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## Analyzing the Statisticians: A User's Survey for the Analysis and the Development of the Required Methodological Framework

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Angelos Pantouvakis\*

### Abstract

*In recent years, rapid acquisition of information and, subsequently, data sets has taken place making, thus, necessary the use of statistical software in many scientific and professional fields. However, not all users of statistical software have the prerequisite statistical background in order to efficiently deal with them. So, the need for a "semi-expert" system which will be able to guide "non-expert" users through the phases of choosing and performing statistical analyses up to the interpretation of results has been discussed at the past. In the present paper we concentrate on the consolidation of user requirement for such a software. Our methodology for capturing user requirements has been consisted of several actions. Here we focus on the findings of a large-extent questionnaire survey that has been conducted in the framework of our analysis.*

**Keywords:** semi-expert system; attributes; user requirements; statistical practice;

**JEL Classification:** C42, C44

### Introduction

There is huge trade-off between Statistical science and Informatics. The impact of statistics has been increased in recent days due to the availability of high-speed computers and statistical packages that offer sophisticated statistical analyses with almost zero effort. In addition, in recent years we have seen an explosion of data availability together with an increasing appeal of statistics in the everyday life, especially in socio-economic matters. Large databases can be created containing billions of data and even simple statistical procedures are needed in order to summarize the tremendous amounts of data. On the other hand, this impact of statistics has been recognized and almost every university department has at least one course on elementary statistics (see, e.g. Loftsgaarden and Watkins, 1995). Combining these two events, one can see that, in recent years, statistical methods are used in a wide range of disciplines (see the discussion in Kettenring, 1997 and Moore, 2001). Unfortunately this expansion does not imply that statistics is used in the correct manner. It is a fact, that the majority of socio-economic analysts and some of the official statisticians are not necessarily able to use statistical data analysis methods in the most appropriate way.

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\* University of Ioannina, Department of Farm Management, Agrinio

The need for some kind of guidance has been recognized by commercial packages that started offering it via “statistical wizards”, like those offered by SPSS or Statgraphics among others. However, these statistical software packages are designed to help the user with a moderate statistical background rather than the user with a small level of knowledge. Some kind of expertise is needed to facilitate such users.

The design of “Statistical Expert Systems” has been discussed many years ago (see an early discussion of Hand, 1984). It has been recognized very early that it is quite difficult to transfer the statistical knowledge into an expert system. For this reason, the “expertise” has been focused on specific aspects of generic software, or it has been limited to particular application domains (see Woollard, Clark and Jury, 1996, Grabowski and Harkness, 1995, Prat, Sole, Catot and Lores, 1998 among others). The basic idea is not to replace the statisticians but to protect the user from misusing statistics (Hand, 1986, 1987).

Consider a software that it is designed to perform statistical analyses in an intelligent way so as to help ‘non-expert’ users to handle the data and to take the answers they want from the data. As ‘non-expert’ users we define those with small knowledge of statistics. The large availability of data has led workers in several disciplines to perform even simple statistical analyses (starting from calculating a simple mean to obtaining clustering of observations for example) but at the same time they do not feel at all comfortable with statistics, and in no case they can interpret the results or they are confident that they used the correct way to answer the questions in hand. Such users need a software that can protect them from misusing statistics (and not in fact a system that answers their questions like a crystal ball)

In this paper we describe a large extent survey on the user requirements for such a statistical package that can help ‘non-expert’ users not to misuse statistics. The aim is to capture the needs of the potential users of such a system so as to create a system that will meet their needs. We will concentrate on this user-requirement survey and we will not discuss other issues concerning the software.

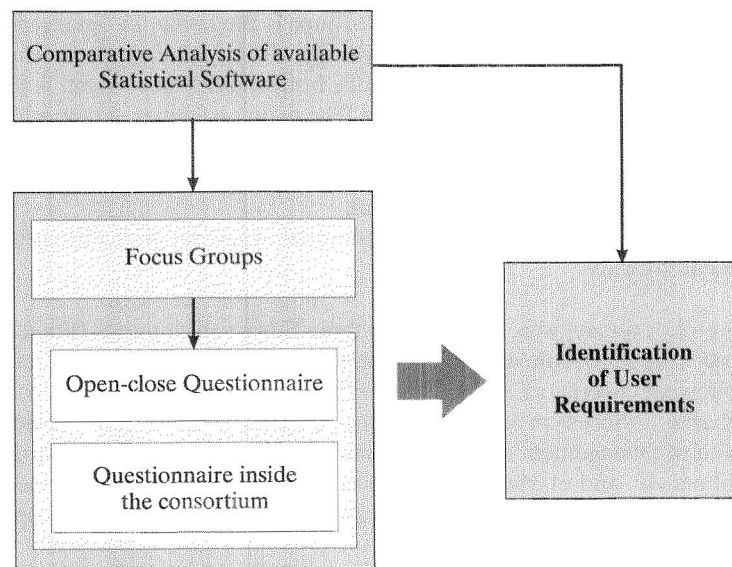
The remaining of the paper proceeds as follows. Section 2 describes the methodology used for exploiting the users requirements. Section 3 presents the main findings of the survey while at Section 4 we gather together the requirements as stem from the entire survey. Concluding remarks can be found in Section 5.

### **Methodology Used**

Requirements Analysis is the process of determining what is required of a future system or product. It is concerned with what needs to be designed rather than how it is designed (see, Jackson, 1996, Jones, 1997a,b among others). Understanding user requirements is an integral part of information systems design. This paper is concerned with the process of establishing user requirements and setting usability goals for the development of statistical software mainly for non- expert users. The user requirements that have been developed are from the user’s point of view. Technical and information requirements have been specified in parallel and they comprise the other component of the system development process

In the following figure, we present a schematic overview of the subsequent steps (the process), which were undertaken, on the whole, for capturing user requirements. These steps are briefly described below.

**Figure 1**  
*An overview of main steps*



### **Market Research**

Firstly, a market research was conducted in order to examine the existing statistical software. It is obvious that the knowledge of the latest changes in the field of statistical software is going to fill in us with the appropriate feedback regarding the tensions of market. It is believed that an investigation in new versions of statistical software is able to provide the appropriate information regarding the adoption of new methodologies and illustration of user requirements. Taking into account the fact that the majority of statistical packages address to experts users, the research in this direction sketched out the needs of this group but it also provided us with sufficient knowledge of helpful functionalities offered by the existing packages.

This survey extended and updated the results of other authors (see Morgan, 1998) as it included general statistical packages (SAS, SPSS, Statgraphics, Statistica, SPLUS, SYSTAT, MINITAB, SPAD) as well as packages for specific methods or packages that offer some kind of statistical methods (STAMP, ECOTRIM, TRAMO/SEATS, X-12 ARIMA, TSP, Microfit, Eviews, RATS, GAUSS, Sigma-Stat, Mathematica, Autobox, Forecast Pro, Microsoft EXCEL among others). This comparison revealed interesting features from each package as well as features that should be avoided while designing a new software.

### **Focus Groups**

Focus groups studies are quite popular in market research (see, e.g. Greenbaum, 1997, Calder, 1997, Stewart and Shamdasani, 1990 among others). They are qualitative surveys, where a group of potential users discuss topics related to the product with a person that directs the discussion towards specific topics and poses questions in the group for identifying particular aspects of their opinions. The major advantage of conducting focus groups is the ability to obtain in-depth and detailed information through group synergy. Group synergy occurs when one participant says something that triggers an idea from another participant. A richness of detail about preferences can be obtained. The main objectives of this qualitative research have been to:

- Explore the current practices, needs and expectations of users of computer programs with no statistical background.
- Assess the appeal and developmental potential of several propositions for new statistical software

Focus groups surveys were conducted in three European countries (France, Italy and United Kingdom) from experienced persons. The participants were recruited on the following criteria: a) All equipped with PC for professional use, b) Using the Excel and/or Access program to manage databases other than accounting - preparation of management statistics, monitoring of customer base, of orders, of staff numbers etc. and c) Manifesting dissatisfaction or expectations concerning the use of these data - or in other words sensing that they will be able to optimize the use of these data.

The discussion in the transaction of focus groups focalized into: a) Perceptions and attitudes towards computing, figures and statistics. b) Perceptions and attitudes of non- expert users (as they defined in the above) towards the IT and computing, c) Practices and expectations regarding data processing and d) Descriptions of the ideal statistical program and test of miscellaneous functions

### **Questionnaire Surveys**

As shown in Figure 1, two different kinds of structured questionnaires were used, directed to different users. The first type of questionnaire was distributed via e-mail among potential users inside national statistical organizations (e.g., NSSG, ONS) or other statistical organizations (e.g., CNAM). Thus the users were considered as having enough statistical knowledge and hence they could not be considered as 'non-experts'. With this survey, we tried to identify the needs of expert users. This survey was a supporting tool in the composition of expert user profile and their needs. This questionnaire was designed with open and close questions in order to avoid bias by having predefined choices. Moreover, the use of such questionnaire allowed the participants to express their knowledge on the subject in full detail. The main aim of this questionnaire was the investigation of the actual use and additional needs for statistical software as well as the actual supply of information about the statistical software and how this could be improved.

The second questionnaire referred to novice users and was based on the results of focus groups. With the use of such questionnaire we tried to specify with more accuracy the requirements of novice users from statistical software. Especially, we tried to identify their needs and taking into account their problems and propositions to design software that it would satisfy the most of their expectations. The survey was conducted in 3 European countries (France, United Kingdom and Italy), and the interviews were realized via phone (telephone interviews). The phone numbers were chosen randomly from professional catalogues in each country. 525 interviews were realized. In the sequel we will present the main findings of this quantitative research and then we will try to synthesize the user-requirements as they stem from the entire approach.

### **Results of Surveys**

The most useful part of the above mentioned approach was the quantitative research in the 'non-experts' group. This survey allowed us to identify the predisposition of such users against statistics (and thus statistical practice) as well as their attitude towards software in general. The other parts of the approach provided interesting information about the functionalities of the existing packages that could be used for creating a user-friendly package, but the main findings stem from the statistical analysis of the quantitative survey. We will present some interesting findings of this survey.

The results of focus groups surveys were studied in order to structure the questionnaire for the quantitative research.

### **Sample Description**

In this survey 525 people responded in the three countries. The 43% of respondents came from Italy, 36% from France and 21% from United Kingdom. There were a filtering question at the beginning of the questionnaire whether the responder uses statistic in his/her own job and only persons that answered that they use statistics were interviewed. Regarding the profession of each respondent one can refer to Table 1. As one can see the sample consisted of workers in several disciplines. In Table 2 one can see the self-reported level of statistical knowledge. It is interesting that many of them consider themselves as 'experts'.

**Table 1: The Professional Profile of the Responders**

Sample Composition	England	France	Italy	Total
Marketing manager	30,0%	16,9%	20,8%	<b>21,3%</b>
Sales engineer	8,2%	8,5%	13,7%	<b>10,7%</b>
Stockbroker	0,0%	1,1%	1,8%	<b>1,1%</b>
Human resources/ personnel manager	24,5%	20,1%	12,8%	<b>17,9%</b>
Medical Secretary	4,5%	14,3%	3,5%	<b>7,6%</b>
Logistics managers	9,1%	15,9%	11,5%	<b>12,6%</b>
Economists	0,0	2,6%	6,6%	<b>3,8%</b>
Analysts in the banking – finance sector	10,0%	11,1%	11,5%	<b>11,0%</b>
Doctors	4,5%	1,1%	8,8%	<b>5,1%</b>
Assistant Managers	9,1%	8,5%	8,8%	<b>8,8%</b>
<b>Total</b>	110	189	226	<b>525</b>
	<b>21,0%</b>	<b>36,0%</b>	<b>43,0%</b>	<b>100,00%</b>

**Table 2: Self-reported Level of Statistical Knowledge**

Level of statistical knowledge	Frequency	Percentage
None	54	10.3%
Basic	182	34.6%
Intermediate	216	41.1%
Expert	68	13.0%
Don't know	5	1.0%
<b>Total</b>	<b>525</b>	<b>100%</b>

As far as their relationship with statistical software is concerned, there is a spread around several different packages. Interesting is the fact that there is a large portion that uses packages from their own company; namely packages that are used to handle data inside the company. Another interesting finding was the usage of packages depending on their nationality, as for example the high usage of SPAD (the only French package) in France, while this package is not used at all in the rest of Europe (or at least in the countries where the French language is not the most-speaking one).

**Table 3:** *Type of Statistical Software they Use*

Statistical software used	Frequency	Percentage
SPSS	34	18.7
MINITAB	20	11.0
Statgraphics	18	9.9
SPAD	10	5.5
Statistica	20	11.0
SAS	26	14.3
Company's	98	54.4
Other	66	36.3
Don't know	10	5.5
Don't use statistical software	343	65.3

### **Tasks Undertaken**

At the first part of the questionnaire, we tried to investigate with what kind of data these people deal, whether they perform any statistical analysis in their data and what kind of software they have used up to now in order to elaborate their data. We explored the statistical methods that they usually apply in their data and especially we focalize in the steps that they usually follow in order to obtain the results that they desire in each case.

A necessary tool in order to explore the users' needs with respect to a novel statistical system is to track down the current customary relevant tasks performed by the respondents, the prospective users of the software under development. Our effort was concentrated on identifying the kinds of the data with which they are confronted, the statistical techniques most often used, the results of interest and, more importantly the problems encountered.

It is clear that the type of data handled depends heavily on the type of jobs undertaken and hence the discipline in which each one works. Data for accounting purposes is the most common type of data, followed by administration-related data. Usually they use large data bases containing amount numbers of data, especially if they work for large companies.

The methods usually applied to their data can be seen in Table 4. This table clearly identifies specific statistical methods starting form descriptive statistics, the cornerstone of every statistical analysis. As expected 'non-expert' users avoid sophisticated methods.

**Table 4:** *Statistical Methods Used by Non-expert Users*

Most frequent results of data analysis	Percentage
Descriptive statistics	61,7
Comparison of groups	42,3
Time series/ Forecasting	38,3
Estimates	36,2
Other	6,9
Don't know	4,2

They also reported that usually they repeat the same tasks on updated data revealing a repetitive habit.

#### Problems during Analysis

In our effort to identify users' requirements, the study of the problems that they encounter when involved with a statistical analysis is a crucial issue. The identification of the problems of the users with respect to statistical analysis and software is, undeniably, a powerful tool towards the users requirements capturing. Its importance lays on the fact that, usually, non-expert users are not able to clearly express their needs. The problems has been summarized in Table 5.

**Table 5:** *Problems Reported by 'Non-expert' Users*

Problems in data analysis	Percentage of respondents
Reliability, checking	20,8
Flexibility, gathering information	15,0
Conciliation of formats, standardization and interpretation	13,3
Not enough software capacity/ too much data	8,3
Extracting and searching data	5,8
Lack of skill concerning the used software	5,0
Too difficult to use, lack of information	5,0
Too long software/ It takes too much time analyzing data	4,2
Insufficient assistance	4,2
Technical problems: setting, use, functionality	2,5
Lack of statistical knowledge	2,5
Lack of sufficient software	2,5
Lack of time	1,7
Technically limited on Excel/ Heavy to exploit	1,7
Update problems	0,8
Difficult access to specialized software	0,8
Other	5,8



The main problem that respondents face in their data analysis is reliability and checking (20.8%). Under this general title, problems with reliability of the software itself, data reliability and checking and more importantly reliability of the statistical methods and derived results were stressed by the respondents. The flexibility and gathering of data also troubles them (15%). Furthermore, since they usually deal with large databases, they face the problem that software are not able to deal with large datasets (8.3%) while it is also difficult to extract the desired information (5.8%). The issue of uniformity is mentioned, too (13.3%). More particularly the users ask for the standardization of the format of statistical software. The diversity in the menus as well as in the produced results (output) seems to confuse them and makes it more difficult for them to get acquainted with the software and the analyses results. Moreover, most respondents are familiar with the Excel interface (60% reported sufficient knowledge off this package) and the deviation of statistical software from that seems to confuse some of them. Statistical analyses of data is an issue where most respondents are not adequately trained or educated. So they have problems of statistical nature (lack of statistical knowledge) as well as problems with the use of the statistical software, which are rather specialized and difficult to be used by non-experts (5%).

In this point we should mention that there exist differences in the problems faced by persons of different profession or level of statistical knowledge. So, doctors and stockbrokers seem to be more preoccupied than the other professionals with the insufficiency of available software to deal with large datasets (20%). The same issue troubles those with expert level of statistical knowledge (11%). These experts are also concerned with the lack of sufficient software for their analyses (7.3%). The demand for conciliation of formats, standardization and interpretation is mainly raised by doctors (40%) and sales engineers (32.3%). Insufficient assistance is mostly stressed by economists (22.2%). It is interesting to note, also, that persons who declared not wanting to improve the analysis process of the data they manipulate view as their main hinders the lack of skill concerning the used software (11.5%) and also ask for standardization (19.2%).

As long as the phases of data analysis where problems are usually detected are concerned, both the choice of the most appropriate technique and the implementation of the chosen method (40.2%) trouble non-expert users. The interpretation of the derived results is not less significant problem (33%). Worthy of note is also the percentage of respondents, which state that they do not know in what phase of data analysis they encounter problems (7.8%). This last figure, combined with the fact that respondents place almost equal weight to the problems encountered in all the phases that constitute a statistical analysis, put forward the need for a well structured wizard which would navigate and assist novice users in all the steps of a statistical analysis.

### **Assistance Needed**

Apart from the indirect approach for capturing users requirements described above, we were also involved in a process of more direct acquisition of require-

ments for a novel statistical software. Non-experts in statistics need help in all the steps involved in a “computer-assisted statistical analysis” (i.e. statistical analysis performed in a statistical package). Assistance is required both on the choice of appropriate statistical method to be deployed as well as to the interpretation of results. Moreover assistance is required on the navigation and proper use of the tools available in statistical software. The complexity of both statistical methods offered and interface of statistical software seems to puzzle them.

**Table 6:** *Reported Type of Assistance*

Type of assistance most suitable for software	Percentage
Guide in choice of most appropriate technique	37,0
Guide in implementation of methods	33,5
Guide in interpretation of results	24,4
Wizard for manipulating data	46,7
Repeated tasks	13,7
Other	4,2
Don't know	4,4

Investigating the importance that users assign to different types of assistance in the implementation of methods and interpretation of results, we find out that the manipulation of data is the most crucial (or problematic) issue for non-expert users, since the largest proportion of them (45.7%) asks for a wizard that aids in any phase of manipulation of data. This can be partly attributed to the incessant accumulation of large amounts of data. Second in importance is the request for a guide that helps in the choice of the most appropriate technique, while tips about the implementation of methods appear to be less important. The idea of the development of a guidance of predefined methods is welcomed by the majority of respondents. Note also that almost half of them (45.3%) considers most probable that such a tool would help novice users perform a complete statistical data analysis. Only 7.8% is the proportion of respondents who regard as unimportant the contribution of such a device.

#### **Evaluation of System's Features**

The findings of the analysis of the focus group survey as well as the review of existing software has already suggested the introduction of several features that would contribute to the functionality of the novel software. However, before proceeding with their implementation we should also check whether these features are also appreciated by the prospective users of the system. The attitude of respondents, on the whole, was more than positive to the proposed features. Based on these, the emerging need for efficient manipulation of data is brought forward. On the other hand, for non-experts it seems that it is less significant the capacity of a system (statistical software) to deal with more sophisticated methods. In Table

7 one can see the mean reported indices of usefulness\appropriateness for several characteristics. The respondents were asked to rate each characteristic in a scale from 1 (very useful/appropriate) to 4 (not useful/appropriate).

**Table 7:** *Reported Usefulness and Appropriateness for Several Characteristics. The Rate was from 1 (very useful/appropriate) to 4 (not useful/appropriate)*

<b>Proposed capacities of the new software</b>		<b>Index of usefulness</b>
Data Processes	Creating different categories of variables	1,96
	Manipulation of data	1,53
Data Processes	Basic graphics	1,58
	Links between several graphs	1,73
Techniques	Descriptive statistical analysis	1,77
	Time series analysis/forecasting	1,90
	Comparison of groups	1,78
	More sophisticated methods	2,33
<b>Presentation of results</b>		
Contents of Output	Only the analysis results must appear in the output	2,02
	They must be explanatory	1,49
	They must describe everything with detail	2,28
Output Form	A Word document	1,90
	An Excel document	1,54
	An HTML document	2,15

Another important, though often ignored, issue is that of the presentation of results of any statistical analysis performed. With respect to this, we may deduce that the users adopt an intermediate (and qualitative rather than quantitative) approach towards the amount of information displayed corresponding to a particular statistical analysis performed. Indeed they seem to agree mainly on an output explanatory enough but not stacked with details of everything. On the other hand of course they don't seem to totally agree with an output where only the bare analysis results appear. As long as the format of the delivered results is concerned, Excel seems to offer the maximum convenience. Output in the form of a Word is rather acceptable, too but the choice of the HTML environment for the display of the results of statistical analysis tends to puzzle prospective users.

### **Consolidation of Requirements**

In the previous section we presented results derived from the responses of the potential users in order to consolidate the user-requirements. In this section the

requirements that have resulted from the previous analyses are grouped in homogeneous clusters with respect to their relation to the activities that the users will perform in the frame of statistical software. The reported characteristics contain also the qualitative results derived from the other phases of the procedure described in section 2. The requirements are summarized in Table 8.

**Table 8:** *unmarizing the Proposed Characteristics of the System*

<b>Non-Expert User requirements</b>	
<i>General System Characteristics</i>	
Conform with any accepted standards for similar systems	Use English language, simple terminology, diagrams
Design to attract people who may have few skills in the use of the statistical software	Use very supportive dialogues to make the user feel comfortable
Attractive interface	Library of statistical methods
Suitable Assistance Advisor /Wizard	Analysis /Scenario maps
<i>Software Interface</i>	
Efficient organization of menus	Ability to add or remove buttons from tool-bars (so as to leave free space)
Existence of toolbar with buttons of the most commonly used methods	Simplification of language in order to have greater user friendliness
Tools of programs should be designing with such a way that progressive level of use to suit the different levels of technical skills of the user	Provision for data transformation and manipulation procedures (e.g. sort, compute)
<i>User Support Required</i>	
<i>Documentation</i>	
User's guide (with directions on the proper use of the system)	Statistical guide (with description of the statistical methods deployed, examples)
Programmer's guide (with detailed description of the procedures, errors etc)	
<i>Training</i>	
Training on the use of software	On-line help
Efficient training by companies	Telephone assistance
Assistance	Local experts
A Wizard that helps in the choice of the more appropriate techniques	Descriptive warnings about the causes of malfunction (ability to detect the origin of "bugs")
A wizard that helps in the interpretation of results	
<i>Functionality</i>	
Ability to handle large datasets (with respect to response time, operation)	Existence of metadata information for the data (metadata linkage)
Automatic database updates, automatic logical controls on the updated data	Scenario maps for helping those lacking statistical knowledge

Logical tests for checking the consistency of data	Rules that prohibit the improper use of statistics
Ability to add-in additional procedures in the system	Ability to create script files and macros Some of these may pre-exist
All the available analyses and procedures accommodated by the software should be also available in scripts (commands)	Special provision for missing values
<i>Output</i>	
Easily navigated and standardized output	Interpretation of results
Display metadata information to the output report	Improve the quality of tables and statistical tools
Conciliation of formats	Ability to view the print out and print in A4

Some of the characteristics were expected as they comprise standard functionalities in recent software packages. On the other hand, topics related to the statistical orientation of the package are quite interesting. In some sense reveal the fear of 'non-expert' user towards statistics. It is also interesting that some features are not available in any existing statistical software, mainly because these packages are created for expert users without special care to those with limited knowledge. Another problem encountered in statistical analysis phase is the statistical jargon that obstacles novice users from interpreting the results.

### Concluding Remarks

In this paper we examined the user-requirements for a statistical package for 'non-expert' users. The original purpose for such a package is not to create another statistical package but to create an intelligent system that can help 'non-expert' users not to misuse statistics. As the user-requirement survey showed all the existing packages can offer the statistical analyses reported as useful from the users, but they have a lot of problems in selecting the appropriate method, or interpreting the results. Thus the user-requirement survey presented was focused not on a simple statistical package but towards an intelligent software that helps the user to make statistical analyses easier. The general architecture of such a system as well as some other methodological approaches can be found in Karlis et al. (2001).

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