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Implementing ICTs in Indonesia's Small-Scale Fisheries

Identifying Common Implementation Challenges and the Development Paradigms that Shape Them

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Communication for Development
One-year master
15 Credits
Submission: Autumn 2017/2018 [March 18, 2018]
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Acronyms and Abbreviations

IUU	Illegal, unreported and unregulated [fishing]
FAO	[United Nations] Food and Agriculture Organization
GDP	Gross domestic product
ICT	Information and communication technology
ICT4D	Information and Communications Technology for Development
C4D	Communication for Development
MDPI	Masyarakat dan Perikanan

Abstract

Indonesia is home to some of the world's most productive fisheries, with Indonesia's small-scale fishermen responsible for the majority of production. Despite their contributions to global and national food stocks they remain amongst the poorest segments of the population and are most impacted by the sector's various economic, environmental and political challenges. International aid agencies and non-governmental organizations have sought to address these challenges through a number of development cooperation solutions over recent decades. Over this period, changing development paradigms have shaped donor's definitions of development, their objectives and the approaches taken—including increasing use of information and communications technologies (ICTs) in program designs.Now, more than four decades after ICTs' first applications in development, this paper seeks to examine how ICTs have been used to further Indonesian small-scale fishery development, how these approaches have been shaped by development objectives and beliefs set forth by prominent paradigms, and the common challenges that have resulted.

To conduct this research, extensive desk-based research was first conducted to understand the priority fisheries challenges that initiatives have sought to address, followed by research on developmental paradigms and ICTs roles within. Empirical research was conducted to develop a case study on mFish, a development program which serves as the basis for analysis of trends in development implementation. Additional interviews, surveys, and in-field observations were also conducted to contextualize the case study within the experiences of other development cooperation solutions.

Findings revealed a common set of challenges encountered during ICT implementation that are can be linked to previous development paradigms and their academic criticisms. These included insufficient engagement of end-users and a lack of understanding of truly participatory design, disconnects between design and on-the-ground realities, and a lack of emphasis on technology sustainability and donor integration. As a result of understanding these challenges and the beliefs that have perpetuated them, recommendations have been developed for more user-centered development approaches that acknowledge and move beyond part limitations.

1. Introduction

Indonesia's fisheries are among some of the most vital to global food stocks, marine biodiversity and human well-being. Their economic, ecological and social impacts spread far beyond the coastal communities where they reside, contributing significantly to Indonesia's gross domestic product (GDP) values and global protein supplies. Despite the size and number of industrial fishing operations, it is Indonesia's small-scale fisheries that contribute the greatest volume of seafood products to national and global markets. Although they are the backbone of Indonesia's fisheries sector, Indonesia's small-scale fisheries are impacted the most by modern fisheries challenges that include dwindling fish stocks, limited access to resources, and illegal and destructive fishing activities that include human welfare abuses. These challenges are perpetuated by a number environmental, economic and political factors, including rapidly increasing consumer demand, climate change, inadequate government regulation and enforcement, and limited engagement with sustainable fisheries management.

In response to these challenges, international donors have targeted aid at Indonesia's small-scale fisheries in a range of development cooperation solutions and approaches ranging from human development and capabilities approaches to marine resource management and income generation. Despite this engagement, the fisheries sector remains a recipient of and target for international aid. Small-scale fisherfolk incomes remain below the poverty line, fish stocks have been seen to significantly decline, and illegal fishing is now estimated to cost Indonesia up over twenty million U.S. dollars each year.[1]

As technology rapidly advances and connectivity continues to grow, particularly in Indonesia, development practitioners have sought to leverage these advances to further development objectives. This practice, referred to as Information and Communications Technology for Development (ICT4D), leverages information and

[1] Fisheries and Aquaculture." *EIBN Sector Reports*, German Foreign Chambers of Commerce (AHKs), 2017, http://indonesien.ahk.de/fileadmin/ahk_indonesien/Publications/EIBN/Fisheries_and_Aquaculture_Sector_Report_2017_FULL.pdf.

communications technologies (ICTs)—that is any device or system that enables storage, capture, transfer or transmission of digital information—toward social, economic or political development. In particular, international donors and non-governmental organizations (NGOs) have looked to mobile phones to address the challenges faced by Indonesian fisheries, including initiatives to use mobile technology to create additional sources of income, provide real-time information and data to increase productivity, and empower fisherfolk to engage in more sustainable fisheries monitoring and management.

While there is a wealth of information and research available on global applications of ICTs in development cooperation solutions, there exists very little research on their application in Indonesia's fisheries, demonstrated best practices, and guidance on proven tools and methodologies. As a development professional engaged in an ICT-driven development program, I was motivated to conduct this research to examine if challenges encountered in my program's work were unique or if many development cooperation solutions encounter similar roadblocks—and if so, how programs can be better designed and implemented to achieve greater and more efficient success.

To explore this and provide a structure for analysis, this study first presents an overview of prominent discourses on the evolution of ICTs in development to better understand how greater factors, such as development paradigms have impacted how and why ICTs are applied in development solutions. At its core, this research project seeks to identify the common challenges face in implementing information and communication technologies for development in Indonesia's small-scale fisheries, and how these challenges are related to institutional development paradigms.

To address this core question, several sub-questions were developed and informed project research design. These included:

- What are the priority challenges that development cooperation solutions need to address in Indonesia's small-scale fisheries, and how have these challenges been addressed by contemporary development programs?

- What are the common challenges that development programs face in implementing ICTs in this environment, and what are the reported best practices?
- How do these challenges relate to past and present development paradigms and discourse on ICT-driven approaches?
- What are the priority areas for improvement, and how can these be addressed for more efficient development interventions?

The research design for this study is comprised of extensive reviews of existing literature and desk-based research studies combined with empirical research to explore on-the-ground realities and recent initiatives. Secondary, desk-based research was conducted as a foundation to establish the global significance of Indonesia's small-scale fisheries, their challenges, and the history of development-driven ICT applications in this sector. Additional desk-research was then conducted to develop a theoretical framework for understanding how shifts in development paradigms have shaped how ICTs have been applied in development solutions and to explore the prominent development discourses on ICT4D.

Upon this foundation of secondary research, empirical studies were designed to analyze ICT applications in support of the study's core and supporting research questions. These consisted of the selection of a recent ICT-driven development initiative, mFish, and case study development; key informant interviews with experienced development, industry, and non-profit fisheries organization professionals engaged with multiple ICT-driven development programs in Indonesia's fisheries; a research survey amongst Indonesia-based development program implementers; and an observational field study tour to gain insights into current uses of technology.

Analysis of mFish, combined with anecdotal findings from other development initiatives indicated that as development paradigms have shifted over the more than four decades that ICTs have been implemented in development settings, they have influenced how ICTs are developed and implemented among target users.

Four primary challenges were observed across the programs that included, limited stakeholder engagement in early phases of design and development, common disconnects between technology solutions and on-the-ground realties, limited opportunities for program continuity and continued learning amongst implementers, and calls for more integrated, multi-disciplinary approaches by practitioners.

2. Literature Review

Indonesia is the second largest producer of wild-capture seafood in the world, however, its fisheries are among some of the world's most challenged by illegal, unreported and unregulated fishing and otherwise destructive fishing behaviors that prevent sustainable and ethical development.[2] Indonesia's fisheries are a major producer of seafood products that support global food stocks and are located in one of the most valuable marine ecosystems. As an economy that supports the livelihoods of millions, Indonesia's fisheries—particularly small-scale—have been a major focus of international development programs that aim to maintain production, increase sustainability, and provide increased opportunities for better livelihoods to those who support it. This section presents secondary, desk-based research that was conducted to establish and understand the significance of both Indonesia's broad and small-scale fishing sectors, their challenges, and the development approaches that have been adopted to address them.

2.1 Indonesia's Fisheries

Indonesia's waters contain some of the richest concentrations of marine biodiversity in the world and approximately 37% of the world's total fish species, many of which have significant economic demand. Indonesia's fisheries sector is a significant contributor to the national economy, with steady growth each year from 2010 to 2014 and thereafter. While Indonesia's national GDP experienced slow growth in 2015, compared to that of 2014, fisheries' gross domestic product (GDP)

[2] "Fisheries and Aquaculture." *EIBN Sector Reports*.

nearly doubled over the same period. The total volume of fisheries products exports has also increased, in turn increasing demand in Indonesia's fish stocks and fishing operations.[3] With the increased demand, so too have fishing efforts and environmental stressors increased, resulting in higher fishing activity with diminishing returns.

As well as being a critical component of the national and global economy, Indonesia's fishing sector is also a major source of employment. As of 2013, the sector employed over twelve million people throughout the seafood supply chain, from catch to processing. Of this, approximately 2.6 million people were employed directly as wild-capture fishermen.[4]

Indonesia's fisheries can be classified into two basic categories: wild-capture fisheries (i.e., fish caught in open water); and aquaculture (i.e., farmed fish). In 2014, wild-capture fisheries produced over 420 tons of seafood, while aquaculture produced six million tons.[5] With seventy percent of Indonesia surrounded by water, it is not surprising that Indonesia's wild-capture fisheries are the primary source of seafood products—including but not limited to snappers, groupers, tunas, shrimp and squid—and are also the main source of livelihood opportunities for those living along the coastline. [6] Within wild-capture fisheries, production can be classified into three main groups: small, medium and large scale—typically determined by vessel size. The majority of Indonesia's fishing fleet is comprised of small-scale vessels that are less than five gross tons and operate within four nautical miles of the coast. [7]

2.1.1 Small-Scale Fisheries

Indonesia's small-scale fisheries produce the majority of the nation's seafood. An estimated 7.9 million Indonesian fisherman are engaged in small-scale fishing

[3] "Fisheries and Aquaculture." *EIBN Sector Reports*.
[4] Stobutzki, Ilona, Mary Stephan and Kasla Mazur. "Overview of Indonesia's Capture Fisheries, 2013." The Australian Centre for International Agricultural Research, February 2014, http://aciar.gov.au/files/app5_indonesian_capture_fisheries.pdf.
[5] Fisheries and Aquaculture." *EIBN Sector Reports*.
[6] Ibid.
[7] Stobutzki, Ilona, Mary Stephan and Kasla Mazur. "Overview of Indonesia's Capture Fisheries, 2013."

activities and produce up to 92 percent of the sector's output.[8] However, despite the sector's reliance on small-scale fisheries, it is these fisherfolk that continue to face poverty and limited access to resources and opportunities for advancement.

The average small-scale fisherman is approximately 45 years old, has an elementary school education and an average family size of five. Thus, on average each fisherman provides for five people as the wives of fisherman normally are not employed themselves or perform unpaid fisheries work, such as preparing for fishing voyages, processing or selling catch.[9]

Small-scale fishers conduct shorter, more frequent trips than medium and large-scale vessels that operate further from shore and typically remain at sea for long stretches at a time.[10] Small-scale fishermen may not travel as far or as long, but their daily work consists of labor-intensive preparations, and result in smaller catch amounts with less income return and limited access to financing for supplies.

While commonly regarded as a sector dominated by men, in reality the majority of coastal inhabitants—both male and female—look to small-scale fisheries for their main source of income and livelihood. Indonesia's fisheries adhere strictly to established gender norms. Men conduct the fishing and manual labor, including unloading and transporting catch, and women performing preparatory work such as procuring supplies for fishing trips, processing, and transactional trading activities. These gender roles are one example of the traditional nature of small-scale fisheries, which proscribe to a set of cultural values and norms that have been practiced for many years. [11]

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[8] "Soejachmoen, Moekti P. "Improving Financial Inclusion in Indonesia's Fisheries Sector." *The Jakarta Post,* May 3, 2017. https://www.pressreader.com/indonesia/the-jakarta-post/20170503/281977492522632

[9] Puspitasari Sudarmo, Agnes, Mulyono S. Baskoro, Budy Wiryawan, Eko Sri Wiyono, Daniel R. Monintja. "Social Economics Characteristics of Coastal Small-Scale Fisheries in Tegal City, Indonesia." *International Journal of Scientific and Technology Research Volume 4, Issue 1,* January 2015, Page 86.

[10] Stobutzki, Ilona, Mary Stephan and Kasla Mazur. "Overview of Indonesia's Capture Fisheries, 2013."

[11] McGoodwin, James R. Understanding the Cultures of Fishing Communities: A Key to Fisheries Management and Food Security, FAO, 2001, http://www.fao.org/docrep/004/Y1290E/y1290e00.htm.

2.1.2 Challenges of Small-Scale Fisheries Addressed in Development Cooperation Solutions

As illustrated, Indonesia's small-scale fisherfolk are the backbone of Indonesia's fisheries sector, yet they are faced with many socioeconomic challenges that result from the sector's historic demands for hard physical work with limited economic return. This fundamental challenge is exacerbated by a host of regulatory, economic and environmental stressors that further threaten the country's fisheries, those that support them, and which many development programs have sought to address. The Food and Agriculture Organization of the United Nations (FAO) summarizes these challenges to include:

> *…overfishing in both marine and inland fisheries waters; low income and standard of living for fishers and fish farmers; lack of financial support in terms of credit schemes; weak fisheries management, particularly concerning monitoring, surveillance and enforcement… [and] illegal, unreported and unregulated (IUU) fishing.*[12]

These sector-wide challenges are acutely felt by small-scale fishers who are often fishing independently or as suppliers to larger fishing operations who consolidate catch from multiple sources, and are particularly impacted by inefficient business operations with low business productivity, influences of environmental factors, and challenges related to poverty. Although there are a significant number of fishermen that report incomes above the minimum wage, the majority of small-scale fishermen fall below the poverty line. Over 29% of fishermen consume less than 380 kilograms of rice per year, which is under the standard of 480 kilograms that signals adequate sustenance. [13] Fishermen below the poverty line spend their income from fishing fulfilling the basic needs of their family according to Maslow's hierarchy—prioritizing food, housing, and health—and leaving little to invest in enhancing skills, business resources, or environmental protection. [14]

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[12] "Fishery and Aquaculture Profiles: The Republic of Indonesia." *Fisheries and Aquaculture Department,* FAO, http://www.fao.org/fishery/facp/IDN/en.

[13] Mochtar, Zulficar. "Small Scale Fisheries in Indonesia." FishCrime, 2016. http://fishcrime.com/wp-content/uploads/2016/10/Presentation_Zulficar-Mochtar.pdf

[14] Soejachmoen, Moekti P. "Improving Financial Inclusion in Indonesia's Fisheries Sector."

Small-scale fishermen's limited resources often compound as they lack the capital to fund their basic fishing and operational needs, forcing them to take out loans to continue their fishing activities. Access to capital from formal banking institutions is extremely limited, and for most, financial needs are provided by informal financial institutions or by the brokers that buy the fishers' catch. While these loans have less administrative requirements, loans often come at the cost of high interest rates that leave many fishermen in mounding cycles of debt.[15] The effects of limited income and resources greatly impact fishers' abilities to engage in community activities, including fisheries management activities. Thus, awareness and engagement in fisheries management and sustainability activities continue to be further challenged.[16]

Although small-scale fishermen and their families rely on fishing income as their sole source of income, there are many informational and educational gaps that exist because of lack of formal training, pervasive traditional customs, and limited access to information. Inefficiencies may result from a lack of information, or may be ingrained in the fishermen's daily operations as a product of habit and tradition. A report developed by FAO explored the traditional values and practices among small-scale fisheries and noted,

> *The Indonesian fishermen generally perform their catching activities based on their experience or ancestral traditions, resulting in less efficient fishing operations. To perform efficient catching operations requires precise information including fishing seasons…[Indonesian] fishermen always pay attention to the weather and related factors associated with the presence of fish in one location and particular depth of the waters; however, most of them still perform the catching activities based on their experience and tradition of their predecessors.*[17]

This lack of consistent access to and use of information and current fisheries knowledge can have a variety of impacts. Limited access to weather information or fish stock data, for example, prevents fishermen from being able to proactively plan

[15] Soejachmoen, Moekti P. "Improving Financial Inclusion in Indonesia's Fisheries Sector."

[16] Puspitasari Sudarmo, Agnes, Mulyono S. Baskoro, Budy Wiryawan, Eko Sri Wiyono, Daniel R. Monintja. "Social Economics Characteristics of Coastal Small-Scale Fisheries in Tegal City, Indonesia." Page 86.

[17] McGoodwin, James R. Understanding the Cultures of Fishing Communities: A Key to Fisheries Management and Food Security.

trips and creates an informational divide between small-scale fishermen and large-scale operations with more financial and technological resources.

In addition, small-scale fishermen are increasingly faced with dwindling fish stocks and damaged marine ecosystems resulting from lacking regulation and enforcement. Although Indonesia's fisheries are some of the largest and most productive in the world, they have also historically been some of the least regulated. Illegal, unreported and unregulated (IUU) fishing practices, largely carried out by foreign, large-scale vessels in Indonesian waters, challenge fisheries and have become a major concern of many national governments and fisheries agencies throughout the region. IUU fishing includes fishing activities that violate national laws, use restricted and damaging fishing gears, or improperly report catch, among other destructive practices. Although it is impossible to estimate the impacts of IUU fishing due to its illicit nature, it is estimated that Indonesia has economic losses of twenty million U.S. Dollars each year,[18] not including its serious consequences to marine habitats, fish stocks, intergovernmental relations, and human welfare. These destructive practices are perpetuated by increased seafood demand with decreasing marine resources, cost-competitive demand for low-cost seafood, and lacking regulatory and enforcement structures. IUU fishing has severely impacted small-scale fishers, as it has greatly reduced fish stocks and also contributes to lower price points given its reduced operational costs and ability to undercut market prices. The Indonesian government attributes the drop in Indonesian fishing households from 1.6 million to 800,000 between 2003 and 2013 to IUU fishing.[19]

The Indonesian government's efforts to address these challenges can be most concisely summarized by pointing to the government's National Long-Term Development Plan— a twenty year plan that is divided into four, five-year Mid-Term Development Plans. The plans' priorities are underpinned by Indonesia's constitution which mandates that natural resources be managed 'for the greatest

[18] Fisheries and Aquaculture." *EIBN Sector Reports*.

[19] "IUU Fishing in Indonesia, Are ASEAN Member States Responsible For?" *International Journal of Business, Economics and Law, Vol. 11, Issue 4,* December 2016. Page 78. http://ijbel.com/wp-content/uploads/2017/01/LAW-146.pdf

prosperity of the people.' As such, the National Mid-Term Priority Framework (2010-2014) priorities include: enhanced community development and empowerment through programs for small-scale fishers, development of mitigation and adaptation strategies for climate change, improvement of the quality and profitability of fish products for small-scale fishers, improvement of fishery-related infrastructure, strengthened monitoring and control surveillance systems to improve management and combat IUU fishing and strengthening human resource capacity.[20]

In addition, any paper on Indonesia's fisheries would be remiss to omit mention of Indonesia's recent and aggressive fisheries reforms under current the current Minister of Marine Affairs and Fisheries, Susi Pudjiastuti. In 2014, Minister Susi announced a moratorium on foreign fishing vessels in Indonesian waters which led to over 175 vessels being destroyed.[21] While there is no established research on the effects of the moratorium on small-scale fishers, research conducted by development programs has found mixed remarks from small-scale fishers on its impact, with some noting that the moratorium increased their fishing productivity as fish stocks rebounded with less large-scale fishing by international vessels; and others reported declining incomes as many work aboard foreign-owned fishing vessels that were not able to operate.

Regardless, the moratorium—and many other regulatory-based government initiatives—have lacked a holistic approach that address the combined economic, environmental, and human-welfare fisheries challenges. Many international donors and NGOs seek too to address these challenges, adopting development approaches that often seek to address one, or a combination of, these spheres.

[20] "Fishery and Aquaculture Profiles: The Republic of Indonesia." *Fisheries and Aquaculture Department,* FAO.

[21] Fisheries and Aquaculture." *EIBN Sector Reports*.

2.2 Development Approaches to Address Small-Scale Fisheries Challenges

For more than four decades, international donors and NGOs have extended aid to Indonesia through development cooperation solutions that largely began after the expansion of international aid to the nation in the 1970s when Indonesia's second president, General Suharto, was inaugurated and aimed to improve Indonesia's economy and attract foreign investors.[22] Foreign aid pulled back around international protests in 1991, but has generally been a steady contribution to Indonesia's economic development and transition into a middle income status.

As government regulations have largely aimed to maximize fishery resources for the greatest economic benefit and prosperity, so too have many development cooperation solutions sought to establish a sustainable, maximum yield for fisheries to protect marine resources and enhance the livelihoods of those that depend on them. As stated in a 2010 peer-reviewed journal article in *Development Policy Review,* "[t]he dominant view in academic and policy arenas is increasingly one that the major contribution of capture fisheries to development should be derived from the capacity of society to maximize the economic rent of fishery resources."[23] Development approaches in the nation's fisheries reflect this, with the overwhelming majority of documented development cooperation results focused on biodiversity management which aim to protect marine resources while establishing and maximizing their maximum sustainable yields.

Many academic and development organizations also recognize small-scale fisheries for their socioeconomic development potential. The earlier referenced journal article also points out that, "it is also widely recognised that small-scale fisheries – if well-managed – can play a significant role in human and socio-economic development. Although Indonesia's gross national income per capita is US $2,611, more than 120 million Indonesians (over half of the population) live on

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[23] Christophe Bene, Bjorn Hersoug and Edward H. Allison. "Not by Rent Alone: Analysing the Pro-Poor Functions of Small-Scale Fisheries in Developing Countries." Development Policy Review, 2010. Page 325. http://onlinelibrary.wiley.com.proxy.mah.se/doi/10.1111/j.1467-7679.2010.00486.x/epdf

less than two U.S. dollars a day—thus, education, health, economic development and environmental concerns have remained a top priority for international aid.[24] Many see fisheries as an entry point for poverty reduction through their role in generating revenues and creating employment, and their contribution to food security and the Millennium Development Goals." [25] And, FAO states that, "… small-scale fisheries can generate significant profits, prove resilient to shocks and crises, and make meaningful contributions to food security and poverty alleviation."[26] Many development programs have focused, too, on this aspect of fisheries development and have utilized human development and capabilities approaches to more directly address and relieve socioeconomic challenges experienced by fisherfolk.

However, aid to fisheries and the approaches adopted have recently shown to be in flux. A recently released report by the University of British Columbia and the Stockholm Resilience Center shows that aid to fisheries in developing countries dropped more than 30% 2010 to 2015, while official development assistance increased by 13%.[27] Other environmental aid areas such as forestry and agriculture also experienced increased aid, while fisheries aid dropped to only $166 million out of $134 billion total. A co-author of this study theorized that these drops in funding may be because aid is being, "…directed toward problems such as political instability, poor infrastructure or other more urgent threats. Another reason may be that…ODA money which does help solve fisheries issues – such as better fish monitoring equipment – gets labeled in other categories, such as "technology."[28]

[24] "Indonesia's Top 10 Donors: Responding to the Promise of Transformation." *DEVEX,* 2012. https://www.devex.com/news/indonesia-s-top-10-donors-responding-to-the-promise-of-transformation-78905

[25] Christophe Bene, Bjorn Hersoug and Edward H. Allison. "Not by Rent Alone: Analysing the Pro-Poor Functions of Small-Scale Fisheries in Developing Countries." Page 326.

[26] "Small-Scale Fisheries: Assessing their Contribution to Rural Livelihoods in Developing Countries." FAO, Fisheries Circular No. 1008. http://www.fao.org/3/a-j7551e.pdf.

[27] Robert Blasiak, Colette C.C. Wabnitz. Aligning fisheries aid with international development targets and goals. Marine Policy, 2018; 88: 86 DOI: 10.1016/j.marpol.2017.11.018

[28] Evans, Ian. "Why Fisheries Aid to Developing Nations has Plummeted." Oceans Deeply. January 26, 2018. https://www.newsdeeply.com/oceans/community/2018/01/26/why-fisheries-aid-to-developing-nations-has-plummeted

The application of technology in development programs is not an approach itself, rather, it can be used as a tool for achieving human development, resource management, and capability-developing objectives. While the study cited above does not conclusively establish that aid to fisheries is being funneled through technology-driven programs, there is evidence that development funding for technology-driven solutions has been increasing over the past decades.

2.3 Information and Communication Technologies in Development

Although the definitions for each information, communication and technologies can be debated themselves, information and communication technologies can be defined most simply and broadly as, "devices or techniques that apply knowledge in order to process or communicate data."[29] The list of devices and techniques that this encompasses is extremely large and diverse, including televisions, radios, computers, mobile devices, as well as the software and technologies that enable those devices to function, deliver, store, transmit and collect data and information.

In a global environment where business, culture, and development are increasingly driven by technology and data-driven approaches, international donors have progressively looked to information and communications technology as a way to address development challenges. In turn, and as a function of development paradigms that have been embraced in recent decades,

> *There is a growing recognition that ICTs are indeed very powerful tools that can make development effective on a large scale for disadvantaged people. As a result an increasing number of development organisations in all parts of the world use ICT to promote development, poverty reduction, empowerment and participation. Echoing this recognition are the loud voices*

[29] Heeks, Richard. Information and Communication Technology for Development (ICT4D). Routledg. Oxon, 2018. Page 10.

from developing countries at all levels that ask for a stronger emphasis on the use of ICT in development cooperation.[30]

Information and communication technologies first appeared in a development context decades ago, with the first digital computer to be installed in a developing country in 1956.[31] Since, the application and prevalence of ICTs in development approaches have spread exponentially, coined as "Information and Communications for Development" (ICT4D). The prevalence of programs that use ICTs can be seen in data reported by the U.S. Agency for International Development in 2003, which even as of more than ten years ago showed that 95 percent of the more than 80 USAID Missions worldwide had one or more ICT activities in their portfolio, totaling 351 separate ICT for development activities worldwide. In just the 2002 fiscal year, approximately $200 million in USAID's global funds were dedicated to these projects, with an additional $240 million in outside contributions. About 30 percent of these activities were infrastructure focused, and a larger 70 percent used to fund programs using ICT as a development tool.[32]

Connectivity and technology adoption have grown tremendously in Indonesia over the last decade, with the nation surpassing the average for developing countries in 2010 with 91.72 mobile subscribers for every 100 people—although with multiple numbers per person, it is implied that less than 92% of Indonesians own a mobile phone. In 2011, it was reported that 78% of households own an internet-enabled mobile phone—far more than the number of desktop or laptop computers.[33]

While there is a wealth of data available on Indonesian's access to technology and adoption rates, the overwhelming majority of statistics, such as those above, do not distinguish between urban and rural users. Although statistics show that mobile

[30] Weigel, Gerolf and Daniel Waldburger (eds). ICT4D – Connecting People for a Better World. Swiss Agency for Development and Cooperation (SDC) and Global Knowledge Partnership (GKP), 2004. Page 7.
[31] Heeks, Richard. The ICT4D 2.0 Manifesto: Where Next for ICTs and International Development? Development Informatics, Working Paper Series. Development Informatics Group, Institute for Development and Policy Management, 2009.
[32] Information and Communication Technology for Development: USAID's Worldwide Program. U.S. Agency for International Development Bureau for Economic Growth, Agriculture and Trade, 2004. http://pdf.usaid.gov/pdf_docs/Pdabz702.pdf.
[33] Metre, Kanika. "Information and Communication Technologies for Development (ICT4D) in Indonesia: Opportunities and Challenges" AKATIGA Center for Social Analysis, 1996.

phones are being obtained and used to access the internet at increasing rates, it is not clear how many of these users are in urban settings. For example, in June of 2012, Indonesia was reported to be the fifth largest global market for Twitter, with Jakarta having more users than any city in the world. [34] But what does this mean for rural populations? As we recall, Indonesia is an island of more than 13,000 islands—a fact that greatly determines access, connectivity, and adoption. High national adoption rates and usage patterns therefore are likely not representative of rural applications. Despite these research gaps, available market research does indicate that if the developmental objective is increasing access to information that using mobile technology is likely the best approach, compared to more expensive and larger computer technologies.

2.4 Case Study: mFish

To ground the research presented in the previous chapter on Indonesia's fisheries challenges, development approaches, and the increasing use of ICTs in these approaches, the following case study was examined to provide an example of ICT-implementation against which this paper's research questions can be analyzed. mFish was selected as it was implemented within the last five years and findings are relevant and relatable to contemporary development initiatives using ICTs. Desk research conducted on the mFish program's objectives and approach is presented in this section, with further insights and analysis gained from empirical research studies presented in Section Four.

mFish is an Indonesia-based development program launched in 2014 as a partnership between U.S. communications provider, Tone, fisheries restoration accelerator 50in10, and the U.S. Department of State. mFish was launched as part of a U.S. initiative to enhance the sustainability of marine environments and their resources. mFish's mission was to, "make fishing more sustainable and improve the lives of fishermen and their communities by developing practical solutions that

[34] Metre, Kanika. "Information and Communication Technologies for Development (ICT4D) in Indonesia: Opportunities and Challenges."

use the power of commercially viable mobile technology."[35] The program was developed around the concept that small-scale fishers in developing countries face a variety of challenges that stem from overfishing, including increased time spent at sea and therefore higher operation costs, increased fishing effort, and declining incomes.

mFish was designed to leverage information and communication technologies in the form of mobile phones and mobile applications to address three small-scale fisheries challenges—inefficient operations, low-income and environment-related hardships. The mobile technology sought to provide Indonesian small-scale fishermen with additional business tools, such as weather information, navigation, market information; access to basic "ship-to-shore" communication to improve security and well-being; and increased connectivity to enable in-field reporting unsustainable fishing practices that threaten marine resources. mFish first tested this technology in a small-scale fishery in Lombok, Indonesia in 2015, through the "Labuhan Lombok Alpha Pilot."

2.4.1 Strategy and Design

Ahead of the pilot launch, the subcontractors engaged with technology deployment experts in Asia and fisheries experts to design an implementation strategy. From this research, they identified existing barriers to fisheries catch reporting that included the hesitancy to report actual catch due to tax reporting, cultural and logistic concerns regarding carrying additional devices at sea, and fishermen's tendencies to distrust outside organizations and government. In addition, they identified several risks that could result from implementation including unintended adverse effects of additional technology resulting in increased overfishing, deployment of an imperfect technology resulting in decreased fishermen trust and willingness to participate in future endeavors, and risk that a poorly planned pilot

[35] "mFish." *The Secretary's Office of Global Partnerships,* U.S. Department of State, https://2009-2017.state.gov/s/partnerships/ppp/mfish/.

could tarnish partner organization reputations.[36] To manage these risks, the implementing team determined the pilot would be tested with a very small group of fishers, with 15 mobile phones and vessel monitoring systems implemented across five vessels.

It is important to note that pre-pilot research only engaged technology and fisheries experts, but did not engage community members or fisherfolk regarding the technology itself or its proposed features. All technology specifications and features were determined by fisheries, development and technology professionals based on the program's development objectives and their assessment of the information needed by fishermen to address program development objectives. Research involving the end-users was conducted as part of the pilot implementation, after the technology had been developed.

2.4.2 Pilot Implementation

mFish's Alpha Pilot tested the developed mobile technology and application live in a small-scale fishery in Lombok, off the coast of Bali, Indonesia to gather insights on how the technology could be adapted and scaled for more widespread use in Indonesia fisheries. The pilot aimed to inform subsequent and broader deployments of the mobile technology and did not seek to be the sole intervention. The pilot was steered by the three original partners noted previously, in addition to local fisheries organization Yayasan Masyarakat dan Perikanan (MDPI) and nonprofit Future of Fish. MDPI brought local fisheries and area knowledge to the pilot, aiding in the selection of the first pilot site. Future of Fish supported the program's research functions, as explained below.

The Alpha Pilot consisted of two major components: technology deployment and ethnographic fieldwork, which occurred simultaneously. The partners traveled to Lombok to distribute the ICT tools (detailed in the following section) and perform ethnographic research, using a human centered design approach to "identify

[36] "mFish Alpha Pilot". mFish. Submitted by FutureofFish, 50in10. 2015. Page 5.

individual's motivations in order to craft incentives that align existing values with desired outcomes."[37] Ethnographic fieldwork was carried out through formal interviews with fishers at local partner MDPI's office and at fishermen's homes, and a second phase of less formal interviews in the form of observation at the docks and community centers.

The Alpha Pilot was launched in February 2015 and distributed fifteen smartphones to Lombok handline fishermen, installed vessel monitoring systems onboard five vessels, and distributed three tablets. The mobile phones included the /tone app, which enabled basic communication services, and several additional applications to provide additional information and capabilities to the fishermen, including entry of catch reporting data, access to navigation tools, weather information, and plankton data.[38] Technical components are further explained in Section 2.3.2.

With the distribution of the mobile phones, the partners conducted ethnographic studies during two in-field trips that sought to document fisher's behaviors, relationship and reactions to the mobile technology. The first phase consisted of key informant interviews with Lombok fishermen/recipients and informal, unstructured interviews at the fishing docks and community bases. The second phase consisted of at-sea observation of technology in use by the recipients.

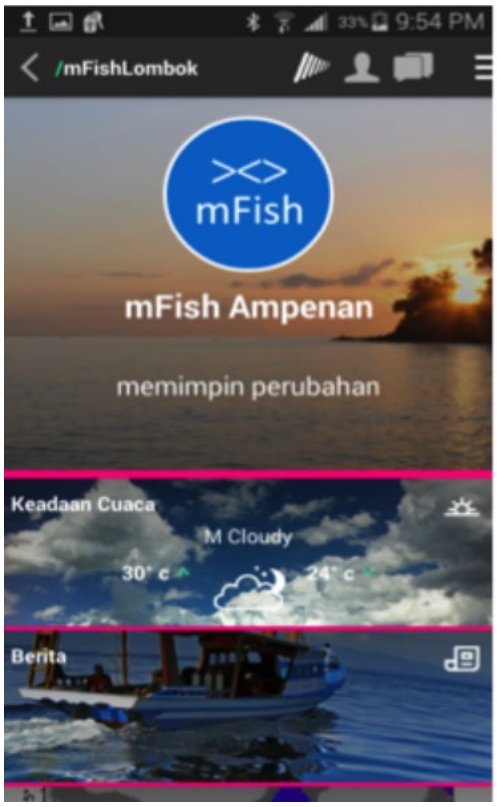
From the first phase of field studies, the researchers summarized four main ethnographic insights which included: community adherence to familial and traditional values, a community emphasis on partnerships and teamwork, the importance of gift giving, and the importance of reducing fisher vulnerability through increased access to data. The researchers noted that the community's familial nature highlighted the importance of making connections for long term engagement, especially as to not disappoint or disrespect the local community. Research also noted that the use of individual mobile devices may challenge the

[37] "mFish Alpha Pilot." Page 5.
[38] Ibid. Page 2.

community's embrace of teamwork, with such an "individualistic device" disrupting the norms of group ownership.

2.4.3 Technical Components

For the Alpha Pilot, mFish distributed mobile smart phones operating on the Android operating system with pre-installed applications, a solar battery charger, six-month data plan, and unlimited access to sector-related content and services during the course of the pilot. After the six month pilot, recipients were able to keep the equipment and were offered subsidized cost data plans that were designed to enable them to keep using the technology with their own "limited" investment. The cost of the subsidized data was not able to be determined through project research, but was not reported to be a successful or attractive incentive for participants.



Screenshot of mFish mobile phone interface used during the Alpha Pilot in Lombok. Credit: mFish

Mobile phone applications included the /tone app which enabled basic communication services and network connectivity was provided by program partner Tone, a U.S.-based private-sector communications company and program partner. Through the /tone app, the program also "sought to benefit social and business partners across sectors, allowing them to deliver content and messaging to previously underserved and disconnected communities."[39] Additional applications were pre-loaded on the phone to enable entry of catch reporting data and provide access to maps to support navigation, weather forecasts, and plankton data.

[39] "mFish Alpha Pilot." Page 5.

Tone leveraged their relationship with the GSM Association, a global alliance of network operators who facilitates global access to mobile networks, to bring onboard Indonesian mobile services provider, XL Axiata to offer mobile broadband services to users. The mobile phones and applications relied on XL Axiata's broadband networks for internet access and capabilities.[40]

2.4.4 Post-Pilot Developments

After the close of the four week pilot, mFish subcontractors assembled a research report to document key findings, challenges and recommendations for adaptation and future implementations. Significant findings from this report are presented in Section 4.1. Pilot reporting was informed by the ethnographic studies undertaken by the subcontractors and observations of technology use. Indicators for quantitative evaluation were not developed or use to inform assessments of pilot success.

3. Theory and Methodology

In order to conduct a well-informed analysis of the mFish program and other applications of ICTs in Indonesia's small-scale fisheries, it is important to understand ICT4D's role in relevant development paradigms, and how these paradigms have affected how ICTs have been applied in development cooperation solutions. The following theoretical section presents an overview of the prominent development paradigms over the past five decades and ICT4D's role within each, followed by an overview of the research methodology developed to address project research questions.

[40] "mFish Alpha Pilot." Page 5.

3.1 Contextualizing ICTs within Development Paradigms

Development paradigms are defined as the, “definition of modalities to achieve development, based on either a codified set of activities and/or based on a vision regarding the functioning and evolution of a socio-economic system.”[41] Development paradigms are linked closely with established development objectives and approaches set to achieve a mutually accepted idea of what “development” looks like. Throughout the more than four decades in which ICTs have been used in development cooperation solutions, development paradigms have shifted and in turn dictated much of how ICTs were developed, designed and implemented. The development paradigms that follow are in no way a comprehensive listing of all existing paradigms, but provide a summary of those that are most prominent and provide a basis for understanding how ICT4D approaches have evolved as a result of the paradigms they exist under. Richard Heeks, in his book, *Information and Communication Technology for Development,* provides an excellent summary of these development paradigms and their impacts on ICT4D, which the following section draws upon.

3.1.1 Development Paradigms, 1950-Present

ICTs emerged in development among the modernization philosophy which defined “developed” countries as those of the global North which were advanced and modern, and those of the South as underdeveloped. In order to be developed, countries in the global South were required to, “transfer technology, ideas and values from those who had already industrialized.”[42]

Following modernization was the dependency paradigm. Under this paradigm it was argued that development was successful when countries broke away from an exploitative world system, and in the context of ICT4D encourages that countries develop their own technologies. While this approach was beneficial for building the

[41] Bellu, Lorenzo G. “Development and Development Paradigms: A (Reasoned) Review of Prevailing Visions.” Food and Agriculture Organization of the United States, May 2011. Page 1.
[42] Heeks, Richard. Information and Communication Technology for Development. Page 19.

capacities of those developing the technologies, it was criticized for doing little to address the basic needs of the larger population—and, in terms of technology, resulted in products that were of lower quality and higher cost that those that were originally being imported. [43]

Neoliberalism, next, embraced elements of modernization and turned back to technology from the global North. But, whereas modernization's diffusion of technology was government-led, neoliberalism looked to market forces and as such, technology experienced more rapid growth and wider reach. As technology enjoyed more globalization than under prior paradigms, it did also negatively impact some of the capabilities that developing countries had built in technology development. While neo-liberalism was seen to be more efficient, it was criticized for again ignoring basic needs of developing countries' poorest populations who were excluded from these technologies and their benefits. The human development paradigm followed and sought to focus on these basic needs and prioritized health, education, income generation and capacity building to the poorest segments of developing countries.[44]

The end of the twentieth century was capped by the post-development and sustainable development paradigms. Heeks states that post-development, "argues the very notion and discourse of development has been a means to entrench the interests of the global North; though…ICTs hold the potential to help indigenous and alternative approaches to emerge." Sustainable development sought to address these criticisms with development that addresses the needs of the poor, without compromising the ability of future generations to meet their own needs.[45] That is, development should be sustainable and consider future needs, particularly those of the environment. Under the sustainable development paradigm, the Millennium and Sustainable Development Goals were developed—the latter of which were established in 2016 and have greatly shaped recent ICT4D applications. The Sustainable Development Goals address ICT specifically, with

[43] Heeks, Richard. Information and Communication Technology for Development. Page 19.
[44] Ibid. Page 20.
[45] Ibid. Page 20.

the goal to significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in the least developed countries by 2020.

As illustrated, paradigmatic shifts have informed many aspects of why and how development agencies and organizations have undertaken development. As Suzanna Schech nicely summarizes in her discussions on ICT and broader links with developmental discourse, "…[t]he promises of new technologies for developing countries are formulated within a broader discourse of modernization and development, which is based on the assumption that a deficiency in knowledge is partly responsible for underdevelopment."[46]

3.1.2 Paradigmatic Shifts: Moving ICT from Top-Down to Bottom-Up Approaches

As development paradigms shifted, so too did development agencies' approaches to applying ICT in development contexts. Prominent development paradigms discussed previously, including modernization, dependency, and neo-liberalism—not only determined what "developed" looked like, but heavily impacted what tools were used in its achievement. Impacts on ICT4D were significant, with no better example than dependency thinking leading technology to be brought in-field, rather than imported from the global North.

While modernization and neo-liberalism both embraced the practice of bringing technologies from developed countries to the developing countries, they greatly differed in that under neo-liberalist, focus was shifted from top-down, government led technology diffusion to the bottom-up, market-driven technology implementation that was seen under neo-liberalism. Neo-liberalism proclaimed that top-down and supply-driven approaches, instead of bottom-up, demand-driven approaches were fundamental to many development challenges. In a report by the

[46] Schech. Suzanna. "Wired for Change: The Links Between ICTs and Development Discourses." Journal of International Devleopment, John Wiley & Sons, Ltd., 2002. Page 1.

Organisation for Economic Co-operation and Development, this shift is further described, noting that as a result of this shift many donors, such as the Asian Development Bank, financed new approaches to facilitate more inclusive and demand-driven design. These new approaches included, "(i) beneficiary consultation and participatory planning; (ii) community development support; (iii) engagement of nongovernment organizations (NGOs); (iv) local government involvement; and (v) private sector participation, defined in this report as the use of private individuals, enterprises, or financial institutions to achieve project objectives." These approaches were coined participatory approaches"—going beyond what was traditionally undertaken as beneficiary participation.[47]

3.2 Methodology

This project's research design was developed to answer the following research questions, with the main objective of understanding recent, sector-specific ICT initiatives, their common challenges, and basis for these challenges as a means of identifying points of improvement that can be used for future ICT applications.

- What are the priority challenges that development cooperation solutions need to address in Indonesia's small-scale fisheries, and how have these challenges been addressed by contemporary development programs?
- What are the common challenges that development programs face in implementing ICTs in this environment, and what are the reported best practices?
- How do these challenges relate to past and present development paradigms and discourse on ICT-driven approaches?
- What are the priority areas for improvement, and how can these be addressed for more efficient development interventions?

To answer these questions, both secondary, desk-research and literature reviews were conducted, as well as empirical research to explore real-world development initiatives and their relationships to development paradigms and discourse.

[47] Effectiveness of Participatory Approaches: Do the New Approaches Offer an Effective Solution to the Conventional Problems in Rural Development Projects? Asian Development Bank, 2004. https://www.oecd.org/derec/adb/35183500.pdf

Secondary, desk-based research was conducted first to determine the significance of Indonesia's small-scale fisheries, the challenges they face, and the approaches taken by development agencies to address these challenges. With this foundation, theoretical research was conducted to establish the development paradigms that have impacted development solutions and understand how ICT approaches have been shaped by these theories. Following, a recent development program—mFish—was selected and researched to provide a basis for further exploration and analysis.

Primary, empirical research was then conducted to explore the case study further and examine other development programs to contextualize mFish findings. This research was conducted through five Key Informant Interviews: one with the current implementer of mFish, three with staff members of additional ICT-focused development programs, one with an industry member and processing company owner, and one with a program manager at a local fisheries organization which supported the mFish Alpha Pilot. These interviews were conducted as both structured interviews and informal interviews that served to gain additional insights on the mFish Alpha Pilot, as well as assess other initiatives to broaden the project's basis for analysis. To further substantiate these findings, an electronic survey, via Survey Monkey, was conducted amongst Indonesia-based development practitioners with fisheries experience. Finally, visual observations were gathered in Manado, Indonesia, allowing insight into on-the-ground technology use, connectivity, and interaction with fisheries stakeholders.

Several limitations were encountered in the implementation of this research methodology, and required active use of adaptive management techniques to gather information needed to address the study's research questions. Most significantly, the project's original research design included a panel of key informant interviews with Alpha Pilot implementers and a survey of beneficiaries to assess short and long-term program impacts that were not able to be conducted under this project.

Once research began it became clear that the Alpha Pilot was far more limited in scope than program promotional materials had indicated. Given that the Alpha Pilot was largely unsuccessful is testing any of the developed applications, beneficiary evaluations were removed from the research plan as limited impact was achieved. As a result of the limited success of the pilot, it also became much more difficult to identify and contact pilot implementers for interview. As representatives of current companies and organizations with commercial interests and reputations to maintain, many individuals identified for interviews were either unable to speak on behalf of mFish or unwilling because of sensitive inter-organizational dynamics that resulted from the pilot. As a result, interviews and surveys were broadened to development professionals from other initiatives.

4. Analysis

The following section presents the results of the empirical research undertaken to address study research questions, as well as analysis of these findings against discourse on development theories.

4.1 Detailed Analysis of Design and Implementation

This section further examines the mFish case study, with focus on its approaches for design, development, adoption and sustainability. Analysis of this case study draws on discourse of ICT4D's shifting role among development paradigms and ICT4D approaches. The following analysis is presented not as a critique or evaluation of the mFish program or other initiatives, but rather as a way to identify common challenges that may be reinforced by development paradigms. Information used for this analysis was gathered from desk-research, including project wrap-up reports from mFish's Alpha Pilot; and empirical studies, which included informal interviews with mFish implementers, key informant interviews with development professionals, survey results from a sample of development program implementers, and observational field study findings.

4.1.1 Program Design and Pre-Pilot Approach

The mFish program was launched and funded by the U.S. State Department out of a U.S. government initiative to end overfishing by 2020. One out of a portfolio of initiatives to achieve this goal, mFish was launched by the Secretary's Office of Global Partnerships and implemented by private sector partners under the Department of State's guidance.[48] From its launch, the program was designed as a partnership between the U.S. government, private communications company Tone, and a fisheries organization. Thus, program objectives were predetermined by the donor agency and plans established to use mobile technology, through Tone, to achieve the program objectives. This approach is not uncommon for internationally funded initiatives, where development programs are created to address specific, priority issues that have been identified according to national political, economic, or humanitarian agendas. In developing these programs, implementing partners are selected based on their qualifications, technical proposals, and value to the initiative, including contribution of leveraged funds.

With the inclusion of private-sector technology partner Tone, elements of neo-liberalism are seen, with evidenced market-led development instead of government-led development and technology diffusion characteristic of older development paradigms. The program's approach to tackle overfishing through the dissemination of mobile technologies is closely linked to modern sustainable development approaches which characteristically strive for "development" through increased access to information and communication.

With the program objectives and high-level mobile for development approaches determined, mFish program documents report that it consulted with fisheries and technology experts to determine and design the mFish technology. As Heeks remarks in his working paper series, *Development Informatics,*

> *"Laboratory" pro-poor innovation is done outside of poor communities but on behalf of the poor…This can be an effective approach for engaging*

[48] "mFish Alpha Pilot." Page 4.

> *resources from the global North in developing country problems. However, it runs into the danger of "design-reality gaps": a mismatch between the assumptions and requirements built into the design, and the on-the-ground realities of the poor.*[49]

mFish's approach was effective for engaging technology resources, but prioritized engagement with high-level fisheries and technology experts over in-field research or stakeholder engagement. Ultimately, the approach identified with top-down approaches where technology development and stakeholder engagement do not occur in tandem. This approach is not categorized as a development practice and reflects ideals of modernization approaches, however, it was evidenced to be seen across other fisheries development programs as well.

In primary research, it was acknowledged by interviewees that technologies are often developed prior to community engagement. One practitioner noted, "If you're creating a solution for [fisherfolk], you can design your application based on expert advice and knowledge, and then…learn [fisherfolk] behaviors through prototype testing and human-centered design —you can adapt what features are added, what are dropped, [and enhance] user experience." While this approach does allow for direct product feedback, it also—as cited above—runs the risk of developing a product with design-reality gaps that does not speak to users, user needs, or site-specific realities for hardware and software design.

4.1.2 Tools for Development: Design and Implementation of Hardware and Software

mFish's pilot design included simultaneous technology rollout and research. Before engaging the in pilot site, mFish worked with a panel of experts to select the mobile technologies that would be used, including Android smartphones and accompanying solar battery chargers and waterproofing gear, as well as select and develop the applications that would be loaded on phones for participant use.

[49] Heeks, Richard. The ICT4D 2.0 Manifesto: Where Next for ICTs and International Development? Development Informatics, Working Paper Series. Development Informatics Group, Institute for Development and Policy Management, 2009. Page 13.

The most significant finding from the Alpha Pilot was the incompatibility of distributed technology in the pilot's rural setting. Through the pilot, researchers quickly found that many of the applications, were unusable due to limited to no cellular connectivity in the pilot site. As fishers were asked to carry and use the technology at all times—both on land and at sea—researchers observed that connectivity was either not strong enough or available at all to enable the applications to be used. Limited or lacking connectivity was not factored into application design, thus many tools such as the maps for navigation and weather apps were not enabled for offline use, rendering many of the program's features as unusable and untested. This challenge was echoed by interviewed development practitioners who noted this as a well-established critical consideration that should be built into any ICT tool.

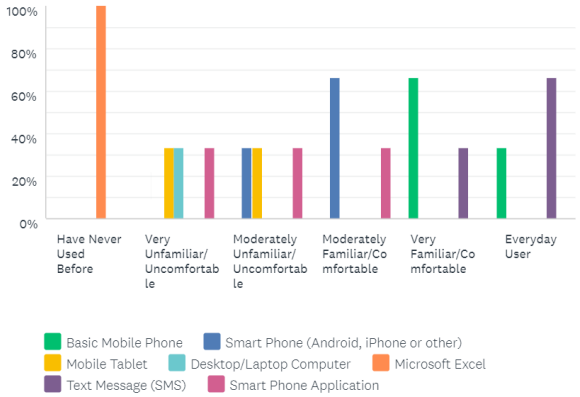
The pilot also served to inform what content was of value to the users. While the three apps for weather, mapping and plankton were not usable due to connectivity issues, one app was accessible that enabled catch documentation. Fishers reacted negatively to this application with reported, "fear from the test group that learning the technology might slow down their paper-based process and thus risk supply chain relationships."[50] This reaction impeded uptake of the documentation app, which rendered the majority of applications to be pilot either rejected or unusable. Fishers did, however, suggest a host of applications that would be usable to them, including information on sea surface swells. Researchers found this information available on line and made an ad hoc addition of this information on the platform, directing users to a sea swell website. Unfortunately, the website was only available in English, but researchers reported that the fishers were, "enthusiastic about the potential, and especially appreciative of the effort to respond to their requests." [51]

[50] "mFish Alpha Pilot." Page 14.
[51] "mFish Alpha Pilot." Page 15.

In addition to challenges encountered with the application software, researchers also reported that "[f]or the captains and the fishers, not only were the /tone platform and apps unfamiliar, but many had never used a smartphone. …Fishers and captains are not accustomed to classroom-style learning, and should not be expected to grasp abstract ideas and unfamiliar technology by way of written guidelines and oral presentations." [52] Field research conducted for this project also showed very low levels of user familiarity with new technologies.

Disconnects between the developed hardware and software and the on-the-ground realities of connectivity, usability, and relevance are all indicators of the "design-reality gaps" that Heeks cautioned are a risk of "laboratory" development conducted outside of the implementation site and audience. Vikram Parmar elaborates on this point further in his call for a multidisciplinary approach to ICT4D, nothing that, "…content developers may not be knowledgeable about the social environment and information needs of the rural users."[53] And further that, "…technology developers are often unaware of how technology will be adapted to the local field-specific requirements and applications. Due to this lack of local contextual knowledge, issues such as availability of technological infrastructure and local maintenance of hardware and software receive less attention from technology developers."[54]

Figure 1. Survey results reporting familiarity level of small-scale fisheries stakeholders (fisherfolk, buyers, suppliers) with various types of technology.



Laboratory development may rely on statistics on national technology access, adoption and user behavior that is not indicative of site-specific or rural settings. Under early ICT4D approaches that came with modernization development

[52] Ibid.Page 13.
[53] Parmar, Vikram. "A Multidisciplinary Approach to ICT Development." USC Annenberg School for Communication & Journalism. Volume 5, Number 4, Winter 2009. Page 90.
[54] Ibid. Page 90.

approaches, “[In ICT4D 1.0], with timescales short and pressure to show tangible delivery, the development actors involved with ICT4D did what everyone else does in such circumstances. They looked around for a quick, off-the-shelf solution that could be replicated in poor communities and developing countries.”[55] It is evidenced by mFish and other researched development initiatives that this tendency is still very much active in contemporary development solutions.

The Alpha Pilot used readily-available hardware and software that was minimally adapted for the pilot context, yielding technology that was not context relevant. This reinforces the importance of utilizing a bottom-up approach that considers site-specific hardware and software specifications. Field research and observations showed that this is a common problem to other development programs in these fisheries (Figure 2).

Figure 2. New technology for production line data capture was observed during key informant interview with Blue Ocean Grace International and non-profit organization BOGI. This is the second phase of a pilot program in which technology has been optimized to be more sustainable and site-appropriate. Previously, laptop computers were used with little success. Under the current pilot, a data station has been created that is waterproof and limits damage to the technology from continued movement.

4.1.3 Stakeholder Engagement/Research

mFish pilot reports tout the programs’ use of user centered design, an approach that has been praised by academics and development practitioners as a progressive and effective approach. User-centered design, “tries to optimize the user development around how users can, want, or need to work, rather than forcing the users to change how they work to accommodate the system or the function.” [56] Further, “adopting a multi-disciplinary design approach when

[55] Heeks, Richard. The ICT4D 2.0 Manifesto: Where Next for ICTs and International Development? Development Informatics, Working Paper Series. Page 4.
[56] Parmar, Vikram. A Multidisciplinary Approach to ICT Development. Page 90.

developing ICT interventions…and employing a user-centered design framework as a tool [can] help achieve higher user acceptance and efficient information transfer."[57]

But, in mFish's case, the Alpha Pilot simultaneously rolled-out the mFish technologies to fishermen and conducted ethnographic research on adoption incentives, program risks and recommended technology adaptations for further implementations. While this approach allowed researchers to conduct research directly in response to the information and communications technology, it limited the pilot as research was only able to inform future iterations of the technology. While this approach engaged stakeholders directly, it can be argued that this is not a true user centered approach to design, and if so, it was initiated too late in the design process.

It is important to distinguish stakeholder engagement from participatory development. In its implementation, mFish did engage stakeholders through testing activities and ethnographic research, but they did not engage in participatory development.

Participatory theories of development, which are often critical of modernization theory's top-down approach, urged that development communication be redefined to increase participation in development, inform, motivate and train populations.[58] Thus, development initiatives that design stakeholder engagement for participatory development and adoption, not just for transfer of information, are recommended to increase buy-in, adoption, and greater results.

4.1.4 Sustainability

As important as developing an efficient implementation strategy is the development of a sustainability strategy that is integrated into technology design. While ICT4D

[57] Ibid. Page 89.
[58] Waisbord, Silvio, PhD. Family Tree of Theories, Methodologies and Strategies in Development Communication. Rockefeller Foundation. Page 18.

initiatives used to more commonly take, “an invention-down approach – bringing new technologies into development contexts – much more [often] than [they] took a use-up approach of understanding how existing technologies were being applied within poor communities,” development paradigm shifts have positively influenced technology development sustainability in that use-up approaches often are more successful in gaining the user trust and buy-in that is imperative to sustainable adoption. [59]

These concerns about approaches used for earlier ICT4D projects have led to an emphasis on thought around, “sustainability, with an emphasis on ensuring the longevity of projects; scalability; …and evaluation, given that [ICT4D has often been] held aloft by hype and uncorroborated, self-interested stories.”[60]

During the Alpha Pilot, program sustainability relied on quick user adoption and buy-in to subsidized data plans provided by the communications provider. Significant user value was not exhibited enough to warrant user investment and relied on the assumption that users would be able to finance continued use without a substantial incentive plan. Key informant interviews underscored the importance of incentives for continued participant use, including models that paid users for their contributions.

4.1.5 Adaptation

Following the Alpha Pilot, in August 2016, program leadership was transferred from the U.S. Department of State to EcoHub, a U.S. based company that specializes in the application of technology to bolster fisheries sustainability. Through EcoHub, mFish has evolved in a number of ways due to reflections on the Alpha Pilot and EcoHub insights. Now, nearly four years after mFish’s launch, the program has

[59] Heeks, Richard. The ICT4D 2.0 Manifesto: Where Next for ICTs and International Development? Development Informatics, Working Paper Series. Page 5.
[60] Ibid. Page 5.

shifted to use a new implementation model which includes revised distribution plans, technology, and uses to support broader expansion.

Research insights following the Alpha Pilot were captured by the subcontracted program researched that conducted the technology distribution and ethnographic fieldwork, and are summarized in Table 1. Findings heavily focused on coordination and technology improvements.

Table 1. Research Insights and Recommendations Resulting from Alpha Pilot Implementation[61]

Coordination	Small-scale rollout and portfolio approach for risk mitigation
	Importance of local mFish coordinator and on-the ground tech support
	Logistical and technical difficulties highlight need for adaptive planning
	Co-Design aspect of Alpha Pilot appealing to fishers
Technology	Pre-loaded apps miss the mark – mapping app not functional offline, plankton app outdated, weather app fails to forecast
	Ad-hoc addition of makeshift data app for swell heights popular with fishers
	Enumerators hesitant to adopt new data-recording technology
	Vessel Monitoring System initially met with caution, eventually embraced and praised by fishers
Capacity Building	Participants faced double learning curve (more dynamic training needed) (use of smart phone AND new apps)
	Setting realistic expectations critical for training process

Although mFish was designed and implemented long after development had shifted from away from modernization approached where technology was disseminated in a hierarchical, top-down fashion, there are evidences that these approaches are still being used in program design, perhaps as a function of

[61] mFish Alpha Pilot. Page 5.

international donors' distance from end-users and implementation sites, or perhaps from a tendency for implementers to believe that technology and solutions that work in the global North are still the most appropriate and effective for development. Many of the findings summarized in mFish's end of pilot report highlight failures from the top-down, externally developed technology solutions.

Following the transfer of the mFish program to EcoHub in 2016, EcoHub took a step back from development implementation to address the challenges that resulted from the pilot implementation. Recognizing the importance of beneficiary trust, buy-in, and responsibility to deliver, EcoHub noted in an interview conducted for this study that, "[Development practitioners] don't get many opportunities to go into these communities and when they do, they need to deliver. These commitments are seen as a promise to the community." As such, EcoHub has revamped the mFish tool in three main ways: enhanced technology to increase connectivity, improved financing model, and revised partnership strategies.

EcoHub has focused intensively on enhancing the program's financing model and has significantly reworked the cost of use and investment approach. Whereas the Alpha Pilot partnered with large private sector providers to offer a limited free-trial with a subsidized data financing that followed; the new mFish model has developed partnerships to alleviate investments completely from the fisherfolk. This approach steps away from the sustainable development paradigm's embraced of providing affordable access to technology and information. What this approach lacks is the acknowledgement that affordability is relative, and when not seen as a priority to the end-users themselves even a subsidized model does not incentivize their own expenditure. When interviewed, EcoHub highlighted that mFish is, "not a product, but a no-cost *service* that seeks to aggregate data and share knowledge."

To facilitate this, mFish has developed new partnerships, including use of Facebook Free Basics platform that enables information sharing without data charges. mFish's information offerings are no longer app-based, but instead browser-based to cut costs and increase reach. This adjustment allows existing technologies to be leveraged, while considering local use and needs. According to

market research, in 2011, Indonesia was Facebook's third largest market, with 90% of digital consumers in the country using the site. [62] Further, "…A large portion of Indonesian Facebook users have never accessed the Internet through more traditional methods such as desktops or laptops. As a result, Indonesians who have not previously used the Internet prior to accessing Facebook through their phones are not always aware that they are using the Internet when they use the social media application." [63] In addition to providing information in a way that acknowledges connectivity limitations, this approach also addresses gaps in user experience and the steep learning curves that the Alpha Pilot experienced.

In addition to improvements that were needed in application use, mFish also found that the model for data exchange was incompatible with local network bandwidths and capabilities. As such, in EcoHub's newest improvements to mFish included stripping out all of the javascript in the tools to enable the platform to operate in 2G environments that are available in fisheries, not for 4G networks which the program was originally designed for and unable to access. In addition to increasing usability, this also enabled a more sustainable financing model, as the cost of data is high relative to fisheries incomes with limited realized returns to the end-user.

In June of 2017, EcoHub announced it will expand and launch the mFish initiative in Malaysia, Vietnam, Philippines, Thailand, Myanmar, Bangladesh and the Maldives, expanding the tool's reach to more than 100,000 users.

4.2 Key Findings and Recommendations

As illustrated, Indonesia's small-scale fisheries have a host of unique sociological, economical, and environmental factors that must be considered to for successful and sustainable ICT solutions. Analysis of the mFish program, along with other recent ICT initiatives, resulted in the identification of four key challenges and

[62] Metre, Kanika. Information and Communication Technologies for Development (ICT4D) in Indonesia: Opportunities and Challenges
[63] Ibid.

recommendations for ICT implementation that acknowledges past limitations imposed by development paradigms and expands beyond them.

Limited (Early) Stakeholder Engagement in Design and Development –

The most significant, limiting and common thread was limited stakeholder engagement/participatory engagement in the program design phases. Most often, program objectives, approaches and tools are already defined before communities are approached. So, stakeholders often have limited ability to provide inputs into the type of ICT model, design, specs that is being implemented. Or, are not engaged at all until a prototype is already developed. Fisheries' complex socioeconomic and traditional dynamics challenge external interventions, highlighting the importance for early engagement and relationship building for tailored approaches.

In 2001, the United Nations' Food and Agriculture Organization published a report on the cultural characteristics of small-scale fishing communities which sought to inform fisheries officials on how small-scale fishing communities, "are organized and function, what their important value orientations are and how they can be strengthened and protected."[64] The report states:

> *…Because the cultures of small-scale fishing communities are usually the result of considerable accumulated adaptive experience, fisheries officials who hope to bring about changes in them should proceed with caution. Indeed, fishing communities may have much to teach fisheries officials about the most appropriate means of utilizing and managing a fishery… Yet while the cultures of small-scale fishing communities are strongly rooted in adaptations to particular marine ecosystems and the availability of certain marine species, they are seldom rooted there exclusively. This is because they are usually also connected with other cultural systems: the culture of the nation of which they are a part, for example, and, increasingly for many communities, the world's globalizing culture and economy as well.*[65]

Thus, it is imperative to not only consider the objectives of a development intervention, but to fully consider and account for the dynamics of the target

[64] McGoodwin, James R. Understanding the Cultures of Fishing Communities: A Key to Fisheries Management and Food Security.
[65] Ibid.

population, including their culture, existing knowledge and practices, and hierarchical sociological systems.

> *"Collaborative" (para-poor) innovation is that done working alongside the poor communities… The very nature of ICT4D participation is… difficult because it requires multiple divides between designer and user to be bridged: techie vs. non-technie; rich vs. poor; often Western vs. non-Western mindset. And for certain projects, urban vs. rural; men vs. women.*[66]

Disconnect between Tech Solution Design and On the Ground Realities – Indonesia's small-scale fisheries are not as connected, or technologically advanced as national ICT statistics indicate. While mobile phone use and connectivity continues to grow in market research, this data often doesn't acknowledge rural connectivity and beneficiary "fluency" with advanced technologies. Challenges experienced in user adoption and understanding underscored that,

> *ICT development for socially complex and infrastructurally weak environments, such as rural contexts, demands an understanding of several development issues before sustainable implementation of ICT intervention can be achieved. Solutions to these developmental issues are not often found in a single discipline… There is no formal platform or framework with which to amalgamate the knowledge from these [various] disciplines into the ICT development cycle. As a consequence, current ICT development has mainly followed a fragmented approach, where cross-disciplinary knowledge has not been efficiently leveraged in the development cycle.*[67]

This takes us to our third finding, **ICT4D cannot stand on its own and needs to be coupled with other development approaches**. ICT-driven programs stand to benefit from integration with other development approaches and techniques. While technology experts excel at designing and developing technology, they are not and cannot be expected to be behavior change experts, anthropologist, or economists. Particularly in the setting of small-scale fisheries, other developmental disciplines

[66] Heeks, Richard. The ICT4D 2.0 Manifesto: Where Next for ICTs and International Development? Development Informatics, Working Paper Series. Page 13.
[67] Parmar, Vikram. A Multidisciplinary Approach to ICT Development. Page 90.

should be engaged to develop and implement programs that are sensitive of site-specific conditions and values.

> *"Fishing, as one among many ways of providing for human existence, requires certain human adaptations and behaviors, with these adaptations and behaviors necessitating the development of certain cultural characteristics. These adaptations are rooted in the requirements of exploiting particular marine ecosystems… and then are ramified through the cultures of their fishing communities. Therefore it is important to underscore that a fishing community's approaches to fishing, the fishing gear it utilizes, and its organization of other fisheries activities is usually the result of considerable experimentation over a long period of time."*[68] – FAO, Understanding the Cultures of Fishing Communities: A Key to Fisheries Management and Food Security

As highlighted through this excerpt from FAO, and as seen in mFish's implementation, understanding and incorporating the human elements of behaviors, traditions, motivators, and cultural practices into program and implementation strategies is critical for development of effective, efficient and sustainable development solutions.

Continuity and Continued Learning – Lastly, undertaking of this project and knowledge gained through key informants highlighted a lack of access to information on past development projects, including their challenges, approaches, methodologies and best practices. As a function of development programs being implemented by donor agencies and private-sector contractors, there is a lack of information sharing due to business interest, confidentiality and intellectual properties. Developed products are often the property of the donor organization or fade away without continued funding. Research highlighted the need for increased information sharing amongst development programs and increased interest in enhancing existing technologies rather than continued focus on the development of new technologies.

[68] McGoodwin, James R. Understanding the Cultures of Fishing Communities: A Key to Fisheries Management and Food Security.

5. Conclusions

While Indonesia's small-scale fishermen are of vital importance to the nation's economic goals, which have placed a large emphasis on fisheries, they continue to fall into the lowest economic segments of poverty and are most impacted by fisheries challenges. Development cooperation solutions have sought to address these challenges, increasingly through technology solutions, however there is little established research on best practices, common challenges and on the considerations vital to program success. Despite these informational gaps, development programs continue to serve these populations and develop new innovations to serve economic, social and political challenges.

As development practitioners, it is important that we leverage others' challenges to benefit future program designs and development. Further, it is beneficial to understand where these challenges stem from and if they may reflect past or current weaknesses of our development approaches and paradigms.

Through this study, four key challenges were identified: limited engagement of stakeholders in program design and development, disconnection between technology solutions and on-the-ground realistic, adoption of siloed development approaches that fail to integrate technical experts and approaches with broader disciplines, and deficiencies in knowledge sharing to catalyze continuous development.

These challenges reflect past and evolving development paradigms. With modernization approaches outdated by decades, many programs still show evidence of top-down, government-led technology development and diffusion. And, many programs' emphasis on technology above all illustrate discourse on development being defined by increased access to information and connectivity, rather than measurable improvements in quality of life. As development practitioners continue to evaluate the shortcomings of current development approaches, it is likely that development paradigms will continue to evolve and benefit target populations.

> *"[Critics] of the mainstream development paradigm find the prospect of accelerating the spread of Western knowledge through the new ICTs alarming…However, there lies some hope in using the new technologies to produce a different truth about capitalist development, from the perspective of it victims, those who have been excluded from it…New technologies can become sources of empowerment and emancipation; they are the tools through which true knowledge can be established and disseminated."* [69]

Further research could benefit the field by exploring in more depth, with larger survey groups, what programs have been the most successful in ICT deployment using program evaluation documents and independent evaluation studies to gather qualitative data on the realized impacts of multiple ICT implementations. While market research is abundant, independent efforts to consult small-scale fishery populations are limited or non-existent. Additional studies on these populations, their priorities, and most desired incentives would benefit the field greatly.

In conclusion, perhaps one of the most significant recommendations and impacts of this research is the recognition that ICT-focused development cooperation solutions, despite being implemented under evolving and advancing development paradigms, still commonly fail to fully engage end-users and utilize a broad range of development approaches available. By engaging with other development practitioners, particularly Communication for Development practitioners, donors and implementers may be able to more effectively achieve development objectives and aid-recipients may more fully be able to realize the benefits of foreign aid.

[69] Schech. Suzanna. Wired for Change: The Links Between ICTs and Development Discourses. Page 2.

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