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ITC Contribution in Surveys

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Abstract: ***This paper aims to underline the Information and Communication Technologies (ICT) contributions in survey implementations. We used ICT tools in the Chad Malaria Indicators Survey (CMIS). We found that ICT are revolutionising surveys. Their implementation considerably improves survey operations by eliminating some over-budget steps, enriching data quality, and facilitating data manipulation. This highlights the contribution of ICT in smart surveys. Smart surveys, which utilise ICT tools, were examined with a focus on the contributions of ICT in these surveys. A use case was giving through our implementation of smart survey.***

Keywords: ***Information and Communication Technologies; Computerized Data Collection System; Survey; CAPI, PDA, Phone.***

I. INTRODUCTION

Chad through its National Malaria Control Program has organized its second Malaria Indicators Survey in (CMIS). It is a representative sample survey at the national level, grouping regions and places of residence (urban or rural). This survey saw the participation of several entities from different disciplines (National Institute of Statistics, Economics and Demographic Studies (INSEED), ESSO-Chad, National General Reference Hospital (HGRN), Ministry of Public Health, University of N'Djamena and JHPIEGO). It got financial support from the Global Fund. The primary objective of the Malaria Indicators Survey is to inform about the key malaria indicators in Chad. It aims to provide mainly information relating to:

- The possession and use of long-lasting insecticidal nets (LLINs);
- The proportion of the population at risk protected by residual indoor spraying in the last 12 months;
- The prevalence among pregnant women, children under 5 and in the general population;
- The rapid and effective treatment of febrile episodes by antimalarials;
- The use of Sulfadoxine-Pyrimethamine (SP) for intermittent preventive treatment (IPT);
- The estimated prevalence of fever in children under 5 years;
- The estimation of the prevalence of parasitemia and anaemia;
- The assessment of the level of knowledge, attitudes and practice in the prevention and management of malaria in the community.

During this survey, ICT tools were used. We call such surveys smart surveys. We found that ICT are revolutionizing surveys [1], [2]. Their implementation considerably improves the survey operations by eliminating some over-budgeting steps, enriching the quality of data [1]. Indeed, the use of ICT in conducting surveys makes significant improvements. Each technology we used in survey operations provided added value either at the organizational level (data collection, data control ...) or at the operational level (data analysis and processing). Yu et al. [3] said desktop computers, laptops, followed by PDAs (Personal Digital Assistant) and minicomputers were used with great satisfaction in the surveys.

Nowadays, with the emergence of various lightweight communications mediums such as tablets and mobile phones supporting advanced operating systems (Android, Mac OS, Windows Mobile or Linux) and mobile applications, progress in conducting surveys is observed [1], [4], [5]. It used cloud computing, too. This ITC use motivated the present paper. In fact, the Chad Malaria Indicators Survey examined various technological tools for use in our operations. We have identified several useful ICT tools and would like to outline the current state of the art of these tools in survey operations. We will put a particular emphasis on data collection tools because it is the most expensive phase of surveys in terms of time, money and other resources (human, material, etc.) [6]. A collection method is defined by the support, the communication channel, and the presence of an interviewer (a natural person). The questionnaires always have, as primary support, the paper or the computer screen. They can be addressed to the interviewees through several communication channels, including sight and/or hearing, and can mobilise an interviewer (hetero-administered questionnaires) or not (self-administered questionnaires). In traditional surveys, questionnaire support was paper [6]. The use of ICT in conducting surveys, known as a smart survey, reduces the costs associated with data collection. It eliminates several steps in traditional data collection, including printing questionnaires, handwriting data on paper questionnaires, coding, and transporting boxes of questionnaires, among others. It substantially reduces the time between data collection and analysis because the data collected is immediately available for processing and analysis. The phase of data entry (transcription of paper questionnaires on a computer), which is also budget-sensitive, is eliminated [1], [7]. In addition to data collection, there is also an improvement in the conduct of smart surveys; the use of the Internet and telephone facilitates communication within teams and with supervisors.

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The use of the cloud enhances verification and data security: the collected data is sent at the end of the day or the end of the cluster surveyed to a dedicated server. These data are checked to correct possible errors and inconsistencies. With this server, the failure of a device (tablet or memory card) does not entail a total loss of data. The purpose of this work is to show the ITC contributions in surveys and present some ICT tools used in surveys. The benefits and limitations of using ITC in surveys are discussed too. In the remainder of this paper, we will present our research methodology in Section 2. Then, we will show the results at point 3, distinguishing between the traditional survey and the smart survey. Point 4 is the discussion. We will focus on the smart survey, exploring its benefits and limitations in the context of ICT. We will also present our implementation of a smart study. And finally, we will finish with a conclusion.

II. METHODOLOGY

We primarily employed the methodology of literature review, drawing on the experience and lessons learned from surveys in which we participated, from design to data analysis and deployment on the sites. We defined our research question as "What is the contribution of ITC in surveys?" and what ITC tools are used? We are interested in traditional surveys to compare with the smart surveys. The literature review shows us that ICTs are used in several surveys [4], [7]-[11]. [8] used it in a survey on factors associated with mosquito net use in Amhara (Ethiopia); [9] in a survey on coverage and use of paramount malaria prevention and control interventions; [12] in Knowledge of malaria and its association with malaria-related behaviors results from the malaria indicator survey. Many National Malaria Control Programs (NMCPs) used ICT tools in malaria indicator surveys [13]-[14]. [10] had used PDA (Personal digital assistants) in tele dermatology in creating and utilizing a Multimedia Dermatology Medical Record. [7] introduced an innovative method that uses personal digital assistants (PDAs) equipped with global positioning system (GPS) units in household surveys to select a probability-based sample and perform PDA-based interviews. They used PDAs with GPS to rapidly map all households in designated areas, choose a random sample, and navigate back to the sampled households to conduct interviews. [4] used Open Data Kit (ODK) technology on Android mobile devices during a household survey in the Niger Delta region of Nigeria. Their paper outlines the advantages and disadvantages of deploying ODK for data management. [5] described the development, use, and impact of a Web-based application to facilitate data management in participatory action research (PAR). They noted that the Web-based management application was successful in improving data collection time efficiency and engagement among data collectors. A diverse audience can efficiently use this management solution, which is adaptable to support various settings. [2] had made a literature review on Mobile Phone Surveys for Collecting Population-Level Estimates in Low- and Middle-Income Countries. They found most surveys were conducted using CATI. [15] described the development, implementation, and evaluation of a mobile device-based system to support such services. [11] discussed the challenges in using mobile phones for collection of antiretroviral therapy adherence data in a resource-limited setting. These works put more emphasis on the use of ICT to facilitate their tasks. We will place particular focus on the contributions of these ICT tools in carrying out surveys. Our study is closest to that of [1], [16] aimed to compare data quality parameters in the data collected using mobile electronic and standard paper-based data capture tools in one of the health and demographic surveillance sites. They focused on data quality. [1] made a comparative study of data collections using smartphones and Pen-and-Paper. They demonstrated that using smartphones for data collection, compared to pen-and-paper methods, eliminated data recording and entry errors, had similar reliability, and required an equal amount of time per interview. They focused only on using smartphones for data collection. We consider all ICT tools used in the survey.

III. RESULTS

A. Traditional surveys

A survey is an operation that collects information on a given subject in a sample for extrapolation to understand the behaviour of a larger population. Completing a study involves several steps. [6] have identified eleven steps. It ranges from the problem of survey design to the publication and archiving of data, encompassing the steps of organisational aspects, budget, training, field survey, data processing, and analysis. All these steps are subject to ICT use, but our focal point will be the site survey and processing, where ICT supply is essential [17]. The site survey is mainly characterized by data collection and processing through coding and data clearance. These steps are briefly presented below. Data collection is particularly cumbersome and a bottleneck for traditional surveys. In conventional surveys, questionnaires were supported by paper. Then, the data collection was done using paper and a pen; afterwards, the collected data was entered on a computer. Data entry is performed by operators other than the data collection agents through a specific application. This operation was tedious and prone to error, particularly among data collection agents and data entry operators. Manual data collection is difficult to organize on a large scale because it is costly. The coding of the questionnaires is a crucial step in producing the digital file of the survey. It consists in assigning a relevant code to the responses to facilitate their subsequent processing during analyzes. The coding phase can occur either before, during, or after entry. It takes a lot of time in traditional surveys because we consider all the questions in the questionnaire and all the interviewees [6].Data clearance is the step to ensure data quality [18]. During this phase, the survey data file undergoes numerous checks and consistency tests to ensure its quality is enhanced. Consistency tests make it possible to detect data errors, inconsistencies in the declarations of respondents and also to check the consistency of situations that are difficult to identify when entering or re-reading the questionnaires [19]-[20]. This step often occurs immediately after entering the questionnaires, but when the input period is lengthy; it can take place simultaneously. Figure 1 shows the main steps of the traditional survey.

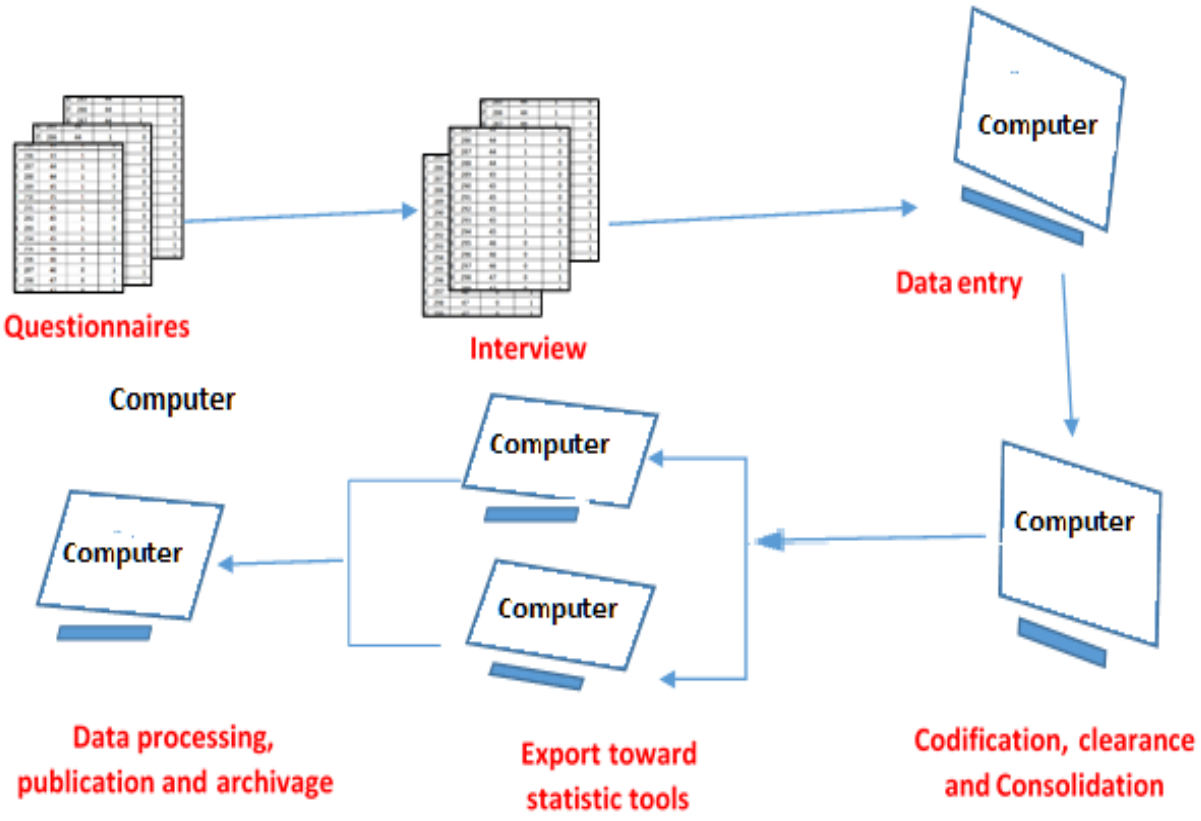

Figure 1Steps of a traditional survey

B. Smart surveys

Today, modern tools, especially information and communication technologies (ICT), are used to facilitate surveys, particularly to create digital questionnaires that do not require paper and pen. The numerical questionnaires are primarily designed to enhance the data collection phase. ICT tools are also used for other survey steps, but their contribution to data collection is so substantial that this step gets more attention.

In smart surveys, questionnaires can be administered through an ICT device (such as a tablet, PDA, smartphone, telephone, or internet connection) with or without an internet connection. Thus, several methods of data collection are proposed:

- Computer-assisted personal interviewing (CAPI) method: In this method, the interviewer goes to the interviewee with a mini-laptop or tablet and enters the answers directly during the interview [3], [21]

- Computer Assisted Self-Interviewing (CASI) method: a pre-programmed computer is used in the presence of the interviewee, or left at the address of the respondent for the data collection. Surveys CASI types solve some problems of feasibility in the case of sensitive topics to discuss face to face or particularly long questionnaires (multi-themes surveys of single-source type) [22].

- Computer-assisted web interviewing (CAWI) method: data collection method used in Internet surveys [23]. The surveyed user directly completes the questionnaire, often presented in a form.

- Computer-assisted telephone interviewing (CATI): used for some telephone-based surveys [11]. The handover and entry of questionnaires are done using the telephone. This type of collection is usually outsourced and requires appropriate physical infrastructure.

- The optical capture method: used by some survey departments with an optical capture workshop. This method requires an appropriate system with a graphical format for the questionnaire. Optical data collection is fast for closed questions (checkboxes and numbers), but open questions are usually entered by hand by typing operators.

All these methods greatly enhance data collection and effectively eliminate the bottleneck of data entry in traditional surveys. Figure 2 presents the main steps of the smart survey.

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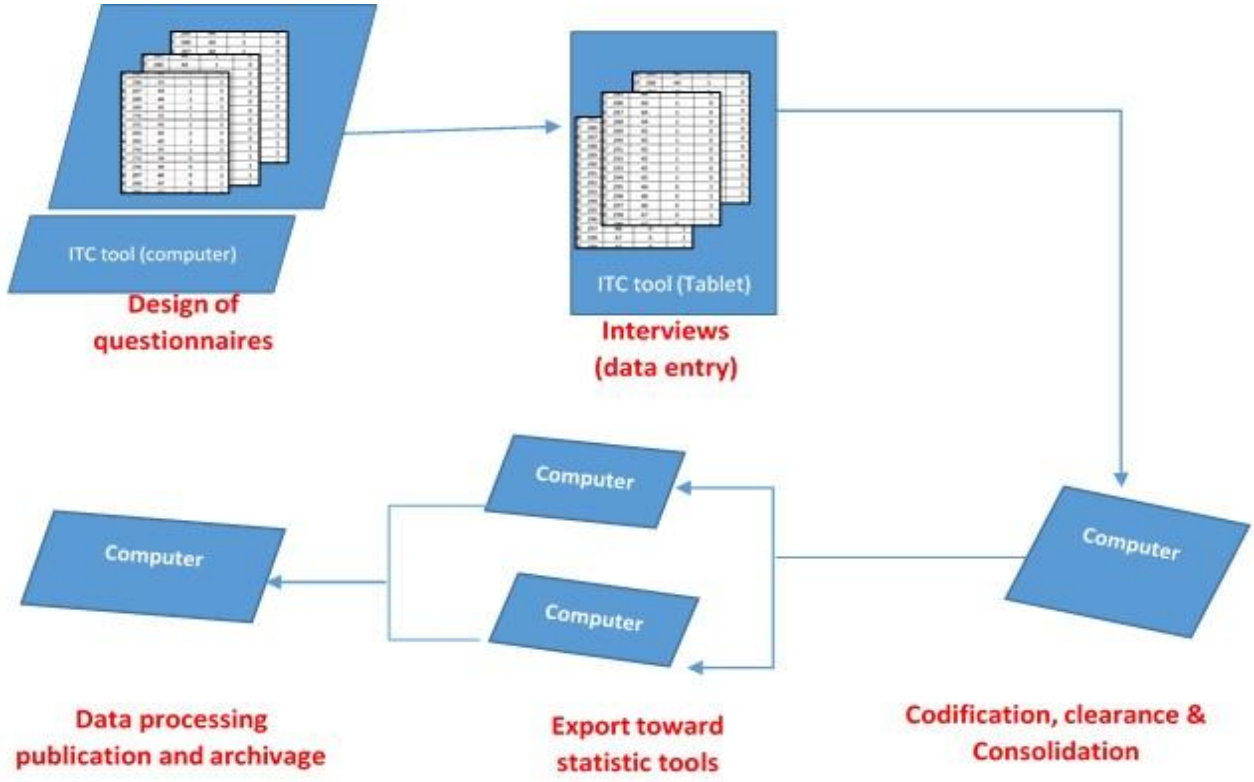

Figure 2: steps of smart survey

C. ICT materials needed for surveys.

ICT materials that can be used to create digital surveys to solve traditional problems in data collection and data entry activities include commonly used materials such as computers, mobile phones, PDAs (Personal Digital Assistants), tablets, and the internet. A description of some of these materials attesting to their use in surveys is presented below.

1. Computers

The desktop computer was the first ICT tool used for conducting surveys in the 1980s. His intervention was in the transcription of paper questionnaires into digital data files and in the analysis of data through data analysis and statistical software [17]. Today, they are also involved in the CASI, CAPI and CAWI surveys for data collection [7], [24]. Laptops offer the same services as desktop computers and are admired for their compact size and lightweight design. They are easily transportable and more suitable for site surveys than desktop computers.

2. Phones

Phones are used in interviews to reach people who are more mobile and more difficult to reach physically. They are involved in Computer Assisted Telephone Interview (CATI) type surveys [2], [11]. They allow for the drawing of numbers to be interviewed in the sample, as well as guidance and control over the questionnaire, etc.

3. PDA, smartphones, tablets

PDAs, smartphones, and tablets are ultra-thin laptops that come in the form of a touchscreen and offer the same functionality as a personal computer. They provide access to multimedia content such as television, web browsing, consultation, sending e-mail, agenda, calendar, and simple office automation [25]. PDAs, smartphones, and tablets have revolutionized Computer Assisted Personal Interviews (CAPI) [7]. Due to their popularity and accessibility, they are easy to use in surveys [3]. They have the following advantages: a relatively low cost, speed of data entry, good ergonomics (including images, possibly sounds, online help, and interactivity), control possibilities, integration with the phone, GPS, and other utilities.

4. Server and Internet

The internet has enabled the conduct of online surveys on web servers. We are talking about Computer Assisted Web Interviews (CAWI) [5]. Internet surveys have proven successful in specific market research or for targeted samples. They can take various forms:

- permanent presence on one or more sites,
- survey agent using the Internet instead of the telephone (webcam ...),
- sending e-mail based on a selection of addresses,
- random presentation by pop-up,
- etc.

This type of survey brings the benefits of the internet and web services. Servers are used in a cloud to secure data during the site survey.

D. ICT software needed for surveys.

We create a sketch of a state-of-the-art software used in surveys. We will focus on CAPI-type surveys for data collection [7]. In general, data analysis is done using statistical analysis software such as Stata, Statistical Package for the Social Sciences (SPSS), Statistica, SAS, or MS Excel [3], [25]-[26].

First, it is necessary to distinguish between software for designing digital questionnaires and software used for collecting digital data. This last one proposes solutions that combine data entry, survey management and data manipulation functions [25]. These are, for example:

Survey Solutions (available online at https://solutions.worldbank.org/ is an entirely free and easy-to-use data collection, survey management and data management software requiring only minimal technical support. It is a simple yet powerful tool, suitable for both small- and large-scale surveys.

The CapiPlus system (developed by INSEE, France) was designed to offer statisticians a computer architecture able to host CAPI surveys with households by reducing the costs of computer development to those of the programming of the questionnaire and the audit program, which are specific to the survey.

Mobi-Survey(http://www.soft-concept.com/mobisurvey-software): a revolutionary solution for creating questionnaires and forms on mobiles and tablets. These collection media can operate in connected or disconnected mode. A central platform allows tracking deployed applications and automatically synchronizing data with mobile devices. Mobi-Survey is available on both Android and iPhone / iPad.

LimeSurvey (www.limesurvey.org): a tool that allows quick creation of online questionnaires and surveys that can receive responses from tens of thousands of participants.

As for the software for creating digital questionnaires, it offers the possibility of designing and developing graphical interfaces corresponding to the questionnaires and their business objectives. They make possible the development of any solution for data collection and manipulation (merge, sort, export, etc.). In this class, we can cite as examples:

1. CSPRO (Census and Survey Processing System) [27]: an integrated system for collecting, entering, processing, tabulating, and disseminating data of surveys and censuses. It is produced and supported by the United States Census Bureau and distributed free of charge. We note that the first version of CSPro for tablets and Android phones was introduced in 2013, enabling digital data collection. CSPro is in the public domain and available online for download at www.census.gov/ipc/www/cspro.
2. SYWARE Visual CE: An integrated development environment for creating databases and forms on devices such as pocket PCs or PDAs using the Windows Mobile operating system [27]. Since 2015, a version for the Android system has been developed [28].
3. ODK (Open Data Kit): a free, open source tool for collecting data in the field [14], [29]-[31]. Designed by Harvard University, ODK is distributed and supported by international organizations such as UNOCHA, UNHCR, IRC, etc. It is mainly used by professionals and researchers working in developing countries [4], [30].

IV. DISCUSSIONS

A. Benefits of ITC use in surveys: CAPI data collection

The ITC, primarily used in CAPI surveys (on tablets), is the ideal tool for data collection at sites and in public polls. It is a system designed to help survey agents, supervisors, and the central office collect, supervise, and monitor data collection operations at the sites.

It has several advantages:

- Reduced costs because the data does not need to be re-entered, as in paper questionnaires. The interviewer conducts face-to-face interviews with a PDA or tablet on which he can capture and/or transmit information in real time [1]. Interviewee can enter data from the CAWI method.
- Increased response rates, thanks to better ergonomics and the attractive appearance of the tablet;
- Accelerated processing times and real-time data availability;
- Ability to collect new information (geolocation, photos, signatures, etc.) The use of tablets can save time: during the collection, questions are asked and chained according to the respondents' answers, referrals, and jumps are automatic. This selective sequence of questions reduces the time of the interview [7]. The data entry phase, which is a bottleneck in the surveys, is not necessary because the data is available in real time, and you just must extract it and export it to analysis tools [32].

Tablets also provide cartography assistance. In addition to personal information, the interviewer can record geographic information (GPS coordinates) and multimedia (photos, sounds and videos) [7], [25].

The tablets help with sampling; they offer an automatic draw of individuals or households to interview [2], [25]. Team leaders are supported in managing their teams. The assignment of interviewing households to the interviewers is done directly on the tablets.

The control of work by team leaders and supervisors is facilitated through the use of these tools. Indeed, it is sufficient for the team leader to resume the interview sequences to ensure the consistency and quality of the data. Supervisors can do as much as team leaders, but they can also transfer data to computers and perform their checks. Supervisors can do this work on the site with the survey agents as at home thanks to a centralized management of data on a cloud server (Dropbox in the case of CMIS).

B. Limits of ICT use in surveys

The use of ICT tools in surveys also presents some difficulties. Here, we mention the limits often found on PDAs, which are easily generalizable to other media. PDAs have demonstrated fundamental limitations in their use on the survey site in three key areas: on-screen display, storage capacity, and memory. In fact, the low resolution of the screen poses visibility problems for users, especially in bright light conditions. It is also worth noting that the small screen size does not always.
facilitate easy reading.

It can be difficult to store a significant amount of data in the PDA [25]. We are thus obliged to use external memories and expose ourselves to attacks by viruses. The low memory of the PDA results in frequent bugs that occur during data collection, thus interrupting the agent in the middle of an interview. However, these difficulties are mainly solved by using tablets, whose screen size and memory are essential, which can significantly minimise the bugs.

Another problem is the autonomy of the used devices. If the batteries have low capacity, this can hinder the smooth operation of surveys. However, using an additional energy source, such as a generator or solar kit, can remedy this situation.

C. Architecture of CAPI

The computer-assisted Personal Interview (CAPI) is a technology that works on mobile devices (PDA, laptop, tablet, smartphone, and mobile phone). It can leverage the Internet or cellular network to help survey agents collect data on-site. In this context, an interview can be remotely attributed to site data collectors [25]. Data is collected on a mobile device using digital questionnaires and then transmitted to headquarters, where it is monitored in real-time and analysed. It should be remembered that a questionnaire is a set of questions organized according to a logic allowing to reconcile the constraints related to the management of the information, the nature of the subject addressed and the conduct of the interview. It is structured to facilitate the dialogue between the interviewer and the person consulted. In general, the questions are grouped into major themes that make up the sections of the questionnaire. The sections are logically well-chained. Within these sections, the collector follows the order in which the questions are asked of one another [1]. In CAPI, the sequence of questions is automatic.

CAPI also offers active data collection management tools such as automatic survey progress reporting, which allow survey managers to track and organize site work effectively.

D. Our Case Study: organization of our data collection

As part of the CMIS, we used Huawei brand tablets, specifically the model FDR-A01L, for data collection. These tablets are equipped with an Android operating system (5.1.1) and a GPS (Global Positioning System) tracking system. They are equipped with a 1.6 GHz Qualcomm MSM8939 processor, 2 GB RAM, 16 GB internal storage capacity, and a 1200 x 1920 screen resolution. GPS are used to record the geographical coordinates of the households surveyed. We used the CSPRO software (version 6.3) [27] for the programming of our questionnaires and deployed them on the tablets. Our programs are in line with the models proposed by the Centers for Disease Control and Prevention, Atlanta, USA [33].

The data is collected through the questionnaires programmed on our tablets. To ensure the identification of individuals and the confidentiality of data, Unique identifiers have been implemented. Every night, the information collected in the tablets is transferred to a cloud server (Dropbox) to create a secure backup. This avoided possible loss of data for various reasons (theft or loss of tablets, software split or tablet failure, etc.). The extraction of data from tablets and their export into a data analysis software was made using CSPRO tools. The statistical analysis software used is STATA [34], designed and developed by Stata Corporation. At the request of some Data Analyst Consultants from the CMIS, an export of data in SPSS format was also conducted during the data analysis workshop.

V. CONCLUSION

We focused on highlighting the contributions of ICT tools in surveys. We presented the traditional survey and the smart survey. We found that the use of ICT tools in conducting surveys is very satisfying because they facilitate the different steps of the surveys, particularly the data collection step, which was a bottleneck in the past. Although the use of ICT in smart surveys incurs a cost (acquisition of equipment and training required), this cost is generally offset by the total or partial elimination of costs associated with printing questionnaires, storage, and data entry. ICT tools offer better data quality, as they enable automatic referrals and systematic verification of response quality during the interview. They reduce the risk of data loss by backing up data on cloud servers.

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