KNOWING IN TIME
How technology innovations in statistical data collection can make a difference in development

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Disclaimer

The opinions expressed in this paper are those of the authors and should not be attributed to the PARIS21 partnership or its members.
Abstract

The availability of statistics and household survey data in developing countries has improved in recent years, thanks to an increased focus on measurement and indicators, and better statistical capacity. Yet, statistical production systems remain relatively slow and are unable to meet an increasing demand for more frequent and up-to-date statistics needed to assess and monitor an increasing number of volatile development challenges such as economic crises, weather shocks or political conflict. Fortunately, the rapid expansion in mobile connectivity, and progress in technological innovation more broadly, provide new opportunities for increasing the quality, speed and frequency with which data can be collected and statistics produced. This paper provides an overview of technological innovation in data collection in developing countries, with a particular focus on those technologies that enable high-frequency data collection. The review of tools and experiences demonstrates that new technologies can substantially advance the production of faster and more frequent data, even in the most challenging institutional and capacity constrained environments. Moreover a set of new mobile phone based approaches allows for complementation of traditional surveys with relevant high-frequency indicators. In addition, ‘big data’ is becoming an emerging source statistical data in developing countries. Integrating these new data collection approaches successfully in national statistical systems would benefit significantly from NSOs and the NSDS process taking lead in identifying needs, possibilities and limitations for the deployment of such new data collection approaches. Improved statistics produced through these new approaches is an important step towards strengthening evidence-based policy making in response to emerging development challenges, particularly those concerned with volatility and shocks, and a cornerstone in the post-2015 development agenda.
# Table of contents

1 Introduction .......................................................................................................................... 4

2 Background and context ...................................................................................................... 5
   2.1 Development data: more, but not much faster and better .............................................. 5
   2.2 The increasing need for ‘knowing in time’ .................................................................... 7
   2.3 The connectivity revolution provides new opportunities for faster data ...................... 8

3 New data collection technologies and methods ................................................................... 9
   3.1 Electronic survey forms on computers, smartphones or tablets (CAPI) ....................... 10
   3.2 Personal phone surveys: Computer-assisted telephone interviewing (CATI) ............... 12
   3.3 Automated phone surveys: interactive voice response (IVR) ...................................... 13
   3.4 Mobile text surveys (SMS/USSD) ................................................................................ 14
   3.5 Web surveys: Computer-assisted website interviewing (CAWI) ................................. 15
   3.6 Big data: opportunities of turning ‘digital traces’ into real-time statistics .................... 15

4 Emerging lessons from early applications of new data collection technologies and methods .................................................................................................................... 17
   4.1 Technical, institutional and human capacity limitations ............................................... 17
   4.2 Sampling issues and representativeness ...................................................................... 17
   4.3 Non-response, attrition bias and economic incentives .................................................. 18
   4.4 Data quality .................................................................................................................. 19
   4.5 Privacy ......................................................................................................................... 19
   4.6 Costs ............................................................................................................................ 20
   4.7 Beyond collection: processing, analysis and dissemination .......................................... 21

5 Implications for data collection practice and statistical systems ....................................... 21
   5.1 Improving speed, accuracy and costs of ‘traditional’ surveys ....................................... 22
   5.2 Complementing traditional data with relevant high-frequency indicators .................... 22
   5.3 Ensure institutional arrangements and capacity to mine statistics from ‘big data’ .......... 23
   5.4 Designing statistical systems for mixed-mode and high frequency data collection ......... 27
   5.5 Strengthen NSOs role as ‘statistical brokers’ and ‘certifiers’ of new data ...................... 28

6 Conclusion ........................................................................................................................... 28

7 References ............................................................................................................................ 30

Annex 1: Case studies of deployments .................................................................................... 33
   A.1.1: CAPI surveys in South Sudan: monitoring economic and political change ............. 33
   A.1.2: Phone surveys in Latin America: “Listening to LAC” (L2L) ..................................... 35
1 Introduction

Over the past decade, the world has seen a large increase in availability of development statistics. The international development discourse has increasingly focused on results and goals, most prominently illustrated by the Millennium Development Goals (MDGs) and corresponding national development goals (United Nations, 2000). Consequently, the world has also seen an increasing focus on monitoring and evaluations of development results at the project and administrative levels. The current on-going discussions of a post-2015 development framework also focus on the importance of measuring development progress with monitoring of key statistical indicators as a key cornerstone of the future development agenda1.

Despite general improvements data availability, official statistics in developing countries is often not very recent, of varying quality and reported with low frequency. In particular, statistics on important welfare measures – such as poverty, health, and unemployment – are often several years old. If leaders and policy makers lack timely data about problems, it is more difficult to address them. Lack of such data is particularly pressing in the context of development challenges focused on temporary shocks, such as economic crises, food security, weather events or social conflict. As a result, policy makers often simply do not have sufficient knowledge to respond to such rapid changes in time.

Improved connectivity and cheaper technology provides opportunities for collecting data faster and can potentially revolutionize the availability of high frequency data. Globally, the number of mobile phone subscribers has grown from 1 billion in 2000 to over 6 billion today, of which nearly 5 billion are in developing countries (World Bank, 2012). Even in some of the poorest developing countries, more than 90% of households own a mobile phone and adoption is increasing fast. Hardware costs (mobile phones, smart phones, tablets and computers) have also dropped fast. This means that traditional statistical collection through household surveys can be modernized and complemented with new methods such as phone surveys, text message surveys, the deployment of electronic forms on digital survey devices and more.

The perspective and focus of this paper is concerned with how such innovations can help National Statistics Offices and national statistical systems collect faster, more frequent data, and what are the limitations and challenges with such approaches. The key question that this paper seeks to answer is: how can recent progress in technological innovation and connectivity help countries collect better, faster and potentially cheaper statistics? The paper takes stock of recent innovations in data collection, with a particular focus on how the use of mobile phones can help strengthen the frequency and speed with which critical data is collected in developing countries. The paper covers early deployments of such methods conducted in several development countries, by different actors. Some of these examples are small-scale applications and early experimentation of

1 The UN High-Level Panel on the Post-2015 Development Agenda (United Nations, 2013) recently called for a “data revolution”. The Panel suggested that “the revolution in information technology over the last decade provides an opportunity to strengthen data and statistics for accountability and decision-making purposes” – a central premise of this paper.
new tools, while others are larger and global in reach. The focus of this paper is mostly concerned with the type of statistics that is collected through survey data, such as social statistics focused on issues, such as poverty, health, nutrition and employment. Some applications are also relevant to more administrative statistics (e.g. number of health facilities, school enrollment rates, public expenditure, etc.). This paper focuses on the data collection process and not the other stages of the statistical production process and dissemination although it recognizes that important innovations are being brought about in these areas as well.

Based on the review of several new technological approaches and experimental deployments, the key finding of this paper is that new technologies can substantially advance statistical capacity to produce faster and more frequent data, even in the most challenge institutional and capacity constrained environments. Despite some limitations, new survey technologies can both improve the speed, accuracy and costs of ‘traditional’ surveys. Maybe most importantly, a set of new mobile phone based approaches allows for complementation of traditional survey data with relevant high-frequency indicators, which are of importance to policymakers’ ability to act in time. In addition, ‘big data’ sources can become a useful statistical data source also in developing countries, but requires considerable capacity and appropriate institutional arrangements to be fully utilized. Furthermore, NSOs and NSDS processes should take lead in identifying needs, possibilities and limitations for the deployment of such new data collection approaches, and ensure complementarity to existing approaches.

The remainder of the paper is laid out as follow. The next section (Section 2) focuses on the current state of development data production and makes the case for the need for faster and better data production. Section 3 provides an overview of technological approaches and tools that are becoming available for improved data collection in developing countries and provides some examples as well as an outline some general advantages and disadvantages of each of the approaches. Section 4 discusses some of the lessons learned from existing deployments, regarding issues such as capacity limitations, costs, sampling issues, data quality and privacy. Section 5 discusses the implications for data collection practice and statistical systems and provides some recommendations for the way forward. Section 6 concludes while Annex 1 provides a short case studies with some further details of existing applications of some of the technologies discussed in this paper.

2 Background and context

2.1 Development data today: more, but not much faster and better

In recent years, the development field has seen an increased focus on evidence-based policy making and monitoring of development indicators. The decision to adopt and focus on the MDGs has maybe been the single most important driver of the increased availability of development data globally. At the same time, there has also been a deliberate focus on improving statistical capacity, illustrated by initiatives such as PARIS21, which focuses on improving national statistical capacity and the integration of statistics and reliable data in the decision-making process. The Paris Declaration on Aid Effectiveness also put an increased focus on results, mutual accountability,
and how results get measured, and this is also becoming a key element in the post-2015 development agenda.

As a consequence of this increased focus on measurement and results and increased funding for statistical capacity building and surveys, the world has more data about development than ever before. For example, the World Bank, now has official, comparable poverty numbers for 98 developing countries between 2005 and 2010, as compared to less than 80 countries ten years earlier (See Figure 1). Overall, the World Development Indicators, the most comprehensive database for international development statistics, has grown from an average of 426 reported indicators per country per year in 1990 to 805 in 2009. This growth in the availability of development statistics is reflective in a massive effort in improved data collection and international aggregation. Many of the improvements, particularly on social indicators, are due to increased efforts by National Statistical Offices and donor partners, as well as and international survey initiatives such as the Demographics and Health Surveys (DHS) and the Living Standards Measurement Surveys (LSMS).

![Figure 1: Number of poverty surveys available in PovCalNet](image1)

**Source:** Author’s tabulation based on World Bank PovCalNet.

![Figure 2: Number of statistical indicators available in the WDI](image2)

**Source:** Author’s tabulation based on World Bank World Development Indicators.

This general increase in data availability and production is confirmed by Chen et al (2013) which review surveys from selected countries. They examine the number and type of surveys being conducted on the country level before and after 2000, by reviewing surveys three countries: India, Ethiopia and Ghana. They find that all three countries have seen increasing number of surveys and censuses conducted after 2000. In particular, the average number of surveys each year almost doubled in Ethiopia and Ghana. The trend illustrates the increase in number of surveys that were not only conducted, but also documented and even disseminated at the international level.

Despite such improvements in the quantity of data collected and eventually available, the frequency and speed at which such data is available to policy makers have not improved
Accordingly, it often takes years before key indicators and micro data sets are available and the international level. For example, although we have comparable poverty numbers for close to 100 countries in the early 2000s, data for fewer than 40 countries has been released after 2008. This means that five years after the 2008 global financial crisis, we do not have comprehensive data to say what the impact of the crisis was on the world's poor. This is also illustrated by the clear from the clear drop in data available for 2009, 2010 and 2011 in Figures 1 and 2 above. Even when working at the national level, the most recent household surveys data sets are often more than three years old. The problem is not only the frequency of surveys, but also the lag between collection and data dissemination that frequently takes more than a year. This is often simply due to the capacity and design of traditional systems that are unable to process and produce data faster.

Beyond timeliness, there are also a number of other concerns with data collection in the developing world today. Many are concerned that data quality is poor, with Devarajan (2013) using the term “statistical tragedy” to describe the situation in Africa that the lack of reliable data renders the monitoring of development progress difficult. Carr-Hill (2013) suggests that although there has been a large increase in household surveys, they tend to underrepresent the poorest, with 200-250 million are missed worldwide from the sampling frames, which may have led to substantial bias in global development monitoring. These are important concerns in discussions of the state of international development statistics but not the key focus of this paper.

2.2 The increasing need for ‘knowing in time’

While we have more data on big picture development progress and the state of the world in the years from 1990 to 2010, the data availability for measuring data in near-real time is much poorer. For policy makers at both international and national levels, knowing what is happening sooner is increasingly important to optimize policy responses in an increasingly volatile world.

Development challenges are increasingly connected to shocks and crisis of different kinds in which factors are changing fast and better data is needed. First, with the world being increasingly economically and politically interconnected, financial crises and political shocks can have impacts reaching even the most remote populations in developing countries. In fact, many of the projects and approaches documented in this paper have emerged partly in response to policy makers demand for better data to assess of the international food and financial crises of 2008 and 2009. Second, natural disasters seem to be occurring with higher frequency, magnitude and impact, in many parts of the world, requiring rapid responses and increased preparedness for which data often is unavailable. Third, social and political conflict is becoming an increasingly prominent development challenge. In fragile and conflict-affected states (FCS) data availability is often particularly poor due to low statistical capacity and difficulties conducting surveys. Yet in such contexts, timely data is maybe more important than anywhere else. For example, having up-to-date data on the welfare, sentiments and sources of insecurity can be crucial to prevent renewed conflict.

Even in the countries where the traditional methods have been optimized and implemented as effectively as possible, policy makers express frustrations over not having the kind of data that
they need soon enough. For example, in Indonesia, the national statistics office, BPS, is conducting quarterly national household surveys SUSENAS a nation-wide survey with more than 300,000 household interviews annually, with the objective of collecting quarterly poverty data and several MDG indicators and other socio-economic and welfare indicators. This is a continuously on-going data collection effort at an impressive scale that most developing countries cannot realistically replicate with their current capacity. Yet, even though it only takes a couple of months between the time of collection and the statistics and key indicators being available to policy makers, policy makers in Indonesia concerned with designing ‘early warning systems’ and ‘crisis monitoring’, the data is not available soon enough. Ideally, these policy makers want to know in near real time how key indicators, such as school attendance, prices, health and food security are changing, to be able to respond appropriately.

There are several reasons for why data is not available to policy makers sooner: some due to capacity, budget resources and even politics. However, a key reason is the relative slowness and low frequency of data collection is due to methods of collection and production. Although data availability has improved, the methods for collecting data used have largely remained the same: pen and paper household surveys – sometimes referred to generally as Pencil/Pen and Paper Interviewing (PAPI). There have been some improvements in the data processing stage, with the use of scanners for automatic data entry, but overall the process largely remains similar to what it has for many years: enumerators go from door to door to collect data with paper questionnaires. Moreover, statistical systems are mostly focused on large survey exercises focused on long, complicated questionnaires rather than monitoring of key leading indicators of current conditions. Two areas which has seen some improvements in the frequency of reporting is in prices (inflation figures) and some measures of food security by international organizations such as the World Food Program (WFP).

2.3 The connectivity revolution provides new opportunities for faster data

The speed and magnitude at which mobile connectivity and technology has spread in the developing world are startling. Globally, there are more than 6 billion mobile subscribers and penetration numbers are quickly rising (Figure 3). Even the poorest and most remote citizens are increasingly connected. For example in Kenya at the end of the 1990s, less than 3 percent of households owned a telephone. By the end of 2011, 93 percent of Kenyan households owned a mobile phone (Demombynes and Thegeya, 2012). Internet adoption is also growing fast, particularly mobile internet connectivity is showing promise in many countries.

The immense progress in connectivity and technology adoption seen in developing countries can have large potential consequences for the frequency and speed of statistical collection and data availability. With the rapid changes in technology, we do not need to solely rely on traditional surveys with enumerators administering surveys upon household visits. The ability to administer survey questions over the phone, which is standard practice in developed countries, is starting to be feasible in many developing countries. Many other possibilities are also emerging: data

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2 Based in interview with BPS officials, October 2012.
collection can increasingly happen over SMS and the web. The next section provides an overview and assessment of such methods.

![Figure 3: Number of mobile subscriptions per 100 people in the World](image)

Source: World Development Indicators.

3 New data collection technologies and methods

A wide range of data collection methods and sources have become available as a result of the sweeping improvements in technical hardware (lower cost and better technical features) and connectivity (mobile ownership and network coverage) in the developing world. These approaches have mainly been implemented to allow faster data collection, either as a substitute for smaller surveys formerly done by pen-and-paper interviews (PAPI), or as a complement to achieve fast data on a selection of key indicators in near real-time.

Three main developments have given rise to the increased feasibility of these new methods:

1. **Cheaper and better technology for use by in-person interviews**: Personal interviews carried out by an interviewer using smart phones or tablets for recording answers and direct data entry provides improvements to traditional survey methods. With increasing availability of mobile data networks and internet, instant transmission of data for analysis, or even the use of simple online forms are also becoming viable options.

2. **Mobile ownership and network coverage**: The sudden availability of cheaper mobile phones offers a multitude of opportunities to collect data. Personal interviews carried out by calling people is one approach that is increasingly feasible in developing countries. Furthermore, because mobile phones can allow respondents to record answers themselves without the help of an
enumerator, text based data collection over text methods (SMS and USSD) and automated voice calls with keypad responses.

3. **Digital traces — “big data”:** Last, rapidly increasing mobile phone used and technological adoption also creates huge amount of digital traces – data about usage, movements and transactions – often labeled ‘big data’. Such data can be mined and analyzed to help understand the welfare and movement of people in near-real time and be a useful complement to traditional data collection.

This section outlines technological approaches that have been deployed for various statistical purposes in developing countries by governments (often national statistical offices), international organization or NGOs. There are many versions and combinations of applications, so it is not possible to describe all configurations. Nevertheless, key technical characteristics and requirements, as well as the main disadvantages and advantages of each of the approaches are sketched out below. This section also mentions example deployments of these technical approaches, some which are documented further in Annex 1.

### 3.1 Electronic survey forms on computers, smartphones or tablets (CAPI)

The substantial reduction in costs of simple computer hardware, such as smart phones and tablets, and improvements in connectivity and battery life have made substituting paper with simple electronic forms much more viable. Computer assisted personal interviewing (CAPI) is an umbrella term for a set of survey technologies that substitute traditional paper surveys with electronic forms on tablets, smartphones, mobile phones or computers. Traditionally, the main advantage of CAPI has been that it skips the data entry stage required when collecting surveys on paper. CAPI is not new, but has been considered expensive and impractical in many developing country contexts.

Several recent improvements to CAPI technology makes it more feasible and useful for deployment in developing contexts: First, technology costs have plummeted with smartphones and even very simple phones now being useful devices for CAPI surveys. Second, connectivity improvements means that data now can be transmitted directly to a data warehouse or database, which can allow for near-instant reporting of data. Third, because of software improvements, more complex surveys are also feasible to administer using CAPI devices. Fourth, because the devices now used for CAPI are tablet computers with a wide range of communication options, they can also be used to strengthen survey management and supervision of enumerators.

Since CAPI devices can have a wide range of features, it can be useful to distinguish between three broad categories of CAPI tools: (1) traditional CAPI using computer or personal digital assistant (PDA) devices; (2) simplified CAPI using simple mobile phones, which could be referred to as mobile assisted personal interviewing or “MAPI”, which uses java applications that can run on very simple phones (costing less than US$30); and (3) CAPI using smartphones or table computers which have a data connection (internet) for phones currently costing around US$100 and more. Examples and characteristics of the three categories are outlined in Table 1.
Traditional CAPI has been tested by many developing countries to improve the efficiency and accuracy with which data is collected, but has not become widely adopted. The technology has been expensive and the advantages have often not been deemed great enough to justify it. With mobile phones, smartphones and tablets coming down in price quickly, CAPI has become a much more viable option to deploy also in developing countries and can also bring new advantages, such as instant transmission of the data to data warehouses. CAPI software and devices can increasingly handle complex and long questionnaires and is therefore becoming a real, viable alternative to paper (PAPI) surveys.

<table>
<thead>
<tr>
<th>A. Traditional CAPI on PDA or computers</th>
<th>B. Simplified CAPI on simple mobile phones or “MAPI”.</th>
<th>C. CAPI on Smartphone, Tablet with GPS and data connection</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>Disadvantage: used to be expensive, coming down in price.</td>
<td>Disadvantage: small screen, limited complexity of forms, etc.</td>
<td>Disadvantage: more expensive, but can now be done even on US$80 phones (several software)</td>
</tr>
</tbody>
</table>

There is now a growing community of development agencies and practitioners using mobile phone based CAPI (or MAPI) for data collection purposes, especially for monitoring and evaluation. Several survey platforms are open source, or freely or cheaply available. Some of the more simple solutions, such as the java-based EpiSurveyor and Nokia Data Gathering, have so far mostly been used for collecting data for monitoring and evaluation purposes (e.g. Schuster & Brito, 2011). But such tools could also hold promise for smaller statistical surveys collecting few indicators for which high frequency collection could be useful. The open source tools in the Open Data Kit, which has more advanced CAPI features runs on Android phones, has thousands of deployments across the world. IRIS (2011) provides a useful overview of the increasingly expanding landscape of CAPI software being deployed by development actors.

**Applications in developing countries**

An example of an NSO deploying such tools is the National Bureau of Statistics (NBS) in South Sudan that, with technical and financial support from the World Bank, carried out the High Frequency South Sudan Survey (HFSSS) in 2012. The government and international partners needed higher frequency data on economic, social and political issues during the first turbulent
months for the new country's existence, when things were changing fast in many parts of the country and economic and political stability was uncertain. The survey uses Android-based tablet computers to collect data on the social, economic and security conditions in the country with both market and household surveys. The data was instantly transferred to a central database over the mobile data network as it is collected, allowing immediate identification of hardship and changes in economic indicators. Despite the country's low level of development, limited infrastructure and limited statistical capacity, the experiment was successful in collecting faster and better data about key development issues in the young country and plans are now to scale the survey to a nationwide high-frequency panel survey. Annex 1.1 details this experience further. A similar project is also planned for Somalia.

3.2 Personal phone surveys: Computer-assisted telephone interviewing (CATI)

Personal survey interviews by telephone, technically known as computer-assisted telephone interviewing (CATI), is a surveying technique in which the interviewer follows a script of questions provided by a software application and asks these questions to the respondent at the other side of the line. In developed countries, many statistical surveys are conducted by phone. This has been a feasible method in developed countries because virtually the entire population, or at least a statistically representative sample, is reachable by phone. In recent years it has become increasingly possible to deploy phone surveys in also in developing countries because of the rapid increase and ubiquity of mobile ownership.

CATI has several clear advantages over both CAPI and PAPI approaches. The most obvious advantage is that phone surveys enables surveys to be administered to geographically dispersed samples more cheaply and quickly than by using traditional field interviews. It has a clear advantage compared to PAPI and CAPI in terms of travel costs and makes it possible to avoid clustered sampling, which today is common in field surveys. CATI also has the same advantage of CAPI that it skips the data entry stage as answers are captured electronically.

But there are also disadvantages associated with CATI approaches: It can be difficult to sample respondents, especially in developing countries, as there often is no comprehensive registry of subscribers to sample from. Often a baseline household survey is required for sampling and information purposes, which adds costs, although it is still likely to be less expensive than doing the full survey in-person (face-to-face), which would require multiple field visits. Furthermore, there seems to be survey fatigue and attrition from phone surveys, making longer and more complex surveys more difficult to administer over the phone. Experiments in both Africa and Latin America also showed that, while most people own a mobile phone in urban areas, some of the poorest households in remote areas do still not have phones (Croke et al, 2010). Several deployments have overcome the lack of mobile phone ownership by handing out phones to respondents who do not have them (Demombynes et al, 2013).
Applications in developing countries

A large scale pilot deployment has been conducted in Latin America by the World Bank and partners. The “Listening to LAC” project (Latin America and the Caribbean) - nicknamed L2L - is an innovative pilot project, which tested not only CATI, but also a host of other mobile data collection approaches. L2L was motivated by demand from country governments to have near real-time household data following the food price crisis of 2008. The L2L has completed a pilot phase in Peru and Honduras. After initial face-to-face interviews with each participating household, the L2L survey asked monthly questions pertaining to themes associated with shocks, vulnerability and coping strategies: unemployment, food security, illness, violence, and education (Ballivian and Azevedo, 2013). Similar surveys have been conducted in Tanzania and South Sudan, and a “Listening to Africa” project is underway (see Demobynes et al, 2013 and Croke et al, 2012).

The L2L project also stands out with the rigor and attention it has put to testing the statistical validity of different methods, which is a key concerns for statisticians who wish to deploy such methods in the context of national statistics systems. The pilot has tested the attrition rates of different survey modes: SMS (text), Interactive Voice Recognition (IVR), Computer Assisted Telephone Interviews (CATI), and face-to-face interviews (PAPI). For more about this experience see Ballivian and Azevedo (2013) and Annex 1.2. and Section 4 of this paper also summarizes some of the key findings from that study regarding the relative merits of the different methods and approaches.

3.3 Automated phone surveys: interactive voice response (IVR)

Surveying by automated phone calls is also becoming increasingly possible in developing countries. In such set-ups, a computer plays pre-recorded questions over the phone line and the respondent answers by recording voice response or by pressing the keypad (e.g. ‘press 1 for “yes”, press 2 for “no”’, etc.). The general technical term for this type of set-up is an automated interactive voice response system (IVR).

IVR is attractive primarily because of the reduction of costs in having a computer ask questions rather than a human interviewer. IVR may also be advantageous for asking more sensitive questions (such as questions about corruption or sexual behavior, financial information, etc.) where surveyors are concerned that respondents may feel less comfortable providing answers to a human interviewer. In many ways, the survey possibilities of IVR are similar to those of SMS/ USSD (see Section 3.4) in that both represent interactions with a computer. This has the advantage that questions will be asked identically to all respondents (reducing enumerator error) at low costs. However, it also has the clear disadvantage that it does not allow for clarification of questions and the building of trust that is possible with an enumerator. IVR has two clear advantages over SMS/ USSD in that (1) it does not require literacy on the part of the respondent and (2) since the it is an incoming call, it does not cost anything for the respondent to participate (which it might in the case of SMS).
Applications in developing countries

IVR has been tested in both Africa and Latin America with moderate success for shorter surveys. It seems to suffer from very high attrition and non-response rates if compared to more personal methods (face-to-face, CAPI and normal CATI). This is especially true for surveys in excess of 10 questions according to tests conducted by the L2L study by Ballivan and Azevedo (2013).

3.4 Mobile text surveys (SMS/USSD)

Many proponents of the survey potential of mobile phones is proposing simply sending text messages to respondents, more technically known as short message service, or SMS. SMS is a technology that is available on any mobile phone, even the cheapest types. Unstructured Supplementary Service Data (USSD) and is a protocol available to all GSM mobile phones, which for the respondent is similar to SMS, but with the advantage that it can be a bit faster and also that it does not cost anything for the respondent to respond to the messages via USSD.

SMS and USSD surveys works in the way that respondents receive a text message with a questions and responds with a text message indicating the answer. The big advantage of text message surveys is that it is cheap on part of the surveyor and can easily be scaled to a very large sample as the marginal costs are low. Although responding to the SMS can be made free also for the respondent, a potential barrier is that sending text messages often is associated with a cost on part of the sender. Therefore USSD is sometimes preferred, although this is a less common technology.

There are several other disadvantages with text messages that make them undesirable for large sample surveys. SMS relies on the respondent’s reading comprehension ability and attention span and time commitment to answering the questions. All in all these advantages may contribute to explain the high attrition rates observed in the L2L study, which found that fifty-five percent of participants who originally agreed to join a survey panel did not respond to the first SMS survey sent to them.

Applications in developing countries

The most prominent experimenter with text messaging surveys in developing countries is a private company called JANA (formerly known as TextEagle) which claims to be able to survey more than 2 billion mobile subscribers in their system. These users will answer survey questions in exchange for a small amount of airtime (calling credit). The vast majority of mobile users in developing countries pay for their mobile use with pay-as-you-go fees, which makes transfer of such phone credit an effective payment form. JANA’s approach can also be used at the national scale and does not require much more than a so-called SMS gateway or software for sending large volumes of SMSs. There are several free and cheap platforms for this.

In 2011, the UN Global Pulse leveraged JANA’s global SMS reach to assess the impact of the global financial crisis on households across the world. A set of questions about well-being were translated into 15 languages and sent directly to mobile phone users in more than 30 countries,
collecting more than 90,000 responses (UN Global Pulse, 2011). While this gave interesting answers, the resulting data is likely to suffer from large biases in both sampling and non-response, which would mean that it is not statistically representative, making it less useful for statistical purposes. Hamadeh et. al (2013) used JANAs services to conduct a price survey and compensate data collectors, but did not use SMS as the main form of data collection tool.

3.5 Web surveys: Computer-assisted website interviewing (CAWI)

Having respondents answer questions via online forms have become increasingly popular in developed countries for many different surveys, also for statistical data collection purposes. Web-surveys, or “computer-assisted web interviewing” (CAWI) as is the technical terms, is an internet-based surveying technique in which the respondent self-administers a survey by following a set of steps and answering questions provided on a website. It is also sometimes referred to as Computer-Assisted Self Interviewing (CASI).

A limitation in the development context is that, although internet penetration is increasing, many people in developing countries do not have internet access, making such surveying approaches prone to biases. However, this approach may still play a role in developing countries for several reasons: the first is that mobile internet is growing very quickly and cheaper and cheaper mobile handsets have internet access which will make this a more viable survey tool in the future. The second is that for administrative data collection, such as collecting data about government services within government, this tool can be useful. Many government officials now have access to internet and email even in the least developed countries. It may also be increasingly feasible for survey of larger businesses, on topics such as production data.

A clear advantage is that such surveys are relatively cheap once internet infrastructure is in place. Moreover, it allows questionnaires to be more complex and provide extensive guidance to the respondent. The clear disadvantage is of course that it can only be used where a statistically representative share of the population has access to internet and is willing to answer these surveys. There are not yet many practical experiences from this work that have been documented, thus this paper does not present a separate case study for this.

3.6 Big data: opportunities of turning ‘digital traces’ into real-time statistics

While quite distinct from the different survey technologies laid out above, so-called ‘big data’ is becoming an emerging source for official statistics (UNECE, 2013). Groves (2011) suggests that: “We’re entering a world where data will be the cheapest commodity around, simply because society has created systems that automatically track transactions of all sorts” (pp. 867-868). Thanks to increased mobile penetration, internet use and technological innovation, this is also true in developing countries. Such data is produced independently of any data collection effort such as surveys – it is often the data that is available as by-product of user-interaction with digital services, such as mobile phone call records, social media posts (Twitter, Facebook, etc.) and online search records (for example, search statistics, such as that available through Google Trends).
These types of data are sometimes also referred to as ‘organic data’ since they are not produced for statistical purposes and emerges independent of data collection efforts, which can be referred to as ‘designed data’ (Groves, 2011). Such emerging data sources can be ‘mined’ and analyzed to monitor human and societal behavior in near-real time and potentially turned into statistics.

**Example of applications**

There is potentially large amount of useful statistical data hidden in mobile phone call records, and particularly mobile money transactions, which can help understand people’s movements and behavioral responses to certain events. The explosion in mobile phone use also leave ‘digital traces’ that produce an unprecedented amount of data about human behavior that can be leveraged for policy purposes. For example, recent research by (Wesolowski et al, 2012), shows how mobile phone data can be used to trace the spread of malaria in Kenya. By combining mobile phone data (to trace people’s movements) and data on malaria incidence, they were able to trace the spread of malaria outbreaks across the country. In Rwanda, researchers used mobile phone data to investigate how people transferred money to earthquake victims (Blumenstock, et al 2012) and to investigate internal patterns of migration (Blumenstock, 2012).

There are many other examples of such use of ‘big data’ for economic, social and policy purposes. As internet use increase, people’s online behavior can also be used for monitoring economic and social issues. For example, researchers at Google have demonstrated how search data can predict the development of several important social and economic indicators (Varian and Choi, 2009). Increasingly this has also been demonstrated to be feasible in developing countries, with a new service from Google which accurately predicts dengue breakouts in Brazil, India and Indonesia by monitoring how people search for dengue-related topics and symptoms (Google, n.d.). Statistical offices in both developed and developing countries are increasingly looking for ways that such data can be leveraged in statistical production (Ayoubkhani, 2012).

Social media is another increasingly cited source of ‘big data’ that could be useful for statistics. Such data could be particularly relevant to satisfy demands for near real-time analysis of human sentiments, such as subjective well-being, and may also be useful to monitor economic and political confidence. The UN Global Pulse is a promising initiative that has facilitated several interesting experiments in this field, such as mining Twitter data to monitor food prices with surprising accuracy. In Indonesia, they show that the way people speak about rice on Twitter can be correlated with the actual market price of rice (cited in Letouzé, 2012). While some developing countries already have a large share of the population using social media, the applications are so far limited, but will certainly grow in the years ahead. Indonesia is one country in which both the number of social media users and government interest is emerging as a leader in minding social media for statistical purposes.
4 Emerging lessons from early applications of new data collection technologies and methods

The previous sections provided a background for why more frequent and faster data is desirable and how new technologies and increased mobile connectivity can help achieve this objective. This section lays out some lessons learned from applications. The scope of this paper is not to address such issues in depth and they are inherently context specific, though they are useful to highlight to understand the relative strengths and weaknesses of each of the methods. We look at technical, institutional and human capacity limitations (4.1) sampling issues and representativeness (4.2); attrition, non-response and economic incentives (4.3); data quality (4.4); privacy (4.5); costs (4.6); and finally briefly discuss steps beyond collection pertaining to processing, analysis and dissemination (4.7).

4.1 Technical, institutional and human capacity limitations

A common concern about using these new approaches for data collection in developing countries is whether technical (particularly mobile infrastructure), institutional, or human capacity will limit the possibilities of deployment. In terms of technical considerations, two potential limiting factors of mobile phone surveys are mobile service coverage and electricity. Extensive mobile service coverage is required to avoid sampling biases (for a more detailed discussion see next section). Moreover, electricity and battery capacity is another frequently cited concern.

Institutional arrangements and capacity may also be a limiting factor as these new approaches are fundamentally different from traditional methods for data collection. While certainly providing a challenge in certain contexts, it has not been prohibitive in the examples reviewed in this paper. Of course, there is a chance that attempts that have failed are not equally well documented in the emerging literature on such approaches. Nevertheless, it is encouraging that some of the successes originate from some of the most challenging contexts imaginable in African countries.

Another institutional concern in some countries may be regulatory issues which limit sending unsolicited SMS or making unsolicited phone calls or 'robo-calls' with questions, which are often (mis-used) by tele-marketers and therefore prohibited. This may necessitate the consent of the respondent to participate through a household survey at the sampling stage.

4.2 Sampling issues and representativeness

For a random sample to be statistically representative of the population, it is important to minimize selection bias at the stage of sampling respondents. While not necessary for all purposes, most statistical data collection exercises require representative samples of the national population. Sampling bias can potentially be a big issue for the approaches that require respondents to have their own mobile phone to be sampled or participate in the survey. For example, it is likely that mobile phone ownership is lower among the poorest share of the population, leading to these being underrepresented in a random sample of phone numbers drawn from national registries.
Many of the pilot implementations that have tried to obtain statistically representative samples have been acutely aware of this and found ways to overcome such challenges. For example, several implementations have sampled through traditional household visits or existing sampling frames. Some have overcome the lack of mobile phones in some households by simply handing out cheap, simple phones to respondents who do not have them. This practice was tested in Tanzania, South Sudan and Honduras with success. For the CAPI approaches, the sampling issues faced are not very different from those of normal paper surveys.

4.3 Non-response, attrition bias and economic incentives

Similarly to the risk of bias at the sampling stage, care needs to be taken to minimize biases resulting from non-response and attrition. The non-response rates have been found to be high for some of the approaches. For example, the L2L project in Peru finds a rate of attrition close to 80% for IVR and 70% for SMS. For the personal phone survey (CATI) the rates are lower, but still considerable at around 50% (Ballivian and Azevedo, 2013). If respondents who do not answer surveys or drop out of a panel surveys differ systematically from the people who participate, this can lead to biases.

The study of L2L by Ballivian and Azevedo (2013) showed that attrition and non-response increase significantly with the number of questions asked. Particularly this became an issue for automated methods, such as IVR and SMS/USSD after 10 questions. This is an important limitation of these methods and is one of the main reasons why these methods do not seem suitable to replace more complicated surveys, which often require hundreds of questions to be answered. Because of issues, it seems like particularly SMS and IVR methods would be most appropriate in a context where it is sufficient to answer a couple of questions.

The ability to collect data quickly and frequently makes the mobile survey techniques attractive for panel surveys, where questions are reassessed every month week and thus used to monitor changes to key variables over time. Such frequently repeated surveys can create survey fatigue, leading respondents to dropping out of the panels which could be another source of bias i.e. that the people who drop out of the survey are not systematically different from the people who stay in the survey.

Croke et al (2012) observed that attrition and non-response is mainly and issue in the early stages of the panel surveys they looked at once households are included in the survey, they tend to stay and fatigue do not seem to be an issue. However, they and others find that attrition patterns depend on household characteristics, which can lead to statistical bias if not adjusted for. In particular, the Croke et al (2012) study finds that the age of the head of household, household composition and wealth are all statistically significant determinants of the response rate. An important finding from their review of experiences in Tanzania and South Sudan is that, although attrition on unobservable characteristics can never be controlled for, it should be standard practice to re-weigh the sample based on observable characteristics (gender, household size, economic status, etc.) after each round of a panel survey to minimize the effect of attrition on the overall sample.
To try to deal with attrition and non-response issues, many projects have tried to use economic incentives, in the form of phone credit or cash paid to the respondents. The interesting finding of those that tried to experimentally assign different financial rewards show little or no effect of the incentives and differences in incentives. (Croke et al, 2012; Ballivian and Azevedo, 2013)

4.4 Data quality

A key concern with new methods in statistical data quality is how the methods affect data quality—i.e. how reliable is the data collected, particularly in comparison to paper surveys.

While there has been much interest and focus on the benefits from using CAPI methods to strengthen traditional data collection, there have been few thorough assessments of how they compare. Caeyers et al (2011) provide an interesting randomized study comparing CAPI and PAPI. Interestingly, they find that data quality from CAPI is significantly better in comparison to PAPI and, moreover that in a consumption survey paper questionnaires can lead to estimates of higher mean consumption, lower poverty and higher inequality.

For mobile phone based surveys methods, the L2L project have done some of the best analysis of this issue to date by experimentally assessing the quality of the data collected, in terms of external validity (comparison with traditional face-to-face paper methods), internal validity (internal consistency of answers) and reliability (consistency of answers over time/methods) (Ballivian and Azevedo, 2013). They find statistically difference in how respondents answer over SMS and IVR when compared to those recorded in face-to-face interviews (with the same respondents). Interestingly, the L2L experiment finds that responses collected through IVR and SMS significantly underestimate facts regarding household infrastructure, while over-estimating internet access and self-perceptions on poverty. In contrast, the answers collected through phone surveys with personal interviewing (CATI) were almost identical to the ones collected by traditional methods, with non of the responses tested showing a statistically significant difference. The study also tests consistency of the different methods and find few differences in consistency across the different methods.

Patnaik et al (2009) evaluate the accuracy, speed and usability of three mobile phone interfaces in a health survey in India. They compare the use of electronic forms on mobile phones (MAPI or CAPI) with SMS, and CATI and find that voice is superior in terms of minimizing error rates. The results indicate error rates (per datum entered) of 4.2% for electronic forms, 4.5% for SMS, and 0.45% for CATI.

4.5 Privacy

Data created and collected in new ways can pose some challenges in terms of protecting user privacy. Many of the technologies transfer respondent data wirelessly and store data on online servers, which may make them vulnerable to misuse. There are not yet universal standards for the way survey and statistical data collected over SMS, the web, or phone should be encrypted, protected and stored. Some of the surveys that have been collected with these new tools are concerned with issues of governance, security, service delivery – topics for which data anonymity
are outmost important, both for the sake of data quality and the personal rights of the respondents. Moreover, several of these technologies (particularly modern CAPI), have the possibility for storing precise geographic locations from surveys (using geo-positioning technology), which may be a particular threat to privacy if the data is not treated appropriately.

Particularly in the use of big data sources, many have been concerned with privacy, especially as the users where the data originates from do not even know that it has been collected or is being used (Letouzé, 2012). Moreover, such data can be sensitive because the data often reveal the personal behavior of individuals. For example, in the case of phone records: who users have called, where they have been and how much money they have transferred or received. However, many studies have shown that it is completely feasible to anonymize such data by some level of aggregation or limited panels without rendering it useless for statistical purposes.

4.6 Costs

Clearly costs are also important in the context of determining whether these new approaches to data collection are feasible and whether they are a viable improvement over more traditional collection methods. The general finding seems to be that all the phone methods are cheaper than traditional survey methods, but knowing that they also have more limitations, the resulting cost effectiveness depends heavily on the context in which they are deployed.

For the comparison of PAPI versus CAPI, the big difference is the upfront hardware and software costs that can be associated with CAPI implementation in comparison to PAPI. Caeyers et al’s (2011) experiment, which had quite high upfront cost compared to hardware and software now available, calculate a break-even point between the two methods at 4,000 questionnaires. Below this, paper is cheaper and above this CAPI is cheaper. They give an example of how a survey of 2,500 households would be USD 13,500 more expensive on CAPI, while a survey of 10,000 households would be USD 54,000 cheaper on CAPI than on paper.

Ballivan and Azevedo (2013) also present some cost comparisons. In their pilot in Honduras and Peru, they find that phone surveys approximately halves the cost of face-to-face visits (US$25 vs. US$40 per interview for a 1,500 sample). IVR and SMS is much cheaper at US$17 and US$8 per survey, which is expected given that these surveys are much less costly because the enumeration is done automatically without any labor costs.

The costs recorded by Croke et al (2012) show a much lower level of costs from pilot phone surveys carried out in Tanzania, of between $4.10–$7.30 per interview. Dillon (2012) also finds a similar cost per survey: $6.98. These costs however, do not include those of baseline, which will often be between $50 and $150 per interview, according to Croke et al (2012).

Ultimately, it is very difficult to make general statements about the precise cost-effectiveness of the methods. It depends both on local contexts, and moreover on the purpose and relative benefits from the data collected. But overall, costs of new methods are falling fast and do not appear to be a major prohibitive factor.
4.7 Beyond collection: processing, analysis and dissemination

While the above technologies can improve the data collection process considerably, data collection is only one step in the data production process. Data processing, analysis and dissemination are also important steps that can cause delays. Many deployments of new survey technologies for data collection have not been accompanied by correspondingly fast and robust data processing, analysis and dissemination efforts, which would be needed to reap the full benefits of such approaches. While faster collection is an important element in producing more timely data, processing, analysis and dissemination are important steps that often delay data in being available to policy makers. This was observed as a constraint in some of the cases reviewed for this paper. For faster data collection to be useful, systems and institutional arrangements must also be able to integrate them.

5 Implications for data collection practice and statistical systems

From the relative abundance technology applications available and promising deployments summarized in the Section 3 and the case studies in Annex 1, it is clear that rapid progress in technological innovation and mobile connectivity is already changing the way development actors are collecting data. New approaches are allowing both governments and organizations to collect data in ways that are faster and sometimes of higher quality than traditional methods. There is a large potential for integrating these new methods to strengthen national statistical programs.

This section outlines some key implications and recommendations for how these new data collection approaches can best complement, substitute and integrate with current national statistical systems and strategies. First, we look at three key implications for how data collection practice can be improved: Section 5.1 summarizes the increasing role of CAPI to strengthen traditional data collection, particularly social and economic household surveys traditionally collected with pen and paper. Section 5.2 suggests how mainly mobile data collection processes, such as phone surveys (CATI and IVR) and text message surveys (SMS and USSD), provide opportunities for high frequency monitoring of key indicators which policy makers and other users need more frequently. Section 5.3 summarizes what role big data can have in complementing ‘designed data’ with ‘organic data’. Table 2 summarizes the different methods schematically. Second we look at two implications for statistical systems: Section 5.4 outlines how these new approaches can be integrated into existing statistical systems, focusing particularly on the need to adopt systems that accommodate mixed-method collection methods for successful integration of new methods and the importance of the NSDS system. Section 5.5 outlines a potential emerging role of NSOs as statistical ‘brokers’ given the amount of new actors and sources in data production and collection.
5.1 Improving speed, accuracy and costs of ‘traditional’ surveys

From successful early deployments, it is clear that data collection through CAPI methods has the potential to improve the speed, cost and accuracy with which ‘traditional’ surveys (e.g. household sample surveys) are collected. Although using electronic forms on tablets, PDAs or laptops (CAPI) has already been practices in developed and some developing countries for several years, it is becoming an increasingly attractive substitute for paper and pen surveys (PAPI). Technology (hardware) and software is becoming cheaper and better, and infrastructure and capacity that enables effective deployments is increasingly available in developing countries. While there are still some limitations for CAPI in handling surveys of equal complexity to those of PAPI, the technology is continuously improving and has been successfully deployed in contexts with complex questionnaires and under circumstances with very limited technical infrastructure and capacity. Software is also rapidly improving (IRIS, 2011). The increasing ability of CAPI devices and software to instantly transmit data over mobile data networks also provides a novel advantage over traditional CAPI procedures, in that it allows data to be processed and analyzed shortly after it is collected which can improve data quality.

Overall, this means that CAPI is becoming a very attractive and relevant method for collecting data, which should be embraced, improved and tailored by national statistic offices to strengthen survey activities, even in developing countries. In fact, some National Statistical Offices in developing countries are already ‘leapfrogging’ statistical offices in developed countries, overcoming challenges by seizing new opportunities and technologies to collect data in new and faster ways. In some cases, developing country statistical offices are implementing approaches that only recently are being piloted in developed countries. For example, in the United States, the US Department of Agriculture recently piloted the use of iPads for data collection in the US (Kleweno and Hird, 2012). This is a very similar approach to the ongoing collection in South Sudan, documented in Annex 1.1. Some early deployments of traditional CAPI in developing countries were already conducted 5-10 years ago. The reduction in costs and improvements in technology will likely see increased usage in the near future as the benefits of such technologies are increasing (Caeyers et al, 2011).

The role of large-scale sample surveys is not likely to be diminished in developing countries with introduction of new data collection approaches. In fact, application of CAPI will rather strengthen the role of sample surveys, as it improves the speed, accuracy and cost with which data can be collected. It is clear that other methods, such as CATI and CAWI, are still facing limitations for collecting longer and more complex surveys. Consequently, deploying CAPI is not about ‘replacing’ existing survey approaches. CAPI methods can be used to improve data collection of lengthy traditional surveys (such as household budget surveys, health surveys and agricultural surveys). While some applications are using CAPI for high frequency panel data collection, their most obvious advantage is its ability to improve longer, traditional survey exercise.

5.2 Complementing traditional data with relevant high-frequency indicators

Strengthening existing data collection approaches, for example through CAPI deployments, is only a small part of what new survey technologies bring to the improvement of statistical production in
developing countries. Particularly, high frequency surveys that utilize improvements in mobile connectivity provide a possibility of collecting new types of data. For example, high frequency (daily, weekly or monthly) panel data can be collected via mobile approaches on key indicators that are useful for monitoring changes in welfare of the population, such as food security, economic hardship, unemployment and political outlook. These types of data has not previously been available in developing countries, but can be very useful for policy makers to monitor indicators on key issues and vulnerabilities and enable them to respond in time.

In particular, mobile phones surveys (CATI) conducted by calling respondents to collect data on key indicators are becoming a promising data collection method in developing countries. Because of the rapid increase in mobile ownership and network coverage, even in poor countries and among marginalized groups in these countries, phone surveys are now a real and viable option for conducting rapid and high frequency panel surveys with decent statistical representativeness. Issues of sampling bias can be overcome by giving mobile phones to respondents who do not yet have phones or by conducting complementary high frequency CAPI surveys in areas that do not yet have mobile phone coverage. Such high frequency data collection approaches has proved an effective method for monitoring the economic welfare of households during crises or shocks. Phone surveys have been found to provide higher data quality and lower attrition and non-response rates than many other mobile methods (such as SMS and IVR). Moreover, phone surveys seem to be more suitable in a broad range of contexts, particularly when there are limits in respondent literacy.

Surveys using automated methods by text messaging (SMS & USSD) or automated calling (IVR) are also increasingly feasible. While very cheap, and extremely scalable for very large samples, these approaches suffer from some limitations as outlined in the previous section. In particular, these approaches suffer from high non-response rates, limits to the length of the questions asked and limits on the number of answers, and the requirement of literacy on behalf of the respondent in the case of text message surveys. This makes it less useful for collection of survey data which need to be unbiased and have representative samples, but it can still be useful to monitor trends in prices or single indicators over time, or indicators which do not require broad samples or representativeness to be useful to policy makers.

Web-surveys, which require internet connection by respondents, is not yet appropriate for household surveys in developing countries but can be useful for collecting administrative data within government and potentially with businesses. Since both a large share of businesses and government officials have internet connections, web-surveys has shown potential in collecting data on production and administrative indicators. As mobile data connectivity grows this may also be a viable option for other types of surveys, similar to what now is being done in developed countries.

5.3 Ensure institutional arrangements and capacity to mine statistics from ‘big data’

Emerging examples and assessments suggest that big data has the potential to produce more timely statistics than traditional sources of statistics on certain issues (UNECE, 2013; Letouzé, 2012).
While ‘big data’ provides many new data sources which certainly will be useful also for certain statistical purposes, applications to date suggest that it can be a useful ‘real-time’ complement to traditional statistics that provides near real-time sensing of changes in behavior. For example, in developing countries, there is an increasing potential to create statistics from mobile phone records, in particular from mobile money transactions, which could give a good indication of changes in economic activity with a sudden drop in mobile payments potentially indicating economic hardship. Data on mobile phone towers can give detailed and near real-time data on internal migration.

To fully ripe the benefits of big data in the production of statistics, there are three key steps that need to be taken by NSOs who would like to explore such data sources. First, although some big data sources are public, most such sources are often the property of private companies (such as telephone companies or banks). It is therefore key for statistical offices to establish legal or institutional arrangements which gives them access to such data. Second, privacy is a major concern for many big data sources and needs to be taken seriously, with appropriate arrangements and routines being put in place that does not compromise privacy of individual. Third, because big data sets are often highly unstructured and very large, utilization and analysis may require large processing power, new skills, software and hardware for NSOs to successfully leverage such data sources. As such, it is clear that big data provides no low-hanging fruit in most developing countries, given institutional and capacity limitations. However, if institutional and capacity arrangements are overcome, the upside is potentially large.
<table>
<thead>
<tr>
<th>Data collection approach</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>For what purpose? (what type of statistics)</th>
<th>Suitable contexts</th>
<th>Capacity, technical and institutional constraints (tech, skills, cost)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic forms (CAPI) (3.1)</td>
<td>Similar to paper surveys, but direct data entry and fast transmission. Can also strengthen survey management.</td>
<td>Technology has been expensive, sometime requiring data connection, but becoming less of a problem.</td>
<td>For surveys similar to paper, but with need for faster transfer and data production.</td>
<td>Proven to work in most contexts, even with low infrastructure and institutional capacity.</td>
<td>Requires power and some versions require data connection for transfer of data.</td>
</tr>
<tr>
<td>Personal Phone Survey (CATI) (3.2)</td>
<td>No literacy requirements as questions administered by audio.</td>
<td>Ok for medium length surveys. Sampling based on phone numbers can be difficult.</td>
<td>Where a statistically representative sample is achievable by phones and surveys are short.</td>
<td>Beneficial where literacy is low and for short and medium length surveys required (10-30 questions)</td>
<td>High mobile phone penetration among respondents. Call centers.</td>
</tr>
<tr>
<td>Automated Phone Surveys: IVR (3.3)</td>
<td>Low costs as no enumerator required. Literacy of respondent not required.</td>
<td>Long surveys difficult. Some technical literacy required by respondent if required to key responses.</td>
<td>Cheaper than CAPI and CATI, however problems of high non-response. Similar to use of SMS/ USSD survey.</td>
<td>Useful where a couple of critical indicators are needed at a frequent basis.</td>
<td>High mobile phone penetration among respondents. No particular requirements beyond IVR call center.</td>
</tr>
<tr>
<td>Mobile Text (SMS/USSD) surveys (3.4)</td>
<td>Low costs as no enumerator required. High volumes of respondents feasible.</td>
<td>Long surveys difficult. Questions limited to 160 characters. High non-response and attrition.</td>
<td>Unsuitable for large, statistical surveys, but good for collection of single indicators, such as prices and food security</td>
<td>Useful where a couple of critical indicators are needed at a frequent basis, or for crowdsourcing of data where sampling not a big issue.</td>
<td>Very low technical requirements – SMS enabled phones and SMS gateway and software for sending.</td>
</tr>
<tr>
<td>Web surveys: (CAWI) (3.5)</td>
<td>Cheap, allows for complex surveys.</td>
<td>Requires internet connection and computers or smartphone/tablet.</td>
<td>Situations that require rapid collection of administrative statistics.</td>
<td>Mostly for internal government collection of administrative statistics (service delivery and budget indicators, etc.)</td>
<td>Internet connectivity for both survey designers and respondents.</td>
</tr>
<tr>
<td>Big data (3.6)</td>
<td>Data already available but needs to be mined to create indicators &amp;</td>
<td>Only certain data is available and cannot decide what data to</td>
<td>Real-time monitoring of human behavior (and other)</td>
<td>Where large-scale datasets of ‘digital traces’ are available.</td>
<td>Analytical capacity to handle and mine large data sets.</td>
</tr>
<tr>
<td>statistics. Granularity and details, very high frequency.</td>
<td>collect. Often difficult to distinguish 'signal' from 'noise'.</td>
<td></td>
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</tr>
</tbody>
</table>
5.4 Designing statistical systems for mixed-mode and high frequency data collection

The experiences documented in this paper have shown that new data collection technologies can be used successfully in developing countries. The challenge for national statistical systems is now to adopt them in more comprehensive and meaningful ways that can improve the speed, quality and amount of data collected and the relevance to national policymaking. As with most things in development, technology alone is not a panacea. New survey technologies need to be adopted and integrated into national statistical systems in a way that strengthens the systems and does not overwhelm already stretched capacity.

The new data collection methods discussed in this paper are likely to increase the quantities, types and frequencies of data that is collected by statistical offices. To be able to accommodate a more diverse set of data collection sources, national statistical production systems need to be more flexible. As such, there may need to be a shift away from heavy focus on survey programs and increasing focus on continuous production of statistics from multiple data sources. It is therefore important to design systems that are suitable for mixed-mode data collection approaches that also would allow for integration of other types of surveys. Designing such more flexible systems what many NSOs in the OECD has begun (for a discussion see Erikson et al, (2012)) and which developing countries increasingly also should embark on. Allowing for mixed-mode survey collection will also make experimentation and introduction of new methods easier and sidestep 'big bang' approaches that are seldom successful in technology deployments in low capacity contexts.

The National Strategies for Development of Statistics (NSDS) provides a useful process for guiding the introduction of new data collection methods and their integration in national statistical systems. A key objective for NSDS’s is to provide a vision for where national statistical systems should be in five to ten years and provide key milestones for getting there (PARIS21, 2011). To create an optimal vision and system that also leverages new data collection method, the NSDS provides a useful process to assess where there is demand and need for the type of data that new data collection methods can offer. Moreover, systems and survey plans should be designed with the potential of integrating mixed-mode surveys and particularly consider the potential benefits of CAPI tools in strengthening traditional surveys. A key role of the NSDSs will be to identify which methods should be used for which purposes and prioritize which types of data are most important to collect. For example, if a country is food insecure, this is a likely area of focus for initial high frequency data collection. If a country is prone to security risks, this may be the most important area to get more up-to-date data. For countries prone to health crises, monitoring disease outbreaks on a high frequency basis might be a priority. It is important to explore needs and possibilities in collaboration with users.

Importantly, the NSDS provides and important process to limit the number pilot innovations using new data collection methods, and makes sure that such new data collection methods are not compromising, but rather strengthening, the overall statistical system. It is important that these
new method do not overburden national statistical system's capacity to coordinate national demands and core priorities, as some suggest the MDG data collection efforts may have done (Parabhu, 2005).

5.5 Strengthen NSOs role as ‘statistical brokers’ and ‘certifiers’ of new data

While a few of the experimentations of new data collection methods have happened in collaboration with national statistical systems, much of the innovation originates from actors outside government: either from NGOs, research organizations, private businesses and international organizations. Much of this new data is thus produced outside the national statistical system. To ensure quality and also proper analysis and dissemination there may be an emerging role for national statistical systems as ‘clearing’ houses and certifiers of new data sets and methods. This could both help increase statistical systems' capacity and relevance, moreover it can improve the quality of new data collection methods. It could also reduce costs both for NSOs and data users.

New data collection technologies have significantly reduced barriers for producing data and statistics, a trend that is likely to continue. This means many private and nonprofit organizations outside the government will produce data, which might be useful as official statistics. Quality and methodology standards are often lower among such producers, which can potentially create a role for national statistical offices to help improve or assess the statistical quality of non-official data. NSOs in developing countries could offer assistance to assure that non-official data collection and production can be certified and incorporated in official data production. Offices could either charge for such assistance or simply require that data collected through such external approaches are made available openly, for example through the NSOs website or data warehouse.

6 Conclusion

This paper has illustrated ways in which the new data collection methods can improve the speed and frequency at which development data is available and therefore also policymakers ability of ‘knowing in time’. From the variety initiatives and rich technology applications available, it is clear that there are both increasing demands for faster and more frequent data, as well as an increasing set of technological solutions available to meet such demands, with rapid progress in hardware, software and connectivity.

New survey technologies can improve the speed, accuracy and costs of ‘traditional’ surveys. Moreover a set of new mobile phone based approaches allows for complementation of traditional data with relevant high-frequency indicators, which are of importance to policymakers' ability to act in time. Big data sources offer an emerging statistical data source in developing countries, but which may require quite advanced institutional arrangement and capacity on the part of statistical offices to be adopted successfully.

To successfully integrate and leverage the possibilities offered by new data collection methods, NSOs would need to strengthen their systems in role in three ways. First of all, NSOs can use NSDSs
processes to better understand in what statistical areas faster data collection is needed and is feasible. Second, statistical systems need to be configured in a way that makes them adaptable to mixed-mode and high frequency data collection. Third, because an increasing number of new data sources are originating from outside NSOs, they could increasingly take on a role as ‘statistical brokers’ and certifier of new data collection exercises conducted by third parties.

Finally, as a concluding remark, it is important to remember that timely data is only one of many elements necessary for responsive governments, and that “knowing in time” does not necessarily mean “acting in time”. Even in situations with complete information and perfect, up-to-date statistics, there are often capacity, institutional and political limitations that prevent addressing the problems a hand. But having better and faster data is an important first step to more responsive policymaking in a complex and volatile world.
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Varian, H. R. and H. Choi, “Predicting the Present with Google Trends"


Annex 1: Case studies of deployments

A.1.1: CAPI surveys in South Sudan: monitoring economic and political change

The National Bureau of Statistics (NBS) in South Sudan, with technical and financial support from the World Bank, carried out the High Frequency South Sudan Survey (HFSSS) in 2012 and the project is continuing in 2013. During a critical political and economic period for the country, the South Sudanese government and international partners needed up-to-date data on economic, social and political issues. A series of high frequency data collection efforts using data-enabled tablet computers was initiated to meet the demand for faster data.

The surveys were conducted by enumerators from the National Bureau of Statistics which used Android-based tablet computers equipped with Open Data Kit software to collect data on the on social, economic and security conditions in the country with both market and household surveys. The data collected to the Android tablets was instantly transferred to a central database over the mobile data network as it is collected, allowing immediate identification of hardship and changes in economic indicators.

For the household survey, sampling was conducted using the national sampling frame, but only for a subset of enumeration areas in urban locations. Initially plans were to conduct a monthly panel, but quarterly panels became the preferred frequency due to issues of respondent fatigue and administrative constraints. Questions about household welfare, food security and violence were the main focus of the survey, which were administered to a panel of about 300 households during the pilot stage.

The black market exchange rate survey was important to inform the impact of major economic shock of the shutdown in oil production, the country’s dominant source for government revenue and foreign exchange earnings. The collapse of oil revenues could potentially have a strong negative effect on the welfare of people through high inflation due to high import dependence. Figure A.1.1 shows the rapid devaluation in the black market exchange rate to a level nearly twice that of the official rate and a subsequent gradual strengthening.

Figure A.1.1: Mean exchange rates (official and parallel) for Juba, SSP per 100 USD

Source: South Sudan National Bureau of Statistics (NBS, 2013)
A market price survey tracked prices of more than 20 key food products several times a week. It became a useful complement to the traditional food price surveys conducted in conjunction with the CPI, which happens on a monthly basis. The survey registered rapid increases in food prices during the crisis.

The experience showed that deploying such news survey technologies in a National Statistics Office with very limited technological and human capacity is possible. The office has also previously implemented a mobile phone survey successfully (see Demombynes, et al, 2013). Despite the country’s low level of development, limited infrastructure and limited statistical capacity, the experiment was successful in collecting faster and better data about key development issues in the young country and plans are now to scale the survey to a nationwide high-frequency panel survey.
A.1.2: Phone surveys in Latin America: “Listening to LAC” (L2L)

[Case study adapted from Ballivian, A., and J. P. Azevedo, 2013]

“Listening to LAC” (L2L) was an experimental pilot survey conducted by the World Bank in Honduras and Peru, motivated by demand from governments for near real-time household data following the ‘food price crisis’ of 2008. Traditional surveys were not able to report timely and on the changing welfare of households during the crisis. Faster, higher frequency data was needed to better assess the situation and to decide what policy interventions were needed to respond to the crisis.

The L2L survey was carried out in collaboration with Gallup and tested three different mobile survey methods: text message (SMS), automatic phone interviews (IVR) and personal phone interviews (CATI) (See Section 3 for description of Methods). The survey asked questions pertinent to crisis monitoring; assessing shocks, vulnerability and coping strategies. Questions were focused on topics such as food security, illness, unemployment, education and violence and structured as a panel survey where the same households were re-interviewed on a regular basis.

The key research question that L2L sought to address was whether these mobile phone surveying techniques can help reduce the time and cost of collecting representative data without compromising data quality. The potential of mobile phone surveys is clear, however key concerns that the project sought to address was whether (1) it is possible to representative samples of the national population; (2) achieve adequate response rates; and (3) obtain data of comparable quality to face-to-face interviewing.

In Peru, the sample was based on the sampling frame for the quarterly national household survey conducted by the national statistical office. In Honduras, sampling was done using the Gallup World Poll sampling frame. The sample size was 1,500 households in each country. In Peru, the survey oversampled respondents living at levels close to the national poverty line as it was deemed particularly important to have good data on this part of the population, thought to be vulnerable in the time of crises.

The baseline survey was carried with household visits with initial face-to-face interviews to collect information on household characteristics and to recruit participants. It was deemed difficult to carry out this part of the survey over the phone. Thereafter, monthly rounds were conducted using one of three approaches: SMS, IVR or CATI.

The pilot findings suggested that using mobile phones for short and frequent surveys can produce good quality data more quickly – and even more cheaply – than traditional survey methods. In addition, the L2L survey contributed useful knowledge to in researching the differences between several different mobile data collection methods. In particular, it conducted useful assessment of differences in attrition rates, data quality, the effect of incentives and costs. Many of the lessons from this study are reflected in this paper (Section 4, in particular).

3 LAC stands for “Latin America and the Caribbean”
It is worth highlighting the relatively high rates of attrition experienced by the study. By the end of the panel study (6 months), the overall attrition was 75% in Peru and 50% in Honduras. Across methods, IVR had the highest attrition by the end of the panel, SMS performed slightly lower and CATI was by far superior in terms of attrition (see Table A.1.1). Incentives had a surprisingly low effect on retaining participants, particularly in Peru.

Table A.1.1: Attrition by method to end of panel study in L2L

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Peru</th>
<th>Honduras</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVR</td>
<td>81%</td>
<td>62%</td>
</tr>
<tr>
<td>SMS</td>
<td>79%</td>
<td>60%</td>
</tr>
<tr>
<td>CATI</td>
<td>61%</td>
<td>28%</td>
</tr>
<tr>
<td>Overall</td>
<td>75%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Source: Ballivian and Azevedo (2013)

In terms of data quality and accuracy, the study found differences across the methods used. CATI methods gave answers that were most consistent with the initial face-to-face interviews, while IVR had the highest test-retest reliability. In terms of costs, SMS was by far cheaper. Interestingly, CATI was shown to be 50% cheaper than traditional in-person interviews (face-to-face interviews). Table A.1.2 summarizes the costs across different methods.

Table A.1.2: Costs per question L2L (in USD)

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Cost Per Interview</th>
<th>Cost Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>40</td>
<td>720,000</td>
</tr>
<tr>
<td>CATI</td>
<td>25</td>
<td>450,000</td>
</tr>
<tr>
<td>IVR</td>
<td>17</td>
<td>306,000</td>
</tr>
<tr>
<td>SMS</td>
<td>8</td>
<td>144,000</td>
</tr>
</tbody>
</table>

Another key lesson from the project is that while statistical surveying using mobile phones is possible, it is challenging to initiate such data collection efforts after the onset of a crisis. For mobile phone surveys to produce statistically representative data for policy decisions, preparation and baseline surveys are essential. Moreover, systems for frequent data collection must be in place before the frequent data collection process starts. Moreover, the report does not suggest replacing traditional surveying with mobile methods, but suggest that it can be a valuable complement to less frequent household surveys conducted by NSOs.