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Structural Equation Modeling of Organizational Systems

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Abstract

Organizational systems are complex and difficult to manage by nature. Modeling of organizational systems, as a method of representation of system relations, is even more difficult. Till today, many modeling methods and forms are applied to organizational systems. Structural equation modeling (SEM) is a very general, powerful and popular multivariate analysis technique, that bears on certain phenomenon using a confirmatory, hypothesis testing approach, while most other multivariate procedures are descriptive and exploratory. In this paper solving of complex and multidimensional structures with SEM is described, theoretically and practically, to show the way of complete and simultaneous testing of all relationships in organizational system modeling problems. There are 3 studies in the fields of quality management and its contingencies presented in that aim. Advantages and constraints in SEM application are discussed.

Key words: *Modeling, Organizational systems, Structural equation, Case Study*

1. INTRODUCTION

Organizational systems are complex and difficult to understand by nature. Modeling of organizational systems, for their adequate representation demand even more difficult methodology. Untill today, many modeling methods and approaches are applied to organizational systems. Issues of adequate representation are still challenging due to the following facts.

The macro perspective of organization design has been founded by Barnard's (1938) in [1] long time ago and there was posed a notion of organizational systems as purposeful systems of coordinated action. Leadership, structural arrangements, and organizational processes are considered as the most important building blocks of an organization that should be manipulated to achieve desired results [2]. Traditionally, organizational structure is defined in terms of organizational hierarchies, job descriptions, and control and coordination mechanisms [3]. Quality and other standardized management systems are aimed to connect all important elements of organizational system in good manner [4]. All those elements have causal relationships between each other that are not easy to describe.

On other side, structural equation modeling (SEM) is a very general, powerful and popular multivariate analysis technique, that bears on certain phenomenon using a confirmatory, hypothesis testing approach, while most other multivariate procedures are descriptive and exploratory. In this paper solving of complex and multidimensional structures with SEM is described, theoretically and practically, to show the way of complete and simultaneous testing of all relationships in organizational system modeling problems. There are 3 studies in the fields of quality management and its contingencies presented in that aim. Advantages and constraints in SEM application are discussed.

2. STRUCTURAL EQUATION MODELING (SEM) MAIN FOCUS

Structural equation modeling (SEM) is multivariate technique aimed for relationship analysis [5] as shown in Figure 1. Meaningful relationships and models normally have theoretical basis (underlying theory) and exhibit 'causality' or 'cause-and-effect'. For those 'cause-and-effect' relationships, SEM provides a formal way of analyzing them.

Multiple independent and dependent variables can be accommodated in SEM model and testing multiple relationships at a time is possible.

The basic features of SEM are as follows [5], [6]:

- SEM is a very general, very powerful and very popular multivariate analysis technique.
- SEM is a statistical methodology of the analysis of a structural theory that bears on some phenomenon using a confirmatory (hypothesis

testing) approach. Most other multivariate procedures are descriptive/ exploratory in nature.
- SEM provides a comprehensive method for the quantification and testing of theories.
- SEM is a relatively new method, having its roots in the 1970s, and wider application in engineering management at the beginning of 21 century.

Figure 1. Multivariate statistical analysis techniques [5]

SEM also relies on the following assumptions [5], [7]:
- Observations are independent,
- Respondents are randomly sampled,
- In maximum likelihood estimation, multivariate normality assumption and
- Variables are continuous including the applied Likert scale.

Sample size is very important issue when SEM is applied [6]. As an aabsolute minimum usually is used number of covariances or correlations in the matrix, while as typical minimum 5 respondents per parameter are estimated, while 10 per parameter are preferred [8], [9]. When there is not multivariate normal distribution 15 respondents per parameter are considered [10]. If seen from maximum likelihood estimation point of view one can use as few as 50, but 100-150 recommended, while as ideal sample size is 200 [6], [7].

SEM is a powerful method for effectively dealing with multicollinearity (when two or more variables are highly correlated) which can be seen as one of the benefits of SEM over multiple regression and factor analysis.

Therefore, SEM could be very useful in organizational systems modeling.

3. STRUCTURAL EQUATION MODELING OF ORGANIZATIONAL SYSTEMS

In this part there are three studies in the fields of quality management and its contingencies presented in aim to describe SEM application on organizational systems modeling. Advantages and constraints in SEM application are discussed across chosen case studies.

3.1 **Case study 1 - How TQM works in Serbian industrial companies? [11]**

In a large number of companies the TQM programs and standardization in the field of quality have not led to a higher organizational efficiency, effectiveness and higher performances indicators. Koontz, has noticed (1961) in [12] concerning organization theory, a flood of theories on organization form “a theoretical jungle”. Similarly, Watson and Korokonda [13] about TQM area conclude that it represents theoretical jungle, and ask the questions whether the TQM concept is:

1. organic or mechanistic,
2. universal or context-dependent, and
3. theoretical or practical in its essence.

A definite answer to those questions has not been given to the present day.

Accordingly, there is a need for research framework that is positing an model of contingency factors exercising impact on TQM that will indicate the context-dependent nature of the concept and in that way show how TQM works well. Hypothesis formulation is done based on previous research. The present case study, by investigating coincidences in [14-22], can offer an instrument with considerably lower number of dimensions for TQM.

Contingency factors dimensions are defined according to [1], [2], [3], [4], [23], [24], [25].

The present work, by investigating coincidences in previously mentioned literature can offer an instrument with considerably lower number of dimensions for TQM. Research instrument is the questionnaire with 93 questions, and it is formed using recommendations by Courage and Baxter [26].

Of the 500 questionnaires distributed in randomly selected Serbian industrial companies, 112 companies responded. One questionnaire was unusable error in control question, so the response rate was 22.22%. Sample represents more then 5% of industrial companies` population.

Data analysis was performed through data reduction and structural equations modeling according to recommendations of [5]. Reliability analysis and factor analysis also reduce the studied model.

Results are given in Figure 2. Model adequacy indicators were fine satisfying.

It can be inferred that the best TQM practice is found in large-sized, older companies operating in homogeneous, certain, safe and simple environment, with automated technologically advanced production, using IT, having clearly defined analyzing strategy relying upon cost-based leadership with a smaller-scale innovations, where managers are proactive, plan long-term and motivate employees, who are also proactive, having good personal relations, spirit of fellowship and cooperation. Organizational structure of those companies is mechanistic, with high technocratic specialization and

formalization. On the other hand, if company operates in unfavorable environment, it most often grows slowly, invests less in technology, and has simpler organizational structure. However, it can improve its TQM practice by properly defined strategy, organic management style and employees behavior.

Success of quality program in the company operating in favorable environment and having all prerequisites for growth can be diminished by poor selection of technology, reactive management style, deficiency of planning, poor employees interpersonal relations, etc.

The conclusion is that SMEs can not achieve solid TQM practice through the pathway of demographic variables and organizational structure, therefore it is recommendable to take “alternative road” through clearly defined strategy without risk elements, which further impacts technology (so it can alleviate unfavorable environment impact) and furthermore management style and employees behavior. Also, it is noticeable that in more favorable environment small-sized companies will additionally strengthen technology impact and thus achieve better TQM practice.

The present survey also indicates that it is necessary to combine mechanistic and organic principles. High organizational structure with high formalization and specialization is a feature of the mechanistic approach. Proactive behaviour of employees with a strong spirit of collectivism is a typical feature of organic type.

3.2 **Case study 2 - How QM in Serbian industrial companies works? [27]**

Aim of this study is to indicate significant dimensions of QM that should be provided in domestic industrial companies at as high level as possible in order to achieve better results in the domain of quality. The results can be taken as recommendations for those employed in Serbian industry, to raise the quality management level.

After the analysis of frequency incidence in available literature sources, the following TQM critical factors can be segregated:
1. Leadership and management support for quality program,
2. Training and involvement of employees,
3. Process approach,
4. Systemic approach and documentary evidence for quality system,
5. Beneficial interactions with suppliers,
6. Permanent quality improvement, and
7. Product design according to user demands.

The instrument proposed in the present paper initially contains 31 dimensions. The response to the delivery of 500 questionnaires was received by 112 companies, since case study 1 and 2 are part of the same survey.

Results are shown in Figure 3. Obtained model adequacy indicators were wholesome.

The model in Figure 3 of the second-order factors for QM indicates that holistic approach to QM is necessary, placing emphasis on 22 significant dimensions that should be provided in domestic industrial companies at as high level as possible so that better results in the sphere of quality are achieved.

Importance should be attached particularly to procedures of permanent quality improvement as the factor of highest loading. In this regard, there should be tendency to elimination of internal processes that lead to waste of time or money, application of IT which support QM in better data analysis and determination of priorities in improvements, revise quality system documents if necessary, and utilize methods and techniques for quality promotion to as high extent as possible.

3.3 **Case study 3 - How ISO 9001 influences performance in Serbian industrial companies? [28]**

The objective of this study is to investigate the relationships between the duration of ISO 9000 certification possession and performance measures with examination of the mediating effects of QM practices to that relation.

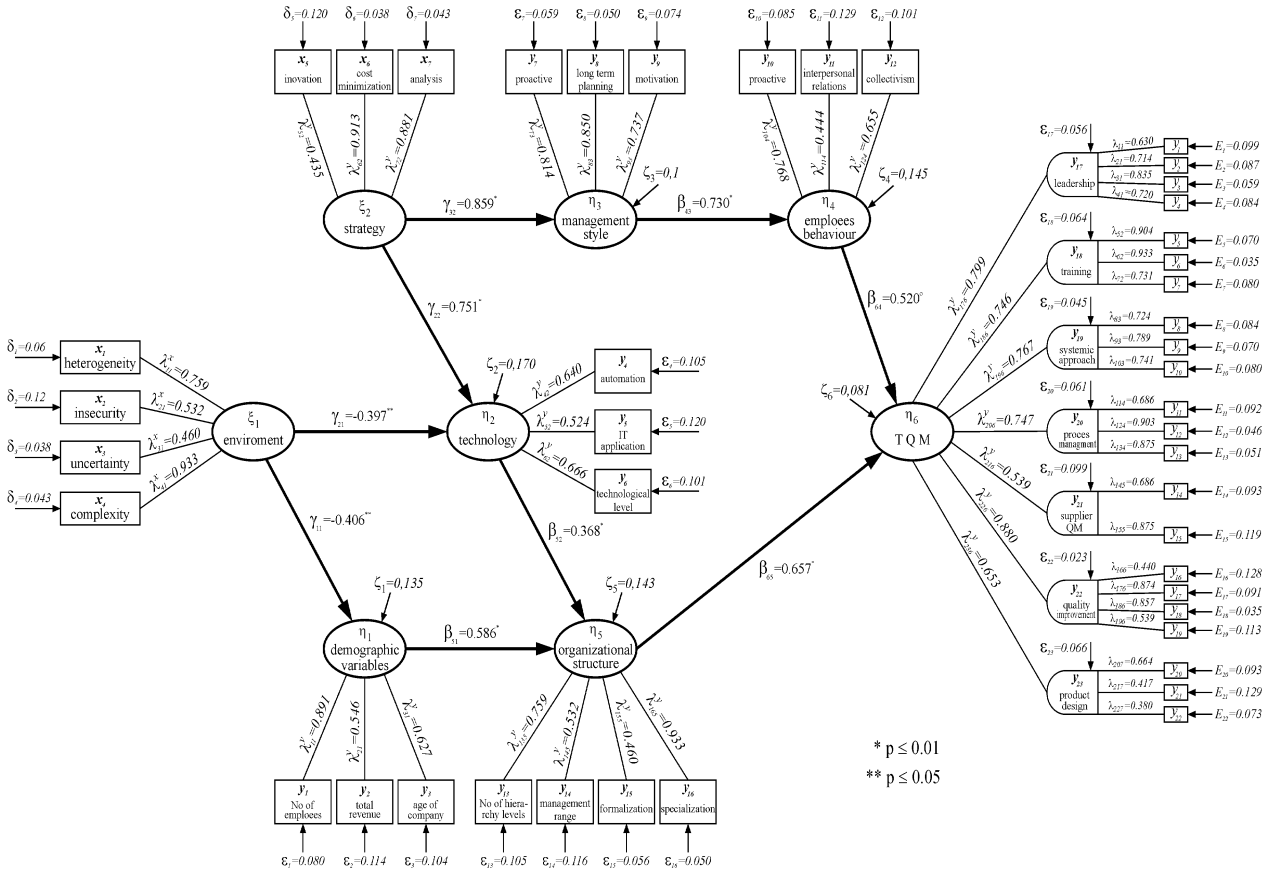

Figure 2. TQM in Serbian context model

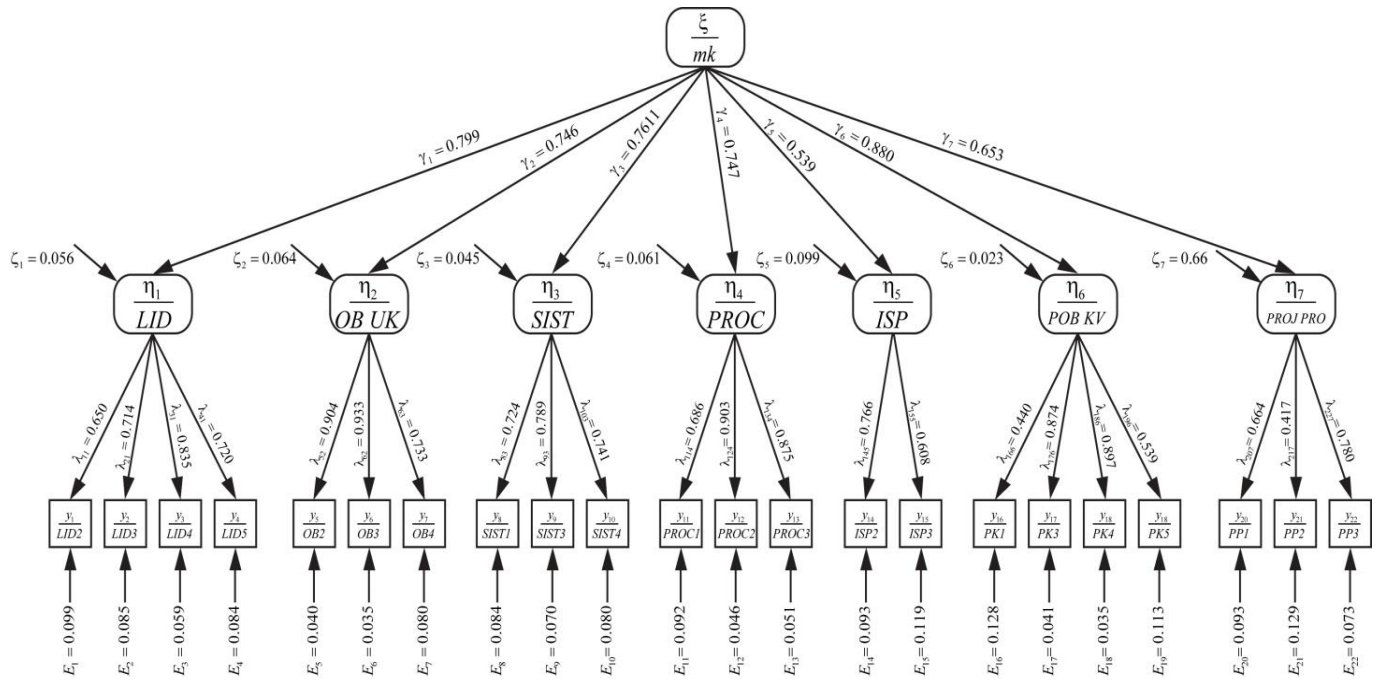

Figure 3. Model of QM in Serbian industrial companies

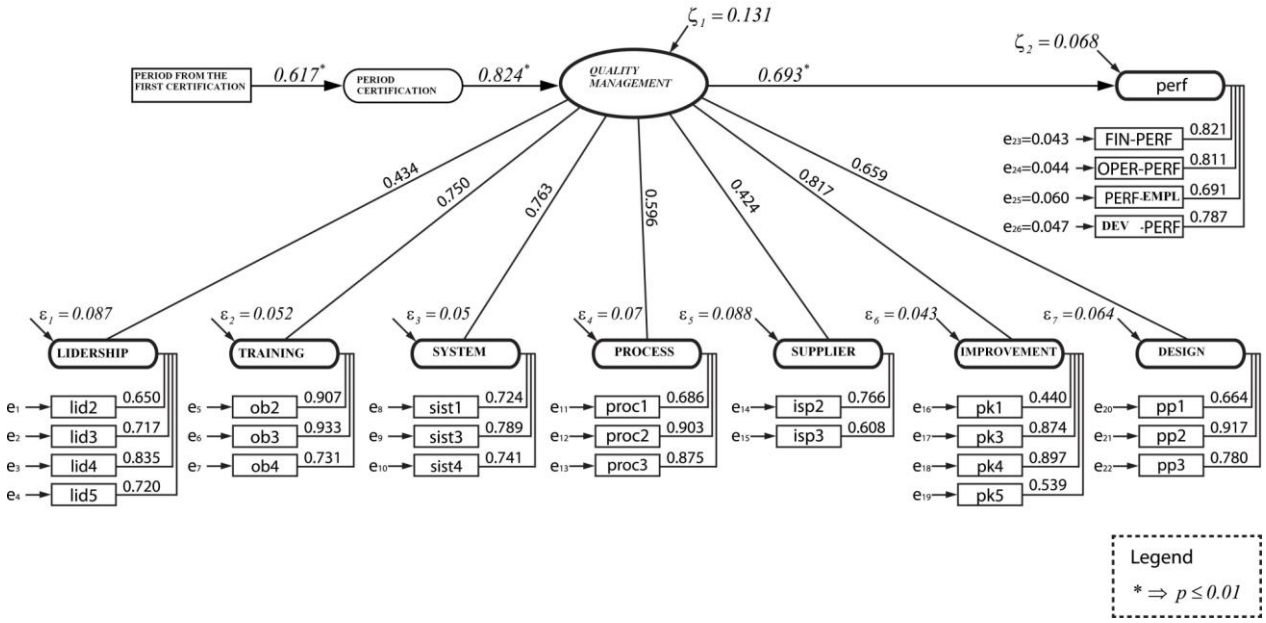

Figure 4. Model on ISO 9001 influences on performance across critical quality management factors in Serbian industrial companies

The main hypothesis of this research is: H1: The length of time period from the first certification achieves a significant impact on enterprise performances.

Auxiliary hypothesis are the following: H2: The length of time period from the first certification achieves a significant impact on QM practice and H3: The QM practice achieves a significant impact on enterprise performances.

Enterprise performance indicators have been considered in this survey based on recommendations in papers as a multidimensional concept form described by financial performances, employee performances, operational and development performances observed in the past three years. QM factors are defined in case study 2.

Modeling results are shown in Figure 4. Fit indices were adequate.

The results of this indicate that Serbian enterprises, earlier adopters of the ISO 9000 standard, have higher level of QM practices and, consequently, better performances.

Many previous studies also have empirically analyzed the impact of ISO 9000 implementation on the company performance.

This study results comply with the results by Benner and Veloso and Martínez-Costa [29], [30] arguing that the early adopter might have gained certain benefits from the implementation of ISO 9000.

4. CONCLUSION

SEM approach has proven to be a very versatile statistical toolbox for industrial engineering researchers, when used to confirm theoretical structures that exist in organizational systems.

Perhaps the greatest strength of SEM is the requirement of a prior knowledge of the phenomena under examination. In practice, this means that the researcher is testing organizational systems' theory which is based on an exact and explicit plan or design.

One may also notice that relationships among factors examined, as given in presented case studies, are free of measurement error because it has been estimated and removed, leaving only common variance.

Also, other very complex and multidimensional structures can be measured with SEM since it allows complete and simultaneous tests of all relationships.

It should be also pointed out that SEM is based on covariances whose stability depends on sample size and it requires special attention in organizational systems modeling.

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