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# **Affordances-Improvisation-Actualisation for ICT4D: An Implementation Study in Papua New Guinea Hospitals**

## **Research-in-progress**

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## **Abstract**

ICT for development (ICT4D) projects are implemented with the goodwill intention to address a wide range of societal issues specific to developing countries. However, due to various constraints, the outcomes of these projects are mixed. Therefore, how to effectively implement ICT4D projects remains an important question in the ICT4D research. This research-in-progress paper explores this question through a case study of ICT implementation in Papua New Guinea hospitals, using affordance theory as the theoretical lens. We unpack the affordance-actualisation process throughout the ICT implementation by identifying three affordances and their actualisation actions and outcomes. Moreover, we identify two improvisation activities, adaptive implementation and flexible adoption, which are critical during the affordance actualisation process. Our preliminary findings extend the theoretical understanding of affordance-actualisation theory in the ICT4D context and emphasise the importance of improvisation for successfully implementing ICT4D projects.

**Keywords** Affordance, Improvisation, Actualisation, ICT4D, case study

## 1 Introduction

Information and Communication Technology (ICT) has significantly bridged the gap between developed and developing countries (Walsham, 2017). The various ways ICT is used for development offer ample research opportunities for Information Systems (IS) researchers, falling under the ICT for Development (ICT4D) research domain. Despite its importance, many questions in this field still need to be answered (Walsham, 2017). For instance, ICT4D projects, whether initiated by external organisations or local communities, often face challenges in achieving their intended goals, such as limited financial donations and tension between people who benefit from the projects and those who do not (Ali & Bailur, 2007; Kumar & Best, 2006; Renken & Heeks, 2013).

In addition to addressing practical challenges, given the complexity of the contextual conditions and processes embedded in the ICT4D phenomenon, Information Systems (IS) researchers are called upon to develop mid-range theories to capture and analyse these complexities (Avgerou, 2017). It is imperative that these theories exhibit contextual applicability, facilitating a deeper understanding of the intricacies of developmental processes and providing potential contributions to the advancement of these regions. (Osei-Bryson et al., 2022). Sein et al. (2019) have identified three key perspectives within existing ICT4D theories: development theories, the role of ICT, and the transformative processes linking ICT and development. Notably, affordance theory has gained prominence in theorising the role of ICT in ICT4D. This prominence is attributed to its relational and technology-centric nature, which enables the analysis of the dynamic interactions between ICT and users (Sein et al., 2019). The affordance-actualization framework extends its focus beyond the potential actions made possible by ICT, encompassing actualised actions and their outcomes. Thus, it offers an appropriate theoretical lens for investigating our central research question:

*How can ICT be effectively implemented in developing countries to yield positive outcomes?*

To explore the answer, we conducted an in-depth case study of ICT implementation in Papua New Guinea (PNG) hospitals, a collaboration between a global non-profit organisation and the PNG Society for Emergency Medicine, aiming to improve continuous medicine education in the PNG emergency medicine community. Our analysis suggests that improvisation is crucial during the affordance actualisation process in the ICT4D context. We use the term improvisation to represent creative stakeholder activities using available resources to address urgent challenges within strict time constraints (Ciborra, 1999).

This paper is set out as follows. First, we review the ICT4D research and outline our theoretical perspective. Second, we narrate our case to provide relevant contextual information. Third, we present our preliminary findings and suggested framework. Finally, we elaborate on the remaining work and provide concluding remarks.

## 2 Literature Review

### 2.1 ICT4D Research

ICT4D research focuses on understanding how ICTs can benefit marginalised social groups and people living in less materially abundant regions (Walsham, 2017; Walsham & Sahay, 2006). This research concerns various societal challenges (Walsham, 2017), such as economic well-being (Duncombe, 2006), inequality (Heeks & Arun, 2010), and the dark side of ICTs (Tarafdar et al., 2015). It also aims to address the issue of the “digital divide” caused by the presence of ICTs, which is the discrepancy between people who can access and use ICTs effectively and who cannot (Walsham & Sahay, 2006).

The extant ICT4D research indicates that ICT-enabled developments have two main approaches: top-down technology transfer versus bottom-up community-driven development. The top-down approach emphasises the technology and knowledge diffusion from advanced economies to developing regions, with local adaptation (Avgerou, 2010). External actors such as NGOs, governments and global enterprises play a significant role in introducing ICTs and providing other resources (Leong et al., 2016). The second approach focuses on development driven by ICT use initiated by the local community, which can be more independent from external actors (Leong et al., 2015, 2016). Local community initiation promotes interconnectivity and engagement among various local actors, advancing infrastructure and ultimately transforming the economic landscape of the developing region (Leong et al., 2016). Both approaches acknowledge the critical role that ICTs play in cultivating growth and development.

In practice, the success of ICT4D projects depends on many factors throughout the ICT4D value chain. The ICT4D value chain refers to a sequential process of activities from chartering and implementation

to use and diffusion and to long-term development impact (Chipidza & Leidner, 2019; Heeks & Molla, 2009). However, ICT4D projects are not guaranteed to succeed. They often face project failures and sustainability issues (Ali & Bailur, 2007; Renken & Heeks, 2013) for various reasons, such as complex social and cultural conditions (Avgerou, 2010) and stakeholders' poor performance (Renken & Heeks, 2013; Thomas et al., 2022). The gap between the goal of ICT4D and reality prevails and needs to be addressed. We aim to unpack the activities throughout the ICT4D value chain to identify the underlying mechanisms of successful ICT4D projects.

## 2.2 Theoretical Background: Affordance Theory

Affordance theory originated from Gibson's theory (1977) in ecological psychology. It has been widely used in IS research due to its explanatory power for complex issues of IS/IT use (Volkoff & Strong, 2017). After debate around the original definition, scholars have reached a shared view of affordance as the relationship between animals and their surrounding environment, which affords animals action possibilities to fulfil their goals (Chemero, 2003; Volkoff & Strong, 2017). This relational perspective has become dominant in the IS field such that technology affordance is not the property of technology but instead the action potential "arising from the relation between an artefact and a goal-oriented actor" (Strong et al., 2014, p69).

One mid-range theory developed from affordance theory is the Affordance-Actualisation (AA) framework proposed by Volkoff and Strong (2014). It extends affordance theory by introducing the actualisation phase, which captures the realisation of affordances by "actions" and "actualised immediate concrete outcomes". This framework has been well applied and further extended in various contexts. For example, Du et al. (2019) introduced an experimentation phase before actualisation when they studied blockchain implementation within a large organisation, thereby extending the AA framework.

Affordance theory and the AA framework have started to receive attention in ICT4D research, given its natural emphasis on ICT use, which can help IS researchers better understand ICT's role in addressing development issues (Sein et al., 2019; Thapa & Hatakka, 2017). The process of affordance actualisation has been explicated by Thapa and Sein (2018) through a case study of telemedicine in Nepal. They proposed a concept, "trajectory of affordances", which illustrates how affordances can transfer from the actors' perception to realised outcomes via different paths. The concept points out a distinct aspect of affordances in technology design – that the designers' considerations are embedded in the affordances of the technological artefact. For affordances to be useful, they must be perceived by users (Faraj & Azad, 2012). Therefore, the actualisation journey of affordances indicates that if the affordances designed within and offered by the ICT cannot be perceived and acted upon, intended use and adoption would not occur, directly impacting the success of ICT4D projects. Moreover, the design and implementation processes should also be informed by how people perceive and actualise the affordances (Thapa & Hatakka, 2017).

However, there is still a lack of theoretical understanding about what enables the process of affordance actualisation in the ICT4D context. Thus, this paper aims to contribute to this gap by introducing improvisation into the framework based on our preliminary findings from a case study in PNG hospitals.

## 3 Methodology

We conducted an in-depth qualitative case study to examine our research question, a "how" question that is explorative in nature (Pan & Tan, 2011; Siggelkow, 2007; Walsham, 1995, 2006). In ICT4D research, case study methodology is commonly adopted to capture rich context factors (Leong et al., 2016; Walsham & Sahay, 2006). We adopt an interpretive approach, which allows us to use affordance theory as a theoretical lens to understand the case, analyse the data, and organise the emergent findings "within its social and historical context" (Klein & Myers, 1999; Pan & Tan, 2011).

### 3.1 Case Setting

Continuing Medical Education (CME) is an established practice to empower medical workers with the ability to "respond to the evolving healthcare environment" in developed countries (ACCME, 2023; Li et al., 2020). However, it has not been widely adopted in developing countries due to various constraints. These constraints include factors such as no incentives from national bodies and a lack of technological support and infrastructure (Li et al., 2020).

As one of the most rural countries in Oceania, PNG has faced various challenges in its healthcare systems (United Nations in Papua New Guinea, 2022). In emergency medicine, there is a high demand for

specific treatments because PNG is an island nation with a tropical climate, distinctive culture, and frequent violence and crime (United Nations in Papua New Guinea, 2022). Nevertheless, according to our collected data, PNG faces significant constraints in its medical resources, including limited hospital beds and a notably low ratio of doctors to patients. This low ratio is represented by doctors and other health workers needing to see 35 to 50 patients a day, and if there is an outbreak, they may need to see over 100 patients per day. This high demand leads to very limited time for healthcare practitioners to regularly update their knowledge via training programs. Moreover, most of the PNG population resides in rural areas with poor networks, transportation, and infrastructure. Therefore, the emergency medicine staff serving this population must face the issues of geographical barriers to travel and a lack of internet access, which makes it challenging for them to commit to CME.

Initiated by the PNG Society for Emergency Medicine, PNG started collaborating with a global not-for-profit organisation, Tech-for-good (pseudonym), to introduce CME on a large scale and improve its healthcare conditions through ICT. Tech-for-good's vision is to design and implement ICTs in countries with difficulties providing CME. It has successfully provided ICT solutions for CME in various under-developed countries, from Nepal to Uganda. The organisation designed a set of ICT solutions catered specifically for rural, low-resourced, and poor internet connectivity settings, such as in countries like PNG. The CME content can be delivered on USB drives and Raspberry Pis and viewed via computers and mobile apps. The PNG project began in early 2022 and finished its second round of implementation in September 2022. As requested by the PNG Society for Emergency Medicine, Raspberry Pis were implemented around the hospital emergency rooms in 16 hospitals, covering multiple provinces in PNG.

### 3.2 Data Collection and Analysis

Our primary data are interviews and archival data. We conducted 25 semi-structured interviews with the ICT implementation team and emergency medicine practitioners from multiple PNG hospitals. Our archival data included reports, travel itineraries of the implementation team, and Tech-for-good's social media data. Using Affordance-Actualisation as the theoretical lens, data analysis started after the initial interviews, and we evolved our theoretical framing as more data was collected and analysed to ensure alignment among theory, data, and the proposed framework (Pan & Tan, 2011). Although there is still more data to be collected for model validation, we propose a preliminary Affordance-Improvisation-Actualisation framework based on our existing data.

## 4 Preliminary Findings

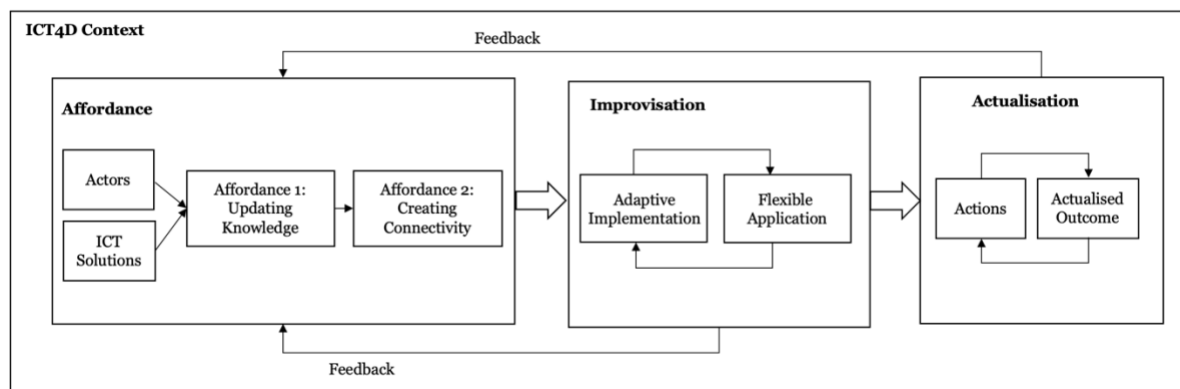


Figure 1: Summary of the Affordance-Improvisation-Actualisation Framework

### 4.1 Affordances

The PNG Emergency Medicine community includes emergency medicine doctors, paediatricians, nurses and health extension officers. Despite different expertise, they share the same ultimate goal: saving patients' lives and providing emergency care for better health outcomes in PNG. The implemented ICTs afford multiple action potentials for them. We present and discuss two highest-level affordances.

#### 4.1.1 Affordance 1: Updating Knowledge

The ICT solutions allow the PNG Emergency Medicine community to update their medical knowledge on a regular basis. In PNG, internet access is difficult, even within hospitals. The CME Pis, reconfigured by Tech-for-good, serve as mini-Wi-Fis that allow medical workers access to medical knowledge updates

developed by professional medical content providers in developed countries without subscription fees. They can download monthly updates of PDF and audio files through the app onto their mobile phones and study in their free time. According to Dr Gary, the president of the PNG Society for Emergency Medicine:

CME for people to get up-to-date resources is one of those innovations that will drive continual learning, up-to-date upskilling, and the thirst for progression, which is what we want.

Moreover, the ICT solutions can also moderate the geographical challenges for CME training. Dr Karl, an emergency physician and the lead of the CME program in PNG, pointed out:

It provides a device that can transmit CME activities to those areas of the countries with doctors with limited resources and serving the majority of the population.

Additionally, the CEM mobile app has a search function which serves as a database for medical practitioners to reference and validate treatment methods. Because the number of specialised medical professionals is limited in PNG, this function is especially valuable for other healthcare workers in emergency departments. In emergencies, immediate response to patients with specific injuries is essential. According to a paediatrician in the emergency department:

Doctors are on call. We only come when we are needed. But for the people who are there, [to see] the first arrival of the patient, it would really give them a good hands-on tool for them to, at least, address the initial issues that the patient is coming in with.

With the search function, nurses and other health workers can search for initial treatment methods and evaluate injuries more accurately before doctors arrive. Doctors can also validate their decisions with the established practices documented on the database. Throughout the process, the PNG Emergency Medicine community can update and consolidate their medical knowledge with practices.

Finally, the ICT solutions not only afford the PNG Emergency Medicine community the ability to learn from Western medical practices, but they also provide a channel for the accumulation of medical knowledge that is more relevant in a local context. It is enabled by the “local folder” function, which allows the local community to upload and share their locally developed content across PNG. It fosters their own development regarding locally prevailing diseases and injuries.

#### **4.1.2 Affordance 2: Creating Connectivity**

Lack of internet and transportation infrastructure impedes health workers' continual education and causes psychological isolation and disconnection. To serve 80% of the PNG population living in rural areas, many medicine practitioners must work in isolation. With bad transportation and poor internet infrastructure, they have to fight against psychological loneliness. Dr Gary was concerned about the mental isolation faced by many of the medical workers:

We really don't want physicians to be isolated in an area without assistants...He is not in an area with a network, not an area with communicating...And then they feel disconnected and dis-franchised from the rest of the emergency medicine community.

The ICT solutions could alleviate the isolation by offering a bridge to the emergency medicine practices conducted in the Western world and uniting the local community through shared knowledge and guidelines with a sense of connectivity.

The local folder function also contributes to establishing connectivity within the PNG Emergency Medicine community. The society can upload and share the national treatment guidelines across geographical boundaries, promoting the standardisation of treatment practices. Moreover, it allows different hospitals to share their locally generated content, which strengthens the connections and engagement among the PNG Emergency Medicine community.

Overall, the ICT solutions afford enhanced connectivity of the PNG Emergency Medicine community with the Western medical world and cultivate a sense of connection among emergency medicine practitioners within the community.

These two highest-level affordances capture two critical aspects. The first affordance, updating knowledge, reflects the primary purpose of the CME: education and upskilling. The second affordance, “creating connectivity,” is unique to the ICT4D context. Given the limited internet access and poor infrastructure conditions, the ICT solutions offered the action potential for the PNG Emergency Medicine community to stay connected across their facilities and even connect to Western medical

progress. The trajectory of affordances in this context is that “updating knowledge” is the basis for the emergence of the “creating connectivity” (Thapa & Sein, 2018).

## 4.2 Improvisation

Improvisation refers to actions in which actors solve problems by thinking and acting simultaneously or within a very short period in specific situations (Ciborra, 1999). In the context of ICT4D, we have identified that improvisational activities are critical precedents to affordance actualisation, representing the actions taken by actors to achieve their goals with tangible outcomes. We will unpack these improvisational activities in this section.

### 4.2.1 Adaptive Implementation

The Tech-for-good team had extensive implementation experience in developing countries and conducted detailed pre-departure planning with the PNG Society for Emergency Medicine. However, they still faced unexpected challenges during the rollout, such as airport closure, no internet access, and devices not working. Adapting to solve unexpected challenges in a new environment is key to their success in setting up the devices and enabling the local emergency medicine community.

One example is the Pi configurations. Before departure, the implementation team was informed that hospitals were equipped with WiFi, so they configured the Pis that work within a WiFi-enabled environment. However, they realised the hospitals were not equipped with well-functioning WIFI in PNG, so they had to re-configure the devices. For the re-configuration, the Pis needed to be connected to internet cables to re-download the materials, which were very difficult to find in PNG on short notice. Given the available resources in their environment, the implementation team decided to connect the devices through TV cables. One of the volunteers from the implementation team summarised the nature of the activities of adaptive implementation:

Thinking out of the box at the moment and trying to come up with a solution.

Another challenge during the rollouts was that even though the ICT solutions were designed to work in low settings, the Android phones still had trouble joining the network due to the variety of older versions of Android systems. Instead of giving in, the implementation team contacted the technical team immediately to troubleshoot the problem and find solutions. Their workaround was to avoid competing networks in the setting by turning these Android phones to aeroplane mode. The experience also informed the design and update of the ICT solutions and future training for implementation. Another implementation lead reflected on their mentality on their adaptive implementation activities:

If you ask about all these hectic issues, can we plan for it? We never plan for it. But when it happens, it will happen. (On) every trip, similar things happen. What do we do? We learn how to deal with it. We just know whenever it happens, we will figure it out. One way or another.

In summary, adaptive implementation refers to the improvisational activities that occur during the process of introducing ICT solutions to developing regions, with the aim of adapting them to the local environment. The implementation team must carefully observe their surroundings and possess the mental determination to swiftly address unforeseen challenges by thinking and acting promptly while utilising all available resources.

### 4.2.2 Flexible Application

Flexible application is crucial in improvisational activities to optimise ICT4D project outcomes, particularly when technology and knowledge are transferred from developed countries. The ability to adapt the knowledge from ICT solutions to address local challenges in resource-constrained settings is critical. Take the PNG emergency medicine community as an example: They can learn from Western medical cases but often lack access to the necessary equipment and diagnostic tests. To effectively apply new knowledge, they must assess their available resources and adapt medical advancements to their unique situations. As one medical doctor at Kaveing Provincial Hospital explained,

We apply it only if it's applicable to our situation...the doctor practices it according to his setting, the drugs available, the treatment that is available, the diagnostic tests available, and then makes a judgment.

Therefore, flexible application serves as a critical precedent to affordance actualisation in the ICT4D context. Resource constraints in developing regions like PNG significantly limit people's actions, particularly in rural areas where unavailable equipment and tests make it challenging for the PNG Emergency Medicine community to fully utilise CME-delivered content. Without the ability to flexibly

apply this knowledge to their context, merely learning from Western settings won't empower them to address their daily challenges. Consequently, the potential afforded by ICTs cannot be realised as intended. We define flexible application as the improvisational activities wherein actors employ ICTs in a flexible and spontaneous manner, utilising a bottom-up approach within the local community to overcome challenges related to technology transfer and knowledge applicability posed by limited local resources.

### 4.3 Actualisation

Actualisation is captured via actions to realise the affordances and their outcomes. After improvisation, we have found two sets of actions and outcomes corresponding to the identified affordances.

Firstly, the emergency medicine community updates their knowledge using ICT solutions, which cultivates the CME culture in PNG. Specialists learn from advanced treatment practices. Nurses and health workers expand their knowledge, too. As pointed out by the health extension officer at Kimbe General Hospital:

[For] some of us, we don't do long-term medical training, but we keep adding. Others just come out new. They need a lot of experience and then keep up with the ongoing medical use.

Secondly, regardless of geographical distances, the ICT solutions establish connectivity among the emergency medicine community in PNG and further link them to the medical advancement in other parts of the world, such that the emergency medicine community in PNG has a glance at what the world is doing. Dr Gary further illustrates that in the long term, this connectivity can translate to the innovation of medicine practices and the standardisation of emergency medicine practice on a national level:

That's better engagement between us nationally and local facilities and emergency care providers. Because we are providing resources that they can use, and they feel engaged with us... then we are speaking the same language. We all speak the same treatment guidelines.

## 5 Discussion

Using affordance theory as the theoretical lens, our research-in-progress paper explores how improvisation enables effective implementation in the ICT4D context through a case study in PNG hospitals. Our preliminary findings unpack the affordance-actualisation process of the ICT implementation and extend the existing framework by highlighting the significance of embedding improvisation into the process. We aim to contribute to the theoretical development of ICT4D research and to offer insights for the effective implementation of ICT4D projects. For the next steps, we plan to collect additional data to cover more aspects of ICT4D projects, including the design process and further develop our theoretical framework.

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