# Monitoring research projects in resource-constrained countries in real-time

In under-resourced countries, paper forms are still frequently used to collect research data. Paper records are expensive to prepare, distribute, store and archive. Paper is easy to lose or destroy, and is not easy to access especially when results are needed quickly. Now that affordable mobile electronic devices like tablet computers and smart phones are on the market, some of these drawbacks can be overcome using electronic data collection systems.

In under-resourced countries, paper forms are still frequently used to collect research data. However, paper forms are expensive to prepare, distribute, and archive, but are easy to lose and delay the availability of results.

These inexpensive electronic devices are especially useful in resource-constrained settings where lack of reliable infrastructure poses major obstacles to standard data collection, and where mobile phone use and coverage have surged in recent years. Existing open-source software tools can serve as a base for developing data collection software to meet specific needs. Therefore, we

developed a software tool to facilitate data entry and to monitor the progress of research projects in under-resourced countries in real-time based on the existing open-source software Open Data Kit (ODK). Briefly, ODK is based on open software standards with a modular and customizable architecture, speeds up data collection, and reduces opportunities for errors. The *e*Management tool *"odk_planner"* extends the ODK framework with an intuitive web interface. *odk_planner* uses minimal internet resources and is thus suitable for under-resourced settings. Users can easily configure *odk_planner* to meet their needs, and the web interface displays data collected from ODK forms in a graphically informative way. *odk_planner* also allows users to upload pictures and laboratory results, and can send text messages automatically. User-defined access rights protect data and privacy.

Data entry and data management with "odk_planner" in the field. Clinical and laboratory data are entered directly into tablets, and data entry is monitored in real-time on any Android mobile device. Temeke District Hospital, Dar es Salaam, Tanzania.

We present examples from four field applications in Tanzania successfully using the *e*Management tool in the field of tuberculosis, the leading cause of death from an infectious disease worldwide alongside with HIV: 1. Clinical trial on the effect of anemia on tuberculosis: *odk_planner* supported the bimonthly visit schedule of the study participants over a time period of six months, and made available all clinical and laboratory data to an international research team. 2. Observational tuberculosis cohort study with a complex visit schedule, where *odk_planner* was used to graphically display missing data, upload digitalized chest X-rays and laboratory results, and send text message reminders to patients. 3. Intervention study to increase tuberculosis case detection, carried out at pharmacies: *odk_planner* supported a tablet-based electronic referral system which monitored referred patients, and sent automated messages to remind pharmacy clients to visit a clinic for proper tuberculosis diagnosis. 4. Tuberculosis retreatment case monitoring designed to improve drug resistance surveillance: physicians at four public tuberculosis clinics and lab technicians at the tuberculosis reference laboratory used *odk_planner* on smartphones that tracked sputum samples for confirmation of diagnosis, and collected clinical and laboratory data.

In conclusion, the field applications in different settings and with different designs showed that *odk_planner* is an excellent *e*Management tool for scientific studies conducted in under-resourced settings. It is user-friendly, with a variety of functions, is a broadly applicable tool for managing a wide range of studies, and can also be used to improve routine medical care or accelerate collection and delivery of clinically relevant information in routine care.

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## Publication

Managing research and surveillance projects in real-time with a novel open-source eManagement tool designed for under-resourced countries.
Steiner A, Hella J, Grüninger S, Mhalu G, Mhimbira F, Cercamondi CI, Doulla B, Maire N, Fenner L.
*J Am Med Inform Assoc. 2016 Feb 15*