MACBIO
Marine and Coastal Biodiversity Management in Pacific Island Countries

Isn't there an App for that?

Smartphone Apps in (marine) resource management

- ✓ The spectrum of Smartphone Apps in (marine) resource management
- ✓ A guide for App Development
- ✓ Open Data Kit for data driven marine management in Fiji as example

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1. Isn't there an App for that?

The spectrum of Smartphone Apps Smartphone Apps in (marine) resource management

There probably is! Mobile technology is on the rise and more and more people have access to these technologies as well as the internet. In 2016 there are about 2 Billion Smartphone users out of the 4.6 mobile phone users worldwide (statistica 2016), with close to 3 Billion expected in 2020. And today 68% of these smartphone owners use apps. Already in 2013 there have been 56 Billion apps downloaded to Smartphones.

This is not a phenomenon of the industrialized world. While internet and smartphone usage is more widespread here, developing and emerging economies are catching up with 54% average internet use and 37% average smartphone ownership.

A **mobile app** is a software application designed to run on mobile devices such as smartphones and tablet computers. Most such devices are sold with several apps bundled as pre-installed software, such as a web browser, email client, calendar, mapping program, and an app for buying music or other media or more apps (Wikipedia 2016).

Our world is increasingly digitally connected. This changes the way we communicate, work and live, and brings about fundamental social change (BMZ 2016a, p.8). The combination of computational power, sensors, and wide-scale user uptake means that the internet, smartphones and in particular apps provide an unprecedented opportunity (Teacher *et al.* 2013): Opportunities for development, prosperity, quality of life and sustainability worldwide, be it access to information, education, health and safety or data collection, management and participation in political processes – even in the remotest areas (GIZ 2016).
Therefore, Smartphone Apps as on crucial aspect of Information and Communication Technology (ICT) is increasingly used to achieve sustainability, development and conservation. Also GIZ "supports the increased use of ICT in developing and emerging countries and deploys ICT in many of its projects to enhance their effectiveness. Since 2000, GIZ has implemented more than 150 projects with an ICT focus, including around 40 in collaboration with the private sector" (GIZ 2016).

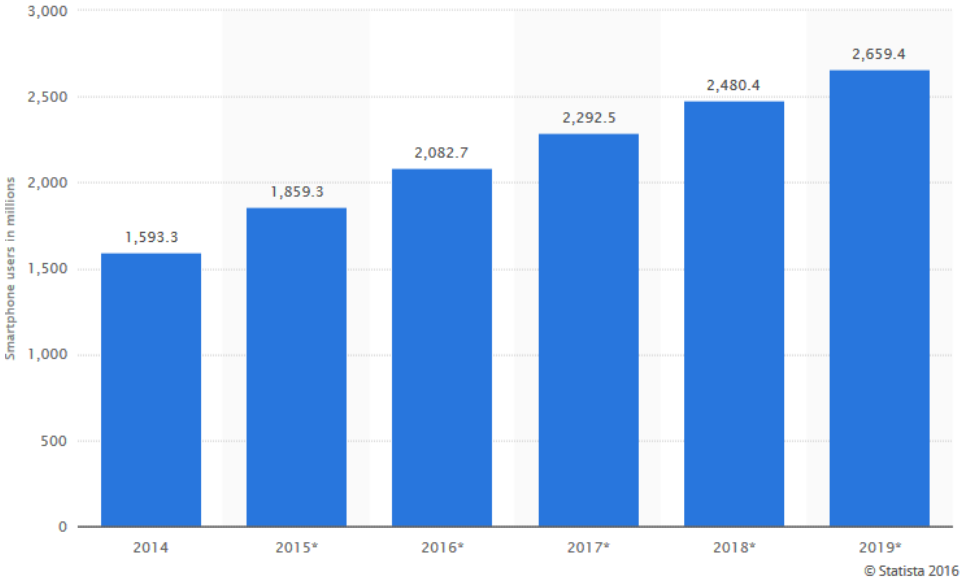
How popular smartphone apps for sustainability have really become, indicates an automated search of the Google Play Store in 2015 that returned data on 36 304 apps, of which ~6301 were nature-themed (Jepson & Ladle 2015). However, despite the large number of apps available, an analysis on the meta level of effectiveness of apps as well as practical guidance how these apps are developed and used is very limited (cf. Teacher *et al.* 2013).

To close this gap, this paper tries to offer orientation in the jungle of apps, their development and application, as well as to exemplify successful app use in natural resource management. In this context Open Data Kit will be introduced and explained, as well as its use for data driven marine management in Fiji.

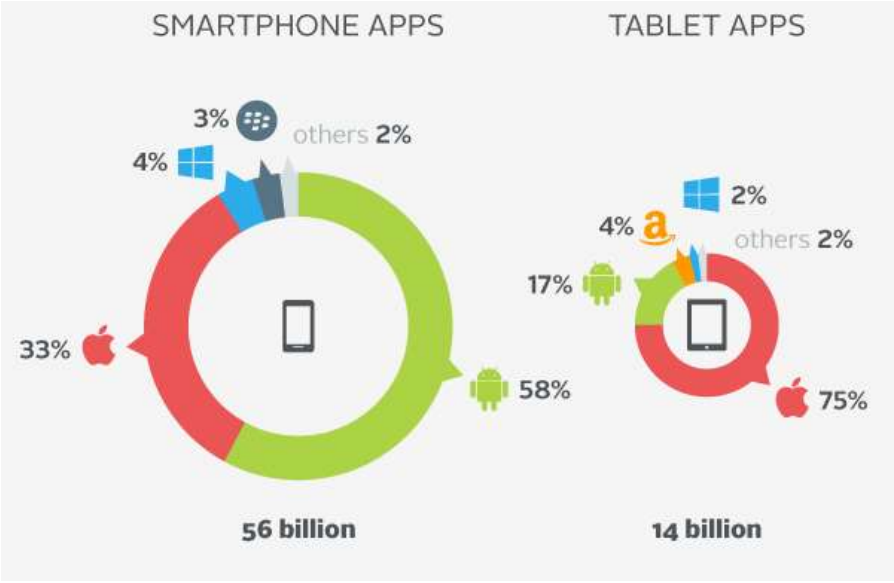
In essence, **smartphones** are portable, internet-enabled computers with a variety of sensors, providing us with a set of powerful research tools for collecting data. Smartphones provide the user with increased computational abilities, particularly internet access, global positioning systems (GPS), access to geographical information systems (GIS), microphones, accelerometers, and cameras with the capability not only to take high-resolution photographs, but also to read QR/barcodes and record video. These tools are accessible to an increasingly large number of people (Teacher *et al.* 2013)

→ **Further Reading:**

- POUSHTER, J. 2016. Smartphone Ownership and Internet Usage Continues to Climb in Emerging Economies. Pew Res. Cent. Glob. Attitudes Proj. Available at: http://www.pewglobal.org/2016/02/22/smartphone-ownership-and-internet-usage-continues-to-climb-in-emerging-economies/

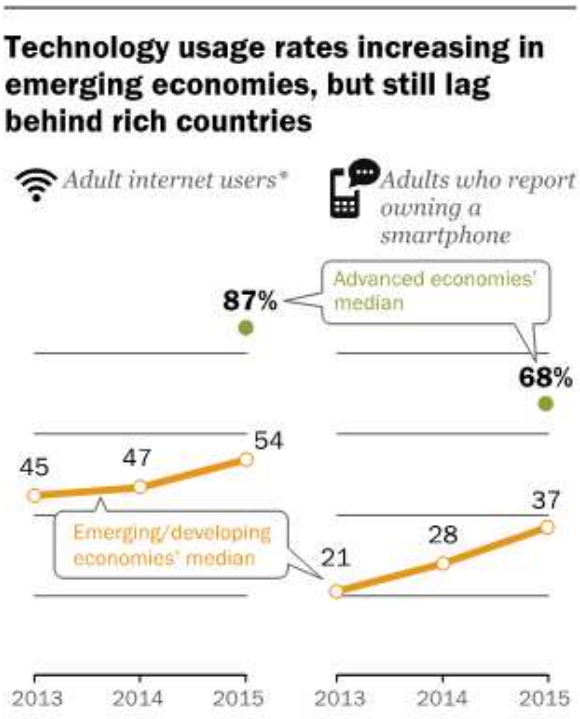


Smartphone users in millions (statistica 2016)

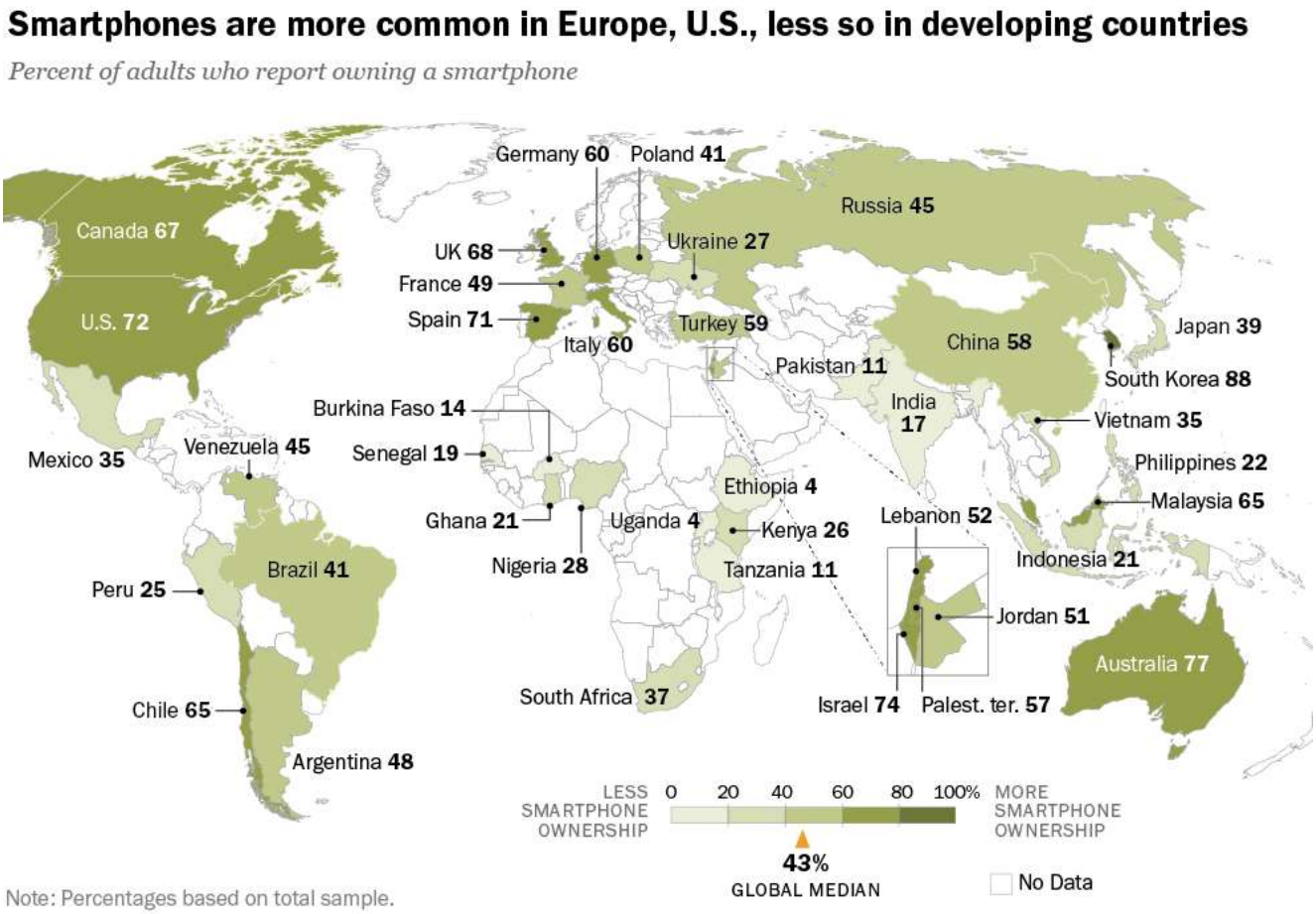


Smartphone and tablet app downloads in 2013 (Shoutem.com 2013)

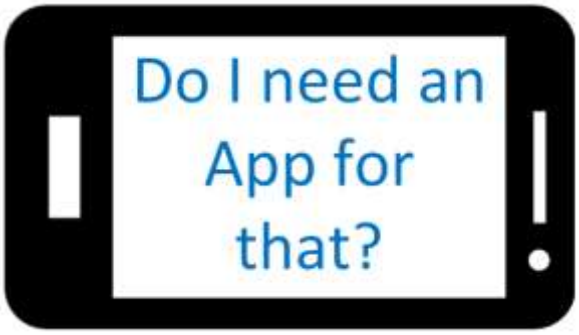
Smartphone and mobile app usage in 2015 (xcubelabs.com 2015)



(Poushter 2016)



(Poushter 2016)



2. Do I need an App for that?

2.1. App objective, types and examples

Apps are widespread and can be powerful tools. Often however, apps are perceived as a "knight in shining armor" - a new solution to an old problem. Novelty and technical feasibility can be deceiving. Digitizing a solution often merely digitizes the problem, and doesn't necessarily solve it. Instead of just going with the fashion, the problem and objective of the proposed (app-) solution should be well defined, followed by a careful SWOT analysis and consideration of possible alternatives. Specific benefits of apps could be, e.g. wide geographical reach, more efficient data collection or more accurate data collection, making use of smartphone sensors (Teacher *et al.* 2013).

For such a strategic approach of app development, use and monitoring, it is crucial to identify the type of app addressing the identified objective, be it "citizen science", "crowdsourcing", engagement, education or individual data collection.
The following list gives an orientation of different app types, providing examples from marine management (cf. OpenChannels 2015a) and other sectors. At the same time this overview can help with the initial market research. Searching the two biggest app market places, the Google Play Store and the App Store, for existing apps is of course also an important first step of the market analysis. In the google play store apps are sorted by category that can help with the search of e.g. a *Maps & Navigation* app. The Bruna Lab (2013) provides an incomplete list with apps for field use (brunalab.org/apps/), as well as Teacher et al. (2013). There is no need to reinvent the wheel, if the answer to "Isn't there an app for this" is yes.

→ **Further Reading**

- TEACHER, A. G. F., D. J. GRIFFITHS, D. J. HODGSON, and R. INGER. 2013. Smartphones in ecology and evolution: a guide for the app-rehensive. Ecol. Evol. 3: 5268–5278. Available at http://onlinelibrary.wiley.com/doi/10.1002/ece3.888/abstract

2.1.1. Information access, education and awareness

In general, apps are ideally suited for providing both stakeholders/communities and professionals with easier and more rapid access to data and information, particularly from field locations. Examples include:

- Enabling visualization of potential **changes** in a location or community and promoting **proactive thinking** about management, conservation, mitigation, and adaptation
  - SLAMM View 2.0 Mobile, which enables interested parties to view and compare sea level rise scenarios and inundation maps on their mobile devices
- Providing information to help users or communities **avoid harmful activities**
  - Whale Alert, which warns mariners when they enter areas of high risk of collision with critically endangered North Atlantic right whales.
- Improving **consumer choices** by providing information about the sustainability and health implications of food options
  - Good Fish Guide App for the United Kingdom
  - Sustainable Seafood Guide for Australia
  - SeaFood Watch App with Project FishMap for the United States
- Increasing **awareness and understanding** of ecosystems and natural resources by providing information
  - Marine World Heritage, which helps users learn about the 45 World Heritage marine sites
  - California Tidepools, which allows users to search a database of photos, common and scientific names, and other information about California tidepool life
  - Ka'ena Point Guide, which shows historical sites, ecological characteristics, and trail information for Ka'ena Point in Hawai'i
  - Expedition White Shark, which provides general information about great white sharks and lets users track satellite-tagged great whites
  - Sea Turtle App, which provides general information about endangered sea turtles and lets users track their worldwide migration.
  - PacfishID Learn to recognize fishes and invertebrates from Pacific Island countries and territories with this application
- Improving **disaster preparedness and response** (assuming the infrastructure for using mobile devices is still functional) by allowing early responders and affected parties to quickly provide information (including photos and GPS locations) about affected areas
  - Hawai'i Tsunami Information Service, which provides interactive tsunami evacuation zone maps and other risk and preparedness information
  - TsunamiEvac-NW for the Oregon and Washington coasts, which helps users determine whether locations are in a tsunami evacuation zone and plan evacuation routes
  - FEMA App, which contains preparedness information for different types of disasters
- Improving **safety** by providing real-time data for planning activities
  - NOAA Buoy and Tide Data
  - NOAA Ocean Buoys
  - CeNCOOS Data Portal Mobile
  - NVS (NANOOS Visualization System) Assets App
  - Smart Buoys for iOS and Android
- Improving **project management** by providing dashboards with real-time data visualizations, plans, portfolios, and status accounts
  - Akvo FLOW Commercial solution for smartphone-based field surveys including visualization in dashboards

2.1.2. Citizen science

While information access, education and awareness apps provide and facilitate information and try to spark interest, citizen or stakeholder science apps provide the public with guidance in studying a subject and furthermore to contribute data (e.g., participate in species inventories, reporting pollution etc.). Specific information on the subject is provided in interactive formats, such as identification guides. Additionally own observations can be recorded,

georeferenced, and sent to relevant management bodies in a structured manner that facilitates their use. This crowdsourcing allows traditional scientific data collection to be supplemented with customary knowledge and observations from community members.

- Mobile field guides for identifying species:
  - Fishes: East Pacific provides 3,600+ images of 1,397 species of neotropical shore-fishes
  - Fishes: Greater Caribbean provides 5,500+ images of 1,599 species of neotropical shore-fishes
  - SeaPhoto provides access to 1,300+ images of 550+ species of marine life of the Monterey Bay National Marine Sanctuary
  - Phyto helps users identify phytoplankton species.
  - Coastal Walkabout automatically takes note of the time and location (GPS) of wildlife sightings before uploading that data in real time to the Coastal Walkabout website (Gaia Resources 2015)
  - Tails' app is designed for use by small-scale fishers to collect "catch" information, recording the quantity of fish they catch and the different species (SPC 2016)
- Apps that harness new technologies such as face recognition software to identify species (e.g., LeafSnap).

2.1.3. Analysis and visualization

Mobile Geographic Information Systems (GIS) and mapping apps allow users to access institutional GIS's, run analyses, and view and explore a huge array of maps, imagery, and features from the field, which can improve field work and extend the time available for conducting work. Examples of mobile GIS and mapping apps include:

- iGIS leading GIS app for iOS
- ArcGIS App for Smartphones and Tablets
- Google Earth for mobiles
- Google My Maps Creating and sharing of custom maps

2.1.4. Monitoring and enforcement

Apps can also help increase monitoring and enforcement effort by allowing stakeholders to report problems (e.g., sightings of invasive species or pollution) and infractions (e.g., fishing inside a no-take area). In the case of species invasions, public reporting of potential sightings — including uploads of high-resolution photos that would allow species scientists to make positive identification — has the potential to facilitate more rapid, and thus effective, detection and response to invasions. In the case of illegal fishing, rapid and anonymous reporting can help law enforcement catch perpetrators. And even when perpetrators cannot be apprehended, accumulated data could provide a sense of the frequency, magnitude, and location of illegal fishing activity and how it might influence the effectiveness of spatial management measures. Examples of apps for monitoring and enforcement include:

- Marine Debris Tracker, which allows users to report trash on coastlines and in waterways. The data can be uploaded for beach clean-ups
- IveGot1, which allows users to identify and report sightings of invasive species in Florida
- What's Invasive, which enables park visitors to document and record the exact location of invasive species within parks.
- Release Mako, which allows anglers to report live releases of shortfin mako sharks in real-time. This speeds and increases the collection of fisheries catch data by enabling commercial and recreational fishers to upload catch information from their mobile phones
- Electronic Catch Documentation System (e-CDS) stores all information, from the legal status of a fishing operation and fishing method used, to volume and origin of catch; is traceable and tamper-proof; and allows for easy data access and entry, records updating, and document verification and validation. Basis for verification and validation of documents for traceability required for all exports to the EU. Additionally collects scientific fisheries data, such as overall stock assessment. WWF, Philippines (Traceall Global 2014, WWF 2014)

- Watch our Seas – Mobile Phone Application Development to Address IUU Fishing and Poaching, operated by Fish wardens, currently being developed by WWF, Fiji
- Marine Traffic Live Ships Map. Search the MarineTraffic ships database of more than 550000 active and decommissioned vessels
- MCS Fishing Vessel App, – SPC (Fiji One 2016)
    - The Monitoring, Control and Surveillance app is an electronic aid for compliance officers to conduct in-port and at-sea boardings and inspections of fishing vessels. It has other features relating to vessel monitoring and searchable MCS reference data. The app is integrated into the suite of tools available in the Regional Information Management Facility (RIMF) of the Pacific Community.
- E-Logbook, is tablet app, which facilitates the captain's submission of fishing and operational activities after every fishing trip, Indonesia (Agustina 2015)
- Happi Fish is a mobile application to report fish landings in the Solomon Islands (Point 97 2014a)
- ABALOBI, as an app suite comprises five inter-connected apps – conceptualised in a co-design process and currently in various stages of development and testing. The five apps cover the full spectrum of stakeholders in the small-scale fisheries sector from hook to cook, governance and beyond.

2.1.5. Field data collection

Apps can provide forms to speed field data collection, geo-reference photos and other observations, serve as memory and input-output devices for environmental sensors, read identification tags, rapidly transmit data from the field to centralized databases/analytical tools, and in turn rapidly receive data from centralized databases/analytic tools to guide next steps for field data collection (e.g., start a new transect). Some of these tasks are currently done with relatively expensive handheld devices. But apps for consumer-grade devices will make these capabilities more affordable and widespread.

- Open Data Kit is a free and open-source set of tools which help organizations author, field, and manage mobile data collection solutions
- Survey Solutions
    - Survey Solutions is a Computer-Assisted Personal Interview technology developed by the World Bank; Getting started tutorial video
- Akvo FLOW pay-for solution for smartphone-based field surveys
    - National inventory of water points, Vanuatu, supported by UNICEF (AKVO 2014a)
    - Post Cyclone Pam rapid assessment, Vanuatu (AKVO 2015b)
    - WASH - Water and sanitation infrastructure in schools, Fiji, supported by UNICEF, Training of teacher association with an age average over 50 (AKVO 2015b, UNICEF 2015)
    - Turtle, Shark bycatch and Whale sharks monitoring, WWF Indonesia and Fiji (AKVO 2014b)
- Cyber tracker is a free data capture software installed in smartphones and tablets used worldwide to record environmental observations.
    - USAID through the Biodiversity and Watersheds Improved for Stronger Economy and Ecosystem Resilience (B+WISER) has enhanced the user interface and navigation of the CyberTracker application for biodiversity and threats monitoring in the Philippines.
- Lami Waste-to-Art Workshop & Suva Harbour Coastal Clean-up (IUCN Oceania Regional Office 2016, p.6) used a digital data card through Google Forms, to make litter monitoring accessible for people with smart phones
- Tails App
    - The app is an innovative mobile or tablet application designed for use by small-scale fishers to collect "catch" information, recording the quantity of fish they catch and the different species; download.

2.2. SWOT Analysis

Once the objective of the proposed app is defined, a Strength, Weakness, Opportunities and Threats (SWOT) analysis can help to decide whether an App can truly add value to an approach or whether to consider possible alternatives. For this purpose hardware and software are analysed separately. The following SWOT template contains general key aspects and can be applied to a specific context and problem statement.

Is a Smartphone the right technology?

Strength • Smartphones are widely available and used • Low costs, as infrastructure already available	***Weakness*** • If smartphones need to be distributed, possibly costs involved, training needed, abuse possible
Opportunities • Reduced cost of outreach (travel costs etc) • Real-time data collection, monitoring and updates	***Threats*** • Acceptance may be problematic for certain audiences, not familiar with smartphones • Technical failures possible, leading to data loss/halt of approach

→**Possible Alternatives:** e.g. Paper based surveys, trainings, websites, SMS based approach, Laptops

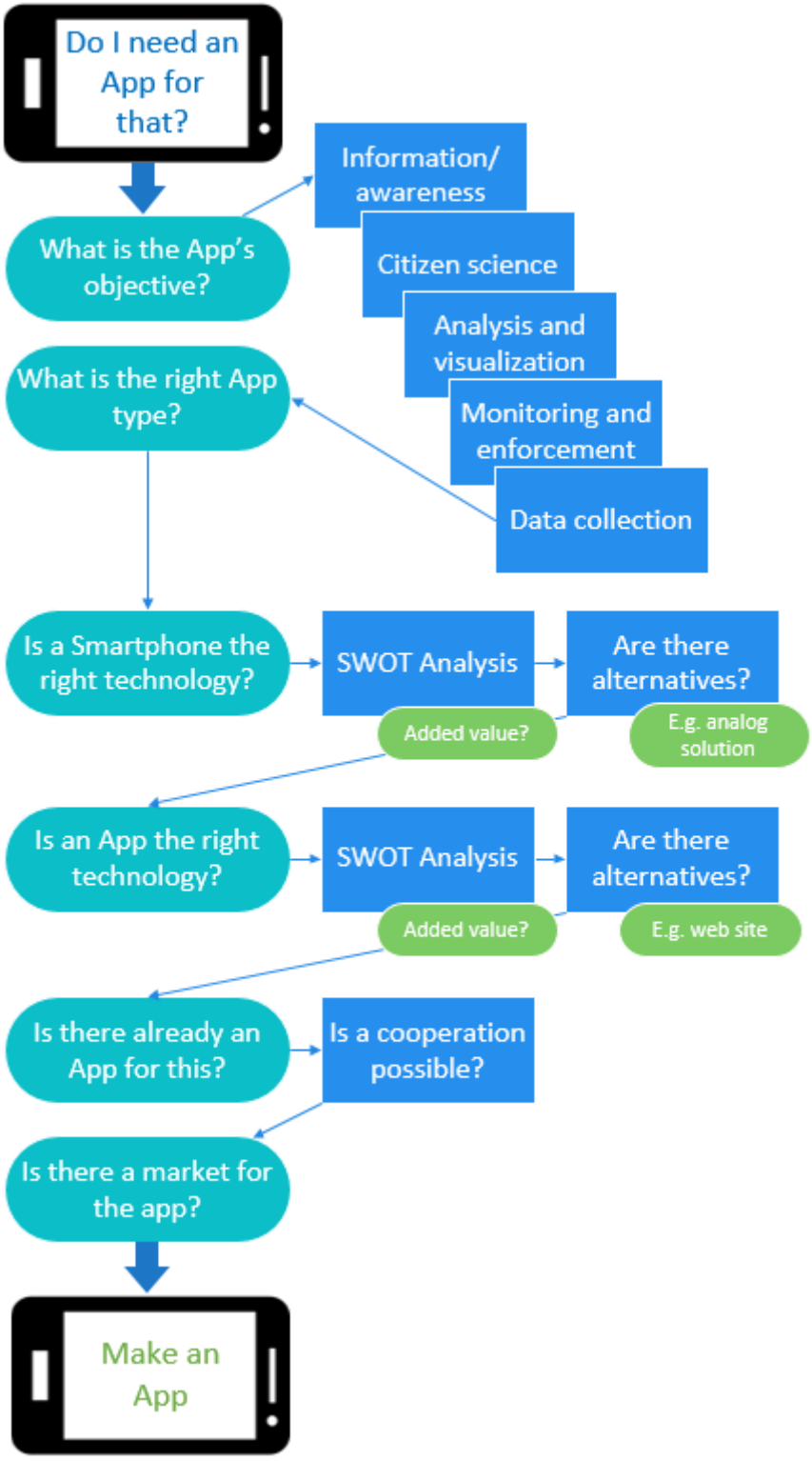
Is an App the right technology?

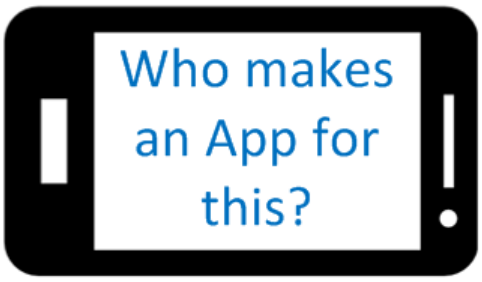
Strength • Commonly used • Novelty may be a unique selling point	***Weakness*** • Development and maintenance costs • Development for different operating systems necessary
Opportunities • Improved efficiency, effectiveness and quality • Wide reach and easy dissemination of approach • Build in incentives for use are possible • Offline use possible	***Threats*** • Limited access internet connectivity and electricity • Sustainability and long term use may be problematic • Technical failures possible, leading to data loss/halt of approach • Support of software versions etc. may be phased out • Data sensitivity issues, if not addressed

→**Possible Alternatives:** e.g. browser based apps, websites, SMS based approach

2.3. Decision tree

The following decision tree can help to understand whether an app may be a useful solution to a given problem statement.





3. Who makes an App for that?

In case a smartphone app can add value to an approach, it needs to be decided, who is going to make the app. A basic decision is whether to keep the app development in house. This can make sense if the app is supposed to become an integral part of the approach or project. The advantage is to keep full control of the app and its backend, and potentially reduce costs and increase flexibility, e.g. during the test phase, to quickly react to feedback or when changes need to be made. Potential "friction loss" in communications with external developers should not be underestimated, especially in an iterative approach.
Obviously staff with the appropriate skill set and experience is necessary. This, however, largely depends on the approach chosen, whether adjusting a building block system or coding an app from scratch.

An underlying principle of digital solutions is to "design with the user" (s.b.). Also for app development this should be taken seriously to increase uptake and ownership, and will influence who is considered developing an app. If, for instance a ministry is supposed to carry out smartphone based surveys, it can make sense to develop the app and questionnaire together with the ministry staff or to train the staff to develop the app themselves. This again depends on the complexity of the app, while more and more tools enable participatory app development.

3.1. Using existing solution

The most straight forward use of an app for an approach is to employ an existing app that already has the required functionality. Thus, as mentioned above, the initial market research is important. The systematic and strategic use of generic productivity apps like

- SpiderOakONE (Secure data storage and synchronization)
- Evernote (synchronized note pad)
- QR & Barcode Scanner
- OpenStreetMap

or specific apps like

- Marine Debris Tracker (report trash on coastlines and in waterways)
- Coastal Walkabout (recording of wildlife sightings)

can add value without much effort and costs involved.
However, it should be kept in mind that the general digital principles also apply for using these solutions. User needs and aspects of distribution, for instance, should not be overlooked.

3.2. Adjusting existing solution

One step further, is the adjustment of existing apps. This can be done by collaborating with the provider of an existing app that e.g. could be adjusted to a certain country or context. Especially when open source standards are used, this transfer can be achieved more easily.
Furthermore, there are numerous platforms that provide a building block system for apps. Epicollect (Imperial College London 2016) and iNaturalist, for example, allow the setup of specific projects to collect data from smartphones and view the data centrally via a website. Spotter provides a customizable platform including components to create a tailored app.

While these platforms simplify the app development process immensely and enable in-house development and participatory processes, they limit the extent to which an app is customizable. The required functionality should be carefully checked against this, to avoid "lock in" effects, in case the app needs to be extended or changed.

There are many commercial solutions of customizable apps, and the pricing model must be carefully taken into consideration. "Freemium" pricing strategy are common, where an app is provided free of charge, but money (premium) is charged for additional features and functionality. Data collection apps often provide a free framework and charge per submission or data storage – on a volume or temporal basis. For upscaling and sustainability considerations, these costs must be taken into account, as well as the fact, that pricing models are subject to the terms and conditions of the provider and may change over-night. Lock in effects can become very expensive or may lead to the failure of the approach.
It should also be considered whether support will become necessary, as some of the platforms offer optional, support that needs to be paid for.
The on- and offline mobile survey app ZWOOR (Zwoor 2015) is on example. The app and backend is free, as well as the first 100 submissions, up to 1000 submissions are then charged with 50 USD, 5000 submissions with 200 USD and 20000 submissions with 600 USD.
The advantage of these pricing models is that first tests and proof of concepts can be carried out at without cost and at low effort.
Other platforms, like Open Data Kit (ODK), are truly free and fully open source. Thus lock in effects can be avoided and additional functionality can be added. Hybrid approaches build a (commercial) service on open source standards, such as SurveyCTO (SurveyCTO 2016). There are numerous such implementation companies. This can be a practical compromise, as ideally lock-in effects are avoided, while core functionality is extended. Using SurveyCTO, developed content, like survey forms, can be migrated, while it renders the deployment of ODK much more user friendly.
How such platform can be successfully adjusted, shows the USAID (B+WISER) project, that enhanced the user interface and navigation of the Cyper Tracker (Spaceacre 2015) application for biodiversity and threats monitoring in the Philippines.

3.3. Key turn ready solutions

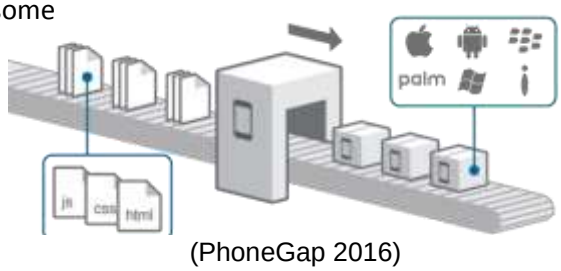
If in-house capacities are limited or for more complex approaches, providers of "key turn ready" solutions may be preferable. To give but one example, the not-for-profit foundation AKVO creates open source, internet and mobile software and sensors. With their mobile product "AKVO FLOW" they provide a "multi-language tool for collecting, evaluating and displaying any quantity of geographically referenced data - using Android smartphones and an online dashboard. While also building on open source standards, the organisation offers a full service, including optional training and deployment in the field. Application examples are

- National inventory of water points, Vanuatu, supported by UNICEF (AKVO 2014a)
- Post Cyclone Pam rapid assessment, Vanuatu (AKVO 2015b)
- WASH - Water and sanitation infrastructure in schools, Fiji, supported by UNICEF, Training of teacher association with an age average over 50 (AKVO 2015b, UNICEF 2015)
- Turtle, Shark bycatch and Whale sharks monitoring, WWF Indonesia and Fiji (AKVO 2014b)

Unsurprisingly, this service comes at a higher cost than the adjustable solutions above (e.g. the cheapest package "flow20": 20 devices, 4000 submissions, 3960 EUR/year). This may be a worthwhile investment, while it may inhibit scalability, ownership and sustainability.

3.4. Development from scratch

Similar to the above mentioned generic approaches, also key turn ready solutions can be limited in its functionality. Providers focus on a set of functions and features which can only be adjusted to some extent. If the required functionality cannot be met, the app needs to be developed from scratch.
While coding a smartphone app is a complex process requiring a specific skill set, it is important to note, that new tools dramatically simplify app development and democratize it to some extent.
There are many building platforms and tools (Mercer 2016) that can be used. The open source based PhoneGap, as one example,



(PhoneGap 2016)

"reuses existing web development skills to quickly make hybrid applications built with HTML, CSS and JavaScript" (Adobe 2016).
Tools are divided in front and back end development. Front-end development tools are focused on the user interface (UI) and user experience (UX) and provide the following, UI design tools, software development kit to access device features and cross-platform accommodations (Wikipedia 2016a). Back-end tools are integrating the front end with the back-end systems, such as the server, user authentication or data services. This list provides an overview of available Front-end development tools and Back-end servers (Wikipedia 2016a).

The selection of an external developer depends on the available budget, required functionality and use of platforms and tools.

3.4.1. A collaborator or student

Tools like PhoneGap enable developers with basic programming skills in HTML and CSS to develop an app. Thus a relatively affordable way of app development can be the collaboration with students or lecturers of Universities' IT departments. At the same time this can be a good way of developing and strengthening local capacity, also ensuring ongoing support and local ownership of an app.

3.4.2. A hired professional

In case there is no local expertise available or the envisioned app is likely to be too complex, a professional app developer should be hired. The field of app development has been steadily growing, and in 2013 there were about 529,000 direct *app economy* jobs within the EU. Clutch and appindex, for example, provide directories for App Development Agencies that can be searched by Size & Pricing, Focus and Location (AppIndex 2015, Clutch.co 2016). It also makes sense to approach other organizations that previously worked with app developers, who may be specialized on a certain sector. When WWF Fiji wanted to develop their "Watch our Seas" App for example, they were referred to Point 97 (pointnineseven 2016), a company specialized on "mobilizing sustainable seafood".

Teacher at al. report from their experience, that "an app developed by a freelancer or a development company will likely cost between GBP 3000 and GBP 10,000 depending on its complexity, and the development time may be in the order of 1 - 3 months".
When a contract with a professional development company is signed, there should be a focus on user-centered design, including test phases in the field, as well as a "agile method of software development involving incremental development, where the requirements and solutions are adaptive" (Teacher *et al.* 2013). Also, copyright issues should be taken into account, as the developer may retain copyright over the app, code, graphics etc. To provide open-source solution, this should be clearly agreed upon in the contract.

3.4.3. Hackatons

A resourceful alternative to a professional can be a Hackaton. One successful example is the Fishackaton (Department Of State 2014, Devpost 2015) an annual global event, organized by the U.S. Department of State. "Volunteer coders, technologists, and designers spend a weekend developing usable solutions to problem statements solicited from fisheries experts around the world. At the end of the hackathons, teams presented their work and an expert panel of judges will nominate a winner from each site, eligible for worldwide grand prizes."

While Hackatons can be an affordable way to develop an app, the potential is much larger, as the events can become a vessel for education and awareness on a certain topic, as well as build and connect local capacity and IT networks.

Some lessons from the 2016 Fishackaton in Suva, Fiji are:

- Participants are willing to put an surprisingly amount of effort into a project that interests them
- Most participants didn't have any prior knowledge of any

A **Hackaton** is an event in which compu programmers and others involved in software development, including graphic designers, interface designers and project managers, collaborate intensively on software projects. Hackathons typically last between a day and a week. Some hackathons are intended simply for educational or social purposes, although in many cases the goal is to create usable software. Hackathons tend to have a specific focus, which can include the programming language used, the operating system, an application, an API, or the subject and the demographic group of the programmers. In other cases, there is no restriction on the type of software being created (Wikipedia 2016).

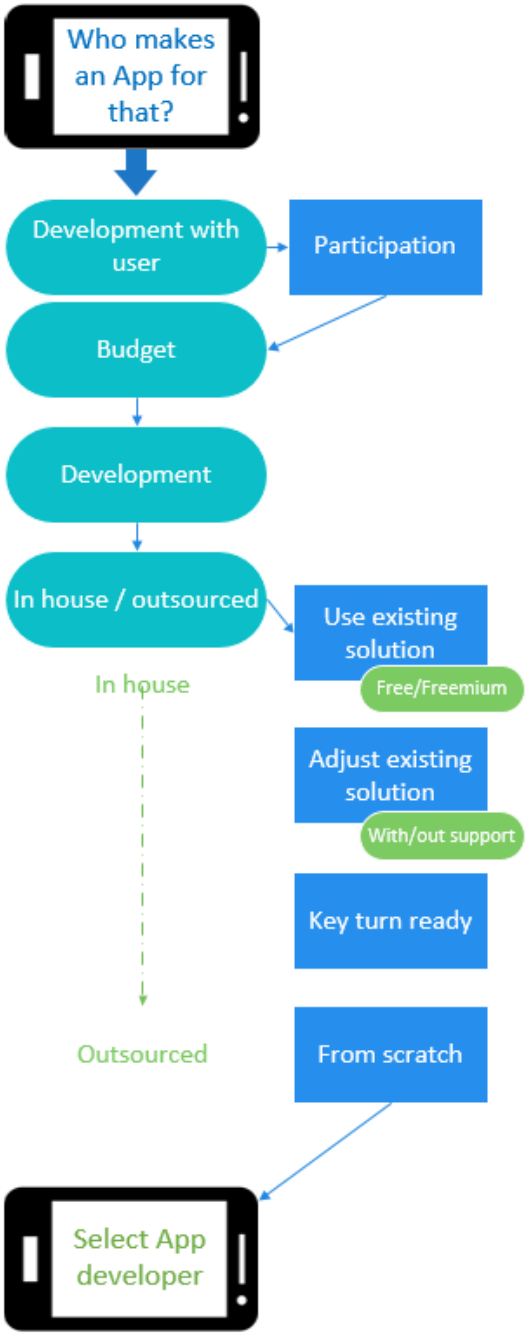
of fisheries related issues

- There was a free exchange of ideas and information: the group didn't have any hierarchy so everyone's opinions were freely provided and received
- Developing mobile software (from scratch) is difficult but can be done by 2-3 people in a weekend
- There was a relatively low level of interest (only 9 participants) even with a global effort and prizes

Generally, the local potentially limited resources need to be taken carefully into consideration, an adequate framework and incentives should be given and there should be an emphasis on open source initiatives, where the intellectual property right does not remain with the organizer. Also, a locally relevant problem statement increases local ownership of the developed solution.

3.5. Decision Tree

The following decision tree can help to decide who is going to make the app.



4. How to make an App for this?

4.1. Principles for app development

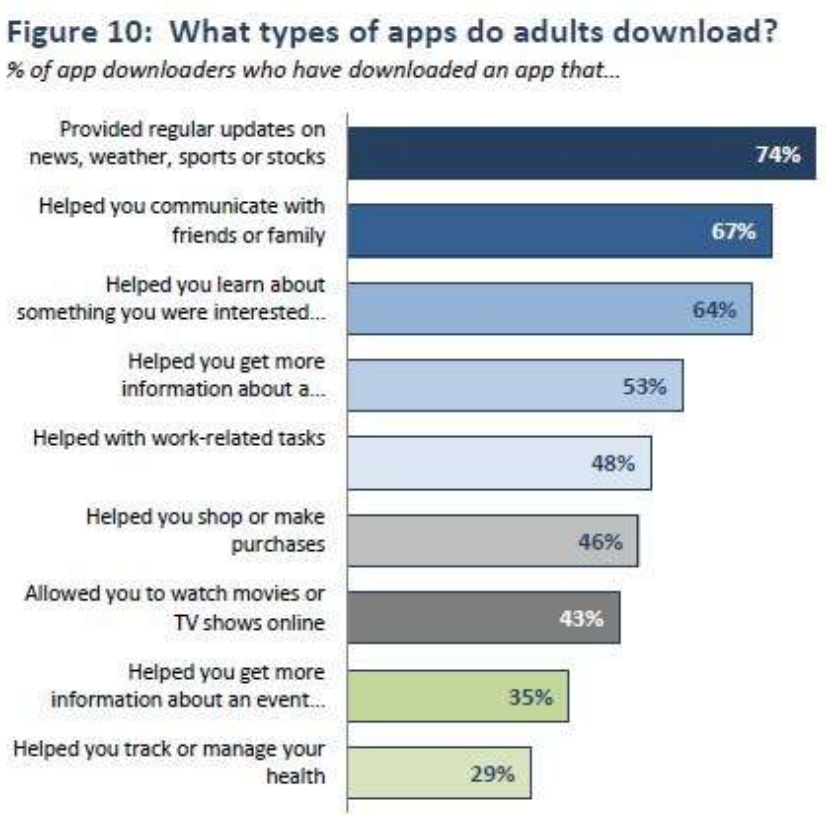
As soon as the objective, type and developer of an app are identified, the development process can begin. While there are various options to develop an app, there are underlying principles that should be carefully considered. The following set of principles represents an effort to "capture the most important lessons learned by the development community in the implementation of technology-enabled programs" (DigitalPrinciples 2016). These principles seek to serve as a set of living guidelines, informing the design of technology-enabled development programs, such as apps.

4.1.1. Design with the user

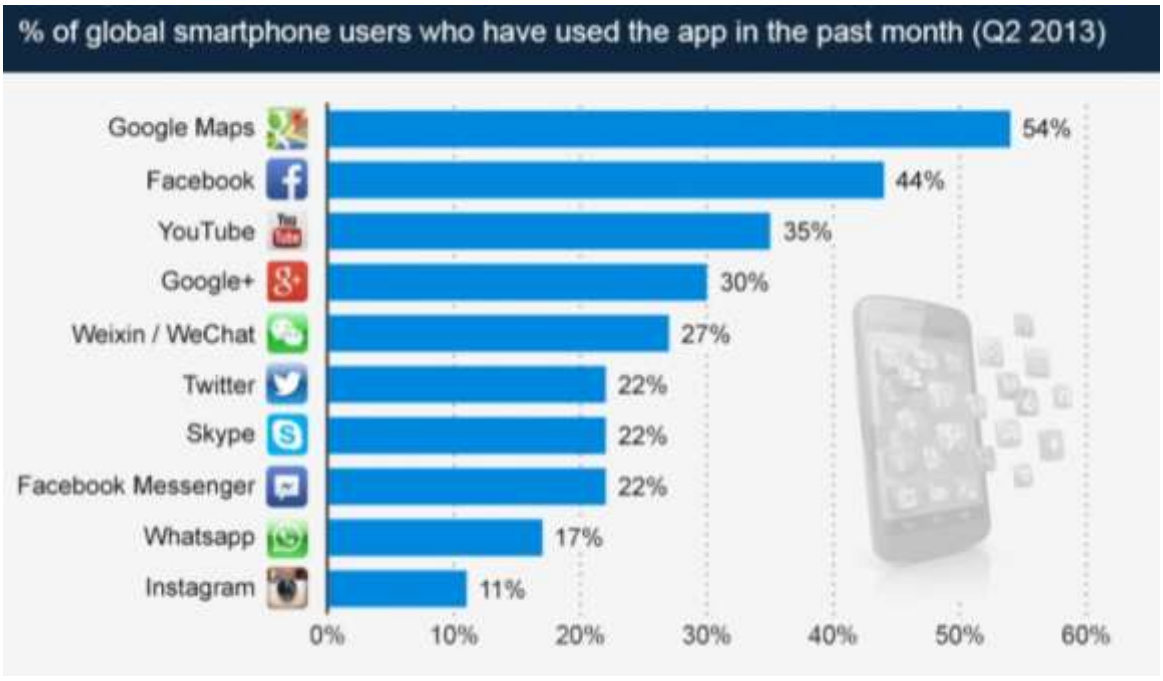
To develop context-appropriate solutions the development process needs to be informed by user needs. Generally, the user choice for apps and perceived added value is influenced by the following (cf. Serm Murmson 2015):

- Access and use of phone utilities
  - Many smartphone apps enhance the navigation, display and capabilities of the smartphone itself. Popular examples are file manager app to manipulate the files on a device, or extensions to share content.
- Interacting with the world
  - A number of apps enable the users to keep track of real-world events and document their life, e.g. through integration with the build in calendar, camera or GPS navigation apps. Also integration with other app allows for a fluid switch between functions, e.g. to open a messaging app from within the camera app in order to send a picture.
- News and update services
  - Thanks to the connectivity of smartphones, users can receive immediate information and news through apps, such as stock and weather updates or RSS feeds.
- Games and entertainment
  - Games are an extremely popular type of smartphone app, ranging from free, simple text based games to purchasable, fully animated 3D action games. To address a certain audience and use apps as a vessel for a subject, gamification – the application of game-design elements and game principles in non-game contexts - can be extremely powerful.
- Media management
  - Smartphones can store and play various media types such as music, books, photos and video clips. Many smartphone apps can interface with cloud-based or streaming media services, allowing access to media without downloading it on the phone.

In line with these basic apps features, users decide predominantly for news, communication, information, work and entertainment apps.

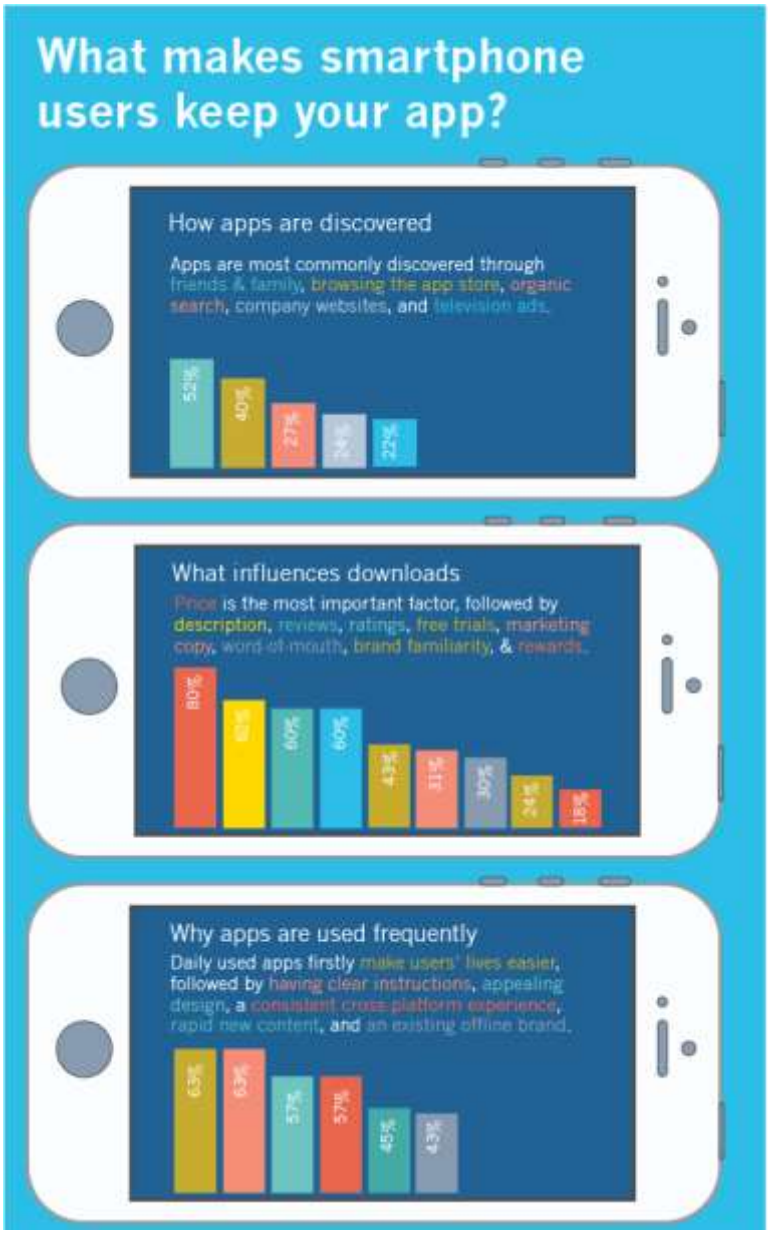


(Purcell 2011)



(Statsitica 2013)

Also when deciding for the distribution and marketing it is important to keep the users and their situation in mind. For example, apps are often discovered through friends and family and downloaded if they have a meaningful description. The long term use, and thus the sustainability of an app based intervention depend largely on the users perception on whether it makes their lives easier, has a clear description and appealing design.



(Business2community.com 2015)

In light of this, it is of paramount importance to include all user groups in planning, development, implementation, and assessment. This can best happen in an incremental and iterative manner, with build in test phases. In addition, app development should learn from previous lessons learnt.

App solutions should be very sensitive to users' contexts, including the most marginalized populations. If connectivity in remote areas or language barriers are issues for example, such aspects have to be considered in the development process. In addition, it is often forgotten to provide users with feedback, e.g. why their records in a data collection app are useful and how they may be used (cf. Adriaens *et al.* 2015).

Finally, Teacher et al. (2013) emphasize "that the usefulness of an app relies heavily on the development process and recommend that app developers are engaged with the process at the earliest possible stage, and commend efforts to create open-source software scaffolds on which customized apps can be built by non-experts". Such an approach builds capacity and can enable the backend users of an app of operating and adjusting an app on the longterm.

4.1.2. Understand the ecosystem

Technologies, like apps, are never isolated, but are part of an "ecosystem". This can be networks and communities of practitioners, which are an essential resource for exchange on lessons of app development. Aligning to existing technological, legal, and regulatory policies and standards is equally important.

4.1.3. Design for scale

One of the big advantages of app solutions is relatively easy scalability due to wide internet and smartphone penetration, and common software and platform standards. If the objective is to reach a wider audience, the app should be design for scale from the start, considering implications of design beyond an immediate project. Accordingly, an app should be replicable and customizable in other regions, countries and contexts, e.g. by including the option of translated versions.

Before scaling however, impact needs to be demonstrated, e.g. in a confined test and learning site. For implementation, but especially for upscaling efforts, partnerships with key stakeholders are crucial and should be considered from the beginning.

4.1.4. Build for sustainability

To achieve the long term use and success of an app, not only user requirements are important, but also considerations like ownership, administration or funding. From the very beginning it needs to be considered who is in charge of the app, who will administer content and potential updates and how running costs, like app store fees, will be covered. Utilizing and strengthening local communities and developers, as well as engage with local governments and organisations is crucial – beyond projects' lifespans.

4.1.5. Be data driven

Smartphone apps have the distinct advantage of the ease of collection of meta data. E.g. real time data on usage can be monitoring and analysed, and thus inform iterative improvement. As discussed below, data privacy should be taken seriously, however.

The focus of app approaches should be on outcomes rather than outputs. E.g. the actual change an App brings about, rather than the mere number of downloads.

4.1.6. Use open data, open standards, open source, open innovation

Thanks to open standards, the development of apps has become much easier. Building block systems can be used to apply existing solutions to new contexts. Open Data Kit, as described below, is a great example for such standard. At the same time, using open standards can improve the uptake and sustainability of an app, as well as harness community support. For this, a good documentation of approaches, as well as providing access to code and APIs (Application Programming Interfaces) is important. If possible, also collected data should be made available for the public benefit.

4.1.7. Reuse and improve

Similarly, the use, modification, and extension of existing tools, platforms, and frameworks utilize and contribute to the powerful dynamics of open source. E.g. an app plug-in developed for a specific solution can be used by others, and vice versa.

Iterative improvement of app versions benefits from test phases and tight feedback loops from the user.

4.1.8. Address privacy & security

As smartphones are pocket sized data collection machines, data privacy and security is an issue that must be taken seriously. Perceived abuse of app permissions and collected data can undermine users trust and endanger the success of an app or even put the reputation of the organisation in charge at risk. Thus risks to the security of users and their data must be assessed and mitigated.

4.1.9. Be collaborative

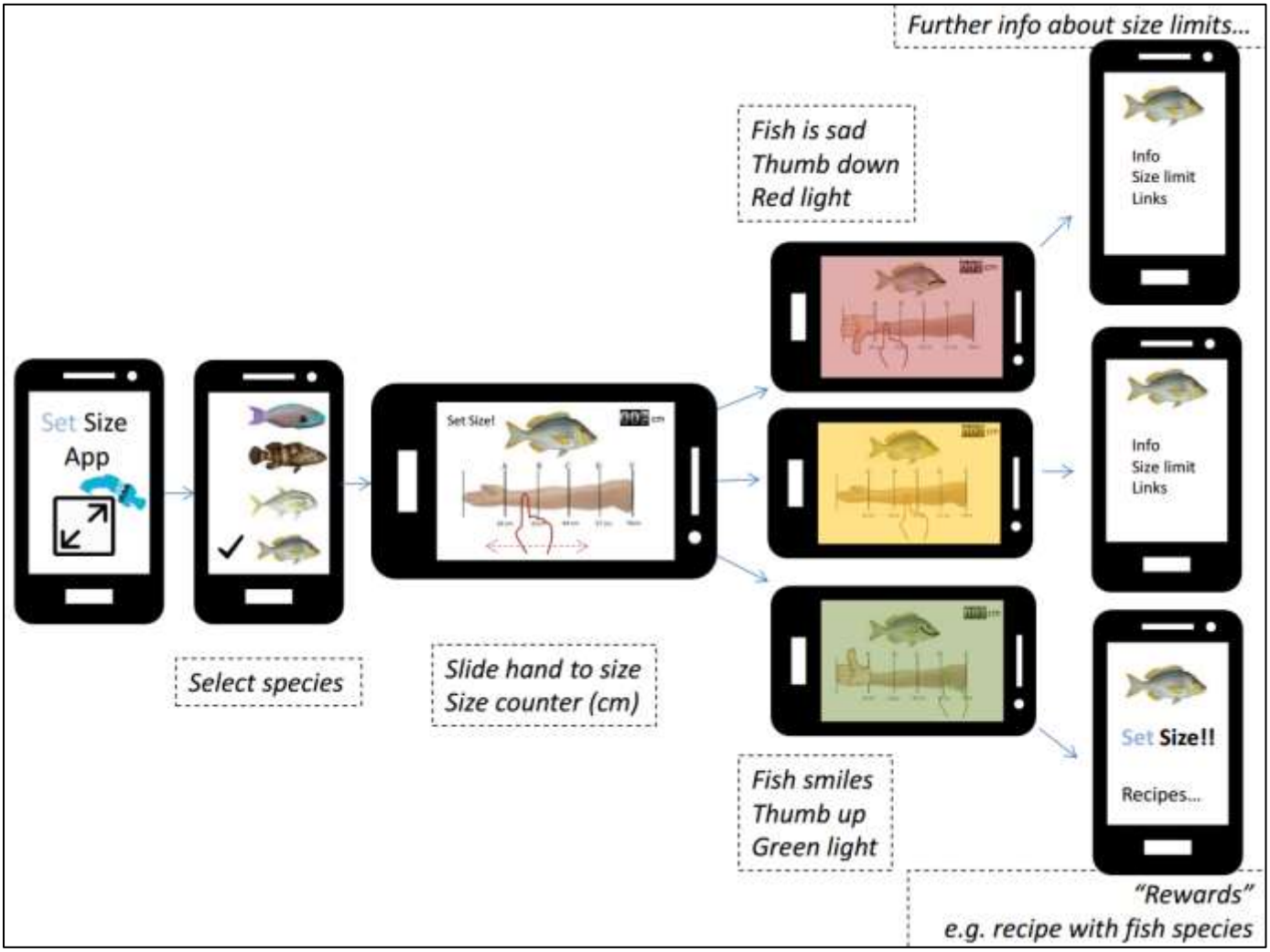
Combining diverse expertise across disciplines and industries can help to overcome silo thinking. An app used in a fishery context may well work in an agricultural setting, too. At the same time, crucial aspects of app use may be overlooked by a small group of developers, but discovered through wider involvement of practitioners in the field. Thus coordination and holistic approaches are important, as is the documentation and sharing of work, results, processes, and best practices. The publication of materials under a Creative Commons license is good practise.

→ Further Reading:

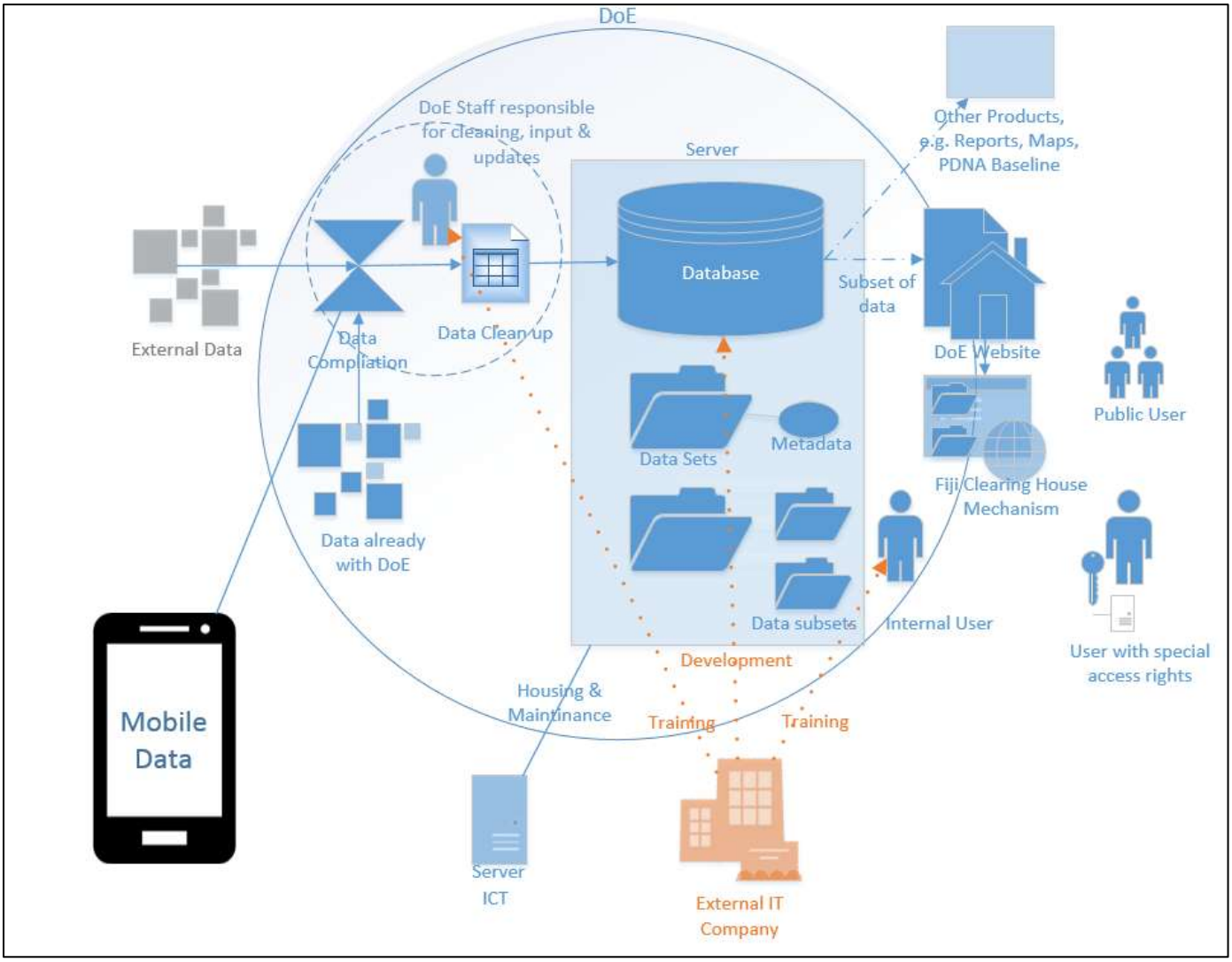
- Digital Principles. 2016. Principles for Design & Development ICT4D. Available at: http://digitalprinciples.org/

4.2. Who is the user?

In line with principle one, the users of the app needs to be at center of app development. There are two different types of users, the front and the backend user. Frontend users are the primary audience of the app, while backend users are administrating data, authorizations etc. “behind the scenes”. Both users have to be considered during app development. In some cases the app use may be moderated by an enumerator, e.g. for data collection in the field, while e.g. in a crowd sourced approach the frontend user operates the app directly (cf. Constantine 2015).
For the involvement of the user from the very beginning, jointly developing a flow chart of the app functionality is a useful communication tool. The following flow chart of the user interphase gives an example of visualizing the functionality and logic in an app. This proposed app for the 4FJ Campaign, aims to raise awareness about minimum catch size of fish species. The flow chart helps to interpret the user’s ideas to the developer. For instance, potential local users where questioned, how they would commonly talk about size of their fish catch. It turned out, that in Pacific islands it is common to indicate size on the stretched arm. The flow chart helped to translate this way of size measurement into a slider in the app.



For backend users, a similar flow chart can be useful, visualizing the ecosystem the app is feeding into, including staff responsibilities, server set ups and data retrieval. This example visualizes a proposed mobile app that feeds information into a ministry’s data infrastructure.



4.3. Required functionality

Based on consultations with the user of an app, the required functionality can be identified. The following aspects should be considered:

- **User interface** (UI): As discussed above, the usability of an app is largely influenced by its UI. In general, mobile UI entails components of both hardware and software, reflects contexts, screen, input, and mobility as outlines for design and aims at an understandable, user-friendly interface. The UI of mobile apps should consider users' attention span, minimize keystrokes, and be task-oriented with a minimum set of functions.
- **Home page**: An app can benefit from a home page with brief instructions on how the app operates. In addition a homepage can go parallel with an app, to use the app function from a (mobile) web browser as well. The homepage can also function as a dashboard, e.g. displaying data collected with the app (in real time).
- **One/Two-way communication**: A basic difference in functionality is whether the app only displays information or enables the user to input information that is processed and/or stored in a central database. The later requires a more complex backend, including server and storage considerations.
- **On and Offline functionality:** Especially in the context of developing countries or in rural settings with limited connectivity, it is important to consider off-line app functionality. Online apps have the advantage of low requirements of storage data and can be easily adjusted, as data is retrieved from the cloud. For off-line apps more data may need to be downloaded to be cloud independent and functionality may be limited. Often apps are hybrids. For instance, data can be collected and saved off-line and uploaded, once an internet connection is established. A map may be usable off-line, whereas links from markers in the maps only work online.

- **Back end**: Focusing on the UI of an app, also the back end should not be forgotten. Aspects like administration, data export or user access management determine the long-term use of an app. If these are unintuitive or overly complicated, backend users may need to be trained intensively or may fail to use the app (especially on the long-term, if knowledge gets lost e.g. due to staff turn-over)
- **User registration:** Access to an app can be granted without or with user registration – before or after app download. Mandatory registration may add an additional barrier for the user, while it can ensure more efficient user management and monitoring. Users can also be granted different levels of access, e.g. view or edit access.
- **Scalability**: For scalability of apps, the option of including plug-ins or add-ons should be included. Providing language support or generic templates, e.g. for survey form creation can also improve the transfer to other contexts.
- **Media types**: Apps can support various types of data and media (Geo-Data, photos, video, audio),
- **Preloading**: Preloading and updating of existing data can be important, e.g. to track data points over time.

4.4. Native or Web App

Based on the required functionality one needs to decide between three different types of apps (Budiu 2013).
Native apps are the type of app most commonly known. They are installed directly onto a device itself, usually downloaded via app stores. They are developed specifically for one platform taking full advantage of the device features, like camera, GPS, accelerometer or contacts, as well as the device's notification system. One very important advantage is that native apps can work offline.
Web apps, on the other hand, are internet-enabled apps that are accessible via the mobile device's web browser and do not need to be downloaded onto a device. Ultimately, they are websites rather than an actual application. While they look and feel like native applications, they are implemented differently, typically written in HTML5. Web apps are run by a browser and users access them as any web page through a URL. This also means that internet connectivity is necessary to use web apps.
Hybrid apps are part native app, part web app. Like native apps, they are downloaded via an app store and can take advantage of the device features. Like web apps, they display HTML web pages in a browser, while the browser is embedded within the app. In a way, hybrids are "wrappers" for an existing web page with a presence in the app store, but with significantly less effort for developing a native app. As the same HTML code component can be reused on different mobile operating systems, hybrids enable cross-platform development, reducing development costs.

To decide for an app type, Budui (2013) summarized them along the most important aspects

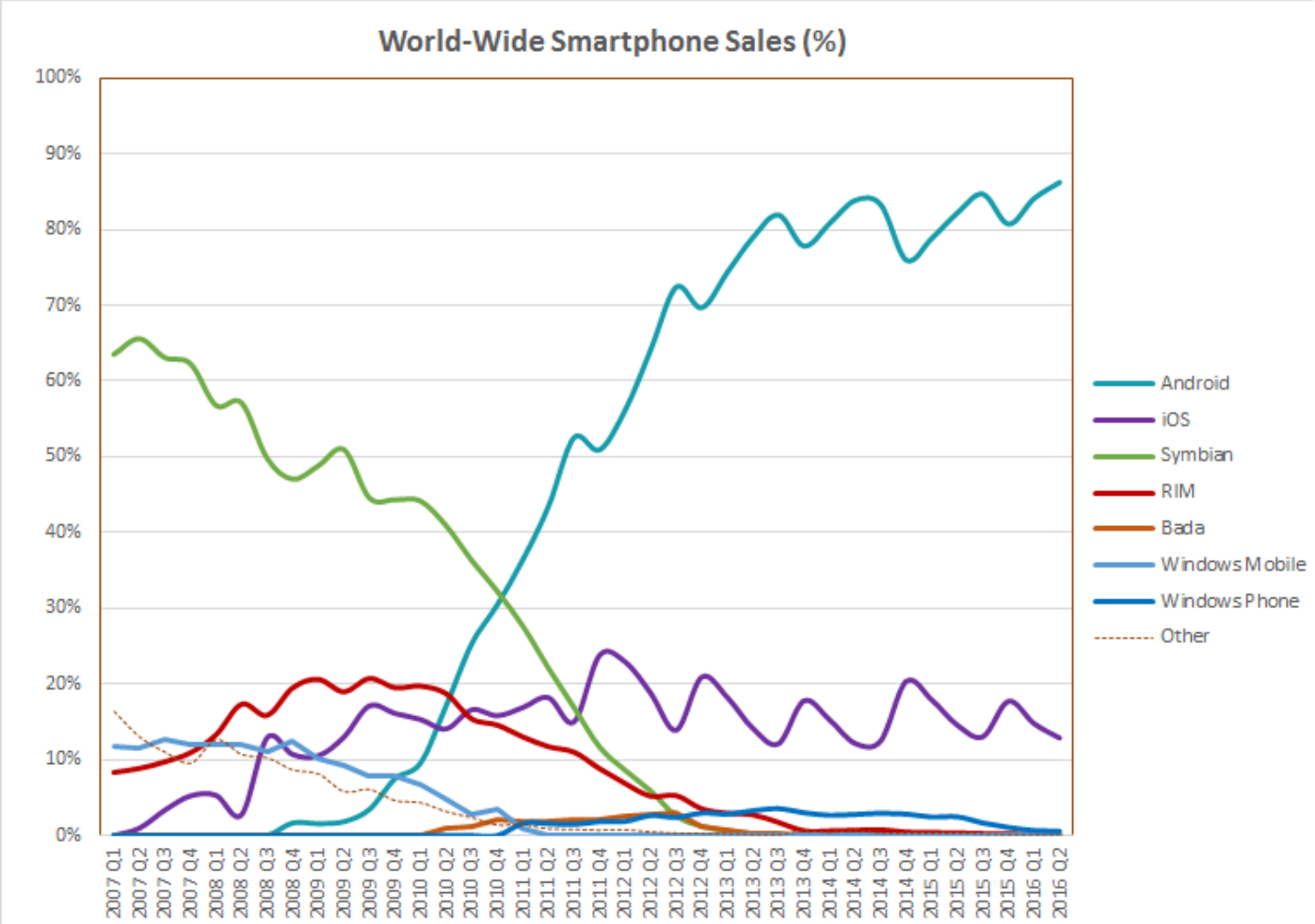
- **Device features:** Although web apps can take advantage of some features, native apps (and the native components of the hybrid apps) have access to the full range of device-specific features.
- **Offline functioning:** A native app is best if an app must work when there is no connectivity. HTML5 enables in-browser caching to make some content of web app available offline, but this is still very limited.
- **Discoverability**: Content of web apps is more discoverable on the web than in an app. Web app content is searchable on all search engines, whereas content in native apps is "hidden", until the app is installed.
- **Speed**: As speed and responsiveness are key to usability, this is an advantage of native apps over web apps that are usually slower in loading content, and more dependent on internet speed.
- **Installation**: Installing a native or hybrid app is more effort for users, than simply opening a link to a web app. Also the native app permissions to device functions, e.g. access to the contact list, may be perceived as sensitive and can present a hurdle to app installation.
- **Maintenance**: Maintaining a native app can be complicated, especially on multiple versions on different platforms. Changes have to be packaged in a new version and placed in the app store, whereas maintaining a web app or a hybrid app is as simple as maintaining a web page.
- **Distribution**: Native and hybrid apps must pass approval processes and content restrictions of app stores, which additionally charged usage fees. As web apps are not dependent on app stores, distribution is much easier.

- **Development cost:** Hybrid and web apps are arguably cheaper to develop, as these require more basic web development skills, than native apps.

- **User Interface:** Native apps can have an advantage of a better UI that is more consistent with the operating system and other available apps on that platform.

4.1. Operating system

As discussed above, there are several different platforms and operating systems on smartphones, which need to be considered for app development – especially for the development of native apps that are platform dependent. In 2016 Q1, more than a billion smartphones were sold and global market share was 84.1% for Android, 14.8% for iOS, 0.7% for Windows Phone, 0.2% for Blackberry and remaining 0.2% for all other platforms (Wikipedia 2016b). Especially in the context of developing countries, more affordable devices are more frequent. Such devices are typically running on Android, making Android the most relevant platform for native app development. To be more platform independent, web and hybrid apps should be considered.



(Wikipedia 2016b)

4.2. Backend

As seen above, the backend is an important aspect of an app. Establishing a server, database, and website provides the necessary ecosystem for the app frontend. Flow charts are a good visualization and communication tool and there are many backend development tools available (see above).
The complexity of backend development depends on the chosen approach. Key-turn ready solutions and building block systems may come with a fully curated server and database, while for individual development the backend is an important position to be discussed with the developer.
In general, Apps can be deployed either to curated **cloud services,** like Google App Engine or Amazon EC2 cloud services, or to **local webservers**.
Cloud services enable easier and quicker installation and are typically scalable. They will automatically scale the app in response to the amount of traffic it receives, so only resources that are actually used need to be paid for. The

primary chargeable consumption is “data store reads”. Small projects, e.g. collecting fewer than 2000 responses, can be free of charge, whereas typical costs for app hosting have the minimum charge of USD 2.10/week (ODK 2016b). Google App Engine, for example, additionally provides built-in services such data storage or user authentication. While local hosting can avoid these costs and provide independence of third party services, it implies taking ownership of configuration, maintenance, security, back-up etc.
Both of these backend options require internet access. However, there are solutions that work completely offline, like ODK Briefcase.

4.3. Distribution

A finalized app needs to be distributed. While for web apps this is relatively straight forward via sending a link, native apps are typically offered in an app marketplace. Google Play has a one-time fee of USD 25, the Apple App Store charges a fee of USD 99/year. These costs need to be considered in the budget and long-term arrangement for the app. At the same time, app marketplaces can be a tool for app distribution, as they are public and fully searchable.
Independent of the technical aspect of distribution, an app should be embedded in a communication and marketing strategy. Clear unique selling points of the app need to be packaged in appropriate messages for the envisioned audience. Incentives, nudges and perks can be built into the strategy to increase chances of app installation and use – especially on the long-term. Such incentives can range from free phone credit to a badge system that rewards use with visibility among peers, e.g. on social networks.
Depending on the audience, also training in app use may be important. If the audience has no previous experience with smartphones this should also be considered. Obviously, addressing demographics, more familiar with smartphones and apps is likely more successful, with less training effort.
Similarly availability of devices is crucial. If mobile devices are not available to the audience or the use of private devices is not desired, devices must be made available (see hardware considerations below) and appropriate training provided. Training can range from providing documentation to face-to-face workshops in the field.
Once an app is distributed and being used, ongoing support may be necessary, in case of technical difficulties, necessary updates, or staff turnover.

4.4. Internet access

Internet connectivity is another key aspect for distribution and use of apps. While web apps depend on constant connectivity, native apps can be used offline. However, in order to receive or send information, at least occasional connectivity is required.
If the audience already uses smartphones, they likely have mobile data plans or pre-paid data. Typically, apps don’t use a large bandwidth end send only small amounts of data. This depends of course on media type. Transmitting video files uses much more data than simple text.
Thus, it may or may not be necessary to provide the user with mobile data. Options include data plans or subscriptions if constant connectivity is required, or (remote) on demand recharge, specifically when user needs to submit data. It can be make sense to cooperate with local mobile phone companies, who may be willing to provide free or reduced data plans, as part of their CSR.

4.5. Hardware

In addition to the software aspects of apps, the hardware is key. Typically apps run across devices, be it smartphones or tablets. However, newer apps may not run on older devices, if functionality is not given or necessary updates to operating systems are not supported anymore. While web apps usually adjust to device type and screen size, native apps have to be developed in a “responsive” way, so they optimize user experience on all device types. For some apps, the bigger screen size and more comfortable keyboard of a tablet may be desirable, e.g. for media and text heavy field data collection.
Again, depending on availability of hardware, purchase and distribution of devices may need to be considered in the app strategy. This may result in significant costs. However, mobile devices are becoming more and more affordable. Basic smartphones are available for under USD 50. Nevertheless, required functionality and user experience should be considered and tested. The support of dual simcards can be a good option, if a device is used with a private simcard as well as an additional simcard that can be charged with mobile data for use of the respective app. Also battery life can be important, especially in remote settings. Additional mobile or solar chargers can be an option.

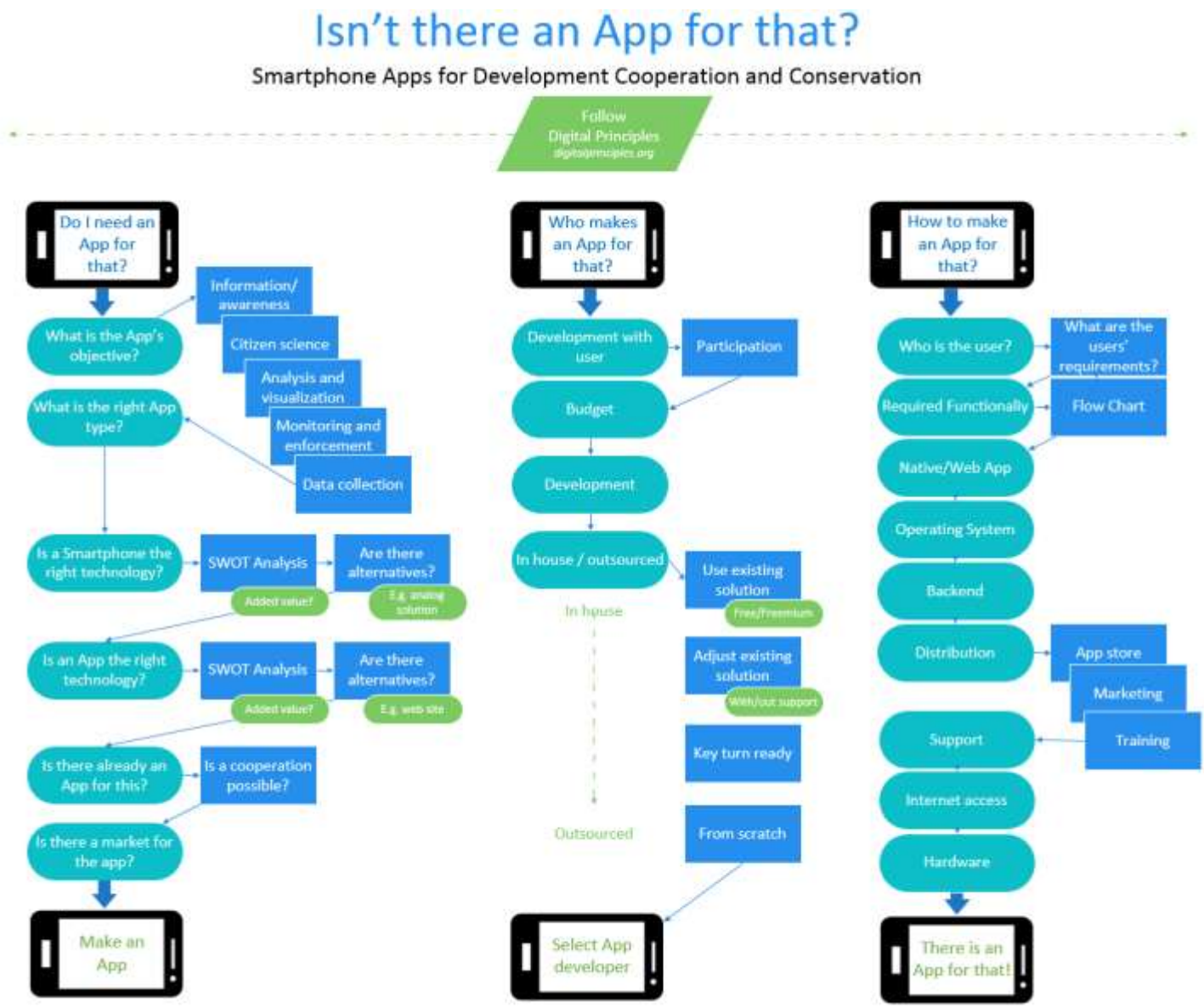
4.6. Decision tree

The following decision tree can help to decide how to make an app.

How to make an App for that?
Who is the user?
What are the users' requirements?
Required Functionaliy
Flow Chart
Native/Web App
Operating System
Backend
Distribution
App store
Marketing
Training
Support
Internet access
Hardware
There is an App for that!

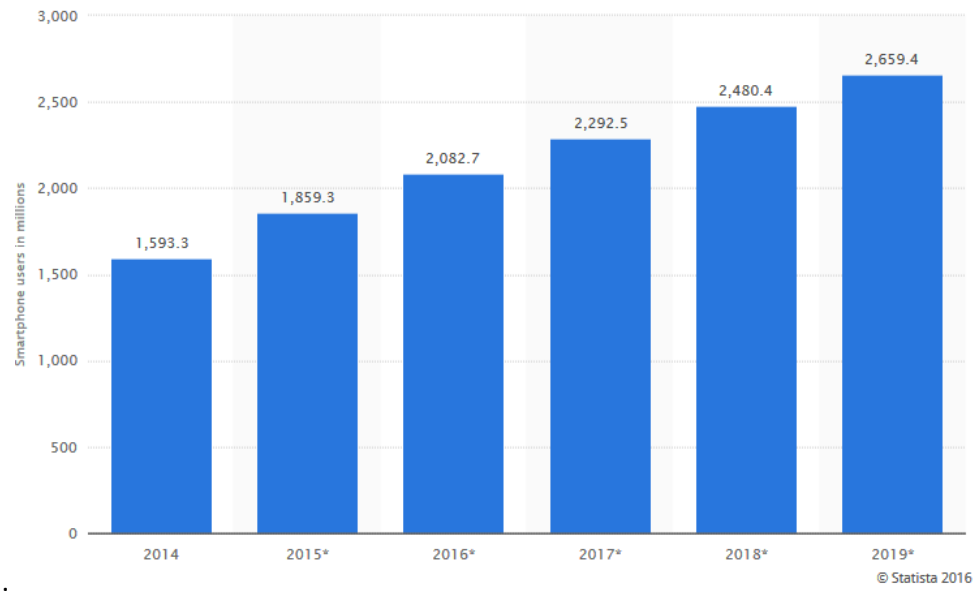
5. Decision tree

This is a summary of the described app development process.



6. Outlook

Both the availability of smartphone as well as the access to internet continues to increase among the public. As especially in developing markets smartphones are on the rise, more and more data will become available and user groups will become wider. Already in 2011, Huawei released an Android phone costing USD 80 in Kenya and in 2016 the cheapest smartphone is about USD 50. Google launched its Free Zone, "allowing basic feature phones with internet connectivity to access Google products without the need for a smartphone". Consequently, also specialists in natural resource management are increasingly using smartphone apps in their approaches (cf. BMZ 2016b, OpenChannels 2015b).
New operating systems like UbuntuTouch and Firefox OS phone provide further opportunities for smartphones in the developing world. Both are free and open-source Linux-based operating system for Android phones. These advances are increasing the potential user groups for app based approaches. At the same time optimizing apps to settings with low available bandwidth will remain crucial for app uptake.
Also on the hardware end advances are to be expected, including better cameras, microphones, storage, processing power, battery life and a wider availability of sensors. A remaining challenge to the potential of app based approaches is the integration of collected field or crowd sourced data with centralized databases. Besides the variety of available building block systems, a truly generic, open source platform for apps is to be expected that allows users without programming skills to fully customize an existing system. With the progress of HTML5 also web apps with all their advantages are likely to become more frequent and usable – across platforms.
Another field with great potential is Augmented Reality (AR), "a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data". Devices like the Google Glass, optical head-mounted displays, will allow to present data directly in the environment it is derived from, rather than in abstract representations. This has a large potential for app based engagement with broad audiences in completely new ways



(statistica 2016)

7. Open Data Kit for data driven marine management in Fiji

7.1. Objective

Managing marine resources heavily relies on data, while in many settings in Pacific Island countries there remains a lack thereof (e.g. Sadovy de Mitcheson 2013). Manual, paper based reporting system are widely used (e.g. AKVO 2015a, Point 97 2014b), even though these are typically burdensome and resource intensive. When forms are re-entered into computers manually there can also be a high margin of error. Furthermore, data often remains locked away in spreadsheets and results are not measurable, visible or accessible.

In line with its objectives, the MACBIO project supports Fiji, Kiribati, Solomon Islands, Tonga and Vanuatu in effective approaches of site management, especially of locally managed marine areas and marine protected areas (MPAs). In this context MACBIO was requested in 2015 to support data collection on locally managed marine areas in Fiji – in particular with the design and development of open-source mobile solutions.

The *Marine and Coastal Biodiversity Management in Pacific Island Countries* project (MACBIO) aims at strengthening institutional and individual capacity to manage and conserve biodiversity in marine and coastal ecosystems, aiming to support sustainable economies and livelihoods of Pacific island states.
Marine Ecosystem Services Valuations highlight the importance of often hidden biodiversity treasures. The sustainable use of these need to be planned and effectively managed on the ground. MACBIO is facilitating stakeholder-based efforts to document and disseminate lessons learnt from effective management of learning sites.
In this context, app based, data driven marine management is an innovative approach tested, documented and disseminated with the relevant stakeholders.
Further info: macbio-pacific.info/app/

7.2. Background

During 2015 there were numerous discussions about the value smartphone app based approaches could add to marine management in Fiji, amongst others with the Fiji Ministry of Fisheries, the University of the South Pacific and the Packard Foundation, while the FLMMA Network was particularly interested. The network usually carries out regular paper based surveys of the 400 communities, including the status of the 135 customary fishing areas and 465 fishing reserves. In this effort four divisional FLMMA representatives visit a subset of the communities in their division once a year and interview a local committee. The collected data is brought back to the FLMMA Secretary in the capital Suva and entered into a central database. In addition to this regular collection, there was a Lessons Learned Initiative planned, aiming at strategically assessing the effectiveness of the FLMMA site management.

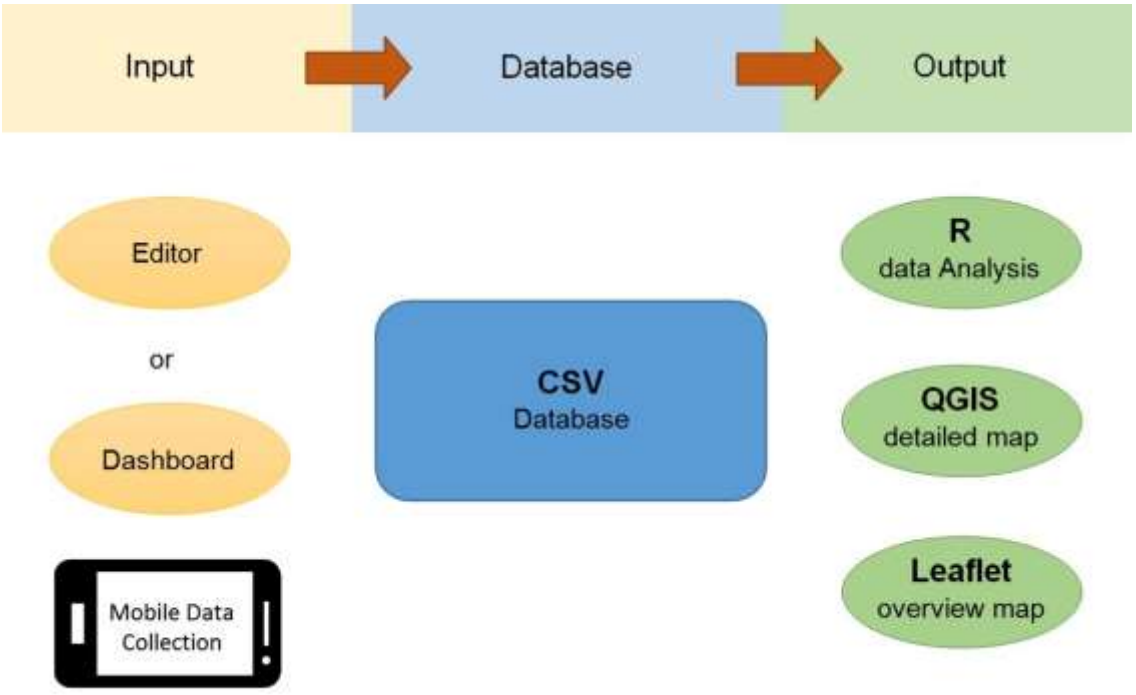
In order to find a suitable solution to streamline the regular and periodic data collection, several discussions with the FLMMA secretariat, the FLMMA database staff and relevant FLMMA members where facilitated. It soon became clear that

- mobile technology can add tremendous value to the so far slow and resource intensive process,
- the approach needs to be integrated with the database
- mobile technology has a big potential for standardized, regular and crowdsources collection of marine data beyond the FLMMA network.

The Fiji Locally Managed Marine Area (FLMMA) network is a non-profit and charitable association of resource conservation NGOs, government departments, academic institutions and over 400 communities working together to promote and encourage the preservation, protection and sustainable use of marine resources in Fiji by the stewards of these marine resources.
FLMMA Network efforts have resulted in 135 of Fiji's marine iQoliqolis (customary fishing areas) being managed and having about 465 fishing reserves or tabu areas covering just over 1000 km2.
LMMA is an international network of natural resource management practitioners working in Asia and the Pacific, who have joined together to share best practices, lessons learned and to amplify their community voices.

7.3. Approach

Against this background and objective, MACBIO facilitated planning of the database infrastructure, and what suitable app solution could input in which way. The following basic flow chart was developed jointly and helped to conceptualize the necessary restructuring of the existing database solution and the role of mobile data collection.



Main challenges discussed were the limited functionality of the existing database, e.g. in terms of free text and language support. It became clear, that the app should be as streamlined as possible, using multiple choice and focusing on quantitative data as much as possible, to assist integration with the database, as well as to reduce typing effort in the app.

7.4. Proof of Concept

For the prove of concept and the initial test phase the on- and offline mobile survey app platform ZWOOR (Zwoor 2015) was selected, with the objective of using a cheap, quick and simple example to communicate and test the proposed app approach. ZWOOR is an example of a key turn ready solution without support, providing the advantage of a free account (100 Submissions), easy setup, a readily downloadable android app and an intuitive, user friendly backend.
With a free admin account survey forms can be created online and accessed on in the app on phone. Data can be filled in on the phone on and offline and submitted once an internet connection is established. The submitted forms are displayed online in real time and data can be downloaded as spreadsheet.

The “Zwoor Survey” app is downloaded for free from the App store or Goole Play, while surveys are accessed via a unique survey code.

Once the green light was given by the secretariat, the existing paper based forms were adjusted to fit the technical requirements of the forms in the app (e.g. multiple choice answers, on answer per question etc) and inputted into the backend, using the easy to use interface.

This solution was presented to the FLMMA secretariat to incorporate feedback. One FLMMA representative was trained and successfully tested the app during a field visit to a close by FLMMA site. Subsequently the form was translated into iTauke (Fijian language), accessible through another unique survey code.
As the divisional representatives did not possess smartphone apps, these had to be provided by FLMMA. Thus the app was installed on sample phones in the local mobile phone shop and tested on two of the most affordable devices.
The LG L20 for FJD 129 (~ USD 60) turned out to have a too small screen to display the app and enable comfortable keyboard input. Thus, the Alcatel Pop 2 (4.5) for 149 FJD (~ USD 70), was selected due to its affordable price, adequate display and the added advantage of dual simcards. These phones were equipped with the minimum charge of FJD 6, valid for 1 week. It was agreed to centrally provide the phones with charge on demand, before a survey is carried out.

During the yearly “orientation meeting” of the divisional representatives a training session was held. Following an introduction of concept, the four representatives as well as other FLMMA staff where trained, using detailed step-by-step training material on the download and use of the app, as well as on submitting filled in forms. Additional material on the app backend was made available to the secretariat. Based on that training, a half hour practice round was done, to let the representatives familiarize with the approach, collect instant feedback and answer additional questions.

Main challenges of the representatives with no former experience with smartphones were to use the keyboard with small keys and to activation the data plans. Thus, also more basic principles of smartphone use were covered. While there were different speeds of picking it up the use, as well as different levels of required assistance, all participants

familiarized themselves quickly with the new technology. Other present FLMMA member successfully installed and tested the app on their private phones.

The instant feedback contained a high level of interest and satisfaction with the app and its advantages. However additional features were requested, including the support of picture upload to support the questions, the ability to review and edit saved surveys on the phone prior to submission, signature capture to verify information and data backup, if e.g. phone is lost.
After the training, the divisional representatives successfully uploaded data from the field. A comprehensive feedback session on the app use and experience is planned back to back to the next meeting, attended by all representatives.

Please note that also a KoBoToolkit (see below) can also be easily used for a prove of concept phase, and is recommended over ZWOOR.

→Further reading:

- ZWOOR. 2015. Zwoor Mobile App Survey online and offline. Available at: http://www.zwoor.com/tutorials-have-your-event-mobile-app-or-mobile-survey-ready-in-minutes

7.5. Open Data Kit

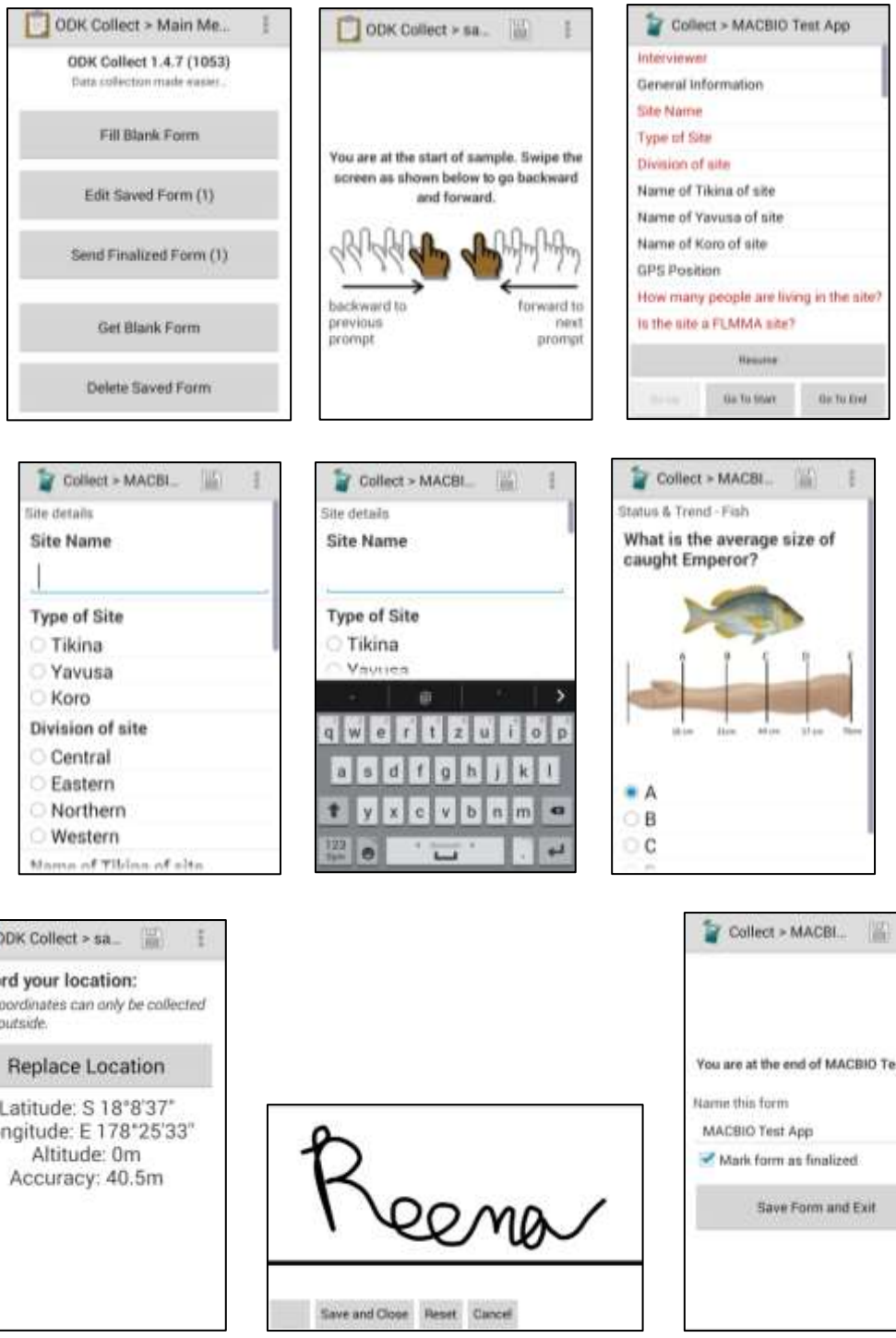
Based on the initial experience and feedback it became clear that while ZWOOR was suitable to communicate and test the app approach, a more adaptable and scalable platform was needed. Especially functions like multi-media, and GPS support, as well as management and editing of saved surveys were needed. To provide an efficient user experience, also a survey logic needed to be included, where follow up questions are displayed, dependent on the answer given. As it became evident that a standard solution of collecting, collating, analyzing and accessing marine data in Fiji – beyond the FLMMA network - is needed, a free, scalable and adjustable solution became imperative.

Thorough research and testing of existing platforms and proven examples identified Open Data Kit (ODK), as suitable fully open source solution (ODK 2016a). While ODK does so far not support iOS, it was still considered suitable, as android phones are most common in the proposed context.
The principle of ODK is similar to ZWOOR and the details described above.

Initial research and tests distinguished two feasible options. Firstly, a third party platform based on the ODK standard can be used, to facilitate setup, hosting, management, analysis and export. While there are numerous such platforms and implementation companies, KoBoToolkit seemed to provide the best solution for the proposed approach. Also, ODK can be set up and hosted completely independently.
The front end app is essentially the same in both approaches, which were examined separately during the test phase.
Similar to ZWOOR, the ODK or ODK based KoBoCollect app is downloaded to a Smartphone for free from the play store. In this app every user needs a username and password that are set up in the app. Through these user details, survey forms can be accessed in the app.

Open Data Kit (ODK)
is a free and **open-source** set of tools which help organizations author, field, and manage mobile data collection solutions. ODK provides an out-of-the-box solution for users to (Doherty 2013):

- **Build** a data collection form or survey (XLSForm is recommended for larger forms);
    - Multiple Question types (incl pics), pics, video, geo-location, multiple language
    - Offline
    - Viewable and editable before sending
- **Collect** the data on a mobile device and send it to a server (cloud hosted via google apps); and
- **Aggregate** the collected data on a server and extract it in useful formats



The app has a wide variety of adjustable features, including multi-media, signature and GPS support, various question types, question structuring on one/multiple screens, survey logic support (only relevant questions are displayed), question overview menu, as well as management and editing of saved surveys.

In order to create a meaningful standard data collection format for (local) marine management in Fiji, considering technical requirements for questions, several meetings with relevant stakeholders were conducted. Based on the FLMMA forms a generic form regarding management and status of marine biodiversity was created.

7.5.1. ODK deployment using KoBo Toolkit

Arguably the easiest way of using ODK is the deployment with KoBoToolkit, a free and open source suite of tools for field data collection. Developed by the Harvard Humanitarian Initiative, KoBoToolbox is funded entirely through grants and donations from partners. In this way it KoBo Toolkit provides a free and easy to use ODK deployment, including form editor, app, synchronization, visualization tools, server and storage.

→ **Further reading:**

- MACBIO 2017. ODK Deployment with KoBoToolkit. Available at http://macbio-pacific.info/wp-content/uploads/2017/07/MACBIO_App_03_Open-Data-Kit_KoBo.pdf

7.5.1. Independent ODK deployment using Google

In addition, ODK was also deployed independently. To do so, a server needs to be set up. While this is well documented, it is a more complex process. To avoid a server setup, ODK can be linked with a google account and its google drive and google spreadsheet. Since every android device needs to be linked to a google account anyway, this account can be effortlessly used for the ODK deployment. The advantage of this approach is that forms can be easily distributed by uploading them to the google drive and/or sending it to the google email address, the device is linked with. Up to 25 devices can be linked to one google account, enabling an efficient workflow for multiple devices.
As forms are based on the same XLS format, these can be easily created and edited and migrated from and to SurveyCTO and other third party platforms. So far, unfortunately, supported media is limited to pictures. Pictures used in survey questions need to be manually copied to the phone.
Once data is submitted, it automatically populates a google spreadsheet that can be made accessible publically or to selected collaborators. Submitted pictures are linked to that spreadsheet. It can also feed into real time visualization of the collected data.

To sum up, the main difference between the two approaches is the dependence on a third party platform. While the front end app is essentially the same, using such platform makes the deployment and backend management easier. Also functionality is slightly increased and can offer features, such as video and audio support. If scalability is of the essence, an independent approach has the advantage of no submission or storage limits. Linking ODK to a google account additionally enables easy distribution and real time data access.

→ **Further reading:**

- MACBIO 2016. ODK_Google_Documentation. Available at: http://macbio-pacific.info/wp-content/uploads/2016/10/ODK_Google_Documentation.pdf

7.6. Feedback

The developed form and the app was field tested with numerous community members in several sites, including the Navakavu tribe, close to Suva, as well as Wailevu and Vuo village in the Labasa district with a total of 60 submissions. The app was centrally installed on private phones, as well as specific project phones, including the Alcatel Pop 2 (s.a.), and Samsung tablets. The app ran on all devices without problems. The field staff members received a brief introduction and were provided with training material, readily available online.

The received feedback from the field applies to both app approaches and stressed that the big advantages of the app - ease of use, portability, media support and quick analysis - render it superior to paper based approaches.

Drawbacks included capturing of open ended questions, water resistance of devices, limited battery life and availability of electricity, slow response of older devices or devices with other applications running in the background, as well as slow initial detection of GPS signal on cheaper phones. One important aspect was the novelty

of the approach, which led to slightly higher initial reluctance of a few participants. They may have got the impression that the knowledge shared would be distributed to a wide audience and could possibly hold against them. In general the app worked better in interviews with individuals, rather than groups. Furthermore a translated version was requested, which is technically easily feasible and planned.

Recommendations and suggestions included a possible hybrid approach of information capturing. Using two interviewers, one capturing information in the app and the other noting down all additional information given, which could include more qualitative and narrative information. Waterproof casing and additional battery packs or solar chargers should be considered as well as backup, paper based forms. All other applications should be closed on the phone before running a survey. Carefully communicating the approach and use of data, as well as taking data sensitivity issues seriously is crucial to build trust in the new, unfamiliar approach.

In general, the field testing and feedback was carried out in an iterative, responsive way. Whenever an interview had been carried out, respective feedback was submitted to the central office via a phone call, where it was incorporated into the backend console right away. By refreshing the app on the phone, the survey could be continued with the updated questions and survey structure. This approach proved to be very efficient and effective, and lead to an increasingly improved app.
It is important to note that training, tests and iterative improvement should not be underestimated. Colleagues who have been using a similar approach (SurveyAnalytics 2016) less successfully, collecting field data for a study in Vanuatu, recommend extensive training and testing before the use of the app in the field (Salcone 2014).

The estimated overall time period to implement the described app approach from first discussion to a running system is between three and six months, much dependent on how much priority is given to the approach, how complex the involved stakeholder landscape is, how quickly the test phase can be carried out and how fast feedback can be incorporated and how many iterations of feedback there are.
Keeping the approach in house had clear advantages in terms of responsively incorporating feedback and iteratively building the approach. Also going through the entire process, enabled a deepened understanding to inform thorough documentation of the approach. While basically no specific IT or app development skills are required, a background and interest in this sector is advisable.

During training sessions with various marine spatial planning stakeholders in Kiribati and extensive testing and field data collection in Fiji, the ODK deployment through KoBoToolkit proved to be superior to other deployments, in terms of ease of development and use and can be highly recommended.

→Further reading

- DOHERTY, J. 2013. Open Data Kit ODK - MOBILE MEETS THE CLOUD - An Exploration of the Open Data Kit. Available at: http://opendatakit.org/wp-content/uploads/2013/04/CALGIS-Mobile-Meets-the-Cloud.pdf
- ODK. 2016a. Open Data Kit – Short explainer video Available at: https://youtu.be/HqqUdfz9Uyc?t=2m33s

7.7. Lessons learnt

There are several lessons learned from using smartphone apps for data driven marine management in Fiji, which fall in line with the digital principles, outlined above.

Firstly, the importance of a strategic approach must be emphasized. Instead of merely "digitizing the problem", the objective and the added value of an app must be identified and carefully considered. Initial market research, discussions with stakeholders and the study of lessons learned help to avoid to reinvent the wheel or affront other stakeholders working on similar solutions (Be collaborative). Further, a proof of concept phase is important. Instead of buying costly key-turn ready solution or employing an expensive professional developer, at the outset, building block systems and free trial accounts can provide a suitable starting point. While technical considerations and perfection is important, the devil is in the detail, such as user contexts, internet and electricity availability, costs and modalities of data plans etc (Understand the ecosystem). Often these soft factors are overlooked, ultimately leading to the failure of approaches, after expensive investments have been made (Build for sustainability). By using an in house, iterative approach with quick feedback loops (Reuse and improve; Be data driven) to implementing staff as well as all relevant stakeholders, a suitable approach can be developed step by step (Design with the user). While trial solutions, with perhaps limited functionality are a good point to start, the use of open source, compatible and scalable approaches (Design for scale) is recommendable from the very beginning, to avoid duplication of development effort, dependencies and lock in effects (be open data, open standards, open source, open innovation). For approaches successful on the long term (Build for sustainability) user needs, e.g. data sensitivity issues (Address privacy & security), must be at the core of the approach.

7.8. Outlook

From this and other numerous examples, it became evident that mobile apps can truly add value to management of natural resources, if they are strategically and participatory designed and implemented. At the same time, however, a common vision and standards are of paramount importance beyond sectoral approaches and narrow project foci, to avoid a jungle of overlapping, unused apps. In 2016 Tropical Cyclone Winston, devastating Fiji, was a drastic and sad reminder for the need of cross sectoral thinking. In the process of rapid damage assessment as well as Post-Disaster Needs Assessments the lack of available socio-economic as well as bio-physical data became as evident as the absence of quick and simple approaches of data collection and the corresponding data base infrastructure (Government of Fiji 2016).

To address this, the approach of a country wide app infrastructure was suggested. Every village or even every citizen could have a standard app installed on their smartphones, on which specific surveys are uploaded on demand. In case of a disaster this could speed up coordinated relief efforts dramatically, but also institutionalize long term data collection, e.g. on reef status. Important here is also the cooperation with existing networks and stakeholders like the FLMMA network. Other key partners include the government, e.g. through the Conservation Officers of the iTaukei Affairs Board, typically from the younger generation and mandated to work with the communities across the country.

More affordable and powerful hardware, more flexible and open software standards, ever increasing internet and electricity coverage and growing familiarity with new technologies in Fiji, Pacific Island countries and the entire developing and industrialized world, provide without doubt fertile ground for a positive response to the question "Isn't there an app for that?"

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EFFECTIVE MANAGEMENT

Collaborating with national and regional stakeholders to document effective approaches towards sustainable marine resource management and conservation

Managing marine resources heavily relies on data, while globally and particularly in many settings in Pacific Island countries there remains a lack thereof. Manual, paper based reporting system are widely used, even though these are typically burdensome, resource intensive and error-prone. Furthermore, data often remains locked away in spreadsheets and results are not measurable, visible or accessible.

In line with its objectives, the MACBIO project supports Fiji, Kiribati, Solomon Islands, Tonga and Vanuatu in effective approaches of site management. In this context MACBIO was requested in 2015, for instance to support data collection on locally managed marine areas in Fiji – in particular with the design and development of open-source mobile solutions.

Beyond this, MACBIO aims at collaborating with national and regional stakeholders to develop long-term solutions and standards for the use of open-source mobile solutions in support of sustainable marine resource management and conservation.

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