DEVELOPING MULTIVARIATE CONFIRMATORY TECHNIQUE IN MEASURING STUDENTS SATISFACTION WITH EDUCATION PROCESS

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Key words: *Measurement model, Structural equations, Education satisfaction, Maximum likelihood estimation (MLE)*

Abstract

Mostly used multivariate procedure for testing both the construct validity and theoretical relationships among a set of multiple variables is structural equation modeling. SEM examines the structure of interrelationships expressed in a series of equations that depict all of the relationships among constructs involved in the analysis. Constructs are unobservable or latent factors represented by multiple variables. Theory based approach is required due to fact that all relationships must be specified before the SEM model can be estimated.

Structural equation modeling, as an extension of several multivariate techniques such as factor analysis and multiple regression that have studied only a single relationship between variables, is used in this paper to examine a series of dependence relationship simultaneously in framework of students satisfaction with education. Furthermore, individual parameter estimates that represent each specific hypothesis will be examined in terms of their statistical significance.

1. INTRODUCTION

In this paper SEM model is developed in a framework of students' satisfaction analysis. This model was based on research made on undergraduate and graduate students on Faculty of Economics, University of Split. The sample of this study consists of 238 undergraduate and graduate students.

Exogenous latent constructs, or latent variables, are foundation for the development of research questions that are measures of each construct. Those exogenous constructs relate to different dimensions of student satisfaction, that is endogenous construct. Exogenous constructs are Organization and Curriculum, Staff, Extracurricular activities and Financial aspects. Each of those constructs is presented with questions as indicators of satisfaction. In this research, each construct, exogenous and endogenous ones, is evaluated with five-point Likert scale of (1) strongly dissatisfied, (2) dissatisfied, (3) neither dissatisfied or satisfied, (4) satisfied, and (5) strongly satisfied. All of those indicators were developed on our own experience as members of Faculty community.

Organization and Curriculum, as a one of the exogenous construct, is identified by using five indicators or questions on satisfaction within questionnaire. Those indicators are faculty's name and reputation, infrastructure, course contents, accessibility of faculty building and its number of available parking places, and students` academic ability and motivation.

Staff construct consists of following dimensions: faculty staff professionalism, accessibility and expertise and courtesy and professionalism of non-educational staff. Likert scale measurement on satisfaction with those elements represents a Staff construct.

Students' Extracurricular activities certainly represent a component that shape overall satisfaction with higher education. Elements of Extracurricular construct are satisfaction with students` organizations, students` restaurants, internship opportunities and programs of additional education and programs of mobility.

Fourth exogenous construct in our SEM model is Financial aspect, which is represented with following indicators of satisfaction: tuition fees, availability and number of scholarships, additional costs of educational process and students` discounts and subsidies.

Total satisfaction with education process is the only endogenous construct in our SEM model. As its indicators we use, what we believe to be, crucial elements that determine satisfaction of each student with its education. Those elements are following: courses curriculum, feeling of belonging and acceptance, possibility of practical implementation of learned skills and acquired abilities and teaching process organization.

The measurement of student satisfaction can be useful to higher education institutions, to help them in identifying their strengths and areas for improvement. To grasp the complexity of learning experience, it is not enough to know the degree to which students are satisfied, it is important to understand the factors that contribute to student satisfaction.

The objective of this research is to identify educational experience that is associated with students' overall satisfaction with education process. Determining which features of the student experience are most closely related to satisfaction may provide information about actions that can be taken to maintain high levels of satisfaction and improve student learning.

The structure of the paper is organized as follows. The second section contains description of literature relevant to education satisfaction research. In third section, after brief description of SEM method, SEM model of students' satisfaction with educational process is developed and results of empirical findings are presented. The last section summarizes goals, findings and conclusions of the presented work.

2. LITERATURE REVIEW

Arbaugh, J.B. (2000) examined factors related to student satisfaction with internet courses based on technological media and student characteristics. Hypothesis in this study were tested using regression analysis. Based on the results, it appears that the flexibility of the medium and the ability to develop an interactive course play a larger role in determining student satisfaction than the ease or frequency with which the medium can be used.

Westerman, J.W. et al. (2002) examined predictors of student performance and satisfaction in management education. They conducted study that empirically examines different person-environment fit approaches.

Oldfield, B.M. and Baron, S. (2002) investigated student perceptions of service quality in higher education. Their focus was on the elements not directly involved with content and delivery of course units. Research was conducted using a performance-only adaptation of the SERVQUAL research instrument. Results suggested students' perceived service quality has three dimensions: "requisite elements", which are essential to enable students to fulfill their study obligations; "acceptable elements", which are desirable but not essential to students; and "functional elements", which are of a practical or utilitarian nature. Appleton-Knapp, S.L. and Krentler, K.A. (2006) investigated the relationship between student expectation and their satisfaction. The results of analysis show that students whose expectations were exceeded were more satisfied then those whose experience fell short of expectations. Strachota, E. (2006) analyzed student satisfaction in online courses. Final instrument included seven items that measured learner-content interaction, six items that measured learner-instructor interaction, eight items that measured learner-learner interaction and six items that measured general satisfaction. Through the use of multiple regression analysis revealed that three of the four constructs significantly contributed to the prediction model for online satisfaction whereas learner-learner interaction did not significantly contribute to the prediction model.

Letcher, D.W. and Neves, J.S. (2008) conducted an analysis of the determinants of overall student satisfaction using the Undergraduate Business Exit Assessment. A factor analysis of the student's responses resulted in the determination of eight factors of satisfaction. Regression results show that advising and quality of teaching in the subject have little or no effect on overall student satisfaction. Self-confidence, extra-curricular activities and career opportunities, and quality of teaching in general are the factors with greater impact on satisfaction. Wasburn-Moses, L. (2008) examined satisfaction among doctoral students. Findings of suvey that included 619 students indicate that students appear the most satisfied with mentoring and support. However, areas of concern include program structure, overall workload and quality of preparation in research.

Neither or abovementioned articles used structural equation modeling in testing specified relationships.

3. DEVELOPING SEM MODEL OF STUDENTS SATISFACTION WITH EDUCATION PROCESS

Structural equation modeling (SEM), an extension of several multivariate techniques such as factor analysis and multiple regression that have studied only a single relationship between variables, can examine a series of dependence relationships simultaneously. In simple terms, SEM estimates a series of separate, but interdependent, multiple regression equations simultaneously by specifying the structural model used by the statistical program. It is the best multivariate procedure for testing both the construct validity and theoretical relationships among a set of multiple variables. SEM foundation lies in two multivariate techniques: factor analysis and multiple regression analysis.

Although different ways can be used to test SEM models, all structural equation models are distinguished by three characteristics:

- Estimation of multiple and interrelated dependence relationships
- An ability to represent unobserved variables in these relationships and correct for measurement error in estimation process
- Defining a model to explain the entire set of relationships (correlations and dependences)

As combination of statistical methods, SEM aims to explain the relationship among multiple variables. By doing that, it examines the structure of interrelationships expressed in a series of equations that depict all of the relationships among constructs (the dependant and independent variables) involved in the analysis. Constructs are unobservable or latent factors represented by multiple variables (much like variables representing a factor in factor analysis). SEM is declared as confirmatory analysis; therefore theory based approach is required due to fact that all relationships must be specified before the SEM model can be estimated. SEM has the ability to incorporate latent variables in the analysis, as it can be measured indirectly by examining consistency among multiple measured variables, sometimes referred to as manifest variables, or indicators, which are gathered through various data collection methods (e.g., surveys, tests, observational methods). Confirmatory factor analysis (CFA) is used to test how well measured variables represent the constructs. When specifying the number of indicators per construct it is recommended to use four indicators (overidentified model) whenever possible, having three indicators per construct (just-identified model) is acceptable if other constructs have more then three and constructs with fewer that three indicators should be avoided (underidentified model). The main goal of SEM is to test the structure of relationships among the factors. Therefore, it is conceptually similar to conducting regression analysis using a set of summated rating scales, each summated rating scale representing a factor that can be recovered with factor analysis. Using SEM, measurement error is lowered and an overall test of fit is provided that will enable researcher to asses the validity of a prespecified set of hypotheses, each represented regression-like relationship between factors.

A complete SEM model consisting of measurement and structural models can be quite complex. Therefore, many researchers find it more convenient to graphically present model a visual form, known as path diagram. This path diagram of the relationships employs specific conventions both for the constructs and measured variables as well as the relationships between them. Estimation for each free parameter within SEM model can be conducted by several options. Early attempts at SEM estimation were performed with ordinary least square (OLS) estimation. These efforts were quickly replaced by maximum likelihood estimation (MLE), which is more efficient and unbiased when the assumption of multivariate normality is met. Although many alternative estimation techniques have become more widely available, MLE continues to be the most widely used approach and is the default in most SEM programs.

Maximum likelihood estimation (MLE) give valid results with sample size as small as 50, but the recommended minimum sample sizes to ensure stable MLE solutions are 100 to 150. It should be noted that as the sample size becomes large (>400), the method becomes more sensitive and almost any difference is detected, making goodness-of-fit measures suggest poor fit. As a result, sample sizes in the range of 150 to 400 are suggested.

If the proposed model properly estimates all of the substantive relationships between constructs and the measurement model adequately defines the constructs, then it should be possible to estimate covariance matrix between measured variables that closely matches the observed covariance matrix.

Developing measurement model is a critical step in developing SEM model in which each latent construct to be included in the model is identified and the measured indicator variables (items) are assigned to latent constructs. Its validity is usually declared through indicator that is called goodness-of-fit (GOF), which indicates how well the specified model reproduces the covariance matrix between the indicator items (i.e., the similarity of the observed and estimated covariance matrix). Each GOF measure is unique, but the measures are classed into three general groups: absolute measures, incremental measures, and parsimony fit measures. The difference between estimated actual observed covariance matrix (S) and estimated covariance matrix (Σ_k) is the key value in assessing the GOF of any SEM model. A Chi-square (χ^2) test provides a statistical test of the resulting differences.

With the χ^2 test in SEM, the smaller p-value, the greater chance that observed sample and SEM estimated covariance matrices are not equal. Thus, with SEM it is preferred p-value to be less than theoretical significance level (usually 5%).

When measurement model is validated and hypotheses that are based on relationships from one construct to another have been defined, it is required to specify structural model. This phase requires assigning relationships from one construct to another that are based on the proposed theoretical model.

The overall fit can be assessed using the same criteria as the measurement model: using χ^2 value for the structural model. Comparison between the overall fit should also be made with the measurement model. Generally, the closer the structural model GOF comes to the measurement model, the better the structural model fit, since the measurement model fit provides an upper-bound to the GOF of a conventional structural model. The researcher also must examine the individual parameter estimates that represent each specific hypothesis. A theoretical model is considered valid to the extent than the parameter estimates: significant and in predicted direction and nontrivial. Exogenous and endogenous latent constructs, described earlier in Introduction, are presented in Table 1.

Table 1: Observed indicators that are identifying constructs

<table>
<tr><th colspan="4">Exogenous constructs</th><th>Endogenous construct</th></tr>
<tr><th>Organization and Curriculum</th><th>Staff</th><th>Extracurricular activities</th><th>Financial aspects</th><th>Students` satisfaction</th></tr>
<tr><td>Faculty’s name and reputation</td><td>Faculty staff professionalism</td><td>Students` organizations</td><td>Tuition fees</td><td>Courses curriculum</td></tr>
<tr><td>Infrastructure</td><td rowspan="3">Faculty staff accessibility</td><td rowspan="2">Students` restaurants</td><td rowspan="3">Availability and number of scholarships</td><td rowspan="3">Feeling of belonging and acceptance</td></tr>
<tr><td rowspan="4">Faculty’s accessibility and number of available parking places</td></tr>
<tr><td rowspan="2">Internship opportunities</td></tr>
<tr><td rowspan="3">Courtesy and professionalism of non-educational staff</td><td rowspan="3">Additional costs of educational process</td><td rowspan="3">Practical implementation of learned skills and acquired abilities</td></tr>
<tr><td rowspan="2">Sports and entertainment facilities</td></tr>
<tr><td rowspan="2">Students` academic ability and motivation</td></tr>
<tr><td rowspan="2">Faculty staff being up to date with their respective fields</td><td rowspan="2">Programs of additional education and programs of mobility</td><td rowspan="2">Students` discounts and subsidies</td><td rowspan="2">Teaching process organization</td></tr>
<tr><td>Courses` contents</td></tr>
</table>

Path diagram shows the covariance structure in the analysis of the relationships between latent and manifest variables. In other words, two models are used to analyze the covariance structure. Measurement model describes the relations between latent and manifest variables, while the structural model defines the relationships only between the latent variables (exogenous and endogenous). From the Figure 1, two confirmatory factor models can bee seen, the first one with four latent exogenous variables and second with one latent endogenous variable that are presented by blue arrows. These two confirmatory factor models are integrated within structural model which is presented with red arrows. Specifically, there are four direct relationships between exogenous and one endogenous latent variable, while curved two-way arrows indicate intercorrelation among four exogenous variables. In this model, a total of 54 parameters are estimated using maximum likelihood method (ML).

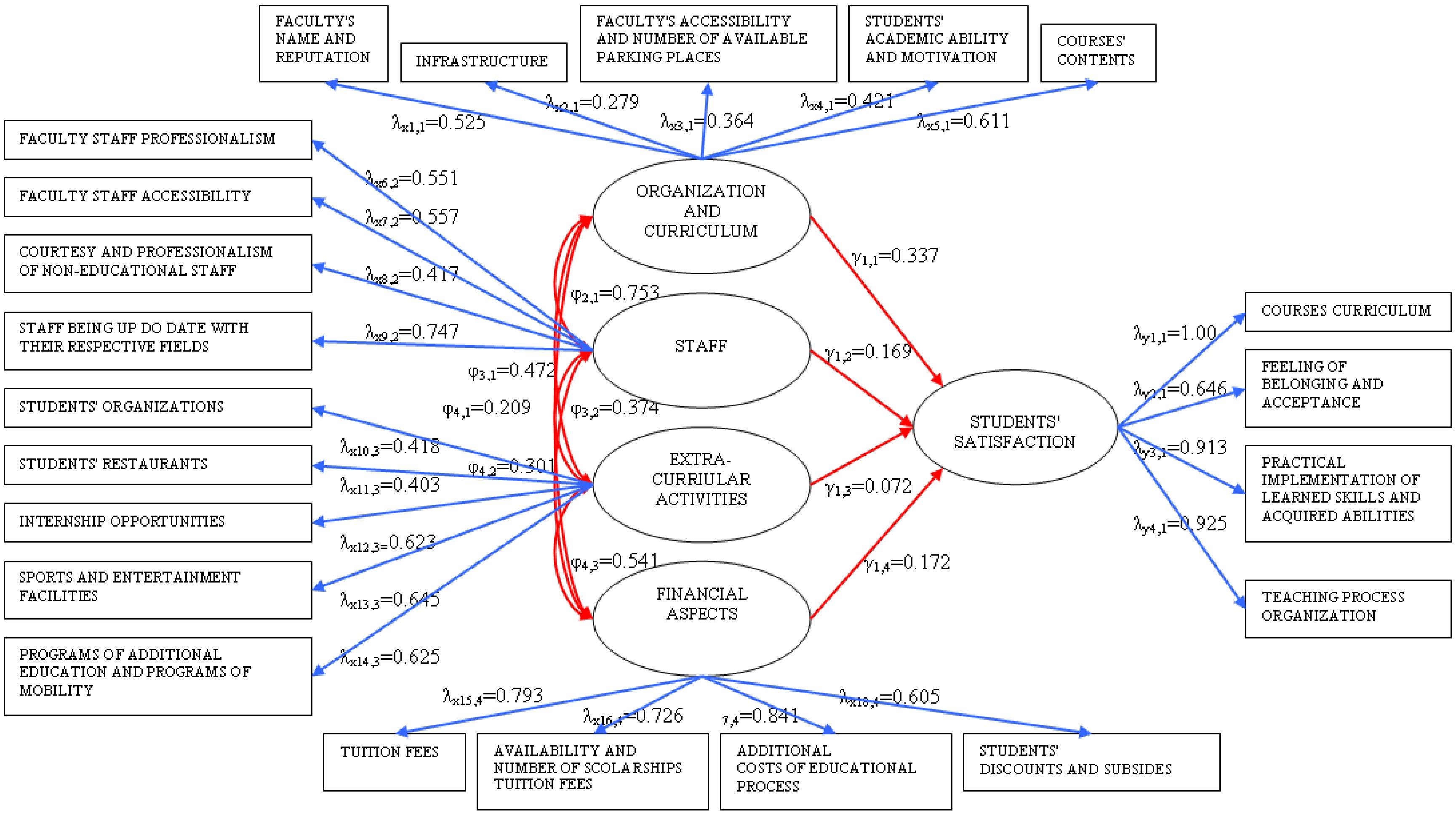

Figure 1: Path diagram of student' satisfaction with educational process

Empirical studies have shown that maximum likelihood estimation is efficient and unbiased when the assumption of multivariate normality is met. The path diagram shows 32 estimated parameters (latent constructs were measured with 22 manifest variables, dependence between exogenous constructs were assessed with 6 parameters and 4 parameters indicate relationship between exogenous and one endogenous variable). In addition, 22 error variance terms are estimated, but not shown in the figure. Therefore, total of 54 parameters are estimated, with 199 degrees of freedom. Measurement model validity depends on goodness of fit indicator and specific evidence of construct validity. Goodness of fit indicator shows how well the model reproduces the covariance matrix, i.e. it quantifies the differences between the observed and estimated covariance matrices. The statistical inference of goodness of fit is based on chi-square test. Chi-square value of 372.695 with 199 degrees of freedom confirms that overall model fits at significance level less than 0.01. However, alternative measures of fit are usually used to correct for the bias against large samples. The possible range of these indicators is 0 to 1, while values greater than 0.85 are typically considered acceptable. The goodness of fit index (GFI) equals 0.877 which indicates model validity. Among all estimated parameters only two are not statistically significant, i.e. direct effects of Staff and Extracurricular Activities on Students' satisfaction. However, their indirect effects can be computed by multiplying value of phi and gamma.

Table 2: Indicators of constructs validity with estimated direct and indirect effects on students' satisfaction

	Construct validity (average variance extracted)	Exogenous constructs dependencies			Direct effects	Indirect effects	Total effects
		Staff	Extracurricular activities	Financial aspects			
Organization and Curriculum	0.389	0.753	0.472	0.209	0.337	0.042	0.379
Staff	0.543		0.374	0.301	0.169	0.060	0.229
Extracurricular activities	0.512			0.541	0.072	0.109	0.181
Financial aspects	0.557				0.172	0.043	0.215
Students' satisfaction	0.776						

From Table 2 validity of each construct is confirmed according to the average variance extracted, i.e. AVE higher than 0.5 suggests adequate convergence. Moreover, in Table 2 total effects of each exogenous construct on Students' satisfaction are presented as the sum of direct and indirect relationships between them. Existence of indirect effects implies several mediated relationships. Organization and Curriculum have the strongest direct and total impact on Students' satisfaction and Extracurricular activities have the strongest indirect, but the lowest total and direct impact on Students' satisfaction.

4. CONCLUDING REMARKS

Structural equation modeling, as an extension of several multivariate techniques such as factor analysis and multiple regression that have studied only a single relationship between variables, is used in this paper to examine a series of dependence relationships simultaneously in framework of students satisfaction with education.

The objective of this research is to identify aspects of the educational experience that are associated with students' overall expression of satisfaction. Determining which features of the student experience are most closely related to satisfaction may provide information about actions that can be taken to maintain high levels of satisfaction and improve student learning. The measurement of student satisfaction can be useful to higher education institutions, to help them in identifying their strengths and areas for improvement.

In path diagram showed earlier, exogenous constructs relate to different dimensions of Students' satisfaction, that is endogenous construct. Exogenous constructs are Organization and Curriculum, Staff, Extracurricular activities and Financial aspects. In this model, a total of 54 parameters are estimated using maximum likelihood method (ML). The path diagram shows 32 estimated parameters. In addition, 22 error variance terms are estimated, but not shown in the figure.

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Among all estimated parameters only two are not statistically significant, i.e. direct effects of Staff and Extracurricular activities on Students' satisfaction. Organization and Curriculum have the strongest direct and total impact on Students' satisfaction and Extracurricular activities have the strongest indirect, but the lowest total and direct impact on Students' satisfaction.

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