ICT4D EFFECTS

IKON - Telemedicine
Shortening distances to strengthen health systems and improve healthcare

APRIL 2015

CONTENT

"Programme Manager Dr Sangaré believes the IICD model of working through local partners to ensure local and sustainable solutions has been critical. IICD played an important role in supporting IKON's methodology and development. IICD facilitated an initial meeting of stakeholders, supported ongoing discussions between stakeholders, increased the capacity of teams and hospital staff through training, financed planning and implementation of the pilot phase, and promoted the project in other countries and to other organisations. Implementation was all managed locally, increasing local ownership and sustainability."

(IKON impact study, 2014)

About IICD

The International Institute for Communication and Development (IICD) is a non-profit foundation specialised in the use of Information and Communication Technology (ICT) as a tool and driver for development and change. IICD uses ICT to help build the capacity of people, organisations and governments in developing countries to generate social change in their own communities and take charge of their own development. (www.iicd.org)

About CERTES

The Centre d'Expertise et de Recherche en Télémédecine et l'E-Santé au Mali (Centre for Research and Expertise in Telemedicine and eHealth - CERTES) is a medical research organisation with operations at the University Hospital 'Point G' in Bamako. (www.certesmali.org)

About IKON

IKON is a network established in 2005, to provide tele-radiology services to Mali's regional hospitals in order to enable remote expert diagnosis. IKON has improved healthcare for patients through access to expert diagnosis, and has facilitated training and capacity building of health workers in Mali's regional hospitals. IKON was implemented by IICD together with CERTES.

ABOUT THIS PUBLICATION

This publication is informed by the findings from recent research[1] conducted to investigate the impact of IKON's telemedicine service on the quality of healthcare in Mali. The research aimed to find out to what extent the telemedicine service had increased the rural doctors' diagnostic ability. Data was analysed for the years 2005-2013.

The IKON tele-radiology service was set up in 2005 and has expanded to eight hospitals across Mali. The study is based on the analysis of relevant literature, interviews with stakeholders and quantitative analysis of data from the IKON platform. The research explored the process and phases involved in the development of the IKON network and the factors that have affected the uptake of tele-radiology in Mali's regional hospitals. It describes the benefits of tele-radiology to patients, doctors and hospitals by analysing the cost benefit of using technology in this context(s), impact on the quality of rural healthcare provision, impact of ICT on the capacity of health workers, value added to outcomes through the use of ICT, impact of telemedicine on the healthcare chain and the contribution of the International Institute for Communication and Development (IICD) to enhancing the process and the outcome. Additionally, it explores the current economic model at IKON, the cost benefits to the patient and hospital, the recent introduction of public-private partnerships, and the future of the IKON network.

> "Until recently, Mali had only 11 radiologists. Ten worked at hospitals in the capital, Bamako. Nevertheless, all seven regional hospitals had x-ray machines and technicians trained to operate them. The absence of trained radiologists resulted in poor diagnosis, errors in treatment, and a high number of referrals to the national hospital in Bamako. In response, the IKON network was established in 2005, to provide tele-radiology services to Mali's regional hospitals that would enable remote expert diagnosis. Three hospitals joined the network during its pilot phase in 2005-6 and an additional four regional hospitals joined between 2007 and 2008. IKON has improved healthcare for patients through access to expert diagnosis, and has facilitated training and capacity building of health workers in Mali's regional hospitals."
>
> *(IKON Impact Study, 2014)*

---

1. Research undertaken by Lydia Tanner and Sarah Jupe from Jigsaw Consult in 2013/2014

SHORTENING DISTANCES TO STRENGTHEN HEALTH SYSTEMS AND IMPROVE HEALTHCARE

Mali: 11th poorest country in the world

2005: only 11 radiologists in Mali, 10 in capital

MALI

TO BAMAKO
DISTANCE: 1,542 KM
TIME: 25 HOURS
COST: 60,000 CFA

KIDAL HOSPITAL

Timbuktu hospital
1 doctor + 5 working for NGOs

Gao hospital
15 doctors

TO BAMAKO
DISTANCE: 236 KM
TIME: 4 HOURS
COST: 6000 CFA

Kayes hospital
47 doctors

SÉGOU HOSPITAL
33 doctors

Mopti hospital
18 doctors

BAMAKO

Morila hospital

Sikasso hospital
23 doctors

BUS STOP
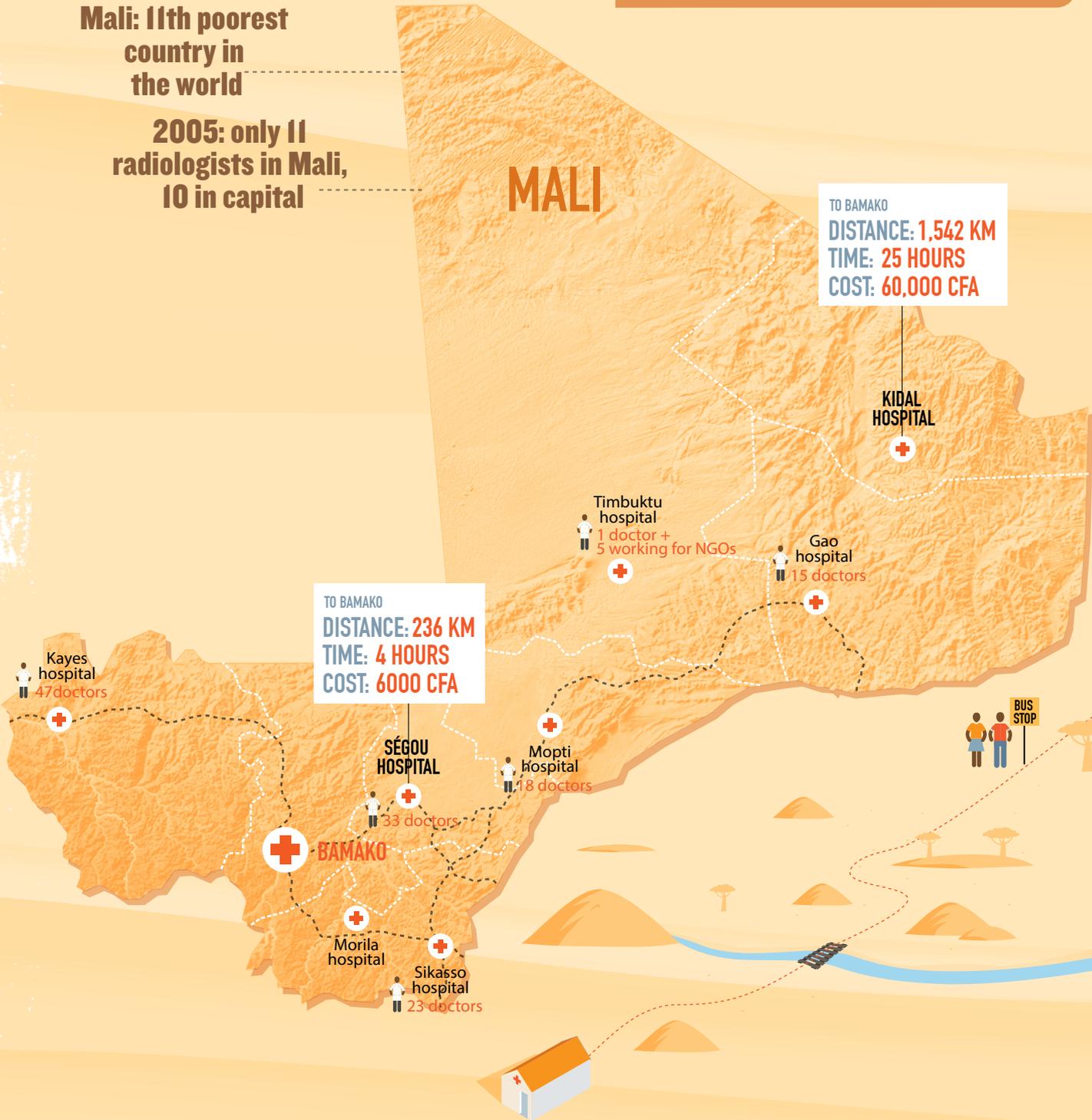
Mali: 1 doctor per 10,000 people

Mopti region: 1 doctor per +/- 113,000 people
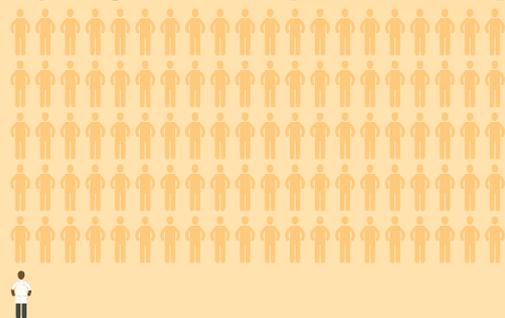
Doctors in remote rural hospitals in Mali, a country with a chronic shortage of healthcare workers, improved their diagnostic ability by more than 70% with the support of radiologists/specialists in larger hospitals.

Objective: Introduction of telemedicine to improve diagnostics in rural hospitals

Scans without primary diagnosis decreased from:

93 %
(in 2005)
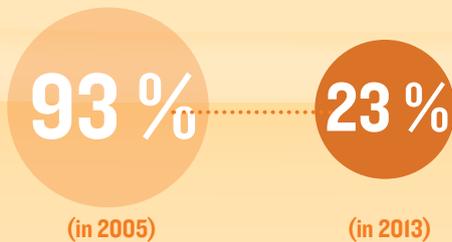
23 %
(in 2013)

Objective: Improvement of the regional doctors' diagnostic ability

Diagnostic agreement increased from:

0 %
(in 2005)
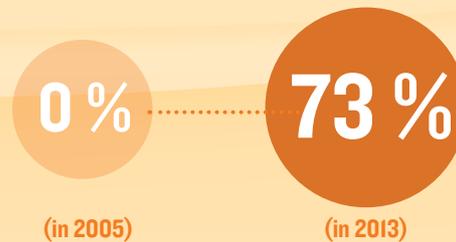
73 %
(in 2013)

	BEFORE IKON	AFTER IKON
NATIONAL LEVEL	Chronic shortage of health workers: only 11 radiologists in Mali, and 10 are based in the capital.	In-country radiology expertise network serves now all regional hospitals in Mali
HOSPITAL LEVEL	Scarcity of specialists: isolated hospitals in impoverished regions separated from specialist expertise by long distances and poor road networks.	Alleviation of human resource constraints by providing access to information and resources to better connect, collaborate, and communicate with other health workers. This contributes to reducing professional isolation and retaining health personnel in remote areas.
	Limited diagnostic capacity.	Increased capacity of health personnel in remote areas: **DIAGNOSTIC CAPACITIES:** Improvement in doctors' primary diagnosis capacity (esp. in non-medical cases): there is an increase in agreement between the diagnoses made by the regional doctor and the expert radiologist (from 0% in 2005 to 73% in 2013) and a decrease in errors by the regional doctor.
	Erroneous diagnoses and treatment: doctors compare X-ray images with those in text books, discussing with colleagues, and/or making their 'best guess'.	Medical staff/health workers in rural hospitals now have: - Access to up-to-date information, expert opinion through peer consultation, professional development through online learning. More accurate on-site diagnoses and improvements in treatments: between 2005 and 2013, 5,628 patients received an expert diagnosis through the tele-radiology programme, leading to an improved perception of the quality of regional healthcare: "When I had an X-ray done, my doctor explained to me that no one here knows how to read that image and there is someone in Bamako whose job it is to read these images. I think it is great that I can get access to this person." (Patient at Mopti Hospital) **ICT CAPACITIES:** On-the-job learning and training on ICT, catalysing wider use of technology by medical and administrative staff.
	Expensive for patients to travel to Bamako or for hospitals to send tests to a laboratory. There are a high number of referrals to Bamako for primary diagnosis due to lack of trained radiologists.	The IKON activities have saved the population a little more than 60 million CFA: or approximately 125,000 USD over 10 years (Bagayoko, director of CERTES). Furthermore, regional hospitals can now charge for a high-quality service and -more significantly- the patient stays at the hospital rather than moving to Bamako. IKON has helped attract more patients willing to pay for these services based on the improved perception of healthcare.

THE BEGINNING

The IKON story began when individuals from within the Malian medical community jointly sought to find out whether it was possible to connect Mali's provincial hospitals to the medical expertise available in the country's capital, Bamako. Inspired by their study of cross-border tele-radiology networks between Bamako and hospitals in Marseille and Geneva facilitating access to specialist medical advice, and recognising the pressing need for enhancing diagnostic capability at the level of Mali's regional hospitals, a collective around Dr Mahamadou Touré ventured to understand what inter-hospital connectivity in Mali would require to be workable and sustainable in the context of financial, technological and human resource constraints faced by the Malian health system.

In 2003, with the support of IICD, Malian radiologists and doctors set up a round table meeting to discuss the opportunities presented by tele-radiology for improving healthcare across Mali. With a deep understanding of the legal, cultural and contextual factors affecting medical practice in Mali, and high levels of intrinsic motivation to improve public health provision in their own country, the team of individuals present at the round table proved to be fundamental drivers of the formation of the network, the development of the associated technology solutions and the creation of a locally sustainable organisational structure.

KEY BACKGROUND FACTORS INFORMING THEIR DESIRE TO DO THE PROJECT

- **Maldistribution of health workers throughout the country, particularly a lack of doctors and health workers in poor, remote areas far from the capital**
- **Low motivation among public health care workers due to insufficient financial and resource incentives, resulting in a loss of the most qualified health workers to the private sector, particularly specialists and technical staff.**
  - **11 radiologists in Mali, 10 of which worked at hospitals in the capital, Bamako (2005)**
  - **X-ray machines available in all seven regional hospitals and technicians trained to operate them**
  - **Absence of trained radiologists at regional hospitals, resulting in poor diagnosis, errors in treatment, and high numbers of referrals to the national hospital in Bamako**

THE IKON IDEA

Following the round table, the IKON team sought to answer a series of practical questions, with each subsequent step building on previously found answers.

The earliest question 'Is it technically and humanly feasible to connect Mali's regional hospitals to Point G hospital in Bamako?' focused on finding ways to realise Internet connectivity and communications for the regional hospitals in Sikasso, Mopti, and Timbuktu, located at distances of 364 km, 635 km, and 1,013 km from Bamako respectively. At the time, none of the three hospitals had Internet access. Sikasso and Mopti had one computer and a printer situated in an administrative part of the building, whereas Timbuktu did not have a single computer. None of the radiology technicians or doctors had even a basic knowledge of ICT or any of the

necessary skills for using an online tele-radiology platform. Next to tackling the connectivity and technology skills challenges, the IKON team anticipated that perhaps the more important question to answer was how to embed technology-mediated communications with Bamako-based specialists in the daily working practices of generalist doctors working at chronically understaffed and under resourced regional hospitals, and how to organise the service such that it can be financially and operationally sustained over time.

This publication will provide insight into the main changes that the IKON model of tele-radiology brought about for the participating hospitals and their patients, and will discuss some key factors that proved to be of influence on the evolution and success of the initiative.

THE THREE MAIN PHASES OF THE IKON PROJECT

IKON's experience can be roughly divided in the following three main phases:

Phase 1	**Pilot in Mopti, Sikasso and Timbuktu**
Phase 2	**Expansion to Ségou, Gao, Kayes and Kidal**
Phase 3	**Decentralisation and Sustainability – The IKON Network**

PHASE I
PILOT OF IKON IN MOPTI, SIKASSO AND TIMBUKTU

The early IKON service piloted installations in three public hospitals: Mopti, Sikasso and Timbuktu, connecting them to the University Hospital Point G in Bamako. The hospitals were selected to test the concept in locations at varying levels of inaccessibility to Bamako – close, mid-distance and far north.

- Sikasso Hospital is close to Bamako and easily accessible thanks to a good road.
- Mopti lies mid-distance and allowed for visits to be combined with visits to Timbuktu
- Timbuktu was chosen as the particularly poor road to Timbuktu makes it very isolated

Each of the hospitals went through five key steps in order to launch the tele-radiology service: sensitisation, training, installation, testing and launch.

SENSITISATION

The IKON team arranged an initial meeting at the regional hospital to bring together all hospital staff to discuss the costs, benefits, possible challenges, and next steps required to join the programme. Many of the directors, doctors, technicians and other hospital staff had never used a computer and were often unsure of the benefits of the programme.

The key challenge during the sensitisation work was to convince the hospital that ICT could help provide a better service to the hospital's patients. The inclusion of all staff proved to be essential to reduce barriers to the hospitals' involvement and ensure that all those with influence were involved from the start.

Sensitisation

Location: on-site at regional hospital

Participants: all senior hospital staff incl. section heads, section deputy heads, all doctors, senior nurses, and medical assistants.

TRAINING

A group of representatives from each hospital, including technicians, doctors and nurses, received training which combined basic ICT skills with technical, legal and ethical aspects of using the tele-radiology platform.

The training activities were conducted centrally in Bamako, giving the representatives from various participating hospitals the opportunity to exchange information and contact details, establishing peer relationships that often sustained throughout the course of the programme. Technicians from various hospitals have reported that they continue to contact each other with problems and provide peer support wherever possible.

Training
Basic computer usage
Online communications
Online data security

Legal and ethical aspects of sending health data online

Communicating tele-radiology process and benefits to illiterate patients

Taking pictures of x-rays
Using editing software
- Compressing images
- Anonymising images
- Increasing contrast

Using the IKON platform to send files to the radiologist

INSTALLATION

The IKON team travelled to the hospital to install equipment and test staff skills (to photograph, edit and send and x-ray over the platform). The distance of the hospitals to Bamako meant training had to be sufficient for the staff to run the tele-radiology service with little external help, so during the installation phase staff practices the tasks repetitively. They were also trained in dealing with technical errors and equipment repair.

For a detailed account of the technology installed during the pilot, and subsequent changes made to equipment choices, see section 'Technology' on page 10.

TESTING

After installation, the IKON team met with hospital directors and all section heads to discuss the training staff had received and test the service. The testing periods lasted three months, allowing for any necessary adjustments before charging the patients for the service. After the testing period, the installation and testing period was evaluated by the IKON team with the senior hospitals staff, allowing for actions to be undertaken addressing unreliable electricity supply, technical challenges with the Internet, or staff conduct in using the service.

LAUNCH

Following the evaluation, the service was launched and patients started to pay for the service. The IKON team continued to visit each hospital twice a year to monitor the service and work with hospital directors and senior hospital staff to embed the service in daily operations.

The tele-radiology service was launched in all three hospitals and doctors were able to begin accessing remote expertise. IKON provided a high level of support to hospitals at this stage to overcome the challenges such as intermittent connectivity, electricity problems and the costs of the high quality scanners (*see 'Technology' section on page 10*). Hospitals received advanced training in ICT maintenance to help technicians solve basic problems and reduce the number of incidences, and critical investments were made in encouraging buy-in and commitment from hospital directors and medical staff.

Steps for a technician sending an X-ray image via IKON:

1. Take an X-ray of the patient
2. Photograph the X-Ray using a digital camera and tripod
3. Use image editing software to adjust the size and tint of the image, and to combine multiple X-rays of the same patient into one image where appropriate
4. Upload image onto the platform and type out the doctor's notes on the patient's condition and history, with the primary diagnosis

Upon receipt of expert diagnosis from Bamako:
5. When the scan appears on the platform, print a PDF letter including the description of the image and the expert diagnosis. This is given to the doctor and the patient.

PHASE 2
EXPANSION TO SÉGOU, GAO, KAYES AND KIDAL

Following a successful pilot phase, four further Malian regional hospitals were integrated into the growing IKON network - Ségou, Gao, Kayes and Kidal. The financial capital required to buy the tele-radiology equipment had significantly reduced due to the IKON team's experimentation with alternative technologies, and the costs of running the service within the hospitals was negligible since hospital's already had X-ray equipment and technicians. Lacking trained radiologists, the benefits experienced by the hospitals from implementing the tele-radiology service far outweighed the costs incurred, and hospitals newly joining the service self-funded the equipment and other investments required to participate in and benefit from the tele-radiology service and network.

The IKON team continued to provide active support by co-ordinating and monitoring the network through visits to hospitals, and organising collective meetings for IKON technicians and hospital directors to jointly review the service, address challenges and capitalise on opportunities. Funding to run and support the IKON network was generated from within the project itself, with a small percentage of the tele-radiology charges going to the IKON secretariat to finance the support services.

PHASE 3
DECENTRALISATION AND SUSTAINABILITY – THE IKON NETWORK

In 2009, IKON was approached by the Morila Gold Mine Health Service, the first private health service to sign on to the IKON service. According to international mining standards, a mining company must have X-rays of its workers interpreted by a qualified radiologist, a service that IKON could readily provide. The health clinic provides a chest X-ray screening for all its miners. In addition to the high technical and security standards employed by the IKON service, ensuring the privacy of employee data and protecting the company from legal disputes, the Director of Morila Health Service choses to partner with IKON 'to access the best radiologists in the country'. The Morila Health Service has since become the heaviest user of the IKON service and is significantly contributing to the financial sustainability of the network, causing IKON to explore the addition of further private health services to the network.

To increasingly decentralising autonomy and decision-making to the level of the hospitals themselves, an IKON focal person was appointed in every hospital who took over day-to-day running of the programme. The IKON team also gave responsibility for co-ordinating the exchange of information across the network to the regional hospitals on a rotational basis. Maintaining the high level of formal interaction between the hospitals through annual co-ordination conferences without dedicated funding for the same has been a challenge, although contact and peer support is reported to take place among technicians and hospital directors who established relationships in earlier training and co-ordination events.

Responsibility for maintaining the platform, logging radiologists' availability, invoicing hospitals and paying the radiologists for their expert advice was absorbed into CERTES, a medical research organisation based at the University Hospital in Bamako. The medical students who were central to the original IKON concept and early platform development are now at the forefront of ICT in the health sector in Mali.

WAR

The conflict in Mali's northern territories that erupted early 2012 has hit the northern region's hospitals badly. Apart from a sharp rise in x-rays with gun shot wounds being sent through the platform for an expert second opinion, Timbuktu Hospital was destroyed during the fighting, staff from Kidal Hospital fled due to the heavy fighting in the region, and Gao Hospital was attacked and its equipment destroyed. Doctors from northern Mali reported that without tele-radiology they would not have been able to handle the influx of war injuries in 2012.

One doctor from Ségou Hospital commented:

'Sometimes, because of the war, I was sending ten radiology images a day. We had never seen someone suffering from automatic weapons. Without tele-radiology we would never have managed. All the war wounded were diagnosed by Bamako, and we couldn't have done it without them. We saved a lot of lives by being able to show bullet wounds to experts'.

- Dr Beye, Ségou Hospital

TECHNOLOGY

Next to figuring out best ways to establish both technical and human connections for tele-diagnostic purposes, practical issues needed to be tackled such as 'How to digitise analogue X-rays such that they can be sent in low-bandwidth environments?', 'How to ensure up-time and service reliability in the face of electricity supply problems faced by the hospitals?', and 'How to realise inter-hospital connectivity to allow IKON to function as a network and reduce dependency on the IKON support team?'.

Some technology-related issues that were found to be key to the project's evolution and success, and that illustrate challenges faced in developing and implementing telemedicine systems in Mali, are discussed below:

TELE-RADIOLOGY PLATFORM

The initial IKON platform was developed by two young doctors who had studied under the tutoring of Dr Toure. The young doctors had had a keen interest in medical informatics during the course of their studies and had thoroughly studied existing cross-border telemedicine projects, informing their own ideas on alternative approaches that in their view would suit the Malian context better.

Wanting to respond to the needs of the IKON tele-radiology project, and realising that at the time there wasn't a platform readily available that would fit the Malian purposes, the young doctors immersed themselves in acquiring relevant software development skills and established a private company specialising in ICT and e-health. This venture created a pool of Malian developers who would later be in charge of maintenance of the code and further evolution of the tele-radiology platform and software.

The initial version of the platform was called OpenYaLIM, and was first implemented in the three hospitals participating in the pilot deployment in 2004. Although the initial version took longer to be developed than if already proficient software developers had done it, the doctors were better able to understand the actual medical requirements and the Malian health sector dynamics and design directly for regional hospital's real needs than generic software developers would have been able to. Once implemented, the main developers were able to easily understand how the platform was performing in the context of Malian hospital structures and workflows, identify its limitations and discuss the requirements for improvement with lead users at hospital level as peers.

The platform prototype and subsequent versions during pilot and later deployment phases, was accompanied by a continuous process of action-reflection-adaptation cycles built into the support programme between the IKON team and the hospital-based teams. Obtaining user feedback during regular on-site visits to participating hospitals as well as during collective coordination meetings in which all hospitals implementing the service participated, provided essential input for iterative and incremental improvement of the platform. By obtaining the feedback on working realities of the various hospitals using the system, the lead users and hospital directors took an active role in directing the further development of the system to meet their key requirements.
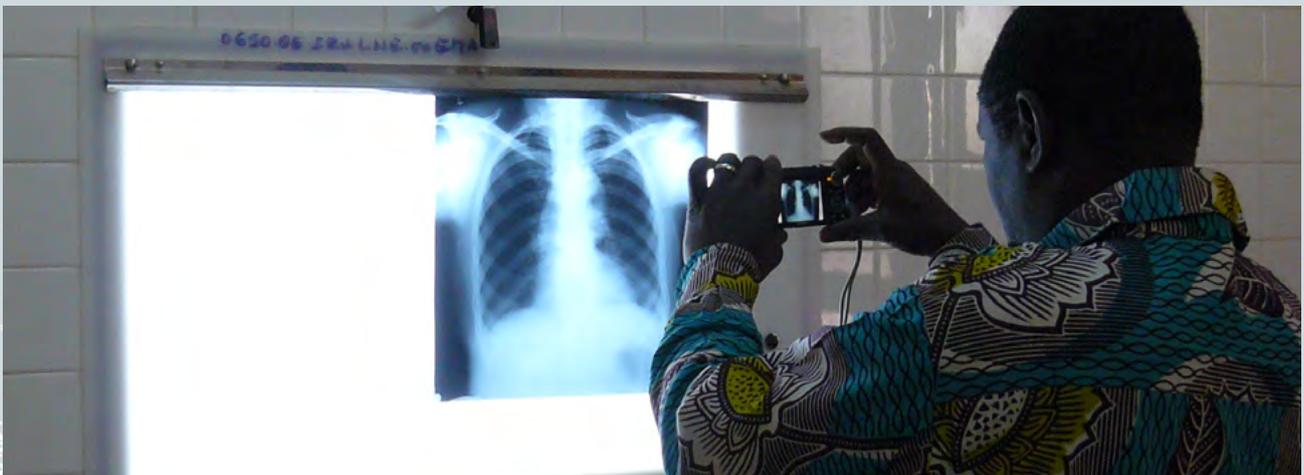
X-RAY DIGITISERS

Another key technology-related experience concerned equipment to digitize the x-rays in order to be able to share them with the radiologists in Bamako via the IKON platform. Internationally available x-ray digitisers used in the US and Europe cost $50,000 per unit, making it financially unfeasible to incorporate such high-standard technologies in the IKON system. Identifying and negotiating with suppliers of less costly systems was labour- and time-intensive and resulted in systems being sourced for the IKON pilot phase costing 10,000 USD[1] each.

Once the pilot service had generated a clear proof of concept, demonstrating the feasibility and value of connecting generalist doctors from the Mopti, Timbuktu and Sikasso regional hospitals to specialist radiologists in Bamako, it was clear that the total cost of equipment would need to be reduced dramatically if the service was to be extended to more regional hospitals. Being technically adept, the IKON team iteratively experimented with other options, looking into a variety of locally available and affordable technology tools. They found that digital cameras used with a tripod could adequately digitize the images for remote diagnosis, and hospitals that joined the network in 2007 used 5-14 mega-pixel digital cameras, costing 100-300 USD instead of the costly scanners. Photographing the X-rays vastly reduced the cost of introducing the programme to new hospitals, and the resulting overall low capital investments required has been a critical factor in hospitals' ability to self-fund their use of the service.
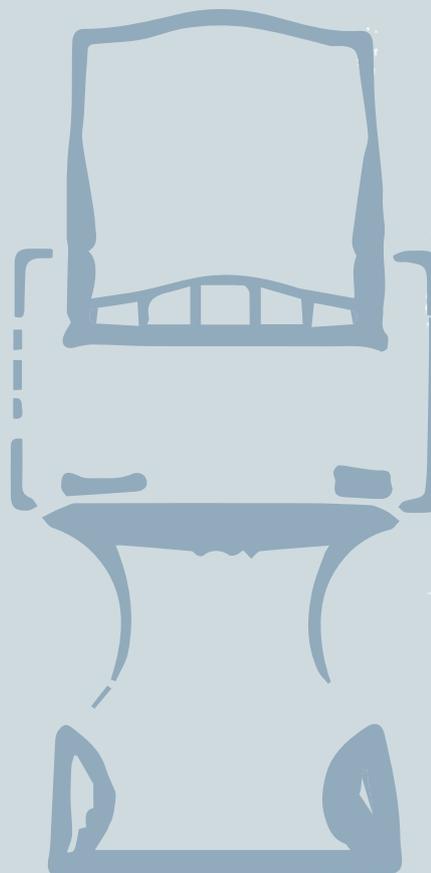
CONNECTIVITY

Problems with the availability, strength and reliability of Internet connectivity in Mali was a challenge for the programme from the outset. Early participating hospitals received modems as part of the technology equipment package, thereby introducing connectivity into the hospitals, but the bandwidth of the connection varied strongly from hospital to hospital. Balancing the size of the image – and thus the time it takes to send the image over the connection – with the resolution required for the radiologist to make a reliable assessment was a challenge, and as a result, the image size varied from hospital to hospital depending on the speed and strength of the particular connection.

In 2009, the VSAT antennas were sourced[2] for the Timbuktu, Mopti and Gao hospitals who faced the biggest challenges in sending files, triggering a significant increase in their use of the service. In general, a hospital's ability to connect to the Internet proved to be a critical factor influencing the success of an implementation, with hospitals using VSAT or reliable broadband connections showing far higher numbers of usage per given year and hospitals which were unable to resolve Internet connection problems using the service less frequently.

1. Model: Vidar Sierra Plus
2. through an IICD/European Space Agency (ESA) collaboration

KEY CHANGES IN MALI'S HEALTHCARE RESULTING FROM THE IKON SERVICE

The health care needs of the country are vast, owing to extreme living conditions, poverty, a high prevalence of diarrhoea, pneumonia and childhood malnutrition, and exposure to malaria, tuberculosis, HIV, measles, cholera, hepatitis and meningitis. These challenges have been compounded by the conflict that broke out in the north of the country in 2012.

1. IMPROVING THE EFFICIENCY AND EFFECTIVENESS OF HEALTHCARE DELIVERY AT POINT OF CARE

The primary benefit of tele-radiology is improving the accuracy of patient diagnosis. Many regional doctors have only had basic medical school training and their ability to diagnose patients using X-ray is low. By improving the quality of diagnosis, tele-radiology makes a tangible impact on the patient healthcare chain in the regional hospitals. The capacity for remote diagnosis is particularly valuable in remote locations. The distance from Bamako, the state of the roads and the cost of transport make evacuating patients to the capital very difficult. Accurate diagnosis allows proper partitioning of patients into those who can be treated locally (and identification of whether treatment is urgent), patients who are healthy, patients who need to be sent to Bamako, and importantly, patients with severe illnesses who might previously have been sent to Bamako but who need end-of-life care locally.

'A patient had an accident and his pelvis had multiple fractures. It was beyond our level. We had a lot of hypotheses but we couldn't really see what was on the image. We went to Professor Toure through the tele-radiology programme and he told us within 30 minutes that the patient had to be evacuated to Bamako because it was a very serious situation. The patient was immediately sent to Bamako and eventually recovered. Tele-radiology helps us to understand if it is really serious or not, because sometimes we don't know.'

- Dr Maiga Moussa, Gao Hospital

COST-BENEFIT FOR THE PATIENT

For a patient, making a journey to Bamako for a diagnosis is a challenge: both the cost and time for travel are often prohibitive. The bus from Timbuktu, for example, takes 17 hours and costs 20,500 CFA. The patient would need to be accompanied, and must pay for accommodation in Bamako while waiting for the results of the radiology examination (at least 24 hours). In urgent cases, the patient would pay for the ambulance and driver. Where income is low, the travel costs are prohibitive. Moreover, patients in a critical condition are unable to make the arduous trip; some patients would not survive the journey.

Although the hospitals charge the patient a fee for use of the tele-radiology service (between 1,000 and 2,500 CFA in the public hospitals), tele-radiology is less expensive than travelling to Bamako or sending texts to a laboratory.

The distances, travel times and costs in the table below give an indication of the cost savings incurred by patients:

Hospital	Distance to Bamako	Approximate time of journey by public transport (one-way)	Approximate cost of journey by public transport (one-way) (CFA)	Patient charge for tele-radiology (CFA)
Ségou Hospital	236 km	4 hours	3,000	1,000
Kayes Hospital	613 km	8 hours	15,000	2,500
Mopti Hospital	635 km	9 hours	8,000	2,500
Timbuktu Hospital	1,013 km	13 hours	20,500	2,500

An academic study on ICT in healthcare in Mali estimated that the IKON activities have saved the population a little more than 60 million CFA, or approximately 125,000 USD over 10 years (Bagayoko 2011). This estimate does not include collateral expenses occurred when travelling to the capital – for example loss of earnings of the patient or the person accompanying them. Tele-radiology therefore provides a real and tangible cost-benefit for the patients.

In addition, faulty diagnosis and consequent incorrect prescription of medicines such as antibiotics or anti-malarial drugs can exacerbate the growing resistance to these drugs. The more precise diagnosis possible thanks to tele-radiology therefore has a beneficial effect on health not just of the individual but also of the wider, global population.

2. BUILDING PROFESSIONAL CAPACITY OF HEALTHCARE PERSONNEL

The tele-radiology programme has made a major contribution to the capacity building of medical staff in regional hospitals through facilitating diagnostic instruction alongside expert advice.

Prior to the IKON programme, doctors in regional hospitals resorted to comparing X-ray images with those in textbooks, discussing the case with each other, and then making their 'best guess'. As a doctor from Kayes put it: *'Before the IKON programme it was very difficult – we just had to trust ourselves that our conclusions would be correct'.*

Tele-radiology ensures accurate diagnosis of complex cases, such as tuberculosis, helping doctors to accurately prescribe life-saving treatments. Even in simple cases, tele-radiology plays an important role in reassuring doctors of their diagnosis and giving them confidence in treatment.

> **'I may be able to tell from the symptoms that the patient has a certain sickness, but I want to be reassured by radiology that I am right. I can interpret simple images like basic lung functions or simple fractures. But with lung problems that are serious or fractures where pieces of the bone are everywhere I don't take the risk. There may be risks of infection, so I always get a second opinion.'**
>
> **- Dr Watara, Sikasso Hospital**

The IKON radiologists not only provide a diagnosis, but also provide a detailed description of what they see on the image, any anomalies or unusual pathologies, and how recount how they have reached their diagnosis. Occasionally, the radiologist will also provide links to resources that explain the pathology. According to radiologist Professor Touré this helps the doctors to begin interpreting images for themselves, since if a doctor sends an image two or three times they will start to recognise the similarities. This manner of providing informational resources (expert diagnoses) together with educational resources, has over time contributed to enhancing doctor's self-confidence in their diagnostic ability.

In 2008, IKON staff generate teaching materials from the case analyses and diagnoses which radiologist Dr Touré

notices are recurrent problems or themes in the regional hospitals. The detailed descriptions of the diagnoses and instructional advice on how to reach the diagnoses are made available in medical case material through the IKON platform for regional doctors to use as reference materials to further enhance their diagnostic ability. In 2009, IKON extends its instructional support further by launching live radiology courses on its website and establishing the National Tele-education Network in Mali.

Many doctors see their own learning as an important benefit of the IKON programme; as Doctor Beye from Ségou Hospital said: *' I used to have no idea, but now I can measure a lot of things on the image – the radiologist has explained a lot.'*

Doctors participating in the study unanimously agreed that the tele-radiology service has taught them how to interpret the images to diagnose common and simple problems. Since learning to differentiate between normal scans and scans with medical conditions, doctors filter the cases they can confidently diagnose and only send on more complex cases for an expert diagnosis.

> **'At the beginning, everything was sent to Bamako, all radiographic images. Eventually we could interpret the simple ones, and everything more complicated was sent to Bamako.'**
>
> **- Dr Keita, Mopti Hospital**

Analysis of the primary diagnoses as sent by regional doctors and compared to the expert diagnoses sent back from Bamako shows an increase in agreement between the regional doctors and the radiologist, a decrease in errors by the regional doctors, and a decrease in the number of scans where no primary diagnosis is given by the regional doctor. More in-depth analysis reveals that the high levels of agreement primarily occur in the case of normal diagnoses, indicating that doctors in regional hospitals are increasingly able to identify a normal scan. When patients have medical conditions however, the regional doctors continue to make errors, and rely on the differential diagnosis from Bamako to confidently diagnose and treat their patients locally.

PRIMARY AND EXPERT DIAGNOSIS (TOTAL)

Legend: ■ DIAGNOSTIC AGREEMENT ■ INACCURATE PRIMARY DIAGNOSIS ■ NO PRIMARY DIAGNOSIS

Years: 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013
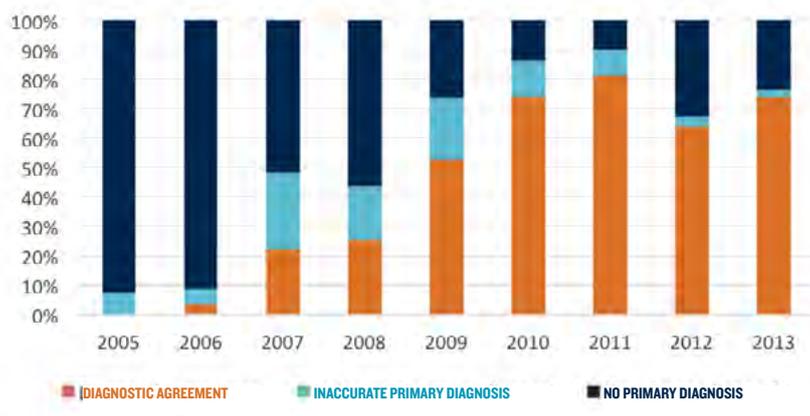
3. ORGANISATIONAL STRENGTHENING OF REGIONAL HOSPITALS

By 2014, only two regional hospitals in Mali had a radiologist in-house, a situation that confirms the current relevance of the tele-radiology service's function in replacing personnel that is lacking in the regional hospitals. Where radiologists are available in the regional hospitals, the IKON service continues to be used for obtaining a secondary diagnosis for more complex cases.

Hospital directors and doctors of participating hospitals contend that tele-radiology has improved their hospitals' overall quality of care, with a cascading benefit in terms of the perception of health care at the regional level. Several hospital directors have stated that tele-radiology gives 'confidence that the services in my hospital are good'. In the case of Gao Hospital, the director believes that hospital activity has doubled due to patients being more confident about the service they obtain as they know doctors can access expertise in Bamako on their behalf, significantly reducing referrals to Bamako. This has had positive effects on the income generated by regional hospitals. Whereas the costs of the tele-radiology service to the regional hospitals are minimal, there is a clear financial benefit: the hospital is able to charge for a high-quality service which generates income for the hospital coffers. 70% of the tele-radiology charge goes to the hospital, of which up to 10% is an incentive for the technician and the remainder goes to the hospital budget. More significantly, the patient stays at the hospital rather than moving to Bamako, increasing bed occupancy rates in the regional hospitals and administering of inpatient care.

Hospital directors have also noted that tele-radiology has enabled them to build better relationships with the local government who since the introduction of the IKON service want to be examined for health check-ups, even without any indication of illness. As the director of Gao Hospital put it: ' They wanted to come to have a diagnosis from Bamako!'

Although the majority of X-rays sent through the IKON service are of the chest area, the service also has its uses for hospitals' other departments, for example gynaecology or surgery. The significant cultural stigmatisation around fertility, for example, has created a high demand for gynaecological examinations in Mali.

'When I first went to Mopti there was no radiologist and I could not read any of the images, especially for the most frequent sicknesses I encountered in hysteron-examinations. It is a great help to have access to a radiologist and I routinely use the tele-radiology service.'

- *Dr Touré, gynaecologist at Mopti Hospital*

Such demand for other services shows the continued potential of telemedicine in strengthening regional hospitals and health care in Mali. Doctors in the regional hospitals regularly indicate feeling overwhelmed by the number of pathologies they see. With a growing clinical burden from cancer and little regional experience there is growing need regional expertise in screening, diagnosis and treatment. As Dr Beye from Ségou Hospital stated: ' Sometimes we operate on tumours and we just have to go in without knowing if it is cancer or not. We wish there was someone who could help us with histology'.

CATALYTIC IMPACT OF INTRODUCING ICT TO HOSPITALS

The introduction and use of the IKON tele-radiology service catalysed the use of technology in the regional hospitals, leading hospitals and staff to explore new ways of using the Internet. Doctors and technicians describe a wider impact since tele-radiology was introduced at the hospitals, including the hospital director becoming more interested in ICT, technicians and doctors increasingly understanding how ICT could help them in their practice and professional development, and the hospital administration making available resources to invest in ICT, replace equipment and maintain connectivity.

The contrast with the situation before introduction of the service is stark – when IKON was first established, more than half the technicians had never touched a computer. Through the training provided though the IKON project, healthcare staff are now using online video conferencing facilities, accessing medical lectures and instructional materials, and contacting international colleagues. The ICT access, ICT training and medical instruction offered by the IKON service is providing opportunities for young doctors and young radiologists to access relevant training and follow specialised degrees from international universities.

Building the technical and human capacity of regional hospitals to integrate and use ICT at the hospitals has thus made a significant contribution to addressing and contributing to the alleviation of human resource constraints faced by the Malian health sector. Doctors have reported feeling less isolated and more connected to their peers in Mali and internationally, as well as feeling more confident in their ability and motivation to provide better care for their patients. Doctors have reported feeling that participation in IKON contributes to their career prospects, despite being located in remote hospitals with severe infrastructural challenges impacting their practice.

Professional development benefits have not only accrued to the regional doctors however, as IKON radiologists in Bamako also reported to have benefited from participating in the programme. Next to being able to learn about ICT from the younger generation and learn to use technology in a new way, one radiologist from Point G Hospital in Bamako commented:

'the training impacted by ICT skills in general - it has enabled me to do more and publish more. The programme has helped me to better interact in the international sphere.'

- *Professor Sidibe, Point G Hospital*

RETAINING KNOWLEDGE

Turnover of staff has been a challenge in retaining knowledge of the IKON platform in the regional hospitals over time since trained staff frequently move to others hospitals. This challenge is compounded by the need to retrain all staff to use new versions of the platform as they come out. Two key elements have become critical parts of the training model to help address these challenges:

- Relay training – those who receive training are responsible for on-the-job training of two other staff members in their hospital
- Selection of candidates – IKON encourages hospitals to select doctors or nurses from the local area who are less likely to move away

CRITICAL FACTORS INFLUENCING THE SUCCESS OF THE IKON INITIATIVE

Next to identifying the impact of the IKON service and network on health care in Mali, the 2014 study investigated the critical factors that contributed to the successful design, deployment, uptake and integration of the tele-radiology service. According to the study, the tele-radiology programme in Mali presents a new model of implementing telemedicine in a developing country context which moves away from cross-border medicine and towards developing in-country expertise networks, and has identified a set of primary factors that play an important role in the success of this new model.

THE IKON INITIATIVE WAS CONCEIVED OF AT THE REQUEST AND WITH CLEAR OWNERSHIP OF ITS DIRECT STAKEHOLDERS

Mali's existing medical expertise residing in its medical community leaders combined with junior doctors' drive and motivation to develop their medical informatics specialisation was the foundation for conceiving of and designing the approach to IKON. Relevant knowledge, both from a context perspective as well as from a content perspective, was embodied in the Malian actors and formed a critical resource for informed design of approach, technology and content right from the outset.

The envisioning of IKON during the Round Table workshop, as well as IKON's place in strengthening the structurally challenged Malian health sector, generated a shared vision among diverse actors and organisations with a stake in the issue, allowing for continued negotiation and collaboration throughout every phase of IKON – a prerequisite for progress on complex issues.

Actors & Organisations involved in the initial conception of IKON:

- Mali's professional association of radiologists (SOMIM)
- Senior staff from Mali's University Teaching Hospital
- Directors and medical staff of Mali's regional hospitals
- Medical school graduates with medical informatics expertise
- Mali's Ministry of Health

EVOLUTIONARY AND LEARNING-FOCUSED PROGRAMME MANAGEMENT

Rather than predefining many details of the organisational structure, platform and service ex-ante, the IKON team in partnership with the IICD programme managers were given freedom to be agile and adaptive in managing and evolving the initiative through investing in practically working out ideas, testing approaches and building on insights generated by the IKON team and in discussion with hospital directors and lead users along the way. This locus of choice and drive lying with the implementing team and their users ensured that the evolution of IKON was guided from a problem-solving perspective with a holistic understanding from within the Malian medical system, rather than being a purely technical problem solving endeavour.

Not knowing in advance exactly what would work best, the team had to able to respond to emerging insights and kept a close tab on the implementations at the participating hospitals by visiting on-site and conducting learning focused review activities and academic studies during the course of implementation. When problems emerged, meetings were called with all hospital staff to collaboratively discuss challenges and solutions, and adaptations to the continuously evolving local context dynamics were discussed by the entire network at twice annual central coordination meetings.

IKON Adaptive Management:

- Light & utility-focused needs analysis and project formulation
- Iterative improvements to technology platforms and implementation approaches - building on what works
- Collective solution generation and trialling of new ideas
- Building of spin-off services from knowledge created within the programme
- Flexibility and freedom to adapt to emerging circumstances during implementation

KEY RELATIONSHIPS, TRUST & BUY-IN

The IKON initiative is characterised by the high levels of trust underlying the critical relationships, both between the IKON team and the support agency IICD, as well as between the IKON team and the key stakeholders within the Malian medical community. This trust is in large part due to the key players coming from a relatively small medical community with high levels of familiarity. Most doctors will have studied at the University Teaching Hospital at which the central players within the IKON team were situated.

Perhaps most critical were the personal relationships between the lead radiologist Prof Touré, the technical development team Dr Edem Kossi and Dr Romain Tohouri, IKON project manager Dr Mohamed Sangaré and the administration of regional hospitals. The manner in which IKON built a human relationship structure around the tele-radiology service was found to be of primary importance in any study that looked into IKON's success. According to the 2014 impact study, the IKON network demonstrates the catalytic impact of investing in individuals and of ensuring their ownership of a project.

Especially Prof Touré and Dr Sangaré worked hard over many years to build trust, transparency and accountability within the network. As an example the project budget was shared openly at the outset to dispel suspicion that the team was making money from the project, to emphasise its humanitarian value and to set the tone for the relationships with the hospitals.

On going and active support from the hospital directors is necessary to encourage doctors to use the service, explain its benefits to new staff, and ensure the equipment is maintained and replaced when necessary. In instances where it was not always possible to gain the support of hospital directors, hospitals would be reluctant to reserve budgets to maintain the required connectivity or ICT capacity, causing the use of the service to drop markedly.

Similar levels of trust and openness were key to the relationship between the IKON team and IICD. IKON programme manager Dr Sangaré believes the IICD/IKON model of working through local partners to ensure local and sustainable solutions has been critical. Even complex aspects of the implementation, such as the development of the software platform, were managed locally with IICD trusting the IKON team to learn to programme for themselves and investing in local capacity building over acquiring off-the-shelf solutions. Dr Sangaré believes they would have struggled to develop the second and third generations of the platform if they had not learnt through building it themselves at the outset.

More in general, the strongest continued commitment and championship of the service and network comes from the individuals who were involved in its initial conception and further deployment. Other radiologists asked to join the service at a later stage and provide expert diagnoses, against a fee, displayed lower levels of commitment than the original team.

CONCLUSIONS & RECOMMENDATIONS

The IKON tele-radiology programme in Mali presents a new model of implementing telemedicine in a developing country context, which moves away from cross-border medicine and towards developing in-country expertise networks. The project's limitations echo the intrinsic limitations of Mali's current healthcare system, most notably the travel distance to access healthcare at regional levels and the cost of healthcare. It is noteworthy that the tele-radiology programme, which serves all the regional hospitals in Mali, is adequately staffed by a handful of radiologists, thus efficiently addressing the lack of specialist expertise at regional level.

It is clear that for those patients who can access regional hospitals, tele-radiology provides real savings to their time, money and health. IKON is also making incremental improvements to the wider healthcare system through the introduction of ICT which is proving to be a fundamental contribution to building capacity among healthcare personnel and is providing opportunities for young doctors to access means for further professional development. IKON has become a sustainable network, with the costs of the programme covered by charging patients a small fee to access the service and new hospitals self-funding their participation in the network. Management and coordination has been decentralised to the regional hospitals, giving the network a large amount of autonomy and self-regulation at user level.

The success of the IKON programme and the lessons learned on key factors contributing to its success, provide valuable indications for making sound investment decisions in resource-limited health contexts:

- **Similar tele-radiology programmes can be applied to new contexts but only with strong local involvement. The programmes should be implemented internally, at the request and with the close involvement of regional hospital staff and national radiologists.**
- **Creating a network of trust between all parties, and prioritising the relationship with hospital directors across the country from the outset is a primary lesson for any venture to replicate telemedicine in a new context.**
- **The implementation phase should involve as many of the hospital staff as possible, creating maximum buy-in.**
- **Technology solutions should be designed and developed by those who will be maintaining the programme in later stages, and ideally be created by individuals with sensitivity to and understanding of both professional content and culture.**
- **Connectivity issues should be resolved as a matter of priority as they arise, since frustrations over connectivity can destroy a programme's implementation.**
- **The importance of widespread and on going training in ICT, especially in remote areas, is vital for the success of any tele-health programme.**