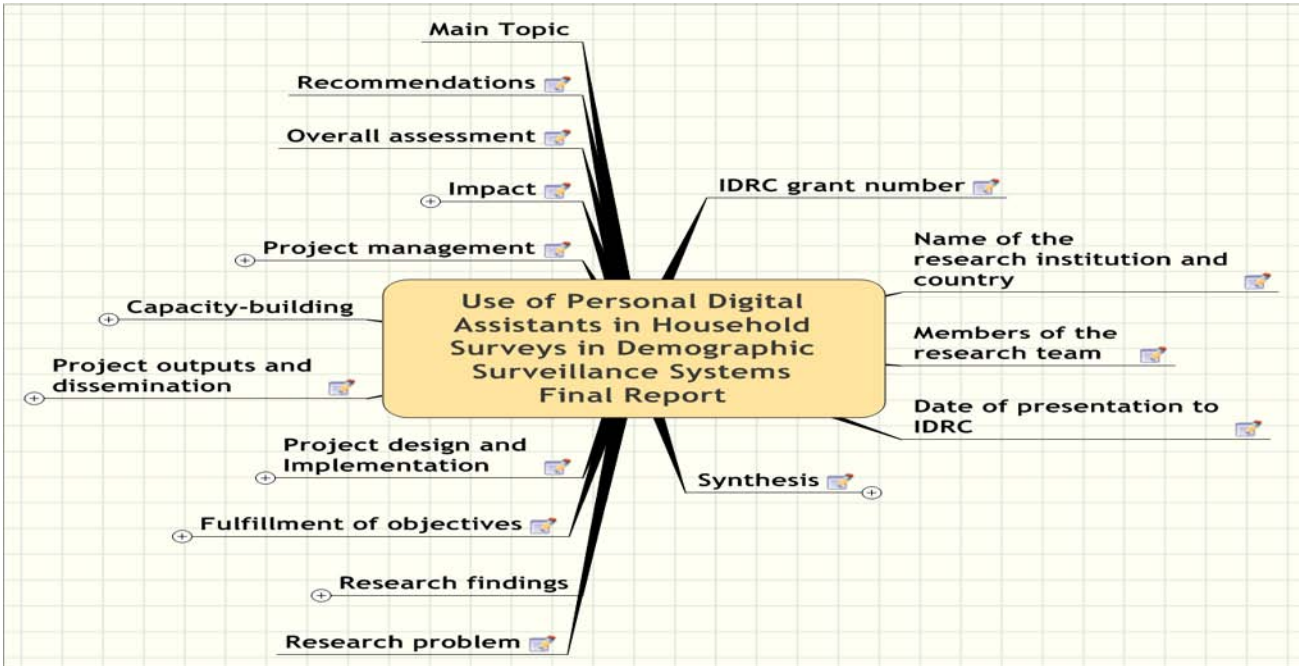


# Use of Personal Digital Assistants in Household Surveys in Demographic Surveillance Systems

## Final Report

Wednesday, October 07, 2009



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## 1 IDRC grant number

102240-001

## 2 Name of the research institution and country

Ifakara Health Institute (IHI) formerly Ifakara Health Research & Development Center (IHRDC) -  
Tanzania

## 3 Members of the research team

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#### 4 Date of presentation to IDRC

November 04 2008

#### 5 Synthesis

##### 5.1 Rationale and research problem

Demographic Surveillance System (DSS) has become an increasingly economical tool for generating evidence for public health programmes(1).In Tanzania the IDRC-funded Tanzania Essential Health Intervention Project (TEHIP) tested the feasibility of an evidence-based approach to decentralized health planning. TEHIP relied on DSS to establish burden of disease using extensive household-based demographic surveys in the form of DSS(2). To date, these surveys have been paper-based. A major challenge of using paper and pen/pencil to collect DSS data is the exceedingly cumbersome and resource consuming process which in turn is highly prone to erroneous data. In that regard the Ifakara Health Institute, formerly Ifakara Health Research &Development Center (IHRDC) tested the use of Personal Digital Assistants (PDAs) to save time and cost and to enhance quality of data in Rufiji DSS in southern Tanzania.

##### 5.2 Overall Objective

To ensure better resource allocation decisions for health purposes in Least Developed Countries (LDC) such as Tanzania by improving the information and data gathering and analysis through the use of Personal Digital Assistants (PDAs) or hand held computers.

### 5.3 Specific Objectives

- To establish the feasibility of employing paperless data collection methods in large scale DSS in rural Tanzania, compare with the high costs involved in a paper/pen type DSS which involves printing, binding, distribution through transportation, storage as well as transcription and quality control of data through:
  - Action research; Training; Software development Cost benefit analysis and
  - Dissemination of results and “closing the loop” for possible policy development by researchers as well as the Ministry of health, and amongst global network partners
- To determine the efficiency of use in the collection and analysis within the health information system evolving from the Canadian –Tanzania Essential intervention project, called TEHIP, and other relevant DSS being undertaken by the same research team and facility

### 5.4 Methodological Approach

Within same framework of the Rufiji DSS interviewers working on paper forms were paired with “shadow interviewers” using PDAs to collect same data for two consecutive rounds of household visits of 4 months each. Evaluation plans were set to compare costs, data quality (completeness, accuracy and timeliness), technical viability, and acceptance by survey respondents and interviewers.

### 5.5 Principal Findings

There were 961 households to which interviews on paper were compared with PDA based approach. Out of these, 43 households were further subjected to an extra process to gather opinion from respondents regarding use of PDA to solicit data from them. Six Interviewers were asked to share opinion regarding use of PDAs and/or paper in terms of user friendliness, technical viability and other aspects like duration of interviews and quality control features/approaches on either side.

## 5.6 Results

PDA system were superior than paper in terms of the following: i) costs with an absolute difference USD 8,500 per year per 1,000 households, ii) data completeness, 89.6% and 86.7% event records had complete data for PDA and Paper system respectively, (iii) data accuracy, 169 and 40 errors (incompleteness and illogical/inconsistency) per 1,000 records for PDA and Paper system respectively, iv) shorter interviews on PDAs than paper with 5.2 minutes on average. However PDAs demanded much more technical expertise in set up of the data collection system and during data collection due to hardware and software issues that require troubleshooting from time to time. Such dilemmas require further work for improvement in order to maximize benefit of PDAs in DSS data collection. Researchers with similar data platforms need to investigate further such an innovation as, if effective, could have important contribution for the monitoring, evaluation and planning for health programmes.

## 5.7 Expected Impact

This grant allows IHI to undertake cost benefit analysis and dissemination of results for research as well as possible policy development. Experiences gained in the Rufiji DSS will be shared with other researchers particularly sites of the INDEPTH network (an international network of over 30 Demographic Surveillance sites in developing countries- <http://www.indepth-network.org/>) for further development and use. The ultimate beneficiaries include policy makers (Ministry of Health) and such other potential research users around the world.

## 6 Research problem

Lack of population-based data in many developing countries hinders development of effective programs. In Tanzania, Demographic Surveillance Systems (DSS) are providing vital information enabling health planners to determine the overall effectiveness of the health system and monitor population health status.

With vital information, they can plan and budget health care services more strategically. Applied to a range of issues such as health, poverty reduction, food security, and environmental issues, the DSS system has become an increasingly economical tool for generating evidence for action on a broad spectrum of public policy.

Yet such surveys, the DSS are based on paperless data collection methods which involves high costs as a result of cumbersome procedures of printing, binding, distribution through transportation, storage as well as transcription and manual quality control processes. Within the informatics toolbox, the use of Personal Digital Assistants (PDAs) to collect health related data has been one of the approaches which have shown promise to mitigate the information barriers particularly in resource limited settings.

This work examined use of PDA based tools for collection and management of longitudinal household based data of DSS type and compare with paper based system. PDA and paper based survey tools were compared in terms of costs, data quality (completeness, accuracy and timeliness), technical viability, and acceptance by survey respondents and interviewers through addressing the following specific objectives

- To establish the feasibility of employing paperless data collection methods in large scale DSS in rural Tanzania, compare with the high costs involved in a paper/pen type DSS which involves printing, binding, distribution through transportation, storage as well as transcription and quality control of data through:
  - Action research; Training; Software development Cost benefit analysis and
  - Dissemination of results and “closing the loop” for possible policy development by researchers as well as the Ministry of health, and amongst global network partners
  - To determine the efficiency of use in the collection and analysis within the health information system evolving from the Canadian –Tanzania Essential intervention



project, called TEHIP, and other relevant DSS being undertaken by the same research team and facility

**Evolution:** Human related factors were later on considered an important aspect for a project of this type.

An additional study of acceptance by respondents and interviewers was later on added

## 7 Research findings

### 7.1 Cost

In general the paper system was more costly than PDA (USD 53,701 versus 45,201 representing an absolute difference of USD 8,500 per year per 1,000 households). There was much more spending in the paper system than PDA for recurrent costs (USD 3,430 versus 2,861 per 1,000 households) as well as on initial costs (USD 49,134 versus 41,511). For specific sub groups with the bigger categories PDA system were more costly on customization and purchase of software whereas the paper system costed more on purchase of computers and related items and other non computer related hardware such as photocopy, binding and duplicating machines (see figure 1.0). For the long term goals the findings on high cost of software puts emphasis on efforts towards development and effective use of open source platforms in order to allow many more users to participate in such new initiatives of using PDAs to collect health related data. There should be concerted efforts as well to strengthen capacity around development of open source software and PDA based tools such that the same is adequately available in developing countries. Labor costed more on paper system than PDA same as on printing logistics and interview time (figure 1.0).

Reduction of cost is likely to allow for more coverage of the surveys and therefore much more representativeness of the data. This is likely to inform policy-makers and programme planners on investment choices for monitoring and evaluation.

## 7.2 Data quality, completeness

Over the period of study, there were slightly more event records from paper than PDA system (1,399 versus 1,396). This was contrary to expectations (were supposed to record same number) but probably represents some overlooks by field workers.

In general terms missing data were less common in PDA than paper system. On date and numeric variables completeness of data were better on PDA than paper while data in character variables in general and more specifically character variables of continuous –typed were more complete in paper system than PDA. When it came character variable of binary format and numeric variable of continuous –typed in data PDA system performed well than paper on in data were more complete on paper than PDA (Figure 2.0).

## 7.3 Data quality, accuracy

The field supervisors on paper system captured 211 errors (representing 22 per 100 household's interview) before the forms reached the data center .This procedure was not applicable to the PDA system for which errors can only be audited after the data is downloaded on server. "Incompleteness" error type was responsible for 45% of the problem and "consistency/logical"," Standard operation procedures –SOPs" errors accounted for 40% and 15% respectively (figure 3.0)

There were 169 and 40 errors per 1,000 interviewed households on validation report, in the paper system and PDA system respectively and PDAs system generated fewer completeness errors than paper. The validation module reports inconsistencies after the data has passed all the stages in the data processing unit. The PDAs system generated fewer completeness errors than paper (figure 4.0)

## 7.4 Timeliness

Data on interview time were available for 346 and 215 households in the paper and PDA systems respectively. Mean interview time regardless of data collection method was 10.1 minutes while there were on average, 5.2 less minutes of interview on PDA compared to paper

The quality improvement reported here (completeness, accuracy and timeliness of data) is promising opportunity in terms of demonstrating impact on major goals and targets such as the Millenium Development Goals (MDGs) poverty- reduction and health programmes. Decision makers should be aware of such trade-offs with respect to quality of data when making investment choices for monitoring and evaluation.

## 7.5 Qualitative assessment

Total of 43 respondents of the DSS survey was interviewed for the qualitative assesment.It was observed that DSS data were collected in a natural and relaxed environment with minimal interference to household's routine activities. This was captured on observations and confirmed during qualitative interviews to DSS respondents. Most interviews were conducted while respondents were doing own 'normal' activities such as breastfeeding their babies, cooking, washing dishes or clothes, winnowing the paddy etc.Some would even make jokes with interviewers. There was no major variation in interviewees'behavior by method of data collection.

### **The DSS in general**

The DSS community seemed to be familiar with interviewers and the type of questions asked. When asked about that most respondent's reaction was that they expected same questions as in previous visits and so it would be easy to answer. In some cases when the interviewers were at the household respondents would start giving answers even before an interview session started officially. Likewise upon arrival in some cases

the interviewers skipped formal introduction and went straight to questions immediately after exchanging greetings. For instance "So tell me what is new here" and respondents would start to name the events relevant for DSS. This approach was more common in visits which involved use of paper than in PDAs. Such familiarity was thought by interviewers and interviewers to shorten time for the interview.

There was unspoken understanding between interviewers and household members that 'you know the questions/what we are looking for' (by interviewers) or 'we know the answers you need' (community members). This was supported by household respondents as well as with interviewers:

Many questions are the same for several years and sometimes when they see you and before you ask anything, they start telling you about all events happened at their household (DSS enumerator)

We know all these questions, we know them, they come here every now and then so nothing new today, may be the PDA (HH respondent)

In some cases respondents provided very brief responses and sometimes interviewers would not record all the information on the spot. They would record only some and moved to the next home hoping to fill the rest at end of the day as they thought they would simply recall. This practice was common in paper interviews and not for PDAs. This was also confirmed in interviews with interviewers

Sometimes you have to take few notes at the field but you need to complete later at home, especially for households with many events (DSS enumerator)

## **The Technology**

The interviewers felt a different experience using PDAs whereby everything must be recorded on the spot. Use or non use of PDA did not seem to attract differently attention of respondents. From the observations, apart from pre-teen kids who used to wonder around the interviewers paying attention to the PDA the adult respondents would pay attention at the very beginning of the session (when they were

introduced to the PDA by the interviewers) but would very soon shift their attention to the interview. The following observation was made during household visit where a PDA was used to collect DSS information.

At the beginning of the interview the respondent stood very close to the DSS enumerator paying a lot of attention at the PDA and listening and answering questions but after some few questions she started doing other activities (as she was answering the questions) such as talking to her daughter, collecting some clothes at the drying place. She also went inside more than three times during the course of interview (Source observation Notes).

Out of the 29 visits in which PDAs were used and the qualitative assessment done, only in two cases the respondent refused initially to be interviewed. However these cases seem to be associated with other experiences in the previous visits rather than use of PDA on that particular day.

In most cases respondents of PDA interviews had positive attitude towards the instrument. Most of them felt that the interview sessions were shorter and the questions were straight forward than in the previous visits on paper system. What delighted most of them was the fact that the names of HH members were already in the PDA and the interviewers did not have to write their names afresh. Interviewers also saw PDA as an inviting factor for HH members to participate.

“Household members are excited with PDA,-because they usually asked some questions after seeing us with papers, they tend to say you are here again with your papers to ask your questions, now they are not saying so”(DSS enumerator)

This was also confirmed from observation as noted down in observation notes.

A respondent who showed reluctance to provide information took interest when she was shown the PDA which will store the information, he asked some questions and later agreed and participated fully (source observation notes)

## **Technical Viability**

On the other hand though the functionality of the PDA was halted and the session had to stop. In some cases it even took them 10 kilometers away to the data center for troubleshooting while keeping the respondent waiting or aborts the interview for another day. This was reported to be disturbing to interviewers as well as respondents. Furthermore, in cases where the basic data (names or codes) for a particular HH or member were missing on PDA the interviewers could not record any subsequent data and had to record on it separately paper. This was thought to be time consuming. In such cases interviewers felt more secure with paper and pencil method due to its flexibility Two out of six interviewers felt more comfortable with papers than PDAs since they are used to them.

## **Information about PDA**

Some respondents were not sure about the use or importance of PDAs claiming that they were just told it was an instrument for recording information from them. In one case a woman said that she did not know why a PDA was used though it seemed good. She thought a PDA was a voice recorder and questioned the DSS process saying "you educated people; you are now coming to take our words and voices as well".

From observations and interviews it was as well learnt that interviewers, in some cases did not mention anything about the PDA at the introduction. However household members would ask questions after the interviews. In this case respondents expressed concern. Out of the 29 interviews conducted using a PDA and for which the qualitative assessment were done only 3 asked specific questions about the equipment; one was on how it functions, another one on what would the interviewers do with the data on PDA and a third one was whether the PDA was recording voice as well.

## 8 Fulfillment of objectives

We briefly describe the process and present best estimate of achievement in a quantitative way.

### General Objective

To ensure better resource allocation decisions for health purposes in Least Developed Countries (LDC) such as Tanzania by improving the information and data gathering and analysis through the use of Personal Digital Assistants (PDAs) or hand held computers.

Rational decision making in health depends on sound and reliable data. This project has generated new knowledge with regard to use of cost effective innovations to improve availability of sound health related data for decision making in resource limited settings. We have proposed a plan to evaluate use of Personal Digital Assistants in Household Surveys in Demographic Surveillance Systems (25%), we have developed, tested and implemented the innovation. However additional work is required to fine tune functions/features of PDAs in collection of DSS data. This requires additional time and resources before the innovation can be widely used (15%). We completed evaluation of DSS on PDAs compared to paper method (25%). We have generated first draft of the publication. The next period will see submission to peer review journals, further dissemination of the experience through attendance to workshops (nationally and internationally), contributing chapters to Books and Monographs and such others (10%)-Overall 75%

### 8.1 Specific Objectives

- To establish the feasibility of employing paperless data collection methods in large scale Demographic surveillance System (DSS) in rural Tanzania, compare with the high costs involved in a paper/pen type DSS which involves printing, binding, distribution through transportation, storage as well as transcription and quality control of data through:

- Action research;

Plan of activities for the project has been completed to a satisfactory level (75%) - see above

- Training

1. Four resident data managers were involved in the development of the system, testing and implementation
2. Two resident data managers participated in two workshops related to PDA data tools ( one in South AFRICA for the OpenMRS group in Cape Town in 2007 and one in Ougadougou for the INDEPTH AGM meeting in Nov 2006
3. Have not been able to create Data manager/s to concentrate on this area because they were all working part time to the project.**Overall 70%**

- Software development

1. Software for Data Capture on PDA, and data Exchange between PDA and PC were developed, tested and implemented.
2. Further work is required to improve features to meet full range of expectations - **overall 80%**

- Cost benefit analysis and

Cost benefit analysis were conducted and results are presented in the "results" section above  
(**overall 100%**)

- Dissemination of results and "closing the loop" for possible policy development by researchers as well as the Ministry of health, and amongst global network partners

1. Publication has been drafted and will soon be sent for peer review.Consultation are going on to select an appropriate journal



2. Have been invited to submit chapter in two forthcoming publications: one in the field of human resources for health, health informatics [<http://www.igi-global.com/requests/details.asp?ID=504>] and health systems, and the other on technology in healthcare [ <http://www.igi-global.com/requests/details.asp?ID=503> respectively.]

This work is considered to contribute to the proposed chapters

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The team expects to present this work in at least 2 international conferences as well as 2 within the country for the year 2009. The INDEPTH Network is looking forward to findings of this study **Overall 40%**

### 8.2 Additional Objective

The human factors were later on considered an important aspect for a project of this type. An additional study of acceptance by respondents and interviewers was proposed, designed and evaluated. Findings of the acceptance study form part of this report

## 9 Project design and Implementation.

### 9.1 Activities supported

There were three phases of the project: The development phase, testing and evaluation phase. The period under this report (June 1 2007 to 31st May 2008) were mainly for the evaluation activities. The cost benefit assessment included comparison between Paper and PDA on costs, data quality (completeness, accuracy and timeliness), technical viability, and acceptance by survey respondents and interviewers

### 9.2 Research methods and analytical techniques

Data for the study came from the Rufiji Demographic Surveillance System (RDSS). RDSS, which was established in 1998, is one of the longitudinal household based data platforms for the ministry of health in Tanzania .The Rufiji Demographic Surveillance Area (DSA) is in Rufiji District (area of about 14 500 km<sup>2</sup>), about 178 km south of Dar es Salaam, the capital To btain data for comparison, interviewers working on paper forms were paired with “shadow interviewers” using PDAs to collect same data. The two methods were compared in terms of relative costs, data quality (completeness, accuracy and timeliness), technical viability, and acceptance by survey respondents and field interviewers. From December 2007 to April 2008interviews on a random sample of households were conducted on PDAs simultaneously with the normal paper based data collection from all households. Interviews were done on different days for households which were visited for paper as well as PDA systems.

### 9.3 The disciplinary orientation of the project

The study entailed evaluation on data quality (completeness, accuracy and timeliness), technical viability, cost, and acceptance. It required a team of data managers, IT people, social scientists and economists to advice on the cost comparison.

## 9.4 Involvement of research users

The INDEPTH network (<http://www.indepth-network.net/>) and Ministry of Health and Social welfare in Tanzania through the National Sentinel Surveillance System unit is the main potential beneficiaries who have been following up the development of this project. They will be invited for review of the results so that they become part and parcel of the plans for the way forward.

## 10 Project outputs and dissemination

### 10.1 Self-assessment of project outputs

Project findings have gone under review through biannual internal assessment mechanism. This final report will be included in the annual progress report to the Board of Trustees which is the main body to oversee functions of the institution. The project falls under specific objective number 1.0 which is "To develop and evaluate health system interventions to improve the coverage, quality, equity and efficiency and effectiveness" and partly under specific objective number 5.0 which is "To promote evidence-based policy formulation and translate research results into public health action". The project is also listed on the website in the list of projects undertaken by IHI (<http://ihi.or.tz>). The project will be judged under these categories.

### 10.2 Outputs planned

Publication to peer review journal. Draft available but yet to be submitted awaiting choice of journal to submit to.

Have been invited (The University of Western Ontario-Contact [skabene5@uwo.ca](mailto:skabene5@uwo.ca)) to submit chapter in two forthcoming publications (in a form of Monographs): one in the field of human resources for health, health informatics and health systems, and the other on technology in healthcare. <http://www.igi-global.com/requests/details.asp?ID=504> and <http://www.igi-global.com/requests/details.asp?ID=503>

respectively. The deadline for submitting abstract is 30th November 2008 and if accepted the chapter will be completed by 15th January 2009.

### 10.3 Information sharing and dissemination

Biannual reports with IHI, annual reports to Board of trustee, publication to peer review journal (draft available), four data managers have attended one conference each. Three in Cape Town for the OpenMRS workshop in April 2007 and one in Burkina Faso for the INDEPTH AGM in September 2007. The project appears on website in the list of projects undertaken by IHI (<http://ihi.or.tz>)

## 11 Capacity-building

### 11.1 New equipment

IHI has embarked on use of PDAs for data collection in several other settings including in cross-sectional surveys and such others. The Health informatics unit has established a special section for Data Entry at Point of Collection (DEAPOC). This unit supports projects in data collection using PDAs and is also involved in evaluation of DEAPOC in various settings. The new equipments, PDAs have added to the stock of equipments needed by the unit.

### 11.2 Training

Four Data managers have been involved in the project. They were introduced for the first time to mobile technology. This is of value addition to the informatics team

### 11.3 Improved administrative skills

Two data managers (out of the four) were involved in the day to day planning and supervision of the activities. It provided an opportunity for them to learn more on management and administrative skills

#### 11.4 Lessons learned etc

The project that evaluates an integration of public health and informatics is not a very straightforward one. While you deal with ideas for the public health problem at hand you are as well confronted with IT related challenges and dilemmas. The team were once subjected to a situation related to incompatibility of hardware and software for the PDAs which took sometime to resolve. In the future one should provide proper attention of such an interaction right at the plan of IT related public health studies

### 12 Project management

#### 12.1 Administration by the research organization

IHI provide conducive environment especially the multidisciplinary team of researchers which is available for exchange of ideas

#### 12.2 Scientific management of the project

The arrangement at IHI provides good environment to manage the project. The PI reports regularly to the management committee and biannual reports. Such an arrangement empowers the research team to fulfill the objectives

#### 12.3 Technical and other support and administration by IDRC

Exchange of information between IDRC and the research team was effective and considers the reality on the ground. It provided sufficient guidance and motivation to the research team to fulfill the objectives. The ongoing efforts by IDRC administration to expose the research team to the outside world has been useful and likely to open so many other research avenues. One example is the initial involvement of the research team to the OpenMRS group, the D-tree research group, and such others.

## 13 Impact

### 13.1 Reach

The INDEPTH network is the main potential beneficiary of findings of this study. More than 30 DSS sites are likely to extend the evaluate and take into account many other aspects of the innovation

### 13.2 Impact

The level of quality improvement reported here (completeness, accuracy and timeliness of data) is promising opportunity in terms of demonstrating impact on major goals and targets such as the Millennium Development Goals (MDGs) poverty- reduction and health programmes. On the other hand reduction of cost is likely to allow for more coverage of the surveys and therefore much more representativeness of the data. Decision makers should be aware of such trade-offs with respect to quality of data when making investment choices for monitoring and evaluation

## 14 Overall assessment

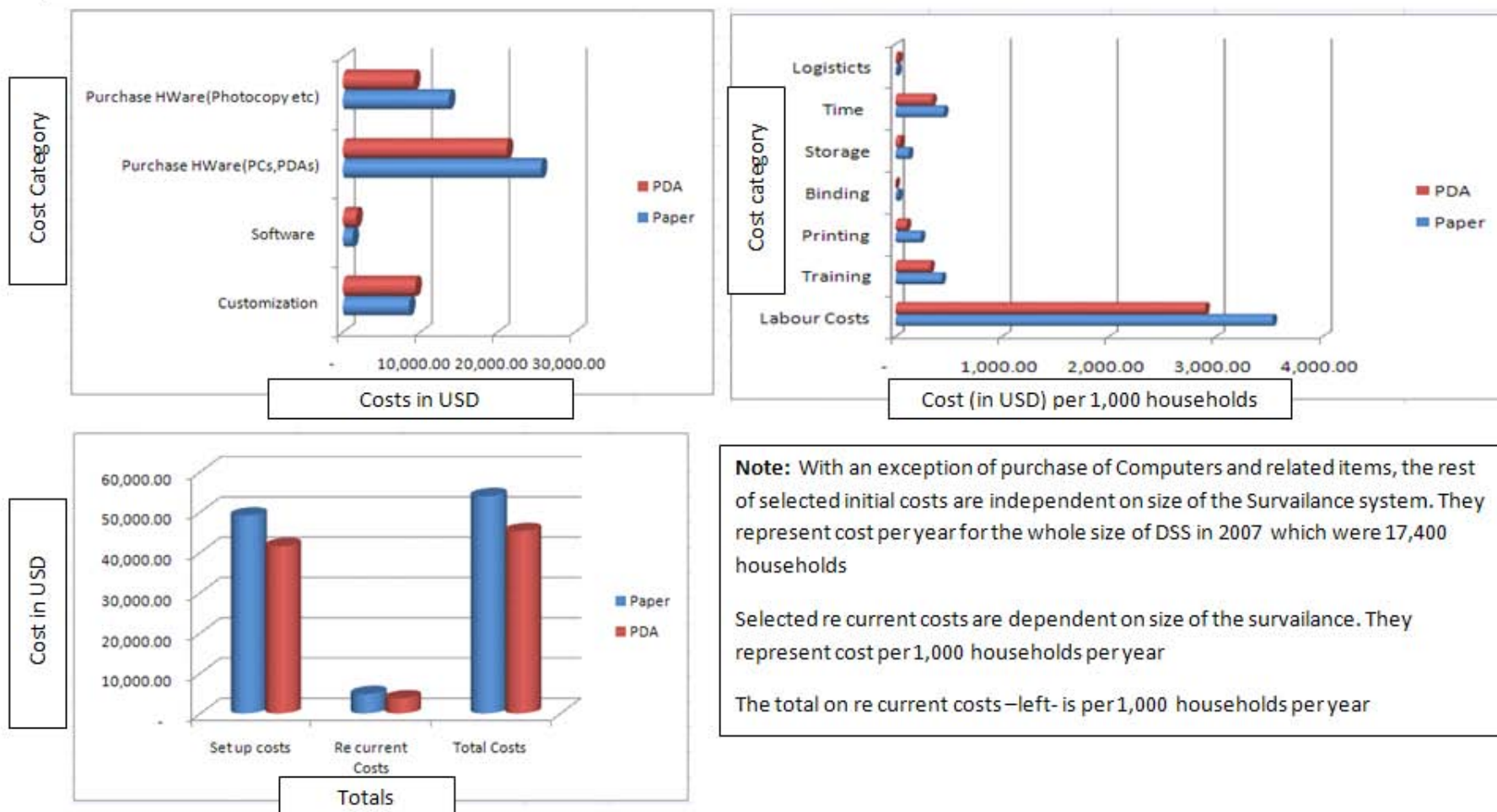
Results of this study have shown feasibility to use PDA to collect data in health surveys in the form of DSS. The findings demonstrate cost saving, reduced interview time and improved quality of DSS data collected on PDAs compared to paper. At this time when the Ministry of Health and Social Welfare focuses on strategies for the reforms and meeting the MDGs and poverty reduction targets these findings are likely to provide appropriate guide to policy makers and programme managers when they are considering investment plans for Monitoring and Evaluation.

## Recommendations

Commitment to effectively utilize information as an intervention to revitalize the health system is at the moment at top of the agenda worldwide. Findings of this study should be widely disseminated in order to stimulate further research on areas requiring more efforts.

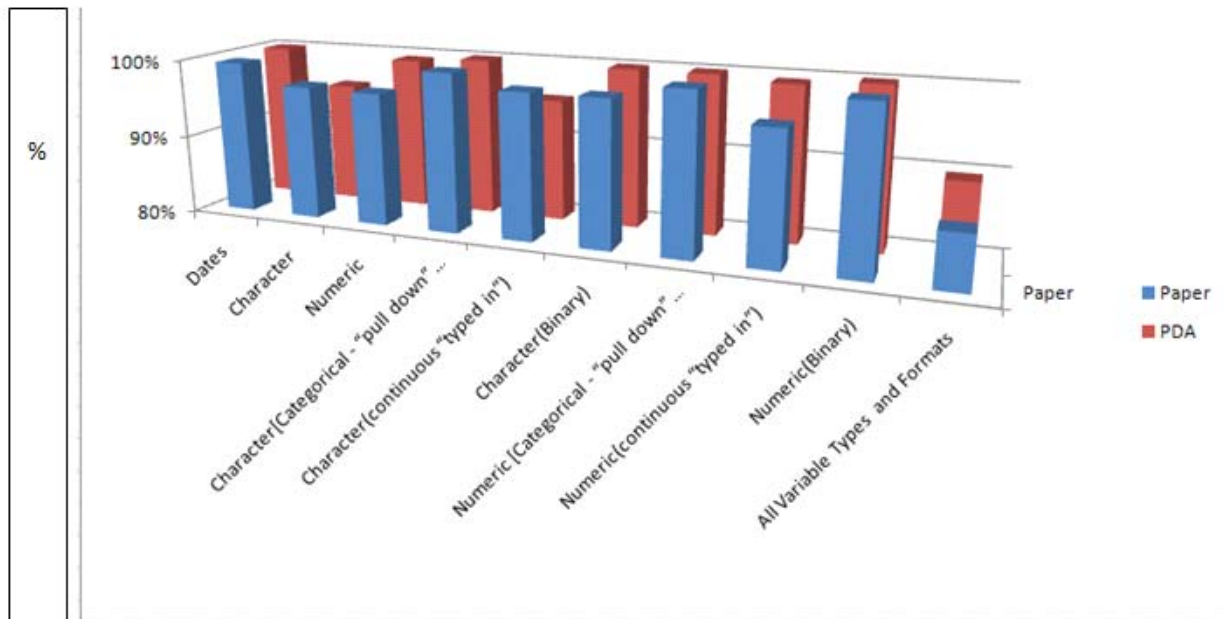
## 15 **Figures**

**Figure 1.0: Average Costs for Paper and PDA systems: Top Left: Initial costs; Top Right: Re current costs Bottom Left: Total Costs**

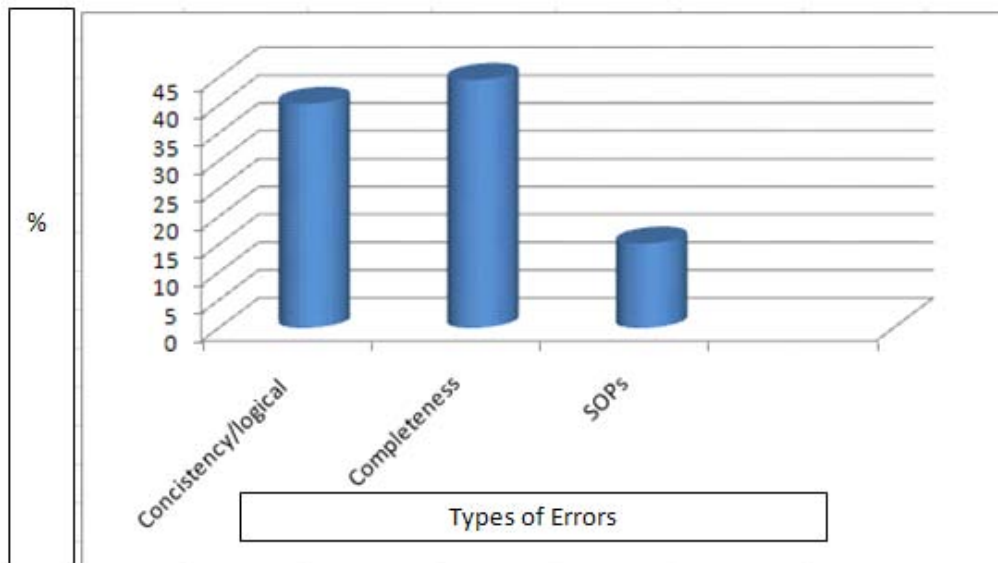




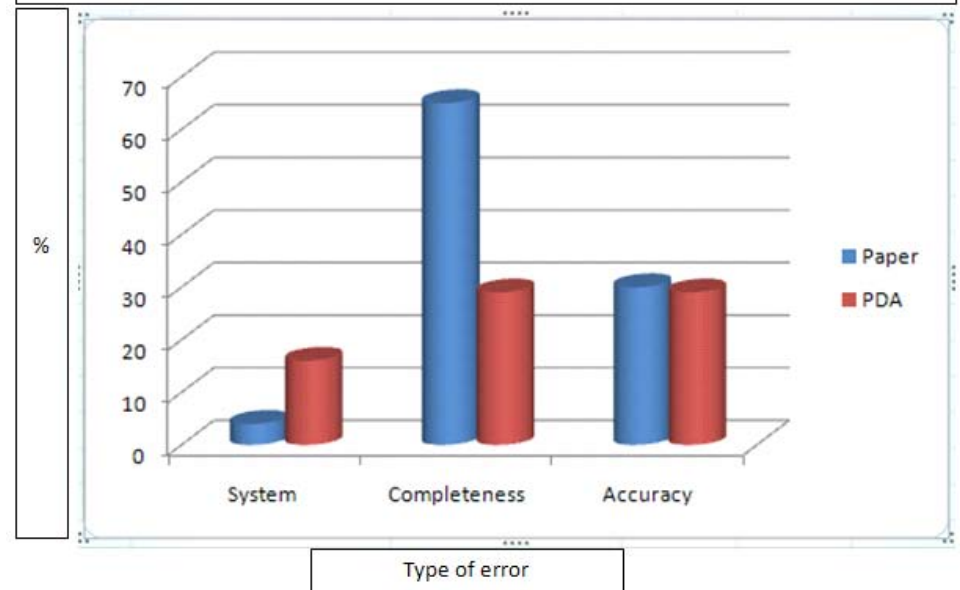
**Figure 2.0:** Showing levels of complete data by type of variable and format of data for Paper and PDA data collection method for the DSS



**Figure 3.0:** Types of errors captured by Filed Supervisors before the forms reached the data center



**Figure 4.0:** Number of errors (per 1,000 households) by type from Validation report for Paper and PDA System



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Ref Type: Serial (Book, Monograph)
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