of belonging as an affective appeal. The appeal to Keralite nationalism is enabled through a 'do your bit' for the home team enabled by a simple like clicked. Since the meme sets a goal number of followers, taking a page out of online crowdfunding campaigns, it builds up a competitive endgame.

Besides this tactic of competitive support for the home team, the 'roasts' of Facebook users who comment on these posts acts as a further means of engagement. The witty nature of the photo-comments, cinema dialogues and textual comebacks both from the police and in the banter with casual users aims to make the pages funny and engaging for citizens. Clever responses are then shared by KP as screenshots on other platforms, including WhatsApp, to reach out to new audiences. Here, KP takes a page out of the twitter strategy of the fast-food chain "Wendy's", which roasts its competitors and Twitter users who tag "Wendy's" and that shapes opinions and enhances sales and marketing. This new face of endearment also creates unanticipated ironic situations, such as this exchange with a young prospective bride.

*"They call us police mama (uncle). Sometimes they ask very amusing things. Someone sent us a picture of a police officer and asked us to investigate him. We thought it was fake. Then she told us that she's getting married to him and wanted to see if he's clean. (What do you do?) We investigate and tell her what we find!"*

Kerala Police Social Media Cell Member, Thiruvananthapuram, Kerala

The intended brand outcome is that of an avuncular, trustworthy authority figure who is looking out for you. The temporal aspect of the carnival ensures that the sanctioned subversion of social order and law allowing for a challenge to authority is confined within that window of opportunity. As the carnival draws to a close, one returns to the ordinary time and to the normal order of social hierarchy and norms. In the case of the police bureaucracy, it is the spatial nature of its activity that is critical. The digital mask of the police mama signifies a performative relationship on social media that breaks away from ordinary interactions with the police and enters into fictive time through the anonymity and normal role loss that the carnivalesque platform allows. This fictional spatial relationship has the promise of a real, physical relationship that departs from the current police-public equation. On the ground, the interactions with the public may not involve the digital jest as suggested by the following excerpt.

*"Go to a police station. How do they behave to ordinary people? How many police officers laugh? They can't cook up humor. My family met with an accident in the night. For the police officer to come check on us he asked for Rs.500 from me. Even though he knew who I was. He forced me to pay up. This is the reality. Can I enjoy the humor during these moments? It is highly superficial"*

Thomas, Political Satire TV Host, Allapuzha, Kerala

For those who have actually dealt with the KP, or continue to do so, the memes were separated from the expectation of real interactions. The skew of the online following towards a young, sizably expatriate population suggests that the target of the PR exercise is intended to operate separately from the actual day-to-day functioning of the KP.



'POLITE' ACTION  
Policemen taking away one of the Youth Congress protesters who blocked the road at Palayam on Wednesday, in connection with the Assembly march. The march was taken out demanding an end to prohibitory orders in Sabarimala and resignation of minister K. T. Jaison | > www

**Fig. 2.** Photograph titled 'Polite Action' that appeared in The New Indian Express (13.12.2018)

Clever messaging on social media owes its success in some part to the convergence of mainstream media with new media. The social media content published by the KP becomes news riding on wit. The image of a protestor being carried away by the KP,

quickly punned as ‘Polite’ action (Fig. 2), got coverage on print and television. The social media post takes a commonly encountered face of police engagement – dealing with protesters – and turns the unsavory, antagonistic engagement into something done so amicably, and in the best interest of society.

## 4.2 Carnivalesque Disciplining

*“We have limitations as a law enforcement agency. We can’t criticize the govt, politics, not even social critique. Memes are used for critique. We are using it as an awareness method. It is a janakiya (popular) art. A way to reach many quickly.”*

Kerala Police Social Media Cell Member, Thiruvananthapuram, Kerala

The carnival presents a space that assumes the suspension of social order, law, and norms. A policing organization can neither turn away from its responsibility of upholding law and order, nor can it cleave itself from the state which grants it the authority to discipline. However, the performative space of social media offers the organization a means to momentarily recast itself by separating the manner of disciplining without yielding the role. In Fig. 3, we see a meme built out of a scene from the film *Aye Auto*, in which one of the key players is an obnoxious policeman (Srinivasan, pictured here), who causes trouble for auto (minicab) drivers. The first panel of the meme is titled – Extraterrestrial Organisms might be amongst us: NASA Scientist. In the second panel, the policeman asks, “Can I see the registration certificate for the vehicle?” The driver with Yoda’s head photoshopped onto his body responds, “Sir, I’m an alien. The policeman responds, “Even if you are an alien, if you want to drive in Kerala, you have got to have proper documentation.”



**Fig. 3.** Meme using a film with an obnoxious policeman to show how rules apply to everyone

The wording emphasizes the police’s ability to discipline, and that nobody is above the law. The meme intentionally sets up for the reader to expect that a bribe will be

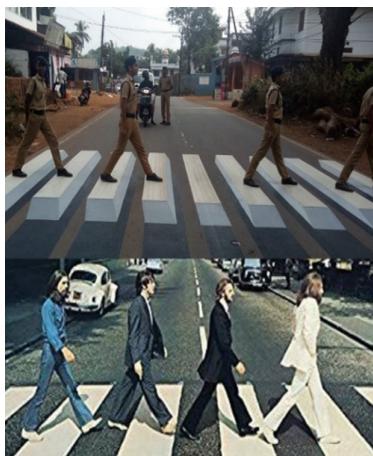
demanded, ironically embracing the fact that the state is distanced from the average Keralite, who at best expects to be squeezed by the police. The traffic stop is among the most common citizen police interactions, and one in which the citizen is invariably at the mercy of the policeman. The scene from *Aye Auto* takes aim at bureaucratic distancing from the average Keralite, highlighting it in the body of the police officer to whom the motorist is a faceless object of power. He may as well be an alien.

In the film, the scene close with a passing motorist yelling a taunt at the policeman squeezing the auto driver, underlining the scant respect afforded to cops by the average Keralite. The scene from the film is frequently aired on television comedy shows and online, recognized for Srinivasan's iconic characterization of an irksome cop. Repurposing a scene widely used to parody them, the KP admits to the audience that it gets how people see them, and nonetheless its work goes on.

*"We have to stay on their level. We can't behave like we are the police and twist our mustaches. We can't stand above them; we have to stand beside them. Only then would we receive responses."*

Kerala Police Social Media Cell Member, Thiruvananthapuram, Kerala

Through their take on the very tools used by filmmakers to provoke a mediation on the state, the Kerala Police appropriate the narrative, using the carnivalesque as a means of performing a policing function – of encouraging compliance with order. Yet the deeper goal is to signify homophily – your neighborhood policeman consumes the same media as you, indeed sees the state much as you do.



**Fig. 4.** Kannur police restaging the Beatles 'Abbey Road' cover

Yet the choice of media objects has politics of its own. The capital of its neighboring state of Karnataka, Bangalore, finds itself targeted by similar one-upmanship 'like' races on Facebook, partly because its online tactics are comparable. In place of regional cinema for visual content, the Bengaluru City police references pop culture such as *Breaking Bad*, *Game of Thrones*, *Chappelle's Show* or a popular catch-phrase from the song *Ridin'*. These are distinctly different from the local-language, popular cinema

content that KP generally uses, highlighting differences in the audiences being performed to. The Bengaluru city police goes after a younger, wealthier, audience that consumes international media, deals little with the police, but significantly with social media. A curious case in point that turns to an iconic but anachronistic global image is the awkward recreation of the Beatles Abbey Road cover (Fig. 4) by Kannur Police to discourage jaywalking, a reference of doubtful recall for the largely rural North Kerala population.

#### 4.3 Re-legitimizing Authority

The style of memetic messaging is aimed at virality, which creates a tension between the kind of message that achieves an intended policing outcome, and one that can easily attract attention. In discussions, those associated negotiated their own understanding of what forms a compelling narrative through trial and error online.

*“Before we started this page, if you tried searching for the Kerala Police on YouTube, the first results would be videos of police accepting bribes, of police hitting people, it would be videos that show a bad aspect of the police. Now our videos are the first results.”*

Kerala Police Social Media Cell Member, Thiruvananthapuram, Kerala

The KP recognized that something too obviously a PR message without its own standalone appeal as an interesting media artifact was unlikely to work. YouTube came up repeatedly in any exchange about brand management in India. The attention to video as a narrative medium is indicative of KP’s appreciation of short-form audio-visual material as form factor, and search optimization as an outreach factor in a complex attention economy. By the time of writing this piece, KP had already made its own short film, which was featured on its channels.

The meme in Fig. 5, is built on the popular 2016 police station drama, Action Hero Biju. The use of Biju, the protagonist of the film, carries symbolic weight. Not only was the film widely seen, but the protagonist played a relatable regular citizen, who happens to be a policeman. He himself navigates life as a member of a bureaucratic system, steeped in its inequities, inefficiencies and asks of emotional labor, departing from clichéd depictions as slaves of politicians or super cops who singlehandedly and violently save the day.

In the film, Biju deals with complex human situations but remains steadfast and effective. In the meme, Biju addresses the Sabarimala issue, a tense and divisive political issue. When the Indian supreme court legalized women’s entry in the revered Sabarimala Temple, a large contingent of the Keralite Hindu population, as well as political establishment aggressively opposed it. The police, acting in accordance with the law, were charged with the duty of escorting women who wish to worship the deity to the sanctum sanctorum, but in the position of enforcing a law that may make them unpopular with a significant portion of the citizenry. The meme states “we are watching”, to remind readers of the panoptical gaze at those that may choose to cause trouble at the site, but the use of Biju, the upstanding cop, presents a normative turn.

The juxtaposition of images invites the viewer to evaluate the rowdy, disruptors of peace to their routine lives and compare it to the righteous police officer who also is



**Fig. 5.** Meme about legitimate authority

upright and doing his job right. The image of the antagonists in the meme is important since they are not dressed as male Sabarimala devotees, who typically wear a specific all-black outfit. It attempts to find solidarity with the section of the public that disassociates from the section that is portrayed as the perpetrators of random violence. Here, the KP treads lightly to not present a value judgment against citizens opposed to women's entry on account of their beliefs, or to other any specific community. They position themselves as peacemakers, who enforce the law of the land and are only opposed to extreme acts that may undermine public order.

*"Because of the Sabarimala issue, we are facing an attack. Whatever we post, they try to comment negatively or publish their ideas under our posts. During the Sabarimala issue, 90k people suddenly arrived on our page. They started liking our page in order to post their opinion in our page. Police are facing the biggest backlash in the Sabarimala issue. We are a law enforcement agency, there is no politics."*

Kerala Police Social Media Cell Member, Thiruvananthapuram, Kerala

The Sabarimala issue presents an important case study of how memes can be used to present an alternative narrative when the institution is under attack. The meme text emphasizes duty, righteousness, and legitimacy, and in crafting fear around miscreants rather than devotees. The meme also shows that the panopticon works both ways - citizens can mean surveillance through sousveillance, and in carefully navigating the text of the message, the police emphasizes that it is on the citizen's side, not as the strong hand of law, but as a thoughtful partner who makes the pilgrimage experience better for everyone.

## 5 Discussion and Conclusion

Kerala Police's use of social media has been arguably one of their most successful PR exercises in recent years. The direct fan following of 1.2 million online is just one metric – the memes have got KP attention in newspapers and television, and other states have since tried to emulate them. They self-present an approachable authority, thereby attempting to forge a new relationship with the public, contesting prevailing perceptions about the police through a carnivalesque fashion of challenging organizations of power, authority, and forms of communication associated with it. In this study, we argue that this may not have been possible without turning to the carnivalesque style and turning to popular culture as its metaphor of reference. The KP performs a diffusion of hierarchical tensions between the police and the public experienced both in lived experiences as well as in the media by revoking formal language and norms.

However, the real problem of power imbalance between the public and the police is steeped in other forms of social inequity which the KP not only does not address, but arguably reinforces. Marginalized groups within the public experience the imbalance far more brutally than the rest, and they are conspicuous by their absence as audience members for the creative PR exercise. The KP's attempts to change its public image is an important case in performative public engagement, but that this is wholly separated from the actual functioning of the institution. The carnival strategy may work for certain functions of the institutions, as it has to an extent with KP, but herein lies the paradox. If public institutions increasingly do the same, without changing their practices and engagement with citizens, that it is purely the lip service is eventually a given.

Despite the tenor of the memes themselves, the hierarchies within the bureaucratic organization remain intact, even in the outreach process. The move to online communication hasn't democratized outreach – all communications run through the gatekeeping process overseen by a superior officer, and new forms of stock responses online replace bureaucratic run-arounds experienced at police stations.

A look at the social media approach of district police departments in the state shows the variance in the content and tone. Even though the headquarters use comic memes and clever means of engagement, this has not trickled down to the level of individual police stations or in smaller towns, where conventional communication such as press releases, posters, record of achievements in the ceremonious, official manner are still the standard means of interaction. This demonstrates a classic problem posed by top-down changes such as bringing in a PR consultant to headquarters – the vision from the top cannot impact the actual working of the nodes without a generational change to the way things are traditionally done.

The popularity of the KP's engagement model has initiated a wave among other bureaucratic departments in Kerala getting on the social bandwagon. Indeed, a paradigmatic change in bureaucratic communication may be underway in terms of both the means and style of informal communicating with the public among bureaucratic departments. In this also lies the 'ICTD' conundrum – who *really* benefits from this?

The reframing of the public service appears to be clearly aimed at the middle classes, as we see in the statistics of who follows these pages. This needs to be seriously interrogated, since it is arguably the poor that deal with the police more often on a day to day basis, without the advantage of lawyers, or political protection. It is also the poor

that are most likely to face the hard hand of police justice, that the memes work so hard to undermine. And yet, as the middle-class outreach attempt has worked well, it has set in motion a range of public services to start their own online strategies, signaling that the aspirational discourse of a modern, witty, and tech-savvy department that appeals to the politically important constituents may go farther than to appeal to the less powerful citizens who use these services.

A reimagining of the relationship between the police and public could be an endeavor to change perceptions that may translate to a change in the organization of relationships, processes and discourses surrounding police bureaucracy and society in which it exists. As we examine the ways in which top-down organizations and the state police force appropriate memes, controlling and disseminating a supposedly democratic means of communicating ideas, future work must look at the broader implications of how organizational communication through social media serves to strengthen existing systems and hierarchies.

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# Cultivating Online Virtual Community of Purpose to Mitigate Knowledge Asymmetry and Market Separation of Rural Artisans in India

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**Abstract.** One of the key deficiencies in many marginalized rural communities is lack of linkage to local and larger metropolitan area opportunity structure, financial, technical, social and political resources. The primary reason behind this is the knowledge asymmetry between rural communities and the urban marketplace and associated agencies, which often disallows rural artisans to sustain profitable entrepreneurial ventures. Knowledge asymmetry occurs when one party (the artisans) in an economic transaction possesses lesser market knowledge (or, lesser understanding about the market context in which a business operates) than the other party (urban marketplace and associated agencies). The resultant market separation derivative of knowledge asymmetry necessitates dependence on middlemen and resultant lack of autonomy for the rural artisans, which often impedes a rural community in achieving workable levels of self-sufficiency. This paper proposes building an online virtual community of purpose to mitigate knowledge asymmetry and market separation of Indian rural artisans. The community of purpose is defined as a community of people, who are going through the same process or are trying to achieve a similar objective. The paper concludes by providing an architectural framework of a Community Information System (CIS), through which we have attempted in building a virtual community of purpose for rural Indian artisans by connecting them digitally with other relevant actors in the craft production system.

**Keywords:** Information · Asymmetry · Knowledge · Asymmetry · Rural artisans · Market separation · Community of purpose · Community Information System

## 1 Introduction

The rural crafts industry accounts for a major chunk of the livelihood opportunities available to marginalized rural communities in developing nations [1, 2]. Despite the promise it holds, rural artisans in the industry suffer from similar deficiency as stated

above. At the root of the issues faced by the artisans is the fact that rural craft industry is largely informal and unorganized, with most of the artisans working as independent craftsmen/women [2]. The consequence of this is the inability of the artisans to leverage the benefits that organized entities enjoy, creating several hurdles in a process. These hurdles are (i) lack of/limited access to quality raw materials and tools required to compete in global markets [3]; (ii) lack of awareness about the wants of people beyond their local markets [4]; (iii) limited abilities to satiate the needs of global customers [5, 6]; (iv) limited ability to affordable capital procurement [7] and (v) limited/lack of access to global markets [4, 8]. These barriers impede artisans' aspirations to sustainably follow their trade and thereby force them to look out for alternate options of living, thus endangering their current livelihood options and the prospects of indigenous talent and culture.

The above review of literature suggests that a major deficiency in many marginalized rural communities is the lack of linkage to local as well as larger metropolitan area opportunity structure, including financial, technical, social and political resources. Since marginalized rural communities are disconnected both physically and digitally from local as well as urban opportunity structures, they have (i) less access to quality educational support, training, advisory services; (ii) less knowledge on available local opportunities (community assets, sharable resources) (iii) less access to market links (buyer, seller, micro-credit etc.) and (iv) less access to any forum to discuss their problems with relevant agencies.

While various public, non-governmental as well as private entities have worked towards providing marketing channels to rural producers, both along physical and digital lines, a significant segment of the community is still deprived of such measures [9]. In order to pronounce market prospects for indigenous goods, different nations have come up with their own innovative means to enhance the rural economy, which majorly contributes to national revenue. The Colombian government in an effort to boost its craft sector, made provisions to connect rural craft practitioners with designers from across the globe [10]. This attempt was done to foster relevant design and idea exchange, which was expected to subsequently improve both indigenous craft practices and pave the path for exhibiting such practices in a global forum. Contemporary rural artisans in India have also witnessed rapid "pop-up" of private and digital forums dedicated to directly engage artisans in the market transaction process. Multiple private E-commerce sites like *Artfire*, *Supermarket*, *Okhai*, and several others have come up to give artisans across globe direct selling opportunities to global consumers. There are initiatives from Government in terms of introducing various E-commerce platforms like GeM, India Handmade Bazaar, etc., which are marketplace models that provide dedicated online storefronts for the artisans to display their products, thereby helping them bypass multiple layers of middlemen and earn better margins for their products [11]. However, it has been observed that the multifaceted problems faced by the artisans cannot be adequately solved through fragmented attempts like providing them access to passive e-commerce interfaces [12].

The objective of this paper is to find out the reasons behind rural artisans' inability to cultivate the linkages to local as well as larger metropolitan area opportunity structure. In so doing, the paper proposes a mechanism to mitigate this disconnection through virtual community formation using a digital platform that connects relevant rural-urban

entities. Effective collaboration taking place in the virtual community has prospects of equipping rural artisans with enough knowledge and its operating abilities, which subsequently has a spillover effect in enhancing their opportunity prospects, thereby leading to better socio-economic performance of rural communities.

## 2 Information and Knowledge Asymmetry

### 2.1 Information Asymmetry

Information asymmetry is thought to arise when buyers and sellers, at the time of the economic transaction, possess differential information. This differential information, disturbing the equilibrium, further influences trade. Most of the work in mainstream economics read informational asymmetry with the assumption that sellers have greater knowledge about their products and that enables them to sell their produce along with terms and conditions beneficial to them [13, 14]. Reading informational asymmetry along such lines is useful in studying large-scale business transactions. However, such an assumption essentially falls short in explaining a plethora of small-scale informal transactions happening in the Indian crafts sector, where buyers are at a more advantageous position and the sellers (the artisans) have far less knowledge about the value of their products in the global market and the market context in which they operate.

The Indian crafts sector is primarily rural-based. Organized in an informal structure and due to multi-faceted hindrances, rural artisans find it quite difficult to hold a prominent place in the urban market [15]. However, this does not imply that there is no demand in the market for their produce. Though the paraphernalia of exotic traditional arts haunts contemporary globalized society, it has done little in improving life chances of artisans [16]. It is true that artisans have more knowledge about their produce than anyone else does in the market, but their disadvantageous market position disallow them to utilize additional information they have in pursuit of profitable returns.

Several initiatives have been undertaken globally to mitigate information asymmetry of marginalized rural communities. Noteworthy among them includes South African government's formation of Small Enterprise Developmental Agency (SEDA) under the public aegis, together with Department of Trade Industry (DTI), which undertook measures to boost indigenous production [9]. The measures were undertaken with the aim to provide the rural crafts community of South Africa necessary information and market connect that is essential for self-betterment. Along similar lines is the joint initiative of the Colombian government with UNESCO to revive its crafts sector [10]. In order to strengthen the identity of Colombian crafts and increase their recognition in the internal and external forum, the nation has tried to take up a policy-wise initiative to supply indigenous producers with crucial information necessary for self-betterment. This initiative attempted to boost the national cottage sector by making provisions for counseling, technical assistance and training in the craft sector, specifically in the areas of design and technology. In the Indian context, a Self-Help Group (SHG) programme was undertaken by the government of India to provide an enabling environment to address poverty and sustainability of rural community by making provisions for microfinance [17]. As

a part of the scheme, several academic and vocational training are being provided to the rural marginalized SHG members to upgrade their information pool, skill set and market prospects.

While the above initiatives can all be categorized as efforts undertaken to address information asymmetry of marginalized rural community, few have been successful in achieving their desired goal. Partly because of their sporadic nature and partly because of their focus on externally feeding information to rural community without developing the target group's ability to process disseminated information. The initiatives have therefore mostly remained redundant in the context of achieving holistic rural empowerment.

## 2.2 Knowledge Asymmetry

Sharma argued that reducing information asymmetry by providing complete information is not enough a condition to reduce problems arising from information asymmetry [18]. The recipient of information may "either have little knowledge to interpret the information supplied or gathered. It could also be that the recipient is not knowledgeable to determine which information should be gathered, is missing or is invalid. "Without the experience, skills and attitude elements of knowledge, the information cannot be interpreted" [18]. In our context of rural artisans, along with providing access to factual data, it is also essential to impart knowledge, which will enable artisans to convert their acquired informational resource into a more holistic knowledge pool [19]. The disadvantageous social location and orientation of rural Indian artisans and their widespread illiteracy, make possession of information or factual data though necessary, but not enough a condition in pronouncing their agency. It is in sufficiently arming them with knowledge, a more holistic pool, that we can envision strategies for rural empowerment.

According to Dellemijn [20], Knowledge Asymmetry can be defined as "lack of equality or equivalence of a combination of information, experience, skills, and attitude between two participants in a transactional relationship". Knowledge Asymmetry consists of an already known construct information asymmetry, as well as experience, skills and attitude asymmetry.

While the artisans share both direct and indirect contacts with other artisans and individual buyers, communication gets disrupted in case of extended entities like wholesale buyers, raw material providers, designers/trainers and government. It is the middlemen, with whom artisans always have direct contact with. The physical, informational and communicational distance that rural artisans share with the above-listed entities make the situation further acute, where the middlemen essentially thrive by capitalizing on artisans' lack of knowledge. The precarious position in which rural artisans are placed is not just because they possess less information or less factual data, but the physical and virtual isolation they suffer from mainstream market impoverishes their knowledge pool. Knowledge is a more holistic concept, which includes within its purview of both information and skills acquired through experience [21]. The marginalization of rural artisans, owing to its origin to the isolation of the community, not only makes the rural population victims of the informational gap but these social constraints hindering easy connection with the rest of the society make the rural community knowledge impoverished. Knowledge deficit from which most rural artisans suffer from can be rightfully

cited as one of the most significant factors leading to poor performance of the rural economy, thereby sustaining marginalization of the rural Indian sector.

### 3 Knowledge Asymmetry and Market Separation of Artisans

Knowledge Asymmetry that exists between rural artisans and urban marketplace disallows the former to have adequate knowledge regarding market dynamics, operations, trends and nature and compel most rural craft producers to rely on exploitative intermediaries in order to sell their produce in the market. This problem cannot be solved by just making additional provisions for market connect. While additional channels of market connect are necessary for the context of rural artisans, they must be coupled with supplementary factors, which include not only socio-economic but also information and knowledge capabilities of rural artisans to exploit those channels. These factors lead to what Bartels [22, 23] refers to as *Market Separation*.

According to Bartels, there are four types of Market Separation and these are Spatial, Financial, Informational and Temporal Separation.

*Spatial Separation* is the location of rural artisans in remote villages, acting as an obstacle for them to connect with different consumers in non-local markets [2]. Even if they target non-local market using some channels, the dearth, as well as expenses of logistics providers, heavily impede such direct connections [22]. *Financial Separation* refers to limited access to financial capital that is in turn responsible for financial separation experienced by rural craft producers. It hinders rural artisans' ability to buy raw materials or tools needed for improved production. *Informational Separation* is limited use of communication infrastructures (e.g. Internet) and devices (especially smartphones) coupled with the spatial separation of rural craft producers from customers. This inhibits them from gauging market demands, both in terms of quantity and type of produce. Accordingly, the rural artisans find it difficult to plan their production schedules [22]. *Temporal Separation* is a typical time-lag between production and consumption, and that is driven by the remote location of rural craft producers, poor transportation infrastructure including poor road conditions, the dearth of logistics providers, etc. [24].

Apart from the four market separations articulated by Bartels, our close investigation of the dynamics of the rural sector, two more categories of market separation can further be added [11]. These are, *Capacity* and *Capability Separation*.

*Capacity Separation* refers to the difference between the order assigned by the customer and artisans' limited capacity to satiate the same because of operative hindrances. The issues intrinsic to rural craft production often impedes easy production. Due to capacity separation, rural craft producers, therefore, often lose out on lucrative market orders, even though they possess the necessary skills required to complete the given order. *Capability Separation* addresses the indigenous skills possessed and practised by rural artisans that are often gifted to them by hereditary sources. It highlights that although most rural artisans possess intricate and sound core skills, they derive the skills mostly from the specialized knowledge of their immediate family and surrounding, which may or may not perform well in a contemporary market context. Lack of exposure, ignorance about innovative market designs, coupled with inadequate knowledge on how to employ technology to enhance production capabilities, together contribute in sustaining the poor market performance of rural artisans [24].

The problems intrinsic to the rural economy can be vastly mitigated by facilitating effective communication and collaboration between rural-rural and rural-urban actors. Through such purposive community formation, we attempt to restructure extant supply chain practices into a more decentralized model, which provides additional opportunities to each actor to reap economic benefits from resultant networking. However, before we delve into explaining how purposive community formation bears immense prospects in mitigating knowledge asymmetry and market separation of rural artisans, in the next section, with the support of a qualitative research study conducted among rural artisans of Bengal, we wish to pronounce how the Knowledge Asymmetry and Market Separation of rural craft producers is not just a theoretical articulation but is a practical hindrance as well.

#### **4 Impact of Knowledge Asymmetry on Rural Craft Industry**

The following study on the rural Indian crafts sector from the angle of Knowledge Asymmetry is based on in-depth qualitative interactions with selected artisans from seven districts of West Bengal, India. The number of respondents interviewed account for up to 70 artisans. The artisans interviewed practice different indigenous art forms such as ethnic stitching on garments, woodwork, bamboo work, conch work, ethnic painting, and embroidery work, to name a few. With the help of a qualitative survey, we have tried to record and subsequently analyze the experiential accounts of these rural artisans to understand the hindrances they face during production and marketing due to lack of crucial knowledge.

The purpose of the interviews and surveys was to provide practical justifications for the theoretical formulations postulated in the paper. The issues addressed in both protocols have been presented below, where a detailed impact analysis has been done to show how the findings of the protocols inform our overall research context. Pertaining to the ethics, we have taken informed consent from both local administrative body and individual respondents, before documenting their experiences. In the analysis part we have not disclosed the identity of our respondents to maintain anonymity. The study has been performed accordingly to understand the hindrances women artisans face due to lack of information and to conduct a need analysis to make the interventions suited to meet the specificities of the local context.

More than 90% of the total artisans interviewed recorded low educational qualifications. Lack of basic education was an omnipresent factor behind the resultant inefficiency of their production.

This discussion will now focus on the entire production process and break it into multiple levels in order to discuss challenges that artisans face in each level due to lack of adequate knowledge. This will enable us to locate the different aspects where the knowledge asymmetry is essential to bridge. The multiple production levels were identified as follows;

**Inability to Produce in Accordance with Market Demands:** Around 80% of the artisans with whom we interacted with stated that they themselves conceptualize or innovate newer designs. The rural orientation of the artisans, coupled with their lack

of knowledge regarding market trends and dynamics does however prohibit them from coming up with appropriate items to satisfy the hunger of the urban market.

**Issues Pertaining to Raw Materials:** Unavailability of appropriate and affordable raw materials both in quality and quantity often pose as a hindrance in the rural production process. Most rural artisans' lack of knowledge regarding the availability of appropriate and affordable raw materials make the difficulty in procurement of raw materials more pronounced.

**Issues Pertaining to Logistics:** Procurement of raw materials as well as delivery of finished products to their buyers, require transportation of goods at bulk. Majority of the artisans interviewed recorded a preference in sharing rides with other artisans in order to save time and money on transportation. However, due to lack of intra and intergroup communication, the location and other details of people having similar procurement and delivery requirements is generally unknown to artisans. This in turn compels them to fully bear their own transportation costs, which is often burdensome given the already financially insecure status of rural Indian artisans.

**The Financial Aspect:** More than 80% of the artisans with whom we interacted with stated that they receive payment only after completion of a placed order. The production process upon initiation does however require liquid cash for procurement of raw materials for example, without which the production process cannot start. There are multiple government-sponsored schemes providing loans at subsidized rates. However, lack of adequate financial and procedural knowledge inhibits most artisans from taking advantage of these opportunities and thereby confine them to locally available moneylenders. This points out the immediate urgency to devise a more target-oriented and contextual rural credit market, suited to mitigate production challenges in the Indian crafts sector [25].

**The Incapacitated District Industries Centre and Rural Development Cell:** The district-level government help-desks serve as the primary source of knowledge regarding various schemes undertaken at the public level for the betterment of these artisans yet most artisans recorded the inefficiencies of such governmental offices. Due to these resultant inefficiencies, rural artisans often remain misinformed or uninformed with regards to the news of fairs held, government-sponsored allowances that they are supposed to get, and other related aspects, which this local government help-desks are expected to provide to the artisans.

**Alienation from the Digital World:** Contemporary digital technologies have heightened to such a status that information and knowledge have become the most important and accessible resources in this era. In our in-depth interaction with the artisans, it was however quite a disappointing result that only 2% of the total artisans interviewed recorded resorting to digital medium for the purpose of their trade. Digital ignorance of the majority has disallowed them access and use the information available virtually for the betterment of their business.

**Issues Pertaining to Communication with Customers:** The physical and virtual distance the rural artisans share with their urban-based customers restricts the scope of communication. Limited communication prohibits the artisans from having accurate knowledge regarding their customers' preferences. 70% of the interviewed artisans recorded such a problem, which directly impacted their trade performances.

**Lack of Skill-Building Opportunities:** Even if the artisans feel that they want to upgrade their skills or learn a new skill, they do not have adequate knowledge regarding the availability of potential trainers and/or knowledge sources that they can tap into. During our interventions, we showed some of the YouTube videos on the design of soft toys and making of low-cost jewellery. They not only liked them but used the knowledge to create innovative products along similar lines. However, those knowledge-channels, online or offline, are mostly absent.

The multi-faceted hindrances, which arise in different levels of the production and marketing process due to asymmetrical knowledge, become further acute due to the lack of preliminary literacy among Indian artisans. The resultant asymmetry in knowledge or possession of insufficient knowledge not only hampers artisans' trade from an economic perspective but also contributes as a psychologically de-motivating force. This reiterates our conceptualization of knowledge, not just as an economically accelerating force, but as a social phenomenon that ensures the overall welfare of the artisan community.

If the intention is to address market failure in the Indian crafts sector arising out of knowledge asymmetry, then it becomes mandatory to devise ways to improve the communicational aspect, which will foster knowledge exchange between actors relevant in the process of rural production and marketing of artefacts. As mentioned earlier, the problems intrinsic to the rural economy can be vastly mitigated by facilitating effective communication and collaboration between rural-rural and rural-urban actors. Through such purposive community formation, we attempt to restructure extant supply chain practices into a more decentralized model, which provides additional opportunities to each actor to reap economic benefits from resultant networking. In the next section, we will show how communication and collaboration between different entities in the rural craft production process can be triggered by cultivating a virtual community of purpose among them.

## 5 Cultivating Online Virtual Community of Purpose to Mitigate Knowledge Asymmetry and Market Separation of Rural Artisans

### 5.1 Community of Purpose

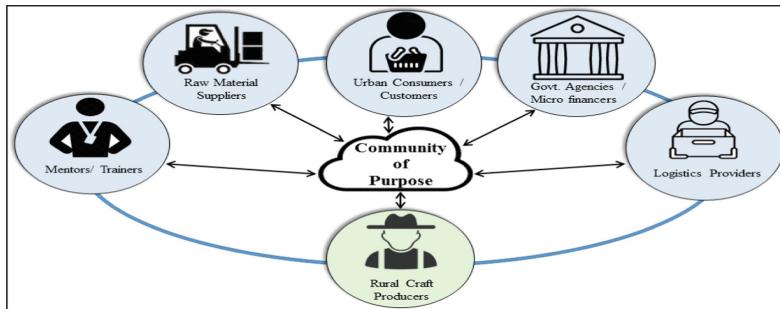
The concept of virtual communities was introduced by Rheingold [26], in his popular book "Virtual Communities" where he described them as "group of people who discuss a topic in a computer-mediated way, sufficiently long, with enough emotional involvement and who form interpersonal relationships". Virtual communities are online social networks in which people with common interests, goals or practices, interact to share information and knowledge and engage in social interactions [27]. It is the nature of social interactions and the set of resources embedded within the network that sustains virtual communities. A virtual community thus acts as a medium of interaction and

communication that binds community members across geography for the purpose of enhancing both bridging and bonding social capital [28]. Social capital is a resource that can combat social exclusion. Trust, social interaction and mutual reciprocity via online communities have the potential to create an interactive environment for children [26].

In our context, what becomes important is which sort of community formation is to be cultivated to attain maximum benefits. Community of practice [29], facilitating practice-oriented collaborations within and across groups enables rural members to enhance their individual capability. However, it does not necessarily guarantee translation of enhanced capability into generating concrete economic results. Thus, community of practice can mitigate knowledge asymmetry of rural producers, but not their market separation. In order to address our dual goal in this paper, we have advocated for cultivating community of purpose [30] among rural urban entities. The community of purpose, although under-defined in existing literature, can be defined as a community of people, unified with a common goal, purpose or objective. The reason why we think the community of purpose can be a prospective means to mitigate both knowledge asymmetry and market separation of rural target group is because of the promise of purposive collaboration and networking that it assures.

Stukes [30] insightfully articulates the parameters responsible for a successful community of purpose supported network. Purposive collaborations occurring via community of purpose have the potential to fill up interaction gaps, allowing smooth communication between interested parties. Resultant networking therefore has the potential to mobilize social capital of communitarian members. Purposive collaboration, both within and across groups, not only helps in mobilizing social capital of rural target group, but also helps in mediating social barriers. Unhindered purposive collaborations help members to counter negative perceptions about themselves, which are gifted to them by the stringencies of social conventions. Moreover, the common purpose which unites members of the community of purpose makes it defiant of social norms and regulations, which otherwise dictate the premise of community formation. This has positive impact in not only enhancing knowledge and its processing abilities of rural target group, but also significantly contributes in promoting market operations of the isolated rural community members. This makes community of purpose an appropriate tool in our research context.

In our context, effective collaborations between rural-urban entities through community of purpose significantly contribute in improving mutual awareness of market dynamics, thereby having positive influence in mitigating market separation of rural producers. In this context, communities of purpose, comprising of relevant rural-urban entities (Fig. 1), will not only ease the process of economic return for rural producers, but will also holistically affect them by facilitating knowledge transactions along the following axes: (i) Connecting rural producers with urban designers or experts in order to receive training; (ii) Linking rural producers with government agencies; (iii) Connecting with micro-financers to ensure finance and financial advice; (iv) Connecting rural producers with a range of raw material providers; (v) Linking rural producers with logistics suppliers to reduce time, effort and money in the context of delivery of finished products.



**Fig. 1.** Formation of communities of purpose

The above-mentioned credentials highlight how the community of purpose, in triggering the above-stated factors, have the capacity to transcend its immediate purpose and can be rightly identified as a catalyst in mitigating knowledge asymmetry and market separation of rural artisans. Moving beyond the traditional concept of community, we attempt to cultivate a community of purpose for rural Indian artisans virtually. By utilizing the connected spirit of contemporary digital technologies, we attempt to devise a Community Information System (CIS) for cultivating a virtual community of purpose between rural artisans and other entities in the craft production system.

Given the widespread illiteracy and digital ignorance of the rural Indian community, we adhere to virtual means only by providing prior digital literacy training to rural mass, so that they can utilize the digital infrastructure to draw independent benefits. It is only by making rural non-users digitally capable through contextual digital literacy training that we can ensure successful implementation of digital technology to address the issue of rural marginalization [31]. In the next section, we will provide the architectural framework of a CIS we designed to cultivate a community of purpose between rural-urban entities.

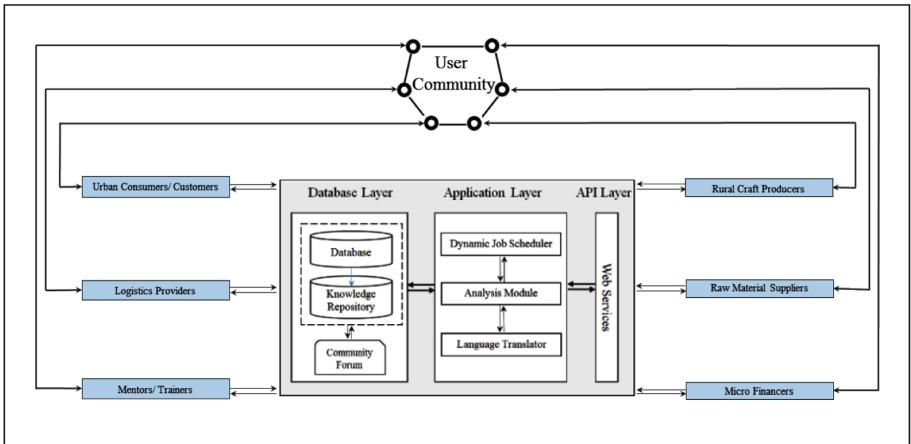
## 5.2 NCoRe – A Community Information System (CIS) to Mitigate Knowledge Asymmetry and Market Separation of Rural Artisans

In this section, we will extensively talk about a Community Information System (CIS), called NCoRe (Next-generation Collaborative and Responsive rural community) to mitigate knowledge asymmetry and market separation between rural artisans and urban marketplace through cultivation of communities of purpose. A CIS can be defined as an information system targeted for a community or a group of communities. It helps community members to strengthen their social networks, exchange knowledge as well as nurture collaborative processes at the local level through the provision of a different form of resources and related support services. CIS approach is one which ideally begins with the local community identifying a need or a possible application and then beginning a process of working with them to respond to or satisfy that need always within a context where the local community is in control and is directing the process of its own technology enablement [32].

Our research initiatives to cultivate a virtual community of purpose via NCoRe is the implementation of a CIS, where rural members will be active participants in the intra and inter-group collaborations taking place via such purposive virtual community. NCoRe is an e-connecting and e-supporting platform, hosting a diverse range of entities, which include urban consumers, mentors or trainers, logistics providers, raw material suppliers, financial investors and rural craft producers, all on one platform. The platform, by facilitating democratic knowledge exchange within the enlisted entities, attempts to cultivate a community of purpose to improve artisans' market performance through necessary collaborations. This section is dedicated to spelling out the system architecture of NCoRe to give the readers a holistic vision as to how NCoRe attempts to achieve the above-mentioned goal.

NCoRe platform facilitates communication, collaboration and trade between rural craft producers, urban consumers and other actors in the system. Specifically, it promotes transactions between rural craft producers, urban consumers and other stakeholders (raw material providers, logistics suppliers, etc.) by providing a standardized, flexible and open platform that not only improves productivity but also ensures fairness and financial benefits to all. The collaboration facilitated by this platform ensures transparency and helps in optimizing the positions of all stakeholders in the business. This platform provides a virtual space through which multiple actors in this system can exchange knowledge between them. We termed this virtual space as 'community'. Thus, this platform (Fig. 1) can be defined as a temporary association space of autonomous crowd workers who establish dynamic peer-to-peer connections to collaborate with each other through coordinated sharing of skills, resources, information, risks, costs and benefits, in order to satiate a given business opportunity.

The different modules of NCoRe, as depicted in Fig. 2, are discussed below:



**Fig. 2.** Block diagram of the platform

**Users.** There are six types of users in the system: (i) Urban Consumers; (ii) Rural Craft producers; (iii) Logistics Providers; (iv) Mentors/Trainers; (v) Raw Material Suppliers;

(vi) Govt. Agencies/Micro Financer. They are connected to this platform via an online digital interface on their mobile phones (Mobile Apps).

*Rural Craft Producers:* The rural craft producers can advertise their product details, contact details, skill sets, production capacity and product feedback, which will be maintained in a digital catalogue. The rural producer is also encouraged to view other rural craft producers' samples to broaden their outlook and learn from peers, while at the same time, make better and more informed decisions about skill-enhancing and price quoting.

*Urban Consumers:* Urban consumers are micro-entrepreneurs or independent urban consumers. They can view profiles of rural craft producers in digital catalogues and 'post a job' for prospective rural craft producers, where the job details, budget and timeline are mentioned. NCoRe also provides provisions for urban customers to customize their requirements by directly communicating and collaborating with rural artisans online.

*Raw Material Suppliers:* It enables the suppliers of raw materials to enroll and participate in transactions as and when needed. They advertise their stock of raw materials, contact details, price, delivery time, etc., which will be maintained as a digital catalogue in the platform. If an order is placed and the platform selects rural craft producers to execute the order, order details will be sent to the mailbox of possible raw material suppliers dealing with the ordered product so that he/she can act accordingly.

*Logistics Providers:* Logistics providers in this platform will do location-specific enrolment and handle and manage the movement of goods from the one place to another based on the requirements of different actors in our platform.

*Mentors/Trainers:* The responsibility of a mentor/trainer in the NCoRe platform is to provide training on skill up-gradation of any rural producer or giving expert advice to rural craft producers on any issue of concern. They will conduct various training sessions remotely (through the platform) to any individual user or to a group of users on a topic. A trainer can also post asynchronous video clippings on any specific topic to train the users in the platform.

*Govt Agencies/Micro financers:* They can provide financial assistance, advisory service, information related to different government schemes and subsidies, etc., to rural craft producers or other targeted individuals as and when needed.

*Application Layer. Analysis Module:* The order distribution, product demands, customer comments, feedback, product ratings, etc., for individual rural craft producers will be fed into this module which will be analyzed to suggest the scope of future improvement in the business of a rural producer.

*Dynamic Job Scheduler (DJS) Module:* This module is responsible for carrying out a scheduling activity between urban consumers and rural craft producers. The DJS module examines the availability of resources, coordinates and selects relevant actors to form an instance of a supply chain to process any activity. This module engages multiple actors (rural producer(s), raw material provider(s), logistics provider(s), trainer(s) and micro-financer(s) to carry out collaborative activity.

**Language Translator Module:** This module uses a backend client library and integrates Google API to translate the content of this platform from one language to another language. Since we have designed this platform keeping in mind the rural context, the platform provides provisions for rural users to navigate using the native language.

**User Community Management.** Basic messages and discussion themes are the core content of NCoRe community. Messages are information that is passed from one person or a group of people to another with the intention of producing an effect. Discussion themes are information or ideas designed specifically to focus the attention of a group on a problem and generate dialogue about possible actions to be taken.

Several studies indicate that most of the talented rural craft producers are fragmented and geographically not well connected. In this context, the ‘Community’ (a virtual knowledge-sharing space) serves multiple purposes. Firstly, it will bridge the communication gap between the community members by creating a digital knowledge repository/space that allows for the provision of knowledge accumulation and sharing, which equally increases the chances of solving local issues and helps rural communities to achieve business prospects through inter and intragroup virtual networking. Secondly, it allows creating a digital repository among all stakeholders in the rural-urban craft production system to necessitate cultivation and up-gradation of their skill set.

**Validation of NCoRe System.** To validate the NCoRe platform, we have worked extensively in more than 7 districts in West Bengal and have a detailed profile data set of 200+ rural artisans ([www.ncore.co.in](http://www.ncore.co.in) and [www.ncore.co.in/v2](http://www.ncore.co.in/v2)). This dataset is used by the analytics module of the platform to understand the level of artisan skills, market and resource-related problems. Apart from the artisan profiling, we have also empanelled the other related entities of the craft eco-system in the platform such as urban entrepreneurs, raw material supplier, logistics provider, trainer, and micro-financer. We have also designed a mobile App to interact with the platform. Several experiments were conducted in order to understand the entire artisan–entrepreneur ecosystem and to identify ways to bridge the gaps between them. For this purpose, a team of researchers were engaged as *enablers* to connect the rural artisans and their products directly with the urban boutique entrepreneurs and sellers. During this process of market connect; we have validated our NCoRe platform that has the provision of connecting rural artisans with the urban buyers directly through NCoRe App. At the same time, urban boutique entrepreneurs can also directly contact with rural artisans to execute their orders and see the status of their order. In our mobile app, we use ‘*Google Language Translator API*’ module to translate the content of the NCoRe platform from English to Bengali language and vice versa. This Language Translator module helps rural artisans to understand and communicate with the urban entrepreneurs in their native language.

## 6 Conclusions

The architectural framework of NCoRe presented above is an integrated, decentralized CIS that can facilitate effective collaboration between rural craft producers and other entities in the craft production system, thereby creating a virtual community of purpose.

NCoRe facilitates purposive knowledge exchange among diverse agents by bringing them in the same platform, thereby addressing knowledge asymmetry and market separation faced by rural artisans. Enhanced inter and intragroup communication enables rural artisans to establish their trade credentials through bypassing exploitative intermediaries or middlemen. The resultant mitigation of knowledge asymmetry, a derivative of enhanced scopes of collaboration through purposive community formation, not only improves rural artisans' economic prospects, but it also has a holistic impact in equipping the rural community with the credential to undertake informed decisions and purposeful choices.

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