

The Use of Hand-Held Computers for the Collection CPI Price Data

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Summary

This paper discusses statistical and practical issues in relation to the use of hand-held computers, or Personal Digital Assistants (PDAs), for the collection of price data for the compilation of Consumer Price Indices (CPI). The paper aims to assess the main advantages and challenges associated with introducing a system of electronic data collection in the context of two practical pilot studies carried out by The UK Office for National Statistics (ONS) in Uganda and Nigeria, in February and July 2007. The main focus of these studies was whether or not it is currently appropriate to further consider the use of hand-held technology for CPI data collection in circumstances pertinent to Africa. Although the assessment presented here is in the context of the countries involved, it is also hoped that the study will inform other countries considering the adoption of such technology for CPI data collection.

Key Words: *Consumer Price Indices, Price Collection, Statistical Capacity Building, PDA, Hand-held Computers.*

Sommaire

Cet article discute des aspects statistiques et pratiques par rapport à l'utilisation des ordinateurs portatifs, ou les aides personnels numériques (PDA), pour la collecte de données des prix nécessaire à l'élaboration de l'indice des prix à la consommation (IPC). L'article a pour objectif d'évaluer les principaux avantages et défis liés à l'introduction d'un système électronique de collecte de données dans le contexte de deux études pratiques pilotes effectuées par l'Office Nationale de Statistique de Grande Bretagne (ONS) en Ouganda et au Nigeria, en février et juillet 2007. L'objet central de ces études était de savoir s'il est actuellement approprié de continuer à utiliser la technologie portative pour la collecte de données de l'IPC dans les circonstances spécifiques à l'Afrique. Bien que l'évaluation présentée est dans le contexte des pays considérés, on espère également que l'étude sera bénéfique à d'autres pays envisageant d'adopter une telle technologie pour la collecte de données de l'IPC.

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Mots clés : *Indice des prix à la consommation, Collecte des prix, Renforcement des capacités statistiques, PDA, Ordinateurs portatifs.*

1. BACKGROUND

A number of National Statistical Institutes have successfully used hand-held computers for local price collection in the context of the compilation of Consumer Price Indices for several years. These technologies are now available at such prices and, in some cases, the general infrastructures are now in place that developing countries can consider their use, thus taking advantage of the considerable benefits associated with adopting such technologies. Indeed some developing countries are already using hand-held computers successfully to aid in the collection of survey data e.g. for the Philippines Annual Poverty Indicators Survey. Several technically advanced and well resourced Asian countries use handheld computers for Consumer Price Index (CPI) purposes.

In a European context the use of handheld computers is more common and indeed the UK Office for National Statistics (ONS) has been using handhelds for data collection of its Retail Prices Index (RPI) (and CPI) since 1995. The ONS CPI/RPI data collection has recently upgraded to use HP iPAQ 2190 PDAs running the Windows mobile operating system. Previously data collection was carried out using Psion palm-top devices.

We are not aware of any African country which uses handheld computers to collect all CPI prices data although some countries and regional organisations are considering the introduction of such technology either to enhance existing CPIs or as part of a wider agenda of regional CPI Harmonisation and possible future integration with another round of the International Comparison Programme. It is under this context that the ONS were tasked with carrying out two pilot studies into the use of Computer Assisted Data Capture (CADC) in an African context in order to provide advice about the key challenges and advantages both specifically for the countries visited but also to inform other countries considering implementing such systems.

2. THE PILOT STUDIES

Taking the advice of colleagues at the African Development Bank (AfDB) it was agreed that Uganda and Nigeria would be ideal candidates for the

ONS Pilot Studies- due to their expressed interest in introducing CADC in the near future and also that the countries differ significantly enough to provide an interesting comparison. Both the Nigerian National Bureau of Statistics (NBS) and the Ugandan Bureau of Statistics (UBOS) welcomed the pilot study and provided the significant support necessary during the missions.

The remit of the study was to consider not only the extent to which handheld computers provide additional scope for product improvement through better quality data and timeliness from interactive live-editing and electronic data transmission but also their potential to assist with other developments such as the identification of discounts, control of forced replacement of items and the provision of information relating to changes in quality.

Each pilot study was carried out by two ONS representatives in partnership with the NBS/UBOS staff and price collectors. ONS spent 5 working days in each country which included 2 days of fieldwork in the markets of Abuja and Kubwa (Nigeria) and Kampala and Jinja (Uganda) where ONS carried out a price collection using hand-held computers in parallel to the standard (paper) collection being undertaken for the Nigerian and Ugandan CPIs. Screenshots of the simple price collection program used for the Nigerian pilot study can be seen at Annex A.

The main focus of this study was whether or not it is currently appropriate to further consider the use of handheld technology for CPI data collection in circumstances pertinent to Africa. This study did not look in detail into which specific technology would be used, such specifics would be addressed at a later date if a particular country decided to implement such a system.

3. FINDINGS

The pilot studies were able to carry out a full practical assessment of CADC methods in Uganda and Nigeria, the key findings are summarised below. These findings were drawn from observations made in the field, discussions with staff at NBS and UBOS and a detailed comparative analysis of the electronic data collected during the course of the pilot study and that collected by the UBOS/NBS price collectors using standard methods (see section 4 for a summary of this analysis).

3.1. Quality

A major perceived advantage of the use of a CADC system is that it would lead to improvements in the quality of CPI data, particularly as increased quality control at the point of data entry would help identify anomalies and ensure that prices imputed are correct. Observations made in the field and analysis of the data collected using CADC versus traditional methods (which revealed some interesting price variations, see section 4) are illustrative of the usefulness of the functionality offered in the field by using handheld computers which has the potential to significantly improve the quality of the final CPI in the following ways:

- i. Price History: The price collection programme available on the PDA's allowed for a more comprehensive price history to be available to the price collector, rather than the one previous price included on paper forms in Nigeria and Uganda. The availability of such data leads to less judgmental editing at the point of data collection and helps ensure the comparability of items, particularly where prices for a particular item are variable. But it is important that the machines are programmed to reveal the price history only after a price quote had been entered so that collectors are not overly influenced by price when choosing an item.
- ii. Quality Checks in the field: The price collection programme available on the PDA's included several automatic validity checks which were used to identify where the price entered varied by +/- a certain percentage from the previous month's price and the average price for that item over a number of months and also flagged up where data was not entered in all required fields (price, weight, indicator code). These checks provided a useful marker when a price needed to be double-checked, in the existing system such checks are carried out in the central office after the data has been collected and therefore audits must be carried out after the collection period when prices may have changed.
- iii. Transcription: There is a major risk of errors when transcribing paper forms, this is not a risk when using PDA's where data can be transferred electronically to the central office.

These quality improvements are perhaps more applicable to areas outside of the main urban areas as quality control is likely to be more difficult in the remote regions simply due to the distance from the central office.

In addition to these advantages in the field the electronic system also allows improvements in quality through operational procedures; see section 3.5, Work Control, for further detail.

3.2. Timeliness

The use of PDAs to collect prices data significantly reduces the time taken to make data available electronically at the central office and between data collection and finalization, this can be achieved through:

- i. Transcription: Data collected on paper must be transcribed onto a desktop computer for computation. This process is time-consuming and resource intensive. When data is collected on handhelds the data can be directly transferred from the handheld to a desktop (see 3.3 for Transmission methods).
- ii. Transmission from regions: Electronic transmission (see 3.3) will allow regions or Zonal Offices (in a Nigerian context) to directly transmit an electronic data file to the central office thus negating the need to courier or hand deliver forms.
- iii. Quality checks in advance: As the functionality is available to run certain quality checks in the field that would normally be run in the office after data had been transcribed the time taken for quality checking centrally can be reduced, or alternatively further check could be carried out.

These improvements to the speed of the processing system might facilitate an earlier publication but any improvements in Nigeria or Uganda are not likely to be significant given the timeliness of the current publication schedule in both countries. In addition the relative merits of speeding up publication need to be balanced against other opportunities, e.g. to spend more time on analysis and interpretation, the production of press notices and associated briefing or the collection of more prices.

3.3. Transmission

Although the pilot studies could carry out no physical testing of the transmission of collected data to the central office we were able to make a practical assessment of the possibilities:

- i. Wireless transmission: Collectors will not always have access to a PC but in both Uganda and Nigeria the mobile telephone network is good

- and widely used. Data could therefore be transmitted directly from the PDA to the regional or central office.
- ii. Email: Although this was not tested in the field, in both Uganda and Nigeria the data could be downloaded on to a local desktop PC and then sent to the central office via email. In Uganda two of the five regional centres have desktop PCs already. For the other three one option, other than actually purchasing PCs, would be to arrange to use PCs in other government offices. In Nigeria the zonal offices will soon have network connections directly to the central office and access to the internet, so local downloading and transmission should not be a problem in principle.
 - iii. Manual delivery: As a last resort supervisors could bring machines to the central office for downloading data but this would involve travel costs and possibly the purchasing of additional memory cards for local price collection when memory cards are being delivered.

The electronic transmission of data from price collectors and regional offices would significantly increase the speed of data transmission to Headquarters and reduce the cost of doing so (e.g. fewer travel and accommodation costs). In addition, headquarters would be able to look up the latest returns of price data from all regions at the same time thereby identifying early on any issues.

3.4. Interface with ‘back office’ systems

The project was able to successfully interface the HP iPAQ with back-office systems in Uganda. Microsoft ActiveSync® was loaded on to a UBOS computer to enable data to be transferred from the hand-held to the desktop. Data was transferred to the UBOS system and analysed. Due to time constraints it was not possible to physically test this interface in Nigeria but an assessment of the IT infrastructure suggests that this would not be a problem.

The interface between UBOS/NBS software and handheld computers was simple as the handhelds can export an Excel file of data and UBOS/NBS both use Excel to analyse CPI data deliveries. This interface might become more complex if additional functions required for the CADC system necessitated other software, which is likely to be the case if hand-helds were to be used for regular CPI data collection.

3.5. Work Control

A CADC system enables certain checks that would improve how efficiently the CPI is managed:

- Check that all prices have been collected: An electronic data collection form can easily check whether all prices have been collected and flag when they have not, this mitigates the risk of the price collector inadvertently forgetting to price a particular item.
- Check to see when prices were imputed: An electronic data collection form can easily add a date/time to the collected price which is useful for validation purposes.
- Indicator Codes: If a specific country were to adopt the use of hand-held computers for their CPI we would propose that they used the opportunity to add certain features to their data collection form. One such feature would be indicator codes, these codes (represented by a single letter) are used in the UK to show when a price collected is for an item on sale, a replacement item, a missing item, a discontinued item etc. This is a simple tool to enhance the ease of validation and the management of the item list. For example, the price of the 'Men's Belt' collected in Garki Market (Abuja, Nigeria) was 270% higher than the average for that location. This was an accurate price quote but one which suggests that the item priced was of much higher quality than previous items. In the pilot study this item was therefore flagged with an 'N' (Non-Comparable) indicator code and details of the physical characteristics of the belt were recorded in order that this change in quality would be taken into account during the compilation of the index.
- Having price histories more readily at hand could:
 - o Make briefing of price collectors prior to fieldwork more effective, e.g. by a better appreciation of when an "outlier" is a legitimate price change and vice-versa.
 - o Add to the quality assurance processes through assisting with analysis when the index has been compiled and briefing is being put together.

These advantages are particularly relevant when there can be significant regional variations in price levels and trends.

3.6. Sustainability

Although the pilot studies could not directly test the sustainability of an electronic price collection system the impression from inter-acting with staff is that there is the capacity to exploit this technology.

Robustness of the technology: Over time the hand-held technology would suffer wear-and-tear, it is important to have spare handhelds and spare parts (batteries, stylus etc.) at the central office in case of a failure. The machines will also inevitably become outdated over time. If they continue to work effectively for the CPI this should not be an issue but as newer technologies are available that would further enhance CPI price collection there may be pressure to upgrade the system. It should be noted that the previous machines used for UK price collection lasted for 9 years and most were working well when replaced with more up-to-date technology.

Ability to cope with changes in the CPI: In recent years as some African countries have come to update their CPI, to bring it in line with international best-practice, it has emerged that their previously developed systems sometimes cannot be adapted to handle changes. It is also often the case that the system has been developed by an external consultant and that the staff at the NSI have little knowledge of its workings. This issue is not as significant in the context of the price collection system as it is with the index computation system, the actual collection system would not need to be significantly altered if the CPI methodology was updated. However, the collection system would need to be able to cope with changes to the basket. Electronic transmission would enable the price collector to receive updated forms with new items etc. directly from the central office with details of the new/dropped items. .

3.7. Costs

Clearly there will be a short term cost associated with the introduction and implementation of an electronic system for CPI data collection, such as:

- The purchase of handheld computers
- Upgrading 'back-office' systems to enable interaction with the handhelds (the extent to which this may be necessary is not known).
- The development of appropriate software for local price collection (costs depend on the functionality and how sophisticated the programme).
- Training of field staff and statistics office staff on using the new systems – There may be challenges associated with field staff not being used to the technology but the pilot studies suggested this is not an unsolvable problem. There may also be resistance from some field staff to the use of new technology as they may lack confidence about being able to operate the handheld, this risk may be mitigated through training and pilot collecting.

The unit cost of the iPAQ 2190, used for the pilot study and for CPI collection in the UK, is about £300 including back-up battery.

There would also be longer-term costs associated with maintenance of the system and training of new staff but we would expect that additional expenditure on the latter would be minimal as new staff must be trained in any case.

3.8. Cost Savings

It is difficult to be firm on the relative cost savings gained from an electronic system of data collection until proposals are fully developed and local familiarisation with the new technology has taken place (regular use will clearly increase expertise). However, it is clear that:

- The current paper collection in both Uganda and Nigeria involves a significant element of staff time and travel. This includes initial price collection, inputting prices into the computer, editing and re-pricing. The number of people months would reduce with the use of handheld computers, from eliminating the need for data transcription and some editing at Headquarters (although central editing will still be necessary) and from the need for less travelling.
- The use of handheld computers would also eliminate costs associated with the printing of questionnaires etc.

Although in the longer-term some cost savings may be gained the implementation of a CADC system should not be seen as a way to save significant sums of money as the set-up costs and ongoing maintenance costs will offset some of the efficiency savings and any net savings should be seen as an opportunity to re-invest in improved outputs e.g. more price quotes and better analysis.

3.9. Other Issues

The pilot studies uncovered a few other issues associated with electronic data collection in the field which should be taken into account if implementing such a system:

- The screens were difficult to read in the sun. There may be an accessory available to resolve this problem.

- Convenience: access and organisation of hundreds of price quotes during price collection proved much simpler using a hand-held computer as opposed to bulky paper forms.
- Power-cuts: Uganda and Nigeria experience frequent power-cuts which would impact on an electronic price collection system as the handhelds need to be charged. The iPaq's do have a long battery life (adequate for a prolonged period of price collection spanning a number of days), internal back-up batteries and come with a spare battery but there would still be a residual risk. The contingency in case of a major disruption would be to collect the prices on paper or for the central office to deliver a spare (fully charged) handheld to the affected price collector(s). In Nigeria it was noted that most price collectors have mobile telephones and therefore must be able to charge the batteries even with intermittent power.

4. DATA ANALYSIS

The Ugandan pilot study was able to carry out a comparative analysis of prices data collected through the regular methods and those collected in during the course of the mission using handheld computers, see 4.1 for a summary of the results.

For the Nigerian pilot study it was not possible to carry out the same analysis but rather an analysis was carried out on prices data collected during the *previous month* through the regular methods and those collected during the course of the mission using handheld computers. This analysis is not included here as merely served to illustrate the major challenges in maintaining the quality of the prices data, particularly in the circumstances facing a country such as Nigeria where the majority of purchases are made in open markets where the prices are negotiable and the products on offer – particularly food- can vary in quality both between market stalls and locations, and over a relatively short period of time. The analysis particularly informed the discussions on quality (3.1) and work control (3.5). What this analysis also demonstrated was that the ease of the data being available in an instant electronic format encouraged more detailed validation.

4.1 Uganda Data Analysis

The analysis was undertaken for prices collected in the Nakasero and in Baita markets of Kampala. The Nakasero analysis focussed on the differences between the data collected using the two methods whereas the Baita

analysis focussed on the functionality available for data validation in the field and how it compared to validation currently carried out at the UBOS central office.

Neither analysis indicated major issues with the quality of the prices currently collected for the CPI in Uganda but did demonstrate the possibilities and ease of validation in the field using an electronic system.

Table 1 shows a comparison of the prices collected using the hand-held computer and those collected under existing methods in the Nakasero market of Kampala. In this exercise two teams worked in parallel with the same list of items to price. But they did not accompany one another so the difference in prices will reflect all those factors influencing price including the stall from which the price quotation was obtained and the quality of the particular item, for example the freshness of “green leaves”. The table gives a comparative analysis of the actual and percentage differences in unit prices collected on paper and electronically.

Table 1: Percentage difference between prices collected using traditional methods and prices collected using handheld computers in Nakasero, Uganda.

	%
No difference	59
+/- 10% or less	73
+/- 20% or less	86
+/- 30% or less	94
More than +/- 30%	6

Table 1 shows that:

- On the whole the prices collected using the hand-held and on paper are similar. Indeed out of the items collected 59% do not differ between the methods of collection, 73% differ by +/- 10% or less and 94% differ by +/- 30% or less.
- In most cases where the prices differ the variance is genuine due to either different market traders asking for different prices or offering slightly larger bundles etc for the same price.
- The analysis provided a good example of the additional facilities readily available from downloading Excel spreadsheets from the handhelds.

The ease of the data being available in an instant electronic format encouraged more detailed validation.

The Nakasero analysis shows that the prices on the whole do not significantly differ and that anomalies picked up by the existing methods of data validation are on the whole the same as those identified by the quality checks on the hand-held. It shows the strength of current data collection in Uganda and therefore, the advantage to the quality of the final CPI through adopting hand-held computers may not be significant.

Unlike the Nakasero collection, the Baita electronic price recording shadowed the paper price collection i.e. the two teams collected prices together for the identical items. The hand-held computers were used to edit in the same way as currently takes place on the data inputted into the computers at Head Office but with different validation parameters. The parameters used would not necessarily be the ones used if the system were live; rather they would need to be reviewed to take into account local circumstances including price volatility. Even so, it was instructive to compare the outliers identified by the handhelds compared with the current CPI programmes.

The exercise also demonstrated that all of the validation checks currently undertaken in Head Quarters following the price collection can be undertaken effectively in the field using automatic checks on the hand-held computers. Although the collection system on the iPAQs used for the pilot study was limited, and in the case of Uganda was only set up to compare new prices with prices previously collected in the same market, it could be adapted to compare the former with new prices collected in other markets or the average price across all markets. If further validation needs to be carried out at the central office this can be done simply if data is instantly available in an electronic format.

5. CONCLUSIONS

The pilot studies in Nigeria and Uganda proved that the introduction of handheld computers for price collection in countries confronted with similar local circumstance would be feasible and has the potential to bring a number of advantages including the delivery to headquarters of prices data which is both more timely and which has already undergone interactive editing in real time. The potential benefit in terms of data quality depends on the extent to which “quality” is observed to be an issue. Uganda, for example, have existing data validation procedures which are relatively

effective and the overall quality of their edited data is high. In other countries, where the existing infrastructure at the central office (in terms of both technology and expertise) may not be as strong, the potential gains are greater.

Initial indications from the pilot studies suggest that the use of handheld computers would facilitate enhanced control procedures to further ensure best-practice CPI data collection principles are followed. Handheld computers also have the potential to speed up the subsequent validation of prices which have been queried and their transmission to Head Office. The more timely processes would also facilitate a number of improvements, for instance the collection of a greater number of prices over the production cycle and more analysis of the consumer prices index and/or slightly earlier publication. The benefits to accrue are particularly so for remote price collection outside of the main urban centres.

The benefit of storing previous price histories, detailed item descriptions etc are universal and could increase with, for example, the introduction of a sub-regional harmonised index or greater integration between data collection for the CPI and for a permanent International Comparison Programme.

These advantages are in addition to advancing the general knowledge of a statistical office in new technology with the associated positive impact on the activities of the office overall.

There are also challenges associated with the implementation of such a system, aside from those to do with the development of the system itself, some practical challenges may include: the risk of the frequent power-cuts impacting on the ability to charge batteries; making sure the price collector does not become a target for theft; the long-term sustainability of the system (including the expertise at the local level for maintenance); and of course the set up costs (although some of these may be offset by efficiency gains in the longer-term).

In terms of hardware costs to set up a system of electronic data collection, this would not be substantial. The main costs are likely to be mainly associated with the development of suitable software, a software which is robust enough to handle the CPI and be relatively sustainable would likely involve several weeks of both business analysis and programming. Some efficiencies might be generated by a reduction in the checking and querying of data by Head Office and also in data inputting but substantial

net savings are unlikely unless there are opportunities to share hardware. Thus the main driving force behind the adoption of handheld computers is likely to be a better index for users rather than the anticipation of monetary savings within the Central Statistical Office. But a country's development costs will be significantly reduced if shared with other national statistics institutes- a benefit which would accrue if electronic data collection was introduced jointly with a harmonised CPI across countries or as part of CPI integration with a future International Comparison Programme.

Any project aimed at implementing an electronic data collection system should bear in mind the longer term sustainability of the system and its resilience over time. In particular the internal staff at the NSI should have full control over the system after implementation and the skills and resources to maintain it. Again, a joint project in cooperation with other national statistics institutes could help to address this issue.

6. RECOMMENDATIONS

The pilot studies proved that there are many advantages to adopting a CADC system for CPI price data collection. African countries should consider adopting such systems particularly if investing in changes to current CPI methods with, for example, the introduction of a sub-regional harmonised index or greater integration between data collection for the CPI and for a permanent International Comparison Programme. The pilot studies in Uganda and Nigeria can be used to inform countries of the benefits and also the possible challenges which need to be overcome.

To further inform countries adopting such a system further pilot studies could be carried out. Any further pilot work should focus on countries where the existing infrastructure at the central office (in terms of both technology and expertise) and the overall quality of the CPI system may not be as strong as Nigeria and Uganda, this may prove that in these cases the potential gains are greater.

Annex A: Screenshots from the Data Collection Program used for the Nigeria Pilot Study

List View



Filter the list by Commodity Group or by 'Not Entered'

Item List – Click item to enter Price Collection Form

Tab between forms
Item information
Enter Details



Validity Checks – % change vs previous month and average.

Price History Form



Price History

Average Price (all locations)