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Metrically Adjusted Questionnaires Can Provide More Information for Scientists – An Example from Tourism

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A B S T R A C T

The article deals with the issue of research methodology, illustrating the use of known research methods for new purposes. Questionnaires that originally do not have metric characteristics can be called »handy questionnaires«. In this article, the author is trying to consider the possibilities of their improved scientific usability, which can be primarily ensured by improving their metric characteristics, consequently using multivariate instead of univariate statistical methods. In order to establish the base for the application of multivariate statistical procedures, the main idea is to develop strategies to design measurement instruments from parts of the handy questionnaires. This can be accomplished in two ways: before deciding upon the methods for data collection (redesigning the handy questionnaires) and before the collection of the data (a priori) or after the data has been collected, without modifying the questionnaire (a posteriori). The basic principles of applying these two strategies of the metrical adaptation of handy questionnaires are described.

Key words: *multivariate and univariate analysis, questionnaire, psychometrics, scientific usability*

Introduction

This article deals with the issue of research methodology: it illustrares the use of known research methods for new purposes. The procedures while constructing new measuring instruments in social (and other fileds of) sciences, with the use of factor analysis as the method to determine construct validity are widely known. However, the novelty of this article is the application of abovementioned method (procedure) in raising scientific value of the series of questions, which are not initially considered to define precisely some specific scientific concept. Hence, this article provides the information how the series of questions could be turned into new measuring instrument.

Questionnaires in scientific studies

The term questionnaire implies the procedure of simultaneous data collection from a large number of examinees on their feelings or thoughts about subjects they are familiar with[1,2]. Questionnaire, in a narrower sense, is a data collection instrument comprised of a series of questions for gathering information about attitudes and opinions from a representative sample of examinees[3]. Design of a questionnaire is relatively simple: based on the hypothesis, the researcher creates a large number of questions that cover the research topic and in the end carefully selects the final set[1]. Two basic concepts are crucial for questionnaire implementation: sample size and questionnaire design. The basic premise is that a small number of representative answers are adequate and sufficient for representation of views of the whole population, represented by the chosen sample of examinees[3].

The quality of a questionnaire heavily depends on two metric characteristics (attributes): validity and reliability. The problem of questionnaire validity is connected to whether the questions »measure« what we want or different forms of prejudice (dishonesty, fear, the will to please etc) perhaps bias the answers[4]. On the other hand, the reliability of results is boiled down to reduced to examinees' consistency in answering the questions[5]. Most problems concerning validity and reliability stem from the way the questions are asked and their content: differences in answers often arise due to different (subjective) interpretations and overall understanding of the questions rather than true differences of opinions[6]. Methodologically, valid-

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ity and reliability of a questionnaire can be improved with the help of an expert (in a pilot study), by the observation and coding of behaviors that point to specific problems during the main research[7]. Moreover, the improvements could be given by the comparison with data gathered by another reliable source, adding more questions within the same domain[8]. However, the validity and reliability during the constructon of questionnaires has to meet similarly strict metric requirements as in the cases of other measuring instruments based on polls (e.g. tests).

Handy questionnaires

Raising the quality of all basic metric characteristics, can improve the scientific value of a questionnaire. It will transform the questionnaire into a measuring instrument, such as its more sophisticated »cousins«, which are actually a specific type of questionnaires: tests, attitude surveys or personality questionnaires. Tests are defined as a specific type of a questionnaire that has the characteristics of a measuring instrument, i.e. which has all of the basic metric characteristics: reliability, validity, objectivity, discriminative power and standardization[1, 2].

In this article, the subtype of a questionnaire that is not initially specified with rigorously defined metric characteristics will be introduced, which can be called a »handy questionnaire«. Simple design of handy questionnaire begins with making a large number of questions about the research topic. However, questionnaires often comprise several objects/topics of measurement, represented by a different number of questions with different content, often expressed in different (measuring) scales[5]. Therefore, it is hard (or questionable) to speak of validity or reliability of the questionnaire in a metric sense, because those characteristics are not really examined. In other words, handy questionnaires are not created initially with the tendency to satisfy all of the basic metric characteristics. At first, handy questionnaires do not have construct validity: therefore, they do not uniformly represent a certain object of measurement and are not grouped thematically in an equally balanced way. One of the most common deficiencies in a typical questionnaire is a large number of questions that hardly could be logically grouped into coherent and equally balanced themes.

Applications of handy questionnaires

Now, two important features of the handy questionnaires are presented. First, handy questionnaires are relatively more common in applied scientific studies that try to find applicable solutions to everyday problems. In fundamental scientific research, investigators usually try to define precisely all relevant variables and constructs[3]. Consequently, in fundamental studies it is more probable that variables in the belonging questionnaires are very systematically organized in thematic units, with relatively proportional distributions of the number of questions in these groups. On the contrary, in applied scientific research, scientists often use data collected by third parties (non-scientists, i.e. businesspersons) during their research, collecting information relevant for practical problem solving. In this case, all relevant variables are usually not precisely defined; variables are not organized into thematic units and are not proportionally distributed through topics of interest. Some single variables sometimes represent complete thematic units, i.e. the question »Are you cultural tourist?« can represent someone's preference for the cultural tourism as a whole. Such surveys can be of great value to the people collecting the data about particular issues. Handy questionnaires designed in this way are often almost useless, if the data from these studies are intended to be used for serious (multivariate) scientific studies, such as the study of the relationship between the hotel rating system, service quality improvement and hotel performance changes[9].

The second important application of handy questionnaires in scientific research is the possibility of the comparison of the results obtained in different studies (conducted by other researchers or by the researcher him/herself in previous studies). It is often very hard to find reference data for the comparison of the results obtained, especially in cross-cultural, interdisciplinary or pioneer research. In these cases, the researcher is often forced to compare data in very robustly performed meta-analyses[10, 11]. Using different research methodologies, in this case methods of data collecting can provide only limited insights toward possible comparison of the results obtained. For example, in the analyses of differences it is not enough to compare two groups with regard to one independent variable (e.g. education level, age group, sex). In rigorous scientific data analyses with clearly defined general goals, scientists need to consider larger number of relevant factors and possible moderator and mediator variables (covariates)[1,12]. Sometimes the number of such intervening variables opens the possibility for designing a new measuring instrument that could allow better systematic interpretation of the results, based on multivariate analyses[3]. In other words, the researchers usually add additional questions (mostly used by other researchers), that will allow easier interpretation of the results.

Two ways to improve the scientific value of handy questionnaires

However, in this article, the possibilities of alternative ways of analyzing the handy questionnaires are discussed, in the context of acquiring as much as possible relevant scientific information from previously collected data. We shall examine the ways to improve scientific usability of the data collected using multivariate analyses. The initial starting point in suggesting improvements is considering the length of the questionnaire, i.e. the number of questions (items). Too large questionnaire weakens the motivation of the participants[13, 14].

The first way of improving the handy questionnaires is including several measuring instruments (e.g. already constructed and verified tests, personality questionnaires or attitude scales) into a handy questionnaire. Meanwhile,

it is very important to respect that standardized questionnaires (that are in fact measuring instruments) have to be as short as possible, to avoid respondents' fatigue[14]. Researchers actually may not use integral versions of longer versions of standardized questionnaires (e.g. personality questionnaires or attitudes scales), to increase the credibility of the responses[13]. They can reduce bias due to participants' conditional fatigue from too many inquiries, using abbreviated versions of standardized questionnaires, with a consequence of using smaller number of questions that adequately represent the topic of research. Among many examples in scientific literature related to tourism, one example is presented.

Wang, Wu & Yuan[15] have analyzed the 197 usable questionnaires, which included 21 items testing the role of various marketing channels, developed to reflect the major classifications of mass media. These categories include (1) print media (newspaper, magazine, guidebook, and travel book/journal); (2) broadcast media (television and radio); (3) out-of-home media (outdoor media and transit media) and (4) supplemental and new media (Internet). Questions asked the respondents to rate a particular communication medium on the decision-making in visiting the heritage destination. The results of factor analysis indicated that communication tools for message delivery can be placed into three types under the headings of »public relation (PR)«, »advertisement (ADV)« and »direct sale & promotion (DS&P)«[15].

The second way is better thematic grouping (making thematic units) of questions that do not initially belong to shortened versions of measuring instruments in a handy questionnaire. Namely, the heuristic value of questionnaires can be improved using multivariate analyses techniques. Here will be shown the example of applying exploratory factor analysis (hereinafter EFA). For this purpose, it is important to notice two practical applications of factor analysis: determining of the latent structure and design of a measuring instrument[16]. The first step in the adjustment of a handy questionnaire for using multivariate analyses techniques (for example EFA) is considering using thematically grouped questions in handy questionnaires instead of formulating »isolated« questions. »Isolated« questions, for example where we simply ask someone to tell us about his/her nutritional habits (»Do you frequently eat fast food?«) have limited importance and could only provide opportunity for univariate analyses. Better thematic grouping of the questions in handy questionnaires can enable both applications of EFA: determining of the latent structure for this set of questions that can now represent the larger and more general topic, and checking metric properties of this set of questions can enable designing new measuring instruments[16]. On the other hand, relatively equal distribution of questions through thematic units could enable the use of multivariate analysis techniques instead of univariate. In other words, with only a small modification of initially provided handy questionnaires, the scientific relevance of the same study could be improved.

Example of using handy questionnaires in tourism

Here is presented an example of one such study in the field of tourism, where the intention of virtually all survey questions were given to broader empirical framework for the interpretation of the results about many factors included in modeling touristic offer in the city, using information technology methods[17]. First, as can be shown in Table 1, one multivariate variable (first order principal component) that can be called the extent of positive influ-

TABLE 1

FIRST ORDER PRINCIPAL COMPONENTS ANALYSIS (PCA) FOR A SET OF VARIABLES ABOUT THE EXTENT OF POSITIVE INFLUENCES FOR THE CITY AS A PLACE FOR CONDUCTING BUSINESS IN TOURISM

Items (estimations: from 1 = rarely/ never to 5 = very often/ always)	Principal component (saturation)	Communalities	Mean	Std. Dev.
showing interest in the development of science and education	.583	.340	3.407	1.000
investment in environmental projects	.774	.599	3.593	1.095
problem solving transport problems	.776	.602	3.567	1.142
developing the entire infrastructure	.826	.682	3.656	1.007
good geographical position	.686	.471	4.056	0.964
good opportunity to expand	.662	.438	4.110	0.971
ambition of stimulating entrepreneurship	.696	.484	3.844	0.923
good transport links	.635	.404	4.067	0.889
spatial planning	.656	.430	3.758	0.993
Variance explained (%)	49.444			
Eigenvalue	4.450			
Reliability (Cronbach's alpha coefficient)	0.870			

Note: only saturations higher than.350 are presented

ences for the city as a place for conducting business in tourism comprise 9 single variables. Namely, single variables describe certain specific aspects that represent positive influences for the city as a place for conducting business in tourism, while this summative multivariate variable (expressed in terms of factor scores), proportionally weights the contributions of these specific positive influences on business in tourism. (TABLE 1)

Second, as can be shown in Table 2, one multivariate variable (second order principal component) that can be called the design and modeling of the touristic offer in the present comprises 7 single first order multivariate variables, aimed to describe the design and modeling of the touristic offer in the city, at the present time. Among those variables, the variable from Table 1 (positive influences for the city as a place for conducting business in tourism) is just one of them. In other words, these seven second-order principal components represent 97 single variables: comprised this way, these seven variables can enable unambiguous conclusions about these issues[17]. (TABLE 2)

Third, as can be shown in Table 3, only 27 first order principal components (just one is showed in Table 3, which comprises single variables from Table 1) and 7 second-order principal components comprise 879 single variables that describe all hypothetically relevant factors about touristic offer of the city, in the context of using information technology. For the purpose of analyses of differences (in the table 3 some gender differences are presented), the researcher used just first and second order principal components. High reliability and good construct validity of the

TABLE 2

SECOND ORDER PRINCIPAL COMPONENTS ANALYSIS (PCA) FOR A SET OF VARIABLES ABOUT THE DESIGN AND MODELLING OF TOURISTIC OFFER IN THE PRESENT

Items (estimations: from 1 = rarely/ never to 5 = very often/ always)	Principal component (saturation)	Communalities
business climate related economic and tourist activities in the city (22 variables)	.597	.356
the extent of positive influences for the city as a place for conducting business in tourism (9 variables)	.715	.511
the extent of negative influences for the city as a place for conducting business in tourism (15 variables)	.451	.203
activities in the city now in progress that you feel good and supportive for their good tourist development (15 variables)	.686	.470
the extent of achieving different organizational forms of tourism product placement for city as a tourist destination (4 variables)	.736	.541
evaluating of different tourist products in order to improve tourism in the city (10 variables)	.807	.651
achievement of different economic goals in the city (22 variables)	.320	.103
Variance explained (%)	40.495	
Eigenvalue	2.835	
Reliability (Cronbach's alpha coefficient)	0.740	

Note: only saturations higher than.350 are presented

TABLE 3

GENDER DIFFERENCES IN A SET OF VARIABLES LINKED WITH TOURISTIC OFFER OF THE CITY IN THE CONTEXT OF COMPUTER USE (THE ANALYSIS BASED ON THE PRINCIPAL COMPONENTS OF THE FIRST AND SECOND ORDER PCAS)

Variables	Mean (N) females (53)	Std. Dev. females	Mean (N) males (33)	Std. Dev. males	Mann-Whitney U	p
the extent of positive influences for the city as a place for conducting business in tourism	1.085	0.149	0.853	0.149	522	>.20
use of computers in tourism	−0.084	0.887	0.135	1.160	778	>.20
design and modeling of the touristic offer in the present	−0.143	0.979	0.255	1.007	354	>.10
design and modeling of the tourist offer in the future	−0.072	0.887	0.111	1.160	645.5	>.20
satisfaction with the tourist products offer	−0.096	0.943	0.189	1.098	546	>.20
sources of information about the tourist products offer	−0.129	1.046	0.264	0.864	286.5	>.10

questionnaires presented in Tables 1 and 2 indicate not only more clear interpretation of the results obtained, but also the opportunity for constructing new measuring instruments. Similar results of the analyses are obtained also while using other questionnaires in the same research, conducted by Morović[17]. (TABLE 3)

Pre-existing tests of metric characteristics in handy questionnaires are a good starting point for further analyses, nevertheless those tests have to be used with a caution, based on the characteristics of the sample in certain study. In advnce has to be considered if the sample is homogenous, according to the relevant factors, such as age, gender, economic status, etc. In other words, the use of the representative sample for certain population in the initial dataset is equally important as the repres entative sample of variables, in order to overcome unintended bias[8].

However, designing of handy questionnaires can be performed using two approaches: modifying initially designed handy questionnaires (*a prirori*) or changing the methods of data aggregation and data analyses after the application of the questionnaires and finished process of data collecting (*a posteriori*).

Design of a handy questionnaire – *a priori* and *a posteriori*

Two approaches are possible to increase the scientific usability of a research with the use of handy questionnaires: during the planning phase before the implementation of the questionnaire (*a priori*) and after the data have been collected by a questionnaire (*a posteriori*).

If the *a priori* approach is used, a plan needs to be made in advance about the design of items and measuring scales in a handy questionnaire, as well as the method for data collection, in order to make the collected data usable as much as possible. To accomplish this, it is very important to adjust questions' content and grouping in a survey before the start of data collection, considering the extent of data that could be collected, depending on time, available financial resources and length of a questionnaire. Based on theoretical concepts, which are the issue of interest, researchers can elaborate a list of variables, important for the scientific research and for the practice, which have to be collected. It is important to bear in mind that these lists of variables should be grouped by themes, measuring precisely defined attributes of certain phenomena. For instance, in the study of different aspects (attributes) of positive influences for the city as a place for conducting business in tourism (as it is shown in Table 1), we could assume that unique latent variable will adequately represent the whole concept of positive influences for the city as a place for conducting business in tourism. However, this thematic unit can represent only one of seven important similarly comprised thematic units that represent the design and modeling of the touristic offer in the present (Table 2).

Steps in planning the research with an *a priori* designed handy questionnaire are as follows:

1. Try to design a certain number of questions grouped by thematic units that are the object of measurement (if possible, use well defined and empirically tested theoretical concepts in order to assure the necessary prerequisites for later interpretation of obtained results in a potential newly-designed measuring instrument, e.g. the design and modeling of the touristic offer in the present);
2. Try to adjust (equalize) measuring scale compatibility for questions within the same thematic units; in other words, it is necessary that all data are using the measuring scale of the same type (e.g. the interval type scale);
3. If specific measuring units or estimation scales are used, it is convenient that those estimation scales are compatible in span. It can be recommended for all the questions that belong to the same thematic unit (e.g. Likert scales that use 5 degrees) and it is desirable to do it for several (or all) thematic units;
4. Predetermine the number of factors /principal components (hereinafter F/PCA) compatible with the number of thematic units (it is often compatible with multivariate defined variables in research) (16). In cases when a correlation between the different thematic units cannot be expected in a complex way, one- F/PCA solution could be predetermined, as presented in Table 1, in case of the extent of positive influences for the city as a place for conducting business in tourism;
5. As a standard procedure in F/PCA analyses, after the initial iteration of F/PCA extraction, exclude the items with inadequate metric features (ones that are unsatisfactory in saturating certain latent dimensions that represent thematic units). Researcher(s) have to replicate consecutive iterations, until finding the solution where all remaining items adequately saturate obtained latent dimensions[16];
6. Finally, when the number of metrically defined latent dimensions is finished, according to the law of parsimony and the criteria of the simple structure, the criterion of interpretability of latent dimensions becomes the most important. Next iterations in F/PCA analyses can be determined as omitting those items that are not matched, with the meaning of latent dimensions that represent some thematic unit. The aim of iterations of F/PCA analyses based on the interpretability criterion is to coordinate both metric and interpretability criteria in multivariate defining thematic units;
7. After getting well-defined latent dimensions that describe certain thematic units, it is necessary to check the reliability of such new-made measuring instruments (the example is showed in Table 1 and Table 2). If the reliability (measured with Cronbach's alpha for example) is not high enough for some specific thematic unit, two strategies are available: in further iterations of F/PCA the unreliable items could be omitted (1) or the variables in that thematic unit could be analyzed in a univariate way (2);

8. At last, researcher has to define factor scores for a certain latent dimension (thematic unit) that will be used for further analyses (to determine differences, such as in the example in Table 3, to determine the correlations, etc.)[16].

Of course, this a priori approach cannot save the time for the researcher(s) about finding the sources of the initial data used for question selection: designing original question set and collecting respondent data from the ground up is a considerable time investment.

However, the researchers are sometimes prevented from planning the research using handy questionnaires in advance: sometimes researchers just have an opportunity to use the questionnaires designed by other researchers or by practitioners. In these cases, the analyses can be obtained *a posteriori*, following these steps:

1. Determine and analyze which thematic units can be identified in the conducted study. Consider whether the items (variables) used in the research can be put in the context approximated to a specific theoretical model? Consider if some groups of items can be transformed or incorporated into an existing similarly standardized questionnaire (measuring instrument)?
2. Analyze which measuring scales were used in variables' definition and make sure they are compatible within the same thematic units. If true, multivariate analyses are possible for certain thematic unit;
3. Make sure that estimation scales (or measuring units) are compatible in span for all the questions that belong to the same thematic unit. If true, multivariate analyses are possible for certain thematic unit;
4. In concordance with analyzed theoretical concepts, it is possible to predetermine the number of F/PCAs that is concordant with the number of thematic units (i.e. the number and type of measurements).

Further procedures are identical to a priori procedures in the analysis of handy questionnaires.

Conclusion

The term »handy questionnaire« describes a poll (questionnaire) or a comprised set of polls, which originally do not have specific metric characteristics (i.e. they are not standardized instruments). The design of the handy questionnaires depends not only on research goals, but also on potential ways to use the results of the survey: for practical purposes (to apply the acquired knowledge in the business), to obtain specific information (for example, the comparison with results obtained by other researchers), or to acquire completely new scientifically relevant information. In this article, authors describe the way to improve the quality of handy questionnaires. In order to create a basis for a reasonable application of multivariate statistical methods, two principles of constructing new measuring instruments from different parts of the handy questionnaire are suggested. The first strategy starts with improving the quality of the questionnaire before determining its final form (*a priori*), while the second strategy describes the way of multivariate analyses of the handy questionnaire after its application (*a posteriori*).

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METRIJSKI PRILAGOĐENIM UPITNICIMA MOGUĆE JE PRIKUPITI ZNATNO VIŠE INFORMACIJA- PRIMJER IZ TURIZMA

S A Ž E T A K

Svrha ovog rada je prezentirati korištenje poznatih/starih istraživačkih metoda u nove svrhe a na primjeru upitnika bez metrijskih karakteristike ili tzv. »priručnim upitnicima« (eng. handy questionnaire). Autori razmatraju mogućnosti poboljšanja znanstvene iskoristivosti putem unapređenja metrijskih karakteristika instrumenta korištenjem multivarijatnih metoda (umjesto univarijatne statistike). Kako bi se postupci multivarijatne statistike mogli primijeniti, potrebno je razviti strategije izrade metrijskih karakteristika instrumenta iz dijelova priručnih upitnika. Ovo se može postići na dva načina: prije donošenja odluke o načinu prikupljanja podataka (redizajniranje priručnih upitnika), prije prikupljanja podataka (a priori) ili nakon što su podaci prikupljeni ali bez modificiranja istih (a posteriori). U radu se podrobnije opisuju osnovni princip primjene ove dvije strategije metrijske adaptacije.