## THE METHOD OF STATISTICAL STRUCTURING WITH ECONOMETRIC IMPACT THROUGH SUCCESSIVE PILOT QUESTIONNAIRES, COMBINED FOR SURVEYS IN EXPERTS' POPULATIONS

**PhD. student Ligian TUDOROIU** (*l.tudoroiu@ronera.ro*) Doctoral School of University of Craiova

### ABSTRACT

A brief introduction enumerates the theoretical objectives of the article regarding the elaboration of a method of staged construction of a complex questionnaire with an econometric impact. The main section of the article describes the strategic steps of an original method, which is pragmatically and effectively used in modeling the opinions of some project management (PM) experts. Several results-related discussions and a number of concluding and creative considerations close the investigation of how best a questionnaire is being developed, pretested and successively piloted along two directions (key success criteria – KSC, and critical success factors – CSF) to generate two databases of endogenous and exogenous variables of an econometric model. Combining the two pre-tests on 36 expert groups for the KSC, and 61 experts for CSF, respectively, brings in the final form a complex and, at the same time, optimal questionnaire.

**Keywords:** key success criteria (KSC), critical success factors (CSF) orkey performance indicators (KPI) project management (PM), sample, questionnaire, statistical structuring and hierarchy method, pre-test or pilot test.

Jel Codes: 022, H43, C46.

### **1. INTRODUCTION**

Some minimal critical theoretical elements, synthesizing the concepts of conceptele *key success criteria (KSC), critical success factors*, (CSF)or key performance indicators (KPI), in managing a successful project, allow the methodological anticipation of a statistical survey of the opinions of an extended group of experts or project managers (PM) to design, pilot and process successive questionnaires to investigate their views. The diversity of issues that the PMs have to solve in the practice of team (partnership, consortium, etc.) building, or in ensuring their efficient and competitive functioning, until the conclusion of the project, often extends beyond the diversity of the

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KSC, offering more and more CSF or KPI alternatives. In essence, a statistical stage management of the opinion investigation strategy, using a pre-tested or volunteered questionnaire on two samples of experts who are after distinct objectives (KSC and CSF or KPI), requires a thorough knowledge of directed selective research and the consequences of applying the techniques for the subjective sampling of the groups (Săvoiu, 2012). A search for MP opinions greatly simplifies the successful completion of a project, yet it will need to focus on an optimal questionnaire, which sets out from a set of rigorously pretested or piloted questions that are later transformed into validated or invalid hypotheses, rankings, gaps, matrix correlations, and eventually even distinctive models of associations between KSC and CSF, statistically materialized in KPI. In an attempt to provide an innovative and simplified strategy for this complex methodological approach, an original method of econometric structuring in endogenous variables (KSC) and exogenous variables (CSF or KPI) was created, by successively pre-tested or piloted questionnaires, reunited for opinion surveys/polls conducted in expert populations, in this case two samples of project managers.

#### 2. LITERATURE REVIEW

In a modern context, Shenhar et al., (2017) asserts that the success of a project has become more and more clearly a multidisciplinary concept, and Rinaldi (2017) notes that it turns into a continuous and multiphase optimization requirement, from its initiation to planning, then in the actual application, going all the way to its completion or conclusion. The last five or six years attempt to outline an extensive theory of the essential dimensions of the success of a project, according to both Müller & Judgev (2012), Rowley (2013) and Tudoroiu (2017a), regardless of its source of funding (domestic or local, regional or international), which brings together: i) the efficiency and effectiveness of the project, both in terms of efficiency of the field or activities, and in terms of PM's effectiveness; ii) impact on customers and communities (stakeholders); iii) success of the business, product, services, but also of the team, partnership, project consortium; iv) the strategic potential of the project in the future for both markets and for project technologies. The multiplication of KSC in projects, synthetically structured in PMBOK® Guide 1983, 2000 and 2013, chronologically reveals the importance of integration, time, cost and scope, along with quality and team, to which communication, risk and acquisitions were added after 2000, and in 2013 the stakeholders, continuously expanding the iron triangle from the triple initial constraint to a set of ten essential KSCs according to Săvoiu and Tudoroiu (2017, pp. 10-11), and the life cycle of the successful project migrated from the area of a predictive life cycle (excess of planning and programming), more clearly towards the iterative and adaptive lifecycle (gradual approach, through new technologies and modern IT solutions, new forms of unconventional energy, etc.). In parallel with the increase in the number of KSC there is also a multiplied increase in CSF or KPI (Osei-Kyei and Chan, 2015), all of which hinder any form of statistical opinion investigation of successful project managers, by the much larger dimension of the KSC and CSF or KPI type variables, in terms of conceptual populations. The attempt to model the connection between criteria, as dependent variables, and factors, as independent variables, is usually preceded by investigations of PM views about factors by capitalizing on surveys focused on complex questionnaires, and generating databases in which associations can be traced and validated or invalidated, or meaningful correlations that carry ideas for optimal modelling of a project's success.

#### 3. METHODOLOGY

Methodology, as a complex notion, etymologically delineating a true science of methods, followed an unusual path in this constructive investigation of a complex questionnaire, starting from a general question, divided into two major directions, which later were pursued successively, and finally reunited by conceiving, selecting and capitalizing on a set of techniques and tools to generate an original method in the scientific research process centered on opinion polls. The practical option was for a final mix of techniques and tools, appropriate to an opinion survey of successful projects and their standardized outcomes (through the parallel investigation of KSC and CSF or KPI). The first methodological question of the article relates to how a questionnaire devoted to the criteria and factors of a successful project could be optimally built. In order to finally identify a "serious" research, we made recourse to pre-tests or questionnaire surveys analyzed as results, and apt to generate very useful discussion. An original and succinct delimitation in the universe of this type of research was authored by Thorstein Veblen, who, in his 1919, in The Evolution of the Scientific Point of View, stated that "the outcome of serious research can be given by simply raising the number of questions to two, in that domain where there was only one before." (Dinu, Săvoiu, Dabija, 2017). This way of thinking led to the identification, after working out the first questionnaire, of two other questions derived from the need to conduct pre-tests or selective pilot tests directed to (PM) experts in the KSC investigation, on the one hand, and CSF or KPI, on the other hand. For statistical reasons specific to the unitary treatment in collecting and recording experts' opinions (PM), and starting from participatory motivations in projects, generating experience in the field, the appropriate type of research (statistical and sociological) was

the *statistical survey* focused on observation on a questionnaire basis, and its implementation period was about six months (more specifically, from September to November 2017).

Two distinct sub-populations of project experts (PM) were investigated simultaneously in order to be able to generate a complex final questionnaire through pre-tests or pilot tests. In its concrete realization, the selective survey conducted, which focused on the questionnaire, coexisted with several concrete stages, in a scientific manner (Săvoiu, 2004; Săvoiu et al., 2005; Vlăsceanu, 2008; Săvoiu, 2013; Săvoiu, Neacşu, Duran, 2017): 1) establishing the object (identifying a successful project model and distinct views on KSC and CSF or KPI), and specifying the aim of the survey (modelling, correlation, comparison, confrontation, identification of gaps, etc.); 2) determining the target groups (project managers and successful project experts) as the population of the survey, including sub-populations structured so as to co-operate in a coherent manner, starting from the type of the questions entered in a questionnaire, to the specific way of formulating them, and ending through their succession, avoiding the "halo" or the undesirable effects on other neighbouring questions; 3) prior assertion of hypotheses, followed by testing, validating/ invalidating them, and decision to implicitly writing them in the form, and so the questionnaire finally ensured the conversion of the research objectives and hypotheses into appropriate questions; 4) selecting techniques and solutions or variants able to eventually lead to a standard model of the survey questionnaire, per subpopulation, and then per the whole set, in point of both format and the inner hierarchies, as well as the inner logical correlations, which simplify the processing and analysis of the data; 5) piloting or pre-test (designed to correct the KSC and CSF questionnaires from the point of view of further statistical elaboration and processing); 6) completion of the questionnaire (1-KSC and 2 - CSF or KPI, and finally 3 - KSC and CSF or KPI); 7) selecting the techniques and methods of administering the questionnaire (carried out in practice by an approach that explores the technique of volunteering through self-selected respondents, and by self-administration, thus providing useful association and correlation information, capable of subsequently leading to a modelling of the criterion-based success in relation to performance indicators or critical success factors); 8) sample delimitation, sampling of the two subpopulations, namely that of the experts (MP)  $(n_1 = 138 \text{ of which } 36 \text{ people responded})$ , and  $(n_2 = 100 \text{ of which 61 people responded})$ , which allowed the making of the final questionnaire and ordering the CSF or KPI classes. Eventually, the final questionnaire 3 - KSC and CSF or KPI (presented in Annex 1 of this article) was finalized, which was later exploited in a large-scale research on a much larger sample.

### 4. RESULTS AND DISCUSSIONS

Starting from the first questionnaire, dedicated to KSC criteria and CSFs or KPI indicators, following the first pilot survey conducted through an average volume sample (138 managers in at least one EU-funded project), there resulted a final format of the KSC. Very much as in any other poll-based pilot survey or expert pretest, the sampling technique was the sampling technique (selection conducted through respondent volunteering). The major characteristic feature of the volunteers to whom the initial form devoted to the standardization of key success criteria (KSC) was sent, was that of having participated in at least one project as project manager, being accountable to an entity (university, research institute or company) either alone, or in partnership, consortium or federation, of writing and leading at least one project funded by EU funds and programs (the initial survey base generated a list of 138 project managers, out of whom only 31 persons became respondents). The content of the first piloted questionnaire is presented in Table no. 1

### Primul chestionar pilotat (pre-testat) de investigare a opiniilor despre KSC a experților (PM)



Source: made by the author from PMBOK® Guide, 1983, 2000 and 2013.

In this first pilot test or pre-test concerning the experts' (PM) opinions of the KSC, two classes of project managers, volunteer respondents (figure 1) were identified: I) the class of those who participated in fewer than six projects (the layer contains 16 respondents, with a dominant value in the range 3-5, i.e. four successful projects); II) the class of those who participated in at least six successful projects (the layer contains 15 respondents, with a dominant value in the range 6-10, i.e. eight projects per manager).

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# The two layers of volunteer respondents and their dominant values in terms of number of projects





Source: made by the author according to the pilot test or pre-test results.

In parallel, four hypotheses of the pilot test or pre-test (Tudoroiu, Săvoiu, 2018) were investigated, and the responses validated the hypotheses:

 $H_1$ ) the specificity of the project generates a distinct hierarchy compared to the *chronological* one of *PMBOK*® Guide 1983, 2000 and 2013;

 $H_2$ ); there is a specific criterion hierarchy specific to the successful projects conducted in Romania based on EU funds, according to the opinions of their managers (which is visible from the very first 3 key criteria - KSC);

H<sub>3</sub>) MP experience leads to significant differences in assessing the importance of each KSC (the hypothesis was tested with test t – Student, and the final statistical decision derived from it was apparently that there was no significant difference in this respect); the sample of 31 respondents, stratified into two subgroups, was analyzed in relation to their experience both between subgroups (the sub-samples or layers mentioned  $n_1 = 16$  and  $n_2 = 15$ ), and also through confrontation with the general one (n=31, where n =  $n_1 + n_2$ ). The *t-test* values calculated for *harmonization* and *acquisition* between the layers *discriminated through the experience provided by the number of successful projects conducted* were 0.837, and 1.197 respectively, and the existence of a significant difference was not validated (they were lower than the t-test values tabulated in the case the Student test for small volume samples (n = 15) following the Test for Equality of Means Between Series);

 $H_4$ ) there are some associations between KSC that define relatively some categories of projects (e.g. industrial, transport, educational, etc.); and experience and time can bring about new associations and correlations into

successful projects, the KSC composition being essentially dynamic and periodically generating new success criteria that can turn into standards or areas of expertise in the PM (Tudoroiu, Săvoiu, 2018).

Thus H<sub>1</sub> and H<sub>2</sub> became validated hypotheses, and some trends emerging from the international researches on the multiplication and nuancing of KSC by area, degree of development and even distinctive typology of the projects that give shape to economies (e.g. agriculture, industry, construction, services, research, etc.) are realities stemming from the specific variability of successful projects. In the correlation matrix of the KSC in the sample of 31 respondents there are some indirect associations with correlation (R) values slightly higher than 0.5 : a) between scope and acquisitions (-0.535), and b) between *time* and *team* or HR (-0.558), which are to be found in nearly all successful projects. The option for extensive heterogeneous or multidisciplinary teams compensates for the time needed to achieve a successful project. The second major methodological direction went towards the piloting of the questionnaire dedicated to the critical success factors of the projects (CSF), statistically re-converted into key performance indicators - KPI (presented in Table 2). In this second survey of the CSF (KPI), or pretesting questionnaire, a group of 60 experts (project managers in at least one successful project) was used, including people selected in equal proportions from three major domains, each having 20 potential respondents  $(\frac{1}{3})$  from the structure of the initial list of those selected:

- a) the academic field (education);
- b) the field of industrial activities and related industrial services;
- c) cultural services, the field of the arts, and local communities.

The non-response rates were slightly different across the three areas (a = 35%; b = 45% and c = 40%); the final number of respondents to the pilot test was 36 experts (a = 13; b = 11; c = 12). The results of the pre-test, or pilot test, were analyzed on two structural levels, at factor class level (CSF classes), and factor (CSF or KPI) levels, and then published in two distinct articles (Tudoroiu, 2017a, Săvoiu, Tudoroiu, 2017). A hierarchy of success factors led to writing them in the order preferred by the 36 experts, according to the results of the interview in relation to rank 1 (A) given to the major typology (defining class). Table 2 shows the weights of each class and the distribution of answers that are normal, even close to the Gaussian pattern (Săvoiu, Tudoroiu, 2017).

# CSF classes ranked by layer 1 allocated, and Kernel distribution of experts' opinions

Table 2

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	Relative	Kornal distribution of avaarts'		
	frequency – n <sub>i</sub> *	opinions		
CSF Class	(%)	opinions		
Q <sub>1</sub> -Stability of the environment				
(political, economic, social and	27.8			
legislative)		Kernel Density (Normal, h = 4.5676)		
Q2-Impact of regional convergence	10 /	.05 -		
and suitability to EU funds	17.4			
Q <sub>3</sub> -Content and substance of	167	.04 -		
project	10.7	03		
Q <sub>4</sub> -Management standards	13.9			
Q <sub>5</sub> -Management tools under triple constraint	11.1	.02 -		
Q <sub>6</sub> -Project manager priorities	83	.01-		
(slightly expanded iron triangle)	0.5			
Q <sub>7</sub> -Status and conceptualization of a successful project	2.8	.00 £.05		
Total opinions	100	.04 -		
Source: made by the author in keepir	ig with the results	s of thos		
Tudoroju 2017) Software used: FV	iew	ř   /		

.02 Since the experts have identified der

Since the experts have identified der<sub>.01</sub> associations between the project manager's prior of status and status of the successful project  $(Q_7)_{00}$ 

the class of critical success factors for EU-function project ( $\sqrt{7}$ ,  $\sqrt{6}$ ,  $\sqrt{5}$ ,  $\sqrt{10}$ 

A statistical tool underlies the two creative methodologies, which is meant to assign a rank or ordering number for each CSF or KPI within the class to which they belong to, preferring a statistical index for the easy-tointerpret percentage expression format:

 $I(\%) = \sum_{i=1}^{n} (\text{scor mediu factor } \times \text{ coeficient de ponderare clasă}) \times 100 \qquad (1)$ 

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The index may be of the CPA and CPB type, as it is built using two original methods, based on the concepts of statistical thinking of homogeneous and heterogeneous notation. *The CPA-type index*, or *homogeneous notation* type index, is obtained from the relation (1), where the weighting coefficient of the class (CP class) is given by the calculation relation by which the CP class is a ratio between the class specific rank and the sum of the ranks of all classes:

I(%) CPA =  $\sum_{i=1}^{n} \left( \text{scor mediu factor} \times \frac{\text{RANGi}}{\sum_{i=1}^{n} \text{RANGi}} \right) \times 100$  (2) where the specific rank RANKi represents the total number of classes

diminished with the previously evaluated classes.

*The CPB-type index*, or *heterogeneous notation type* index, is obtained from the relation (1) where the heterogeneity of factors is attenuated by closer weighted coefficients, which start from a common base (base of homogenization of weighting coefficients – BCCP) according to the relation:

BCCP = 
$$(100\% - \sum_{i=1}^{n} \text{RANGi in \%})$$
: (3)

The difference representing the sum of the ranks is added to the homogenization base in keeping with the criterion. The CPB method is much more homogenizing at the end, and it generates a much lower instrumental amplitude (40-50% of the amplitude of the CPA method indices, according to the concrete results of the pilot test of 61 expert opinions in Table 3). A calculation in the initial class and one in the final class are shown below:

# Examples of calculation of the weighting coefficient of major CSF classes (61 respondents)

Table 3

CSF Class	Score of class		Absolute modal	Weighing oefficient	Homogenization	Weighing oefficient class
	modal	mean	frequency	class - CPA	base -coefficient	-CPB
Q <sub>1</sub> -Stability environment (political, economic, social and legislative)	1	87:61= 1,43	48	[7:28]:100 = 0,250	0,103	(10,3+7):100 = 0,173
Q <sub>7</sub> -Status and conceptualization of a successful project	7	362:61	32	[(7-1) : 28] : 100 = 0,036	0,103	(10,3+0,9):100 =0,112*
Total	28	-	-	1 000	0.721	1 000

Source : excerpted, for illustration, from (Tudoroiu, 2017).

Finally, after the pilot test or the pre-test, the 61 respondents (PM) kept a total of six from the seven classes, and from both original methods of quantification of the score which were proposed, according to eliminatory weighting coefficients, all CSF were retained that had scores well above the

theoretical average of a score range of 0 to 7 (with an average score of 3.5). A total of 43 CSFs remained in the final questionnaire, of which:  $Q_1 = 7$  CSF with a minimum score of 6.36;  $Q_2 = 7$  CSF with a minimum score of 6.08;  $Q_3 = 8$  CSF with a minimum score of 5.97;  $Q_4 = 7$  CSF with a minimum score of 5.97;  $Q_5 = 7$  CSF with a minimum score of 5.82;  $Q_7 = 7$  CSF with a minimum score of 6.33, which became  $Q_6$  in the final Q6 questionnaire, following the removal of the initial  $Q_6$  class). The homogeneous values of the scores of the 43 individual factors (CSFs) allowed, and made it possible, to draw up the final questionnaire, a questionnaire which also includes, under question eight, the 10 key criteria in successful projects (KSC). The method described was finally called the econometric structuring method by successively piloted questionnaires and reunited for opinion surveys in expert populations (MPs).

#### **5. CONCLUSIONS**

Although the pilot test, or the pre-test of the MP's opinions, was conducted on a relatively small sample and there were intentions to expand or complete it with new KSC by drawing on new categories extracted from the multitude of successful projects conducted in Romania and funded by the EU, they could not be taken over and used in the final questionnaire because they have rather highlighted some weaknesses in project management, which in some situations fail to synthesize the key aspects derived from the behaviour of project teams (HR team) in consortia, partnerships and federations, or in the allocation of incentives and sanctions related to the behaviour of project team members. The methodological use of two types of pilot questionnaires devoted in fact to completely different variables in econometric modelling, i.e. the endogenous (KSC) and exogenous variables (CSF or KPI), followed by their optimization by pre-testing with experts (PM) and bringing together the final results of the pilot test within a single support of the investigation, is in turn an innovative method of constructing an opinion poll questionnaire dedicated to a population of in-depth adepts of this particular issue. The process of optimal elaboration of a questionnaire requires in itself special selective research, pre-test investigations or pilot tests, and sampling of experts in order to yield pertinent scientific research. What the proposed method emphasizes is precisely the complexity of the optimization process of a complex questionnaire.

#### 6. BIBLIOGRAPHY

- Dinu, V., Săvoiu, G., Dabija, D.-C. (2017). A concepe, a redacta și a publica un articol științific. O abordare contextul cercetării economice, ed. II, București: Editura ASE.
- Osei-Kyei, R. and Chan, A.P. (2015). Review of studies on the Critical Success Factors for Public–Private Partnership (PPP) projects from 1990 to 2013. *International Journal of Project Management*, 33(6), pp.1335-1346. Retrieved from https://www.researchgate.net/publication/273135777\_Review\_of\_studies\_on\_the\_Critical\_Success Factors for Public-Private Partnership PPP projects from 1990 to 2013.
- Rinaldi, R. (2017). What's the Difference Between Project Life Cycle and Project Phase?Magoosh PMP Blog., Retrieved from https://magoosh.com/pmp/ differenceproject-life-cycle-project-phase/.
- Rowley, J. (2013). 5th Edition PMBOK® Guide Chapter 2: Project Life Cycle Types (Predictive, Iterative, Agile), Retrieved from https://4squareviews.com/2013/ 02/01/5th-edition-pmbok-guide-chapter-2-project-life-cycle-types-predictive-iterative-agile/.
- Săvoiu, G, (2004). Statistică aplicată în domeniul economic şi social, Piteşti: Editura Independența Economică Săvoiu, G., (coord), (2005). Cercetări şi modelări de marketing. Metode cantitative în cercetarea pieței, Bucureşti: Editura Universitară.
- 6. Săvoiu, G. (2012). *Statistică generală cu aplicații în contabilitate*, București: Editura Universitară.
- Săvoiu, G., (2013). Modelarea economico financiară: Gândirea econometrică aplicată în domeniul financiar, Bucureşti: Editura Universitară.
- Săvoiu, G., Neacşu, M.G., Duran, C. (2017). O anchetă statistică despre oportunitatea unui program extrașcolar (atelier de consiliere spirituală) și unele interacțiuni specific, *Revista Română de Statistică, Supliment*, vol (5), pp. 256-274.
- Săvoiu, G., Tudoroiu, L. (2016). Major Factors of the Project with European Funding, Vol. Conferinței Internaționale Progrese în teoria deciziilor economice în condiții de risc și incertitudine, editat de Academia Română-filiala Iași, ICES "Gh. Zane", Ed. Performantica, Iași, pp. 13-20.
- Săvoiu, G., Tudoroiu, L. (2017). Critical factors an major criteria in succesfull projects, based on eforeign financing, *Romanian Statistical Review Supplement*, vol 3, pp. 16-28.
- Shenhar, A.J., Dvir, D., Levy, O. and Maltz, A.C. (2001). Project Success: A Multidimensional Strategic Concept. Long Range Planning, Vol.34 (1), pp. 699-725,
- Tudoroiu, L., (2017a). Instruments for statistical ranking of the major factors of EU-funded projects in Romania, Romanian Statistical Review Supplement, vol 4, pp.126 – 136
- Tudoroiu, L., (2017b). Conceptualizarea proiectului turistic de succes și identificarea factorilor critici specifici în proiectele turistice din România, finanțate de Uniunea Europeană (UE), Iasi: Editura Perfomantica, vol. XXX, pp.112 -120.
- 14. Tudoroiu, L., Săvoiu, G. (2018). The specific hierarchy of the key success criteria (KSF) in the educational projects funded by the European Union in Romania. *The Young Economists Journal, issue 29, (in curs de apariție).*
- 15. Veblen, T., (1919). *The Evolution of the Scientific Point of View*. New York: B.W. Huebsch.
- Vlăsceanu, L., (2008). Introducere în metodologia cercetării sociologice, Bucureşti: Editura Universității din Bucureşti.