

STATISTICAL ANALYSIS OF QUESTIONNAIRES CONSISTENCY

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Abstract *Surveys offer a method of critically testing concepts, and selecting them according to the results of tests, and the quality verification. The paper presents a study of internal consistency of the content of questionnaires, as a side of the quality. Internal consistency refers to the extent to which there is cohesiveness or inter-relatedness among the responses to the multiple items comprising the Likert scale, based on correlation and Cronbach's alpha. The extended use of multivariate procedures is applied in the paper.*

Keywords: surveys, questionnaires, internal consistency, Cronbach's alpha

“There is nothing more necessary to the man of science than its history, and the logic of discovery: the way error is detected, the use of hypothesis, of imagination, the mode of testing.”

Lord Acton (1834-1902)

1. INTRODUCTION

A field of applied statistics, survey methodology studies the sampling of individual units from a population and the associated survey data collection techniques, such as questionnaire construction and methods for improving the quality and accuracy of responses to surveys.



Figure 1. The Survey Lifecycle [4]

Statistical surveys are undertaken with a view towards making statistical inferences about the population being studied, and this depends strongly on the survey questions used. Surveys provide important information for all kinds of public information and research fields [1].

From a new idea, anticipation, a hypothesis, a theoretical system, conclusions are drawn by means of logical deduction based on statistical tests [2]. A defining characteristic of surveys as we see them is that they are designed to produce statistical descriptions of populations [3].

Figure 1 shows the survey production lifecycle [4], which can be iteration within a production process. The order in which survey production processes are shown in the lifecycle does not represent a strict order to their actual implementation. Quality and ethical considerations are relevant to all processes throughout the survey production lifecycle. Survey quality can be assessed in terms of fitness for purpose [5], total survey error, a framework for evaluating survey quality, and the monitoring of survey production process quality.

2. STATISTICAL METHODS FOR QUESTIONNAIRES ANALYSIS

Multivariate Analysis is used to the analysis of data which are multivariate in the sense that each object bears the values of several characteristics of interest. In order to perform multivariate exploratory statistics, these data should be interpreted as attributes/objects matrix [6, 7]. Table 1 presents a questionnaire result example [8], with six questions and seventeen respondents, for statistical evaluations of the quality, using a typical Likert scale with five levels. A Likert scale is an ordered scale from which respondents choose one option that best aligns with their view [9].

Table 1. Questionnaire example

Qu1	4	2	3	5	5	5	4	4	5	4	4	2	5	4	4	2	5
Qu2	4	1	3	2	2	1	3	5	2	4	4	3	2	4	4	2	2
Qu3	4	3	3	3	3	3	3	4	3	3	4	2	3	3	4	2	3
Qu4	4	1	3	3	3	4	3	4	4	3	4	3	4	3	4	3	4
Qu5	4	2	3	2	2	2	4	4	2	4	4	2	2	4	4	2	2
Qu6	4	1	3	3	3	3	4	4	3	4	4	3	3	4	4	3	3

Table 2. Pearson Correlation Matrix

	Qu1	Qu2	Qu3	Qu4	Qu5
Qu2	-0,06				
Qu3	0,39	0,56			
Qu4	0,61	0,34	0,44		
Qu5	-0,01	0,88	0,65	0,22	
Qu6	0,32	0,81	0,46	0,64	0,78

The following tables present the results of the statistical analysis of the questionnaire. The correlation coefficients of all pair questions in are given the table 2. At first sight it seems that the questions were 'good chosen'. Table 3 provides some descriptive statistics, including the sample size for each item, as well as the mean and standard deviation. An internal consistency estimate of the reliability of summated scores, derived from a Likert scale, requires only one administration of the instrument. Internal consistency refers to the extent to which there is cohesiveness or inter-relatedness among the responses to the multiple items comprising the Likert scale [10]. Cronbach (1951) developed this estimate of reliability and named the coefficient alpha (α), the mean of all possible split-half coefficients that can be calculated for a particular instrument [11]. Carmines and Zeller [12] reported that Cronbach's α is a conservative estimate of reliability. The Cronbach's alpha (α) score, which is here 0.8141, indicating a high level of internal consistency because all recommended values are 0.7 or higher.

Table 3. Item and Total Statistics; **Table 4.** Omitted Item Statistics

Variable	Total Count	Mean	StDev
Qu1	17	3,94	1,09
Qu2	17	2,82	1,19
Qu3	17	3,12	0,6
Qu4	17	3,35	0,79
Qu5	17	2,88	0,99
Qu6	17	3,29	0,77
Total	17	19,41	4

Omitted variable	Adj.Total Mean	Adj.Total StDev.	Item.-Adj. Total Corr.	Squared Mult. Corr	Cronbach'
					Alpha
Qu1	15,471	3,59	0,2475	0,762	0,8657
Qu2	16,588	3,124	0,6545	0,8797	0,7705
Qu3	16,294	3,567	0,6835	0,8867	0,7796
Qu4	16,059	3,491	0,5843	0,8628	0,7853
Qu5	16,529	3,262	0,6768	0,9547	0,7611
Qu6	16,118	3,314	0,8653	0,9623	0,7321

The table 4 shows the 'contribution' or 'fit' of each item to the scale, providing useful statistics such as the mean and standard deviation, adjusted Pearson correlations and squared multiple correlation and Cronbach's alpha score when an item was removed from the scale. For each omitted question the coefficients score is over the limit value from above, which consolidates the general Cronbach's alpha score.

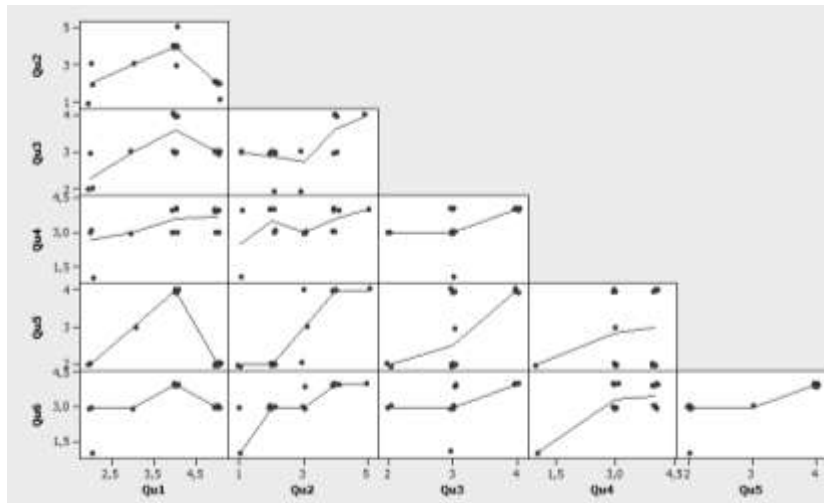


Table 5 Matrix Plot of Qu1; Qu2; Qu3; Qu4; Qu5; Qu6

The matrix plot shows a graph to assess the relationship among several pairs of variables at the same time and is a set of individual scatter plots. This matrix plot describes the pair connections between the scores of different paired questions. It is obvious that these diagrams prove the initial hypothesis of internal consistency.

3. CONCLUSIONS

The paper offers an interesting solution to solve the quality and marketing problems [13] with the modern statistical tools. The applied statistical methods carried out some correlations, interdependences regression functions to evaluate the initial experimental results.

When using Likert-type scales it is imperative to calculate and report Cronbach's alpha coefficient for internal consistency reliability for any scales or subscales one may be using. Then the analysis of the data should use these summated scales or subscales and not individual items. If one does otherwise, the reliability of the items is at best probably low and at worst unknown [14]. Cronbach's alpha does not provide reliability estimates for single items. A questionnaire example, which consisted of six questions and seventeen respondents, was employed to present some statistical evaluations of the quality. The scale had a high level of internal consistency, as determined by a Cronbach's alpha of 0.8141.

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