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Session 3– Invited paper

THE USE OF HAND HELD DEVICE IN THE MUSCAT GOVERNORATE

Submitted by the Ministry of National Economy, Sultanate of Oman[*]

The following facts should be considered prior to discussing the paper:

First: Assessment for the present time focuses on selected areas of the experiment that do not require further investigation and those maintain adequate data. But, a more comprehensive assessment shall be carried out in the near future when relevant information particularly the census final results are made available.

Second: Some interpretation of the weak and/or default areas is based on personal unsupported assumptions though, however, remain acceptable until other indicators proved otherwise.

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Subject Axis:
No matter the methodologies and techniques used in the census, the census operation fundamentals remain constant. Therefore, this paper will primarily focus on the aspects that have direct relation with the HHD. These aspects can be categorized in three axis:

1st **Axis:** The HHD operators' selection, training and assessment of their average
          performance.
2nd **Axis:** The hardware.
3rd **Axis:** Software adopted for HHD operation.

Regardless of the details and views included in each axis, which also represent an evaluation of that particular axis, yet they also represent a guideline to the overall subject.

1st Axis: The Operators

a.   Selection of Enumerators
  Evidences available so far, suggest that the use of HHD in enumeration require special operators with specific characteristics on top of which is the ability to deal with this electronic equipment. To select such a caliber, it will be imperative to subject the candidates to well-tailored examinations.

To the best of our knowledge, the HHD suppliers do not have clear tests or examinations to apply on candidates. This implies that designing of such examinations should be one of the activities to consider in the future.

b.   Training
Tailoring a training programme for enumerators on the use of the HHD in data collection requires exceptional attention. Inadequate training, or even lack of training, of an enumerator literate with the use a paper questionnaire, does not invalidate the enumerator's abilities in data collection, but weakens the quality and quantity of his/her performance. Whereby, on the other hand, it is rather skeptical that an inadequately trained HHD enumerator could do the job even with the minimum competence.

The general training principles and ethics, however, remain constant in both cases, except for nominal procedural variations, summarized as follows:

1. **Training Mechanism**
   The training mechanism applied for traditional counting can be applied as well in HHD training programme. The mechanism signifies that selected technicians nominated by the Census Administration shall conduct training of upper level staff who are normally limited in number. Those upper level staff will then take the responsibility of conducting training and follow up of the enumerators.

2. **Training Duration**
   It was perceived that training on operation of the HHD requires more time than the period needed for traditional enumeration process. Trainees on HHD were sent for a 6-hours demonstration course on the use and application of HHD at one of the local training institutes. They were made acquainted with the HHD, its operation, usage, components and operation buttons. Further to that, they were given additional evening hours to inculcate the operation concept and answer any pending queries.

3. Training Curriculum (subjects)

Apart from the theoretical and practical training on data entry in HHD or paper questionnaire, the training subjects contained several shared topic s for both phenomena. The major notable issue in the training programme is that it did not deal with or point out troubleshooting or how to resolve minor problems and failures without reverting to the technical support authority.

The enumerator's training, in principle, focused on the use of the device particularly how to deal with it in the first place. Consequently, the training programme should contain the following topics:
- Recognition of the device and its characteristics.
- The operation mechanism of device components.
- How to deal with the device.
- How to shift from one monitor to another.
- Components of each monitor.
- Advise notes and messages, and how to deal with them.

4. Training Procurements

Practical training on how to obtain data, is an essential requisite to qualify the enumerators. Whereas few paper questionnaires are required for each trainee in the case of traditional training, the requirement for HHD training implies provision of an equal number of devices to the number of trainees, completely programmed and ready for use. This definitely requires extra efforts and careful arrangements. Moreover, the devices used in training shall need revision and reprogramming prior using them in physical enumeration. We did that.

c. Enumerators' Performance Rates

No test was made during the enumeration period to determine the time taken to enter the data of one household in the HHD other than the preliminary test done during the pre-census test. Evidence however, has proved that the optimum time needed to enter the data of one household does not exceed the time taken to complete an equivalent paper questionnaire, if not less than that as noticed in some cases. This is attributed to the fact that the mental effort needed while using the HHD might be less than for the paper questionnaire. Because the enumerator dose not need to think or consider whether a definite information in needed or not, as the question appears automatically on the monitor as soon as the enumerator finishes with the previous one properly. Moreover, the enumerator dose not need to insert the symbol (-) to denote (inapplicable) as is needed in the paper questionnaire.

2nd Axis: The Hardware

The power and specifications of the HHD used in Muscat enumeration phase were competent enough to meet the technical requirements. Despite this fact, inefficiencies appeared now and then; some were due to defects in the device itself or one of its accessories and some were due to faulty application. Following are brief detail of some defects:

a.   Battery down: Some devices encountered dead batteries shortly after starting the field work a matter which resulted in negative implication on the overall performance. The enumerator was left with no alternative other than returning to the base to recharge the device.

The reason for the battery failure was attributed to many factors:
1. Repetitive lighting of the monitor for long periods and/or use of the device for long periods.
2. Unnoticed insufficient charging of the battery before commencing work might be due improper current connections or sometimes incorrect insertion of the device in the charging unit. Such attitude is disfavour of the coordinator in charge of batteries charging or the controller who was supposed to check the batteries at receipt of the devices.
3. Other defaults related to the battery itself.

b.   Some monitors do no respond when pressing the indicator button even repeatedly. Some attribute that to excessive sun heat on the monitor, an unsubstantiated presumption which dose not match the results obtained during the first pre-census tests which proved that the sun rays have no effect on the device.

c.   It was noticed that the device slowed down by time due to build-in back-up. Some attribute this to the increasing stored data. This also dose not match the results of the first pre-census tests. Another group ascribes its factors related to the device memory itself.

d.   A limited number of the HHD stopped during work sessions, replaced by the standby equipment until repairing the original one. The Census Administration was neither notified of the reason or type of failure, nor the number of faulty devices to allow for counting the percentage of default.

e.   Failure during work sessions, the type that needed resetting. In this case the device will not be ready to operate unless the enumerator enters the operation language. It was not yet detected whether this phenomenon was a characteristic phenomenon of the device or can be resolved through reprogramming. The supplier experts declared that re-operation process of the device impairs its performance ability especially that some unnecessarily do this.

Based on above, we caution the those who are intending to use HHD in their census programmes, to observe the following:

1. Spotlight the devices needed to be used in census programmes to close scrutiny by   the using entity to ensure efficiency.
2. Ensure on daily bases that the charging accessory connections are in proper place and that the battery charging is done properly prior to handing the device over to the enumerator. This process is clearly requested from the coordinators and controllers but some did not abide by the directions set.

Enumerators should clearly be instructed not to recourse to applications that expedite battery consumption, such as lighting the monitor, except in necessary cases.

It would be worthy if the Census Administration would proceed with covering all sides of investigations and assessment in order to reach justification of the discrepancies occurred towards the end of the experiment, particularly the irresponsive the monitor to indicator buttons and the general slow down in reaction.

It would also be worthy to find out the device fault/stoppage rate so as to determine the number of standby equipment needed.

3rd Axis: The Software

At the time the Census Administration decided to use the HHD in the counting the population and housing in Muscat Governorate, neither the Census Administration, nor the supplier had the least knowledge on the application of the HHD in general or background history about it. Therefore, designing and upgrading of the programme was done by co-efforts of both the Census IT personnel and supplier technicians. The supplier donated the basics for building the system such as segmenting the questionnaire form into slides and delineated their sizes and components. The system was then subjected to several amendments and alterations suggested by the concerned users or noticed during the pre-census tests. The system consisted – at the start – a number of application orders and systems meant to lead to maximum accuracy. Of these are:

a.   The operator cannot shift from an incomplete answer to another question unless the former has correctly been fulfilled. This order was meant to forcibly direct the operator not to skip any incomplete information and avoid entering words such as (not stated) in this statistical survey.

b.   No question about a specific individual should appear on the screen if the data related to that question was not needed, e.g. the question about the marital status should not appear if the individual concerned was less than 15 years of age.
This logic will minimize the mental effort of the enumerator and consequently increase his/her performance.

c.   No access for incoherent data. The device signals in case of discrepancy or irrelevant/erroneous answers. The device directs the operator to correct the fault immediately before leaving the respondent's site. Hence proper application of this method will annul office auditing performed on using paper questionnaire.

d.   Nonetheless, this bright face of using HHD has a less bright posterior. Things did not go absolutely as planned. In the following lines we will list some of the most significant alterations we felt necessary to introduce later into the system and software. Some of them were completed prior to actual enumeration phase whereas limited changes were done during the enumeration activities. There are however, some weak points discovered at the work stage that would not allow for disruption. Such weaknesses were:

   i. The second pre-census test has proved that the system that eter the operator shift from an incomplete answer to another question before fulfilling the former question correctly, was sorted a disadvantageous application more than a phenomenon helping in improving the standard of universality and accuracy. The enumerator sometimes faces situations where the household members were unable to respond to certain questions, which needed revisiting the household to meet the concerned person (or householder) who might be unavailable during the first visit. This procedure was skipped for specific questions and replaced by a process in a way that highlighted the escaped questions at the moment of downloading of the data from the HHD into the server. Thereafter, the controller will receive a report of the failed questions so as to deliver them to the enumerator who shall later revisit the concerned household to complete the missing data.
It is worthy to mention that the pending data met on application of this procedure mainly pertains to age, nationality and type of activity. These are significant to other data.

ii.   With regard to not accessing incoherent data, the pre-census authority noticed that some enumerators bypassed this by adding fornicated information to enhance furtherance of the device. Though this attitude happened from a negligible number of enumerators, but it was decided to suspend certain system fields provided that the deleted questions shall appear when downloading the device into the server. This precautionary action created a negative impact when some delinquent enumerators showed less enthusiasm to being more accurate and strict about data collection. This clearly appeared on the reports contents, which comprised several incoherent data causing a tremendous load on the enumerators who sometimes left them aside.

iii.   Some cases peeped up during the enumeration phase, which required introduction of necessary systems. For instance, the device did not accept data pertaining to a householder if he/she was less than 18 years of age. This decision was made by supplier without consulting the concerned statisticians. They just interpreted the wording in the questionnaire saying that the householder should be adult and mature.
       Such a case was dealt with by introducing necessary changes in the particular enumerator's device programme, because changing the programme of all the devices during the enumeration process would be a hectic process, which implies collection of the devices – one thousand units – to amend. This will need time longer than the time assigned for the enumeration phase as a whole.

iv.   Of the problems that appeared during the actual enumeration period, were the unsatisfactory data obtained during downloading related to profession and activity classification. This implied that a revisit was a must to complete the data. It was also noticed that the data pertaining to the housing units and the residents did not stay in the memory of the server for more than one day, no matter they were complete or incomplete. On this, the Census Administration decided to retransfer the data from the server to the HHD and keep it stored there until the end of the enumeration phase. Accordingly, the device programme was modified to store the collected data throughout the enumeration phase.

v.   The device sometimes denies access to the user and did not respond to the user name and pass word. This instituted a retarding problem to the enumerators during the enumeration period. In other cases the device refused to accept neither the reference number nor the enumeration area. This required device reprogramming.

vi.   The supplying company attributed the entanglement to incorrect downloading of data to the computer, or device replacement even if the transfer was correctly done.

vii.   During the office data auditing (still ongoing), some cases require investigating the findings, which in most cases are attributed to software defaults. Of these cases:

       1. Appearance of individual data at specific age or specific profession not asked in principle, i.e. an idle individual for instance (in other words not part of the manpower). Profession and/or economic activity data do not apply on such individual and should never appear on the screen if the individual is classified "self-contented".

       2. Questions regarding television broadcasting should only appear when investigating an Omani national household. However, such questions appeared on the part pertaining to expatriate household. This demanded correcting the situation i.e. lost time in attending unnecessary work.

       3. By virtue there should be a minimum age -limit for Ph.D. holders not less than 27 years. Some cases showed other than this.

       4. The list of answers for a certain question appeared on the screen until the operator selected the required answer. If the operator selected a wrong answer and wanted to correct that, he/she needed to repeat the whole process. And if the operator erroneously pressed on any other part of the screen, the list was gone. Another wasted time.

Test Evaluation – The Result

The assumptions formed when reviewing the technology of HHD and its characteristics at the first time, denoted that the success of application of these devices depended on:
-        Successful selection and training of enumerators.
-        Introducing appropriately studied programmes into the HHD, complying with the questionnaire contents.
-        Designing accurate systems of completeness, validity and consistency.
-        Applying strict quality control roles.

The HHD technology outdo the traditional paper questionnaire forms in the following spheres:

a. Entering data in the HHD requires lesser mental and physical efforts than the paper questionnaire, consequently improves the output.

b. Entering erroneous data is more susceptible on using the HHD than the paper method especially for non-skilled enumerators. But, on the other hand the quality of the data obtained through HHD is more reliable than its counterpart, for the following reasons:

   1.   The HHD does not accept inconsistent data.
   2.   The HHD warns the operator when entering inconsistent data and allows him/her
            to correct the household data before leaving the housing unit.
   3.   The HHD does not accept codes beyond the scheduled limits.
   4.   The HHD does not accept data unnecessary to certain individuals.
   5.   Downloading data from the HHD directly to the server diminishes the regular faults
            committed during the traditional way.
c. On using the HHD, no need for office auditing, coding or data entry after collection. Thus
    Census Administration was able to get the detailed results in a short period unprecedented
    in other censuses.

The attractive brightness of the technology felt at the beginning started to fade out as the hopes to get faultless data, free of discrepancies and requires no further office auditing, fully coded and entered, are found unattainable.

Now the question is: Was the reason for this incoherence due to the technology nature, or was it attributed to the application of the methodologies followed? In other words: could it be a successful application if we repeat the experiment and made use of all the results we have encountered during this experiment? This question remains hard to answer at the present time. Reaching a subjective assessment of the various fields of using the HHD in enumeration is still premature and needs more time. The final evaluation will be made after completion of the now going processes and finalizing the assessment of these results statistically and demographically.

However, it is deemed necessary to document the observations obtained so far about this issue, which can be summarized in:

First Observation:
One of the significant factors that encumbered abrupt census results was surpassing some software systems, a matter which allowed for not responding to specific questions and accepted incoherent data.

The suspension of these systems – as we said before – were linked to protective arrangements found appropriate when decided. The arrangements appear in form of computer reports prepared during data downloading from the HHD to the server so the enumerator can revisit the concerned location to fulfill the incomplete data. But, regrettably, due to incompetence shown from some team controllers and assistant supervisors, the process was not seen to it appropriately.

Second Observation:
The remaining software programmes had, nonetheless, negative aspects such as not displaying irrelevant questions. Though these programmes save the enumerator mental effort and time, they may occasionally lead to faulty data, e.g. if an enumerator erroneously entered somebody's age (4) instead of (14), then all the relevant data pertaining to the age (14) years will not appear on the monitor and consequently the enumerator will not ask them. On the other hand the vise versa is also true.

Third Observation:
All previous drawbacks and discrepancies can easily be evaded, should the HHD technology is used in future in the Sultanate or any other place, after being effectively tested in the 2003-census of the Oman. Most of the difficulties and defaults could have been avoided from the beginning should a previous try had been experienced, or if the census management had extra time for more pre-census trials.

Fourth Observation:
However, some issues remain real problems hindering the use of HHD in census data collection unless resolved. The first is how to deal with prolonged classification such as professional and economic classification. Technicians in the Sultanate of Oman did the best to resolve such problems by using a shortened list of known professions and economic codes. This facilitated the enumerator to select the suitable code if it was included in the list, or otherwise, should define the profession (or the economic activity) where it would be coded later in the office.

At this stage it is not logical to say that the solutions used in the Sultanate were the best attempts for these problems. But this will institute a good point to build up regional and international efforts to reach suitable alternatives.

Fifth Observation:
Skeptical points were raised on whether using HHD would minimize human mistakes in data entry. The presumption first, was that using this technology would nullify usual erroneous data entry encountered in traditional paper questionnaire. But on application of the HHD, it was verified that the mistakes taken by the enumerator in case of paper questionnaire remain the same when entered data in the HHD, but with slight difference in the method of committing the mistake. Some mistakes would have not happened if the enumerator used the paper work – say entering the sex type (male/female) will not be attributed to the respondent or mal-training of the enumerator nor the speed of application. It was only due to data entry mechanism. If such a performance was a resultant of carelessness, then those who consider using the HHD in censuses or the HHD manufacturers as well should take serious efforts to avoid the pre-said problems prior to taking any further decision.

Six Observation:
It is immature at this stage to conduct a feasibility study on the use of HHD in censuses nor carrying out a comparative study on the cost effect between the HHD application and traditional paper questionnaire method. The application of HHD in Muscat Governorate was made under the

overall umbrella of the Sultanate of Oman's census programme. Hence the expenses of Muscat Enumeration pertinent to the cost of HHD, the programme designing, manpower and other expenses, were endorsed in the registers as part of the overall expenses of the census. So it was not easy to determine the amounts of Muscat expenses from in-between the monies expensed in administrative sides or in pre-census tests, awareness and information campaign, construction, cartography and other fields. This is not only the case for HHD, but the same applies if we wanted to know Muscat budget even if the case deals with using the traditional paper questionnaire. The reason simply because the census programme was designed to the whole Sultanate not per region or governorate. There was no idea of introducing new technology or averting the methodology in the interim.

However, a limited comparative cost study can still be conducted from another angle, by comparing the devices cost plus the cost of programming and training expenses against the cost of auditing, coding and data entry works. No matter the result of the comparison price-wise, there are factors that have to be taken into consideration: the data quality and time saved; before getting the detailed results. That is an advantageous aspect only provided by HHD.

In conclusion, it is worthy to remind that the prices paid in purchasing the HHD should not be entered as consumed monies, because the devices shall remain useable after completion of the census project. An example of this, some HHD used in Muscat Census are used by Muscat Municipality for study purposes and others shall be used in the Agriculture Census in the very near future. The Directorate of Social Statistics, Ministry of National Economy is also planning to use the HHD in Household Surveys to be conduct shortly.

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