THE ROYAL STATISTICAL SOCIETY

2003 EXAMINATIONS − SOLUTIONS

ORDINARY CERTIFICATE

PAPER I

The Society provides these solutions to assist candidates preparing for the examinations in future years and for the information of any other persons using the examinations.

The solutions should NOT be seen as "model answers". Rather, they have been written out in considerable detail and are intended as learning aids.

Users of the solutions should always be aware that in many cases there are valid alternative methods. Also, in the many cases where discussion is called for, there may be other valid points that could be made.

While every care has been taken with the preparation of these solutions, the Society will not be responsible for any errors or omissions.

The Society will not enter into any correspondence in respect of these solutions.

Methods vary between countries. The UK conducts regular 10-yearly censuses, the most recent being in 2001. Questionnaires are used, one for each household (<u>not</u> one for each building); these are delivered by enumerators and (in 2001) returned by post in pre-paid envelopes. (In previous censuses, they were collected personally by the enumerators.) Those not returned by post in 2001 were followed up by the enumerators.

Forms contained sections for household entries and separate (but identical) sections for individual members. Because the form was to be filled in by the householder (or another member, but not by an enumerator), questions needed to be as few as possible and as clear as possible, and should have been tested in a pre-census pilot survey. The UK 2001 census had five sections:-

(1)   Residents – the name of each person usually living there.

(2)   Visitors – name, together with the usual address.

(3)   Household – type of accommodation, whether self-contained (e.g. no sharing of kitchen, etc), number of rooms, ownership, central heating, vehicle ownership.

(4)   Relationships between individual members (husband, wife, partner, parent, child).

(5)   Individuals – sex, date of birth, marital status, various ethnic questions such as country of birth, migration, previous address, ethnic group classification, religion, qualifications, various questions on health, provision of care etc, employment, working hours and method of travel.

Some different questions were added in Wales (e.g. language), Scotland and Northern Ireland. There were 5 household questions and just over 20 individual ones in 2001.

Data remain confidential and individuals cannot be identified. However, data for relatively small areas, towns, villages, minority groups, can be obtained. Hence, nationally data will be useful to government for

(1)   planning of requirements of health care, hospitals, schools and colleges; demographic variation and pension provision, welfare,

(2)   in the UK, devolving funds to regions or areas.

Also, (3) businesses and commercial interests, and social research organisations and departments, use these data.

Changes should be minimal between censuses so that comparisons can be made; also, comparisons between countries are very useful. (Note that some developing countries are still developing census methods, and that some developed countries (e.g. Netherlands) use sample surveys combined with administrative registers rather than complete censuses.)

(i)   A target population is that population for which information is required. Results from a survey apply only to the study population which was sampled, e.g. those who respond to the first request for information, or those geographically easy to locate. If there are any real differences between target and study populations, results may <u>not</u> apply to the target.

(ii)   <u>Either</u> the target will be those who already use the canteen, regularly or occasionally, <u>or</u> it will cover all actual and potential users. If the main aim of the survey is to improve satisfaction among existing users, the first is appropriate, but if it is also desired to improve user numbers the second target is appropriate. In that way, information can be obtained on reasons for non-use, such as not supplying the type of food required at lunch time (which would be the main time of interest to the manager), or speed of service, supply of vegetarian means, etc.

(i)   Bias, in general, is a <u>systematic</u> tendency to overestimate, or to underestimate, a parameter of the target population (e.g. a total, mean or proportion). That is, repeated use of the same sampling method would not produce an estimate of the required parameter, but would aim above it, or below it, consistently.

<u>Selection</u> bias is due to the method of selecting the sample (as opposed to using an inappropriate formula for estimating parameters).

Response rate is the proportion of those selected and contacted in the sample who actually provide a reply. Low response rates can lead to (self-)selection bias when only a particular type of member of the population is willing to respond (e.g. those with non-typical views on a survey topic).

(ii)

A: If the target population is only present users, this method could be adequate provided enough time was allowed for occasional (as well as regular) users to be adequately represented among the respondents – but even here the most regular users might be over-represented, so that too high a proportion of "well satisfied" customers was recorded.

For the other possible target, the non-users are not represented at all, so it would be quite unsatisfactory.

Response rates could also be lower among those in a hurry, who may not be so satisfied with speed of service but did not take the time to say so.

B: This is an expensive method, but it avoids selection bias. Response rates could be relatively high, although those who were "too busy", not interested in the canteen or not easily available for interview could produce bias in the results by not answering. Interviewers, if not regularly used to carrying out surveys, would need careful training to avoid bias in the way they asked the questions and recorded answers.

C: Using the list of work email addresses, this is a good method for either target. As in *B*, present usage of the canteen could be one of the questions asked. Effectively this is a complete census, but of course non-response is possible. This could be minimised by sending reminders to those known not to have replied. In fact, people commonly reply to emails quickly (if at all!) and so if a clear and fairly short questionnaire is emailed a large number of responses would be hoped for.

D: A display stand, with questionnaire forms to be taken, could raise general interest in the survey but still may not obtain an unbiased selection of replies, which could be limited to those who were already interested in the canteen and felt they could spare time to reply. Unless there are sufficient questions to check identity of respondents, a few members of the public visiting the offices might answer. This does not seem to be a good method.

E: If strata (as in question 4) cover all the departments, this is potentially a good way of selecting a "representative" sample, but there remains the possibility of variable response rates. Any group which spends almost all of its time in the office is likely to respond better than any whose work is partly external. Prepaid envelopes may possibly reduce non-response among those not always working in the office. But any differences between department groups should be shown up by this method. It can be argued that better stratification would be between (1) regular users, (2) occasional users, (3) non-users. But lists of these would be very hard to construct. Provided strata do have underlying differences in important responses, the method is bound to give better (more precise) estimates than simple random samples, provided also that response rates are similar in all strata.

Ordinary Certificate, Paper I, 2003. Question 4

(i)   Total number of staff = 3000.   450/3000 = 15%.   Use 15% of the number of staff in each group, i.e. Education 165, Social Services 135, Chief Executive's 48, Environment and Resources 102.

(ii)   This achieves equal proportions of employees in each of the departments. It avoids some departments being over-represented in the sample originally selected. (Also it is easy to adapt the stratification method to study groups which may give more variable results, or higher means, or are more expensive to sample (e.g. through low initial response rate).)

(i)   *C* is cheapest; *A* costs only the paper; *B* is most costly in terms of staff time; *D* will have some cost to make a useful and eye-catching display; *E* will have postal costs.

C is quick, even allowing for reminders; *A* and *D* depend on how long it takes to get enough responses; *E* will take some weeks, allowing for reminders; *B* may be slow if only one or two trained interviewers are available.

B and *E* are the only ones where some staff will not have the opportunity to answer (though statistically satisfactory methods). For all the others, the choice whether to respond is theirs, except for the present non-users by method *A*.

(ii)   Multi-stage sampling uses natural clusters (groupings) in the population, samples a randomly chosen set of these, and then samples members within each chosen group. It is economical where clusters are geographical areas and members within them have to be interviewed. In the present case, email, post or telephone contact would make any multi-stage scheme unnecessary; with only four departments, on the same site, which do not necessarily form "natural clusters", saving of time under scheme *B* would be minimal, so multi-stage sampling does not seem worth considering for this survey.

(iii)   An email survey would be satisfactory, and could be backed up by a personal interview survey of any staff not using email, such as maintenance and security staff who do not have individual office space, also cleaners, car park staff, etc. It might also be possible to interview some of those who did not respond to email. This should collect maximum information in minimum time, at no very great cost, without "excluding" anyone.

(i)   A longitudinal survey follows a group ("cohort") of the target population over a period of time; a cross-sectional study takes a "snapshot" at a particular time.

For the present topic, a longitudinal survey would follow the opinions of the same group of people through, say, a year, to note any changes in attitude to food, variety, service etc of regular users. Another example would be to take a newly-arrived group of users and follow their changes in attitude and use.

A cross-sectional study is a single undertaking on the lines discussed in previous questions.

(ii)   A panel would be a group of people, selected at random or otherwise, who agreed to report on their use of, and attitude to, the canteen over a period of time, providing an indication of responses to any changes and initiatives the manager introduced and/or other relevant changes in competition, canteen layout, organisation, etc.

There is always a danger that such a panel, willing to do this task for some time, may be atypical of the whole target population, so causing bias in the results of the study. Also, familiarity with the running of the canteen may in time make them less like the "average" user, again leading to possible bias.

(i)   A possible closed question is:

How well would you say your dietary needs are catered for?

☐ Very well   ☐ Quite well   ☐ Not very well   ☐ Not at all

☐ Don't know (e.g. because never go to canteen)

This aims to obtain a qualitative answer to one point of particular concern, offering alternatives to provide any respondent with a suitable box to tick.

An open question could be:

What, if anything, could be done by the canteen that would encourage those with your dietary needs to use it more often?

[Provide a large box or a few dotted lines for the answer]

This covers the same area of enquiry, but allows the opportunity for respondents to offer suggestions which may be useful.

(ii)   Closed questions provide a number of possible alternative answers, either mutually exclusive such as boxes to tick for amount of income or including a general "don't know" box as above. Open questions do not offer specific alternatives, but merely ask for opinions.

Closed questions are easy to analyse, although respondents may be constrained in thinking about an answer and may wish to answer in a way not provided for. "Other" answers may not always raise points that would have been ticked if a box had been offered for them. Open questions do not limit answers to those expected by the questionnaire designers, and may give very useful feedback. But the more open the answers, the more difficult they often are to analyse. The survey planners cannot know how widespread particular concerns are (e.g. canteen layout, lighting, comfort) unless answers on those specific points have been asked for.

(iii)   The wording of a question may point to possible answers, or discourage people from giving others, which will bias estimates of the opinion in the population on the issue being studied. For example, "How far do you feel that the canteen service should be controlled by money-making motives?" is pointing people to answer against this emotive idea. A better question would be "Should the present system of subsidising the canteen be continued, or would it be better to expect those using it to pay prices sufficient for the canteen to break even?"

Another example is "Do you think that reasonable accommodation should be devoted by the canteen to meeting special dietary needs?", which begs the question of what is "reasonable" – a vague word which should not be used. A better alternative is "How much of the canteen area should be dedicated to special dietary needs?"

(i) Disadvantages of computers –

open-ended questions difficult to deal with, requiring some knowledge and judgement to classify;

need to have a specialist computer package and an operator who can use it.

Disadvantages of hand analysis –

still not easy to deal with open-ended questions;

further analyses after data entry are very time-consuming, and need checking.

Advantages of computers –

after data entry, a wide range of tables, tests and analyses can be carried out;

new (derived) variables can be created and studied;

modern packages have good graphics for use in reports.

Advantages of hand analyses –

very few, except that "rogue" data may be more easily spotted (although even that should be done during data entry).

(ii)   SPSS (for example) requires variables to be set up in variable view, with information on whether variables are numeric, alphanumeric etc, labels to be applied to responses, data to be entered in a spreadsheet matrix related to variables as defined. Questionnaires should therefore be formatted so that it is easy to translate answers into single numbers or very short mnemonic codes. Transfer to computer from questionnaire should be easy, without having to search the form to find codes.

(iii)   Cross-check consistency of answers: e.g. a situation where, if one question is answered "no", there should be no data entered in a following question. A standard symbol (such as *) should be entered where values are missing. Types of entry, numeric, alphanumeric etc, can be checked for appropriateness. Values can be checked to see if they lie in an acceptable range.