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'KNOWING IN TIME': HOW TECHNOLOGY INNOVATIONS IN STATISTICAL DATA COLLECTION CAN MAKE A DIFFERENCE IN DEVELOPMENT[1]

ABSTRACT:

The availability of statistics and household survey data in developing countries has improved in recent years, thanks to better statistical capacity and an increasing focus on indicators and goals in both international and national development. 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. Fortunately, the rapid speed of mobile connectivity and progress in technological innovation provide new opportunities for collecting data and producing statistics on certain indicators faster and with higher frequency. This paper provides an overview of technological innovation in data collection in developing countries, with a particular focus on those technologies that have become feasible due to the rapid rise in mobile phone connectivity. The review of tools and experiences finds that new technologies can substantially advance the production of faster and more frequent data, even in the most challenging institutional and capacity constrained environments. New survey technologies can both 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. In addition, 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. Integrating these new 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.

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

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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. Relatedly, 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 keeps focus on the importance of measuring development progress with monitoring of key statistical indicators.

This overall focus on measuring development, has led to improvements in statistical data availability. However, despite these general improvements in amount of data available, 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. When policy makers do not know the current realities on the ground, it is difficult to address them. Such a knowledge deficit is particularly pressing given the increasing prominence 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.

New opportunities for improving the speed and frequency at which data is collected and statistics is produced have recently emerged, largely due to the rapid expansion in mobile and internet connectivity and the rapidly declining costs of innovative technologies that can be deployed for surveying. The most obvious such development is mobile phone penetration, which has skyrocketed in the developing world. Globally, the number of cellphone 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 cellphone and adoption is increasing fast. Hardware costs (cellphones, smart phones, tablets and computers) have also dropped fast; meaning 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. Such technological advances means that traditional paper and enumerator surveys can potentially be complemented with new ways of collecting data that are faster, cheaper and can be conducted more frequently.

This 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 data is collected in developing countries. The paper covers early deployments of such methods conducted in several development countries, by different actors. Many of these examples are small-scale applications and early experimentation of new tools, while some are larger and global in reach. Nevertheless, 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. Therefore, the key question that this papers seeks to answer is: *how can recent progress in technological innovation and connectivity help us collect*

better, faster and potentially cheaper national and international statistics, while ensuring data quality?

Thus, this paper reviews the success and lessons from initial experiences of how new technologies can be deployed to produce more timely statistics where it is needed the most, and as such give policy makers the knowledge they require to act in time. 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 solely on the data collection process. There are many other aspects of statistical production that also can benefit from and can be modernized through adoption of new technologies. Other processes, such as survey design, sampling, data processing and cleaning, analysis and dissemination are also part of the statistical data production process which are key to improving the speed, frequency and quality of data production. This paper does not address technological advances within these steps in the production process, however these are certainly also important for improving collection.

Based on the review of several new technological approaches and experimental deployments, the key finding of this paper is that that new technologies can substantially advance statistical capacity to report 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. 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. In addition, 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. Integrating these new 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.

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 feasible 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 general 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. Annex 1 provides more detailed case studies of applications of each of the technologies.

2 Background and context

2.1 Data about development: more, but not much faster and better

Over the past decade the world has increased its focus on evidence-based policy making and monitoring of development progress. 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.

As a consequence of this increased focus on measurement and results and increased funding for statistical capacity building and surveys, the world has a lot 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.

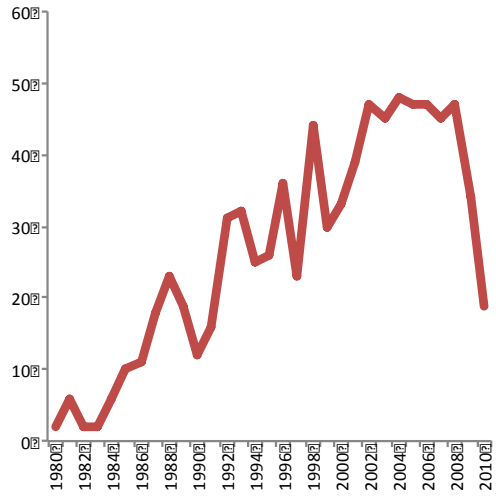
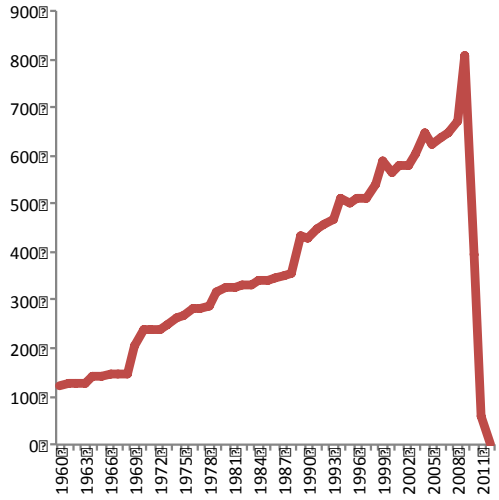


Figure 2. Number of statistical indicators available in the WDI



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 take years before key indicators and micro data sets are available and the international level. 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. Therefore, basing policy decision on data that is several years old is often the only option in most developing countries today.

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 need for 'knowing in time' increasingly urgent

While we do know a lot more about development and the state of the world, and progress from 1990 to 2010, we unfortunately do not know much more about what is happening at present. For policy makers at both international and national levels, knowing what is happing in societies today is necessary to optimize policy responses. For example, are children in the Sahel going less to school as a result of the drought? Have increases in food prices in Asia last month hurt or benefited farmers? These are examples of the questions that everyday policy makers in developing countries wish they had the answers to from their national statistical systems, but which they in most cases do not have.

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 in Indonesia 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 "early warning systems" and "crisis monitoring" the numbers are 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 number of meals eaten 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 remained 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 indicators. 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).

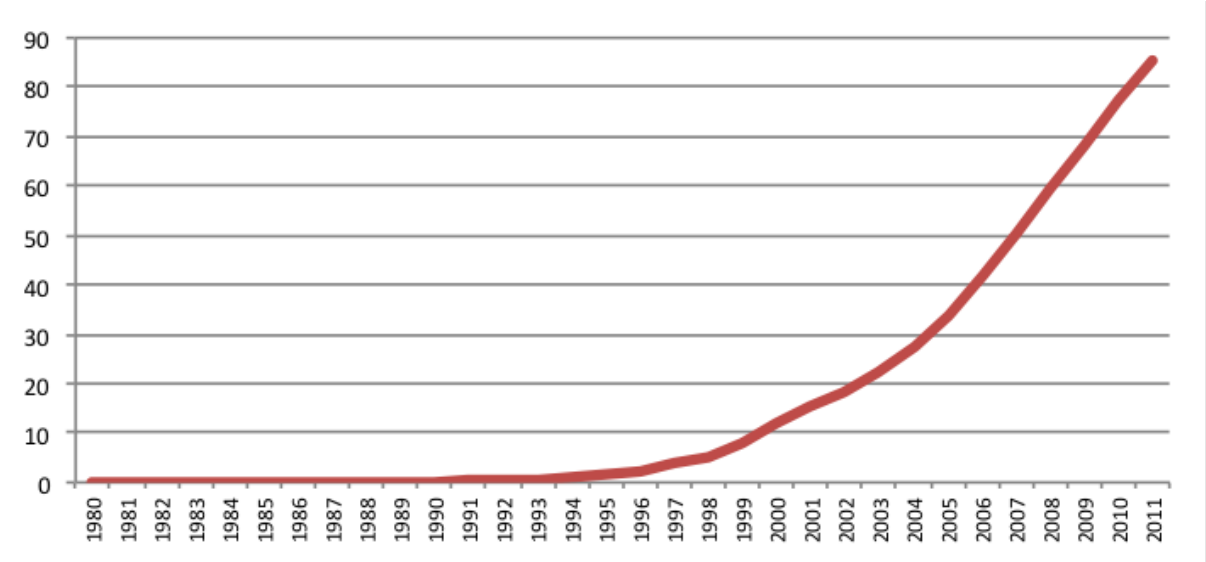
More than ever, national and international policy makers need to know how realities are changing on the ground faster for several reasons. First, natural disasters seem to be occurring with higher frequency, magnitude and impact, in many parts of the world, requiring rapid responses and increased preparedness. Responding to such challenges requires good data about areas affected and impacts. Second, 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. Third, social and political conflict is becoming an increasingly prominent development challenge in the World. 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. 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' that spread across the world in 2008 and in FCS.

2.3 The connectivity revolution provides new opportunities for faster data

The speed and magnitude at which connectivity is and mobile 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, and fewer than 1 in 1,000 Kenyan adults had mobile phone service. 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.

Figure 3: Number of Mobile subscription per 100 people in the World



Source: World Development Indicators.

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 collection can increasingly happen over SMS and the web. The next section provides and overview and assessment of such methods.

3 New data collection technologies and opportunities

A wide range of different potential 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.

This section outlines some concrete examples of technological approaches that have been deployed for various statistical purposes in developing countries by governments (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. This section also mentions example deployments of these technical approaches, which are documented more extensively in the case studies in Annex 1.

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 penetration and technological adoption also creates huge amount of digital traces – data about usage, movements and transactions – or so-called '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.

Annex 1 presents a series of more detailed case studies of the deployment of such tools. The purpose here is not to conduct a thorough review of each of the technologies – this must be done with specific contexts and purposes in mind – but to show the potential and limitations of these survey technologies and for what purposes they have been applied.

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

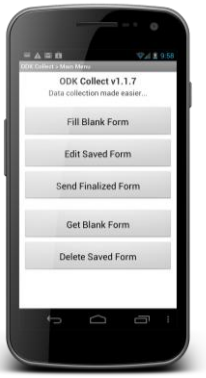
The substantial reduction in costs of simple computer hardware, such as smart phones and tablets, and improvements in connectivity and battery has made substituting paper with simple electronic forms much more viable. Computer assisted personal interviewing (CAPI) is an umbrella term for a set of survey 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.

Four 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 the findings. Third, because of software improvements, more complex surveys are also feasible. Fourth, because the devices now used for CAPI basically are small computers with connectivity features, there are other elements that can help the survey

management, such as periodic update of survey questions, email correspondence with enumerator and genera survey management.

Since CAPI has changed considerably over time, 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 costing US$100 and more. Examples and characteristics of the three categories are outlined in Table 1 below.

Table 1: Different CAPI approaches

A. Traditional CAPI on PDA or computers	B. Simplified CAPI on simple mobile phones or "MAPI".	C. CAPI on Smartphone, Tablet with GPS and data connection
		
Advantages: dedicated survey software, durable.	Advantages: cheap, available on any mobile phones.	Advantages: data connectivity, multimedia, advanced survey software
Disadvantage: used to be expensive, coming down in price.	Disadvantage: small screen, limited complexity of forms, etc.	Disadvantage: more expensive, but can now be done even on US$80 phones (several software)

As mentioned, 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 not been 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 hand complex and long questionnaires and is therefore becoming a real, viable alternative to paper (PAPI) surveys.

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. While 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, but shown promising results in improving accuracy, speed and cutting costs, which also could hold promise for smaller statistical surveys collecting few indicators for which high frequency collection could be useful (Schuster & Brito, 2011). The open source tools in the Open Data Kit stands out and has thousands of deployments across the world, of which a handful has been used for statistically representative surveys by statistical agencies and others. 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 on 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 CPAI 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 could increase costs. Though, at the same time, it will still likely be less expensive that doing the full survey in-person (face-to-face), which would require multiple field visits. Furthermore, there seems to be survey fatigue 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 cellular phone in urban areas, some of the poorest households in remote areas do still not have phones (Croke et al, 2010). Until mobile penetration has reached further into rural areas, the shortfall can be overcome by giving phones to respondents who do not have one, which has been done in several cases.

This is certainly true in poorer countries, especially in Africa – though this is changing fast. In South Sudan, one of the countries in the world with he highest incidence of poverty and some of the lowest development outcomes, a World Bank experiment showed that phone surveys are possible even under such conditions. The problem of the poorest households not having cellphones and thus not being reachable was overcome by handing out phones to households that did not have them (Demombynes et al, 2013).

Applications in developing countries:

A large scale, impressive 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.

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. 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)

Increasingly feasible is also surveying by automated phone calls (or robo-calls) in which a computer plays pre-recorded questions over the phone line and the respondent answers by recording voice response or by pressing the key pad (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) 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 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 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 Ballivian 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 cellular telephones, 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 which makes them undesirable for large sample surveys. SMS relies on the respondent's reading comprehension ability and attention span and commitment to answering the questions. All in tall 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 (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, which is a requirement for many statistical purposes.

The text message approach may be most useful for the purpose of data collection activities where characteristics of the individual respondent is less important in terms of creating biases, or in situations where statistical representativeness is not that important. For example, the World Bank has used JANAs platform to 'crowd-source' price data collection through via SMS and other approaches. The pilot was implemented by non-professional price collectors (the "crowd"), using SMS and computers as means for collecting data. The project collected price data for six months in eight pilot countries: Brazil, Bangladesh, India, Indonesia, Kenya, Nigeria, Pakistan and Philippines (Hemadeh, 2013)

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, very few people in developing countries have internet access. 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 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. Most 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 statistics.

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 turning 'digital traces into' real-time statistics

Although quite distinct from the different survey techniques laid out above, another emerging source for statistical data that is increasingly becoming feasible in developing countries, thanks to increased mobile penetration and technological innovation, is so-called 'big data' or 'organic data'. Generally, 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 (Google 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:

An example is the analysis of mobile phone call records, and particularly mobile money transactions, to 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 Rwandan's 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 (Letouze, 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

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 (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 toe 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, such as South Sudan and other countries in Africa.

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 sampling stage. 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.

There is however ways to deal with sampling issues to some extent. Many of the pilot implementations that have tried to obtain statistically representative samples have been acutely aware of this and found ways to overcome this challenge. Fore example, several implementations have sampled through traditional household visits or existing sampling frames and 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.

In theory, one could sample just by drawing phone numbers at random or sending text messages at random to phone numbers. This is often the practice for phone surveys in developed countries where there are complete phone registries and coverage in universal. However, in developing countries, for purposes where statistical representativeness is desirable, many of the experiments to date have done sampling in similar ways to what you would do for a traditional survey (using national sample frames and household visits) as this also helps building trust with the respondent, which can help avoid attrition. For the CAPI approaches, the sampling issues faced are not very different from those of normal papers surveys.

4.3 Non-response, attrition 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 much lower, around 50%. If respondents who do not answer surveys or drop out of a panel surveys differ systematically from the people who participate, this can also 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 ne 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 – rather it becomes a habit, it seems. 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.

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 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 different answers are being reported over SMS and IVR when compared to those recoded 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 do not yet have solid encryption systems and there are not yet universal standards for the way survey and statistical data collected over SMS, the web, or phone should be 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 GPS locations from surveys, 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 (Letouze, 2012). Moreover, such data can be sensitive because the data often reveal the personal behavior of individuals, 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 much 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. The 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.

Ballivian and Azevedo (2013) also present some of the best 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.

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 also observed as a constraint in some of the cases reviewed for this paper.

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 Complement 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. This type 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 & USSSD) 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; Letouze, 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 2: Summary of findings from approaches:

Data collection approach	Advantages	Disadvantages	For what purpose? (what type of statistics)	Suitable contexts	Capacity and institutional constraints (tech, skills, cost)
Electronic forms (CAPI) (3.1)	Similar to paper surveys, but direct data entry and fast transmission. Can also strengthen survey management.	Technology has been expensive, sometime requiring data connection, but becoming less of a problem.	For surveys similar to paper, but with need for faster transfer and data production.	Proven to work in most contexts, even with low infrastructure and institutional capacity.	Requires power and some versions require data connection for transfer of data.
Personal Phone Survey (CATI) (3.2)	No literacy requirements as questions administered by audio.	Ok for medium length surveys. Sampling	Where a statistically representative sample is achievable by phones and surveys are short.	Beneficial where literacy is low and where date on medium length surveys required (10-30 questions)	High mobile phone penetration among respondents. Call centers.
Automated Phone Surveys: IVR (3.3)	Low costs as no enumerator required. Literacy of respondent not required.	Long surveys difficult. Some technical literacy required by respondent if required to key responses.	Cheaper than CAPI and CATI, however problems of high non-response. Similar to use of SMS/USSD survey.	Useful where a couple of critical indicators are needed at a frequent basis.	High mobile phone penetration among respondents. No particular requirements beyond IVR call center.
Mobile Text (SMS/USSD) surveys (3.4)	Low costs as no enumerator required. High volumes of respondents feasible.	Long surveys difficult. Questions limited to 160 characters. High non-response and attrition.	Unsuitable for large, statistical surveys, but good for collection of single indicators, such as prices and food security	Useful where a couple of critical indicators are needed at a frequent basis, or for crowdsourcing of data where sampling not a big issue.	Very low technical requirements – SMS enabled phones and SMS gateway and software for sending.
Web surveys: (CAWI)	Cheap, allows for	Requires internet	Situations that require	Mostly for internal	Internet connectivity

(3.5)	complex surveys.	connection and computers or smartphone/tablet.	rapid collection of administrative statistics.	government collection of administrative statistics (service delivery and budget indicators, etc.)	for both survey designers and respondents.
Big data (3.6)	Data already available but needs to be mined to create indicators & statistics. Granularity and details, very high frequency.	Only certain data is available and cannot decide what data to collect. Often difficult to distinguish 'signal' from 'noise'.	Real-time monitoring of human behavior (and other)	Where large-scale datasets of 'digital traces' are available.	Analytical capacity to handle and mine large data sets.

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 certifier 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 thus policymakers ability to 'know 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 both 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 should strengthen their systems in role in three ways. First of all, NSOs can use NSDSs processes to better understand where faster data collection is needed and is feasible. Second, statistical systems need to be 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.

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Annex 1: Case Studies

[To be completed]

A.1.1: CAPI surveys in South Sudan using tablets

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 on social, economic and security conditions in the country with both market and household surveys.

The data collected 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.

A.1.2: Phone surveys in Latin America (L2L)

[Directly Adapted from Ballivian, A., and J. P. Azevedo, 2012 – Case study to be completed]

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

The key question that the Listening to LAC (L2L) project aimed to answer is this: Can we use cell phone communication technology to reduce the time and cost of collecting probabilistic sample data without compromising data quality? Telephone interviewing has three main problems: (1) obtaining representative samples of the national population, (2) adequate response rates, and (3) data quality compared to face-to-face interviewing, which is the standard method of survey data collection in developing country. The L2L pilot has tested for the validity and seriousness of these problems in a systematic way.

The results suggest that using mobile phones for short and frequent surveys can produce good quality data more quickly –and more cheaply on a per survey basis- than traditional methods. But, this does not mean that it is possible to initiate the data collection effort after the onset of a crisis and obtain relevant data quickly. In order for cell phone collected data to produce enough information for policy decisions, probabilistic sampling and a baseline survey are essential. In addition, several implementation issues explained in this report need to be addressed ahead of time. For this reason the system for frequent data collection must be in place before the frequent data collection process starts. Hence, this method can be a valuable complement to less frequent household surveys conducted by official statistical agencies.

A.1.3: SMS surveys for price data collection

[Directly Adapted from Hemadeh, 2013 – Case study to be completed]

The World Bank Pilot Study for Crowd-Sourced Price Data Collection through Mobile Phones combines the need for high-frequency data, the recent developments in the ICT sector, and power of crowd in an innovative way. Its objective was to study the feasibility of crowd-sourced price data collection. The pilot was carried out by a World Bank contracted private company, JANA. The project collected price data for six months in eight pilot countries: Brazil, Bangladesh, India, Indonesia, Kenya, Nigeria, Pakistan and Philippines.

Despite the challenges faced, the project was successful. The pilot provided insight to the potential use of alternative ways to sample and collect price data across countries. During the survey, prices were collected from around 5,000 supermarkets in close to 300 survey locations, spread across the pilot countries, by over 7,000 NPCs. The developed platform proved that once efficient verification and validation mechanisms are in place, data users across the globe can have access to the price data within days after the data collection.

The collected data showed that crowd-sourced price collection is feasible and thus the developed platform can have a wide variety of applications at the World Bank, international and regional agencies, national statistical offices and non-governmental organizations. The data produced by the method is cost-efficient and timely, enables high item and geographical coverage, is comparable