A Structural Equation Model for the Study of Education Supply Chain Management Practices in Private Universities in Malaysia

Basu Govindaraju[1*], John Jeyasingam[2], Md. Mamun Habib[3], Uvarani Letchmana[4]

Corresponding Author: *Faculty of Business, AIMST University, Malaysia
[2]Faculty of Business, AIMST University, Malaysia,
[3]School of Business, Independent University, Bangladesh,
[4]School of General and Foundation Studies, AIMST University, Malaysia,
[1]basu@aimst.edu.my; basugovin16@gmail.com
[2]aimst.drjohn@gmail.com
[3]mamunhabib@iub.edu.bd
[4]uvarani@aimst.edu.my

Abstract: Structural Equation Modeling (SEM) is a method that is frequently applied by business researchers to assess empirically new theoretical proposals articulated by means of complex models. Hence in this study SEM was engaged to scrutinize the impact of SCM practices on the performance of higher education in Malaysia. Firstly, the SCM practices survey was designed to investigate the main factors which influence supply chain practices in universities in Malaysia. Amongst the pool of constructs include: customer relationship, supplier relationship, information technology, information sharing, and innovation. Next, based on the SEM, the intensities of SCM practices of the universities were quantified in accordance with those constructs. The findings were supported by empirical evidence, as the study established that only information sharing and information technology had a significant positive relationship and impact on the universities performance. This paper provides a greater understanding of the interactions between the key elements of SCM practices associated with university performance and their impact on universities in Malaysia.

Keywords: *SEM, SCM practices, constructs, University Performance.*

1.0 Introduction

Though SEM practices may be less than optimal among social science studies, the use of SEM as a powerful data analysis and causal modeling tool seems to be the most preferred method of estimation of performance by scholars.

The potential merits offered by SEM to empirically analyse theoretical relationships are the product of a sum of multidisciplinary contributions, which started in the seventies [1]. SEM is based on three main pillars [1].

i. the path analysis;
ii. the synthesis of latent variables and measurement models; and
iii. methods to estimate the parameters of structural models.

Literature search reveals that there have been several significant changes in recent years to the way researchers employ SEM as a means of data analysis [1]. Based on the structural equation modeling (SEM) methodology, this research extends the knowledge contributed in the previous study by providing further insight into the inter-relationships which exist between the hypothesized latent variables (SCM components) and their underlying attributes on university performance (UP) in Malaysia.

SEM is a multivariate statistical technique that allows assessment of both direct and indirect relationships among latent variables [3]. Although it is widely applied across many disciplines, its application in social science research is very noticeable. The study also contributes to the development of methodological constructs by describing the application of SEM for analyzing complex interactions of the latent factors within the SCM industry domain.

SEM methodology is yet to gain an established position in social science research despite its acclaimed advantages over other contemporary techniques. [4] and [19], Have all demonstrated SEM as a viable tool for quantifying relationships

for resolving complex cases within the various management domains. This study aims to extend that knowledge contributed in previous studies on the application of SEM to the performance of private universities.

Thus, the data from Malaysian private universities (PUs) will be studied in order to develop a structural equation model to analyse the interdependent relationships among the latent variables the dependent variables.

2.0 Literature Review

2.1 SCM and University Performance

SCM and its related practices are concepts that are valuable dimensions in dealing with the incorporation and synchronization of supply, demand and affiliations within institutes in order to satisfy the final customers in a more effective and profitable manner [5]. SCM practices are those managerial actions undertaken to improve the performance of the integrated supply chain network [6]. SCM practices are also referred to as the complete set of activities which contribute to the effectiveness of the internal supply chain [5]. Accordingly, SCM practices include the organization's planning, strategy and collaboration among the internal functions as well as the coordination of the supply chain across organizations.

Further, it was found that SCM practices are depicted from different viewpoints with the aim of refining organizational performance. [7] Summarizes SCM definitions into three various subjects, such as activities, benefits and components. The initial theme of SCM definitions with regards to activities comprises the movement of resources and facts, and networks of business affairs, concentrating on both in-house (within organization) and exterior (outside the organization) environment. Second the results from the real implementation of SCM approaches might enhance value and raise customer pleasure. Third, provisions of SCM are about organizations' tasks and procedures which contain the supply chain. Overall, SCM practices are categorized into demand and customer management, customer and supplier relationship, volume and source management, service performance, information and technology management, service supply chain and order processing management [8].

The escalating issues among the Malaysian private universities are about the leading causes for the differences in their performances. Although, every university claims that it is equipped with all the basic amenities, facilities, functional departments, SOPs, shareholders and stakeholders, they are still unable to obtain a good number of students or sustain their performances [9]. Generally speaking, most of the universities lack in positioning their resources righteously such as being inconsistent in their partner relationships, shaking in their communication system, outdated information technology and with expired innovation 10]. With regards to the RBV theory, the competitiveness of any organization is established on the resources and the competencies it possesses [11].

Accordingly, the higher level of performance of a university will be seriously influenced by the way it manages its resources such as the growth of the disciplines, student satisfaction, job opportunities, recognition and facilities. These ultimate resources are a portion of the supply chain management practices and they have not been polished by practitioners for a decade [12]. Therefore this study tends to analyze SCM practices and its allied instruments for the betterment of universities' operations.

The research objective is to investigate the impact of SCM practices on Universities performance directly or indirectly. Based on the literature, SCM practices have been shortlisted into five core elements: strategic supplier partnership, strategic customer partnership, information sharing, information technology and innovation [13]. The results of the study also suggest that a real SCM relationship exists in the university's operations with the support of SCM practices in order to achieve sustainable performance. In due course, the relationship shall be tested by using rigorous statistical analysis to prove the expected research outcome. Figure 2.1 below shows the five dimensions of supply chain practices in detail and the following hypotheses are proposed.

H1-Strategic supplier partnership has a significant impact on sustainable performance of PUs.

H2- Strategic customer partnership has a significant impact on sustainable performance of PUs.

H3- Information technology has a significant impact on sustainable performance of PUs.

H4- Information factor has a significant impact on sustainable performance of PUs.

H4-Innovation factor has significant impact on sustainable performance of PUs.

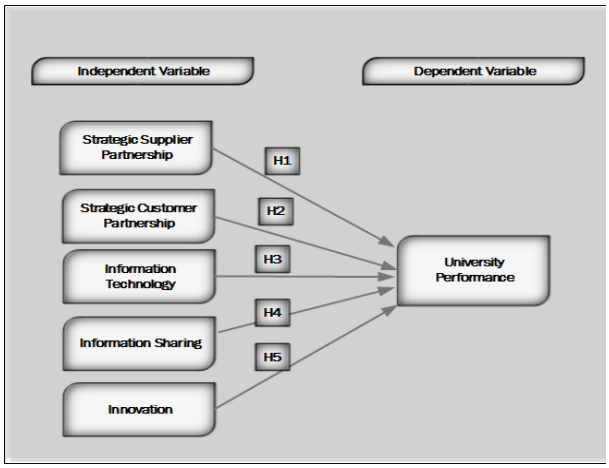

Figure 2.1: Hypothesized model showing relationships between the latent variables

3.0 Methodology

A survey questionnaire was designed to determine the linkage between SCM practices and university performance (UP). Before running the survey in the private universities, a pilot test was conducted, which involved 30 experts from the academia and the manufacturing industry to ensure that the objectives of the questionnaire were clear, the questions were well-structured, understandable and the metrics were appropriate and adequate for measuring SCM in PU's.

All the items in the questionnaires were identified with codes namely SSP1, SSP2, SSP3, SSP4, SSP5 and SSP6 for strategic supplier partnership. These exclusive codes were designed to ease the process of structural model design in confirmatory factor analysis (CFA) [14]. Each of these observed variables are linked to the latent variables (five variables). SEM involves four stages of evolution: model specification, model estimation, model evaluation, model modification by using AMOS23, [1].

In the first stage (specification), the model is developed and tested. In the second stage (estimation), the parameter estimation and model fit functions are executed [1]. In the evaluation stage, the process of evaluating a structural equation model with goodness of fit indices is executed. In the modification stage, adjustments shall be made to the model in order for the model to be fitted to the sample data [15].

Various indicator indices have been agreed upon among researches to measure the fitness of the model [16]. This mode of theory testing appears to be justifiable as long as it can be safely assumed that the theoretical fit and the empirical fit are perfectly matched. The better the empirical fit the better the significance of the parameter estimates in the theoretical model [14]. Besides that, modification indices in combination with theoretical considerations provide the basis for improvement of the original model in this study. The data analysis was carried out in accordance with a two stage methodology offered by ref [17].

Firstly CFA was used to assess the adequateness of the measurement model. Secondly, structural equation modeling was conducted to confirm the structural model.

3.1. Structural Equation Modeling (SEM)

SEM was employed in this research to investigate the inter-relationships between six constructs (five independent variables and one dependent variable) of the hypothesized model. The procedures of SEM was necessary because of the ability to model latent variables, correct and specify measurement errors and their covariance structure, and avoid multi-collinearity that would have resulted if other statistical techniques such as multiple regression was employed [18].

Ideally, SEM consists of two models, a measurement model and a structural model. The measurement model is concerned with the level of fitness among various exogenous variables to measure the latent variables [19]. The measurement model within the structural equation incorporates estimates of measurement errors of the exogenous variables and their envisioned latent variables [20]. On the other hand, the structural model simulates the inter-relationships between underlying variables and allows for direct, indirect and correlation effects to be analyzed unlike regression models which allow for only direct relationships. The researcher employs the structural model to make inferences about relationships between latent traits and the mechanism underlying them. The next two sub-sections demonstrate how it was conducted.

Confirmatory factor analysis (CFA) was employed to create confidence and strength in the measurement model [1]. Accordingly, CFA allows for assessment of fit between observed and a priori conceptualized, theoretically grounded model that specifies the causal relationships between the latent factors and their observed variables. In order to test the strength of the measurement model, CFA was used at recommended levels of goodness of fit (GOF) measures, reliability analysis, and convergent validity [20].

3.2 Model Fit

According to usual procedures, the goodness of fit is assessed by checking the statistical and substantive validity of estimates, the convergence of the estimation procedure, the empirical identification of the model, the statistical significance of the parameters, and the goodness of fit to the covariance matrix [21]. Several well-known goodness-of-fit indices (GFI) were used to evaluate the model fit: the chi-square X2, the comparative fit index, the unadjusted GFI, the normal fit index (NFI), the Tucker-Lewis index (TLI), the RMSEA and the standardized root mean square error residual. The accepted fitness indices estimation is as in Table 1below.

Table 1: Suggested cut-off values for SEM fit indices

Fit Index	Cut-off Values	References
Absolute fit Measures:		
Chi-square/df	≤5.0 ≤	
SRMR	≤.0.08: ≤.05	
RMSEA	≤0.08	
Incremental fit Measures:		[14], [1], [28], [29], [16].
NFI	≥ .90	
CFI	≥ .90	
TLI	≥ .90	
Parsimonious fit Measures		
PCFI	>0.5	
PNF	>0.5	

Source: Adapted and Adopted from Hair et al., 2013.

3.3 Validity Analysis

3.3.1 Reliability analysis was used to determine how the standardized loadings of the measurement paths correlated with their respective latent variables. A threshold of 0.7 was regarded as an acceptable level, which meant that since the loading were correlations, a loading of 0.7 implied that 50 per cent of variance in measured constructs was attributable to the latent variables [22],[19]. The standardized solution of the final model is shown in Figure 2. All path loadings of the measured variables are above 0.7. They are therefore satisfactory.

3.3.2 Convergent Validity

This validity measures the internal consistency of measured variables. For Cronbach's, a cut-off value of 0.7 is used to indicate an acceptable level of internal consistency [23], [24]. As indicated in Table 2, all the features in the final model show values above the cut-off threshold and therefore considered reliable. The average variance extracted (AVE) must be above the cut-off- value of 0.5 or greater to propose adequate convergent validity [1].

3.3.3 Discriminant validity

Discriminant validity is a measure, the degree to which scores on constructs do not correlate with other, which are not designed to assess the same variable [24]. Exogenous (latent) constructs must be independent to each other, in which, the correlation between them should not exceed 0.85 and In order to achieve discriminant validity of the construct [25]. If the correlations were greater than 0.85, one of the highly correlated constructs must
be removed or else multi-collinearity will exist as a problem.

4.0 Analysis and Results

4.1 Assessment of the Measurement Model

The entire constructs predicting university performance was measured through confirmatory factor analysis (CFA). As the viable model is the one that fulfills recommended GOF measures before it is finalized for SEM analysis [25] and [26]. Grounded on a few trials and elimination of some observable variables, the model refinement was achieved to improve its fit to the recommended level (Table 2). The eliminated observable variables were from IT, IS, SSP, SCP and Innovation. They were deleted after the first and second trials due to low correlations (loadings) with their latent factors in the SEM. A summary of GOF attributes for both the initial and final model is shown in Table 2 and indicates that the best-fit measurement model is supported satisfactorily.

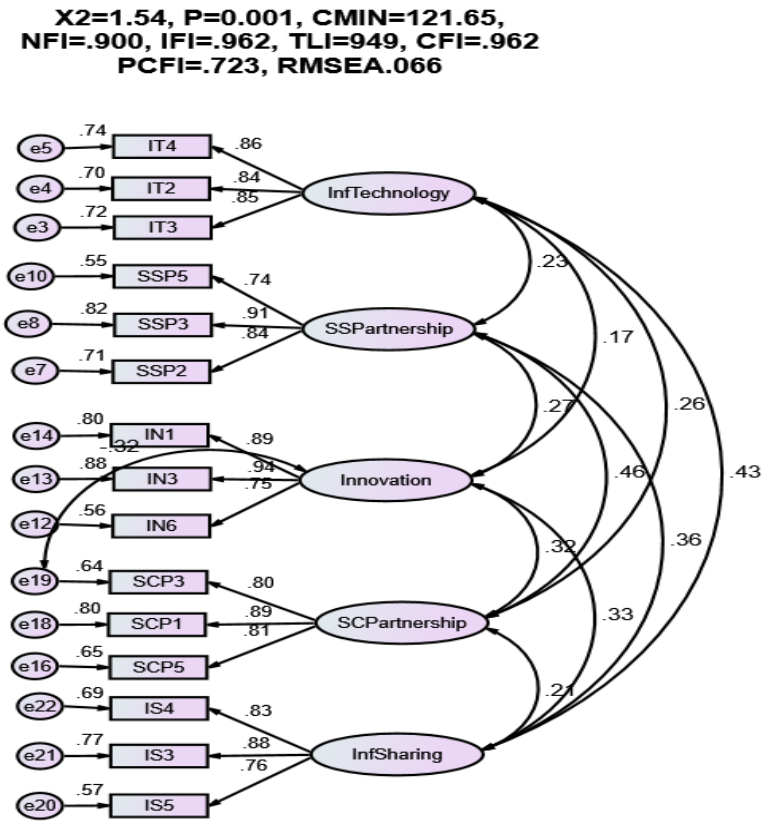

Figure 2: A CFA Measurement Model of SCM Practices

Table 2: Structural Model Fit Results for Universities Performance

Model	NPAR	CMIN	DF	P	CMIN/DF	RMSEA	IFI	TLI	CFI
Default	41	121.656	79	0.001	1.54	0.66	0.962	0.949	0.962
Saturated	120	0	0	0	0	0	0	0	0
Independence	15	1216.221	105	0	11.583	0.291	0	0	0

The standardized estimated loading for these CFA was successfully performed by removing all redundant items. As the goodness of fit indices were improved, the modified model showed a better fit to the data ($x2$ = 121.656, df = 79, P = .001, N = 126). The IFI = .962, CFI = .92, TLI = .949, RMSEA =.066 and $x2$ /df = 1.54. Eventhough the chi-square was still significant. These values suggested that the model fitted the data adequately. As discussed earlier, it is commonly accepted that the chi-square estimate would potentially reject valid models when sample size was large [27]. Confirming that the model fitted the data adequately and the correlations between the underlying factors were less than 0.85 (see the values)

Table 3: Regression Weights and Standardized Regression Weights: SCM Practices

Hypotheses Path			Standardized Regression Weights	Regression Weights			
			Estimate	Estimate	S.E.	C.R.	P
IT3	<---	InfTechnology	0.849	1			
IT2	<---	InfTechnology	0.838	1.249	0.116	10.77	***
IT4	<---	InfTechnology	0.859	1.395	0.127	11.021	***
SSP2	<---	SSPartnership	0.843	1			
SSP3	<---	SSPartnership	0.906	1.191	0.108	11.064	***
SSP5	<---	SSPartnership	0.739	0.903	0.098	9.174	***
IN6	<---	Innovation	0.75	1			
IN3	<---	Innovation	0.937	1.286	0.122	10.564	***
IN1	<---	Innovation	0.894	1.248	0.12	10.358	***
SCP5	<---	SCPartnership	0.808	1			
SCP1	<---	SCPartnership	0.892	1.012	0.094	10.722	***
SCP3	<---	SCPartnership	0.801	1.017	0.105	9.66	***
IS5	<---	InfSharing	0.756	1			
IS3	<---	InfSharing	0.879	1.296	0.139	9.331	***
IS4	<---	InfSharing	0.829	1.179	0.13	9.064	***

4.2. Structural Model

Having established confidence in the measurement model, a final structural equation model with standardized coefficients on the structure paths is shown in Figure 2. The direction of the arrows indicates the direction of the assumed relationships between variables. The significance of the path coefficients corresponding to the five hypotheses was tested using t-values (one-tailed) at 5 per cent significant level. Therefore, a hypothesis is rejected for p-value > 0.05 and accepted for p-value < 0.05, [22].

The structural model results (Figure 3; Table 4) show that this empirical study had achieved a stable model fit. The fit statistics of the proposed hypothetical research model were as follows; (x2 =108.399, df = 74, P = .006, *N* = 126). The IFI = .965, CFI = .964, TLI = .948, RMSEA = .061, and *x*2 /df = 1.465. In general, all fit indices were within the recommended levels as suggested by the model fit [1]. The structural equation model was analyzed further to test the hypotheses of this study to find the significance level of each path.

The results of hypotheses test are presented in Table 5, below. The path results show significant paths and significant levels of SCM practices towards university performance. Out of the five paths, two paths were found to be significant. They were information technology and information sharing (p< .05). Supplier partnership, customer partnership and innovation factors were found to be insignificant.

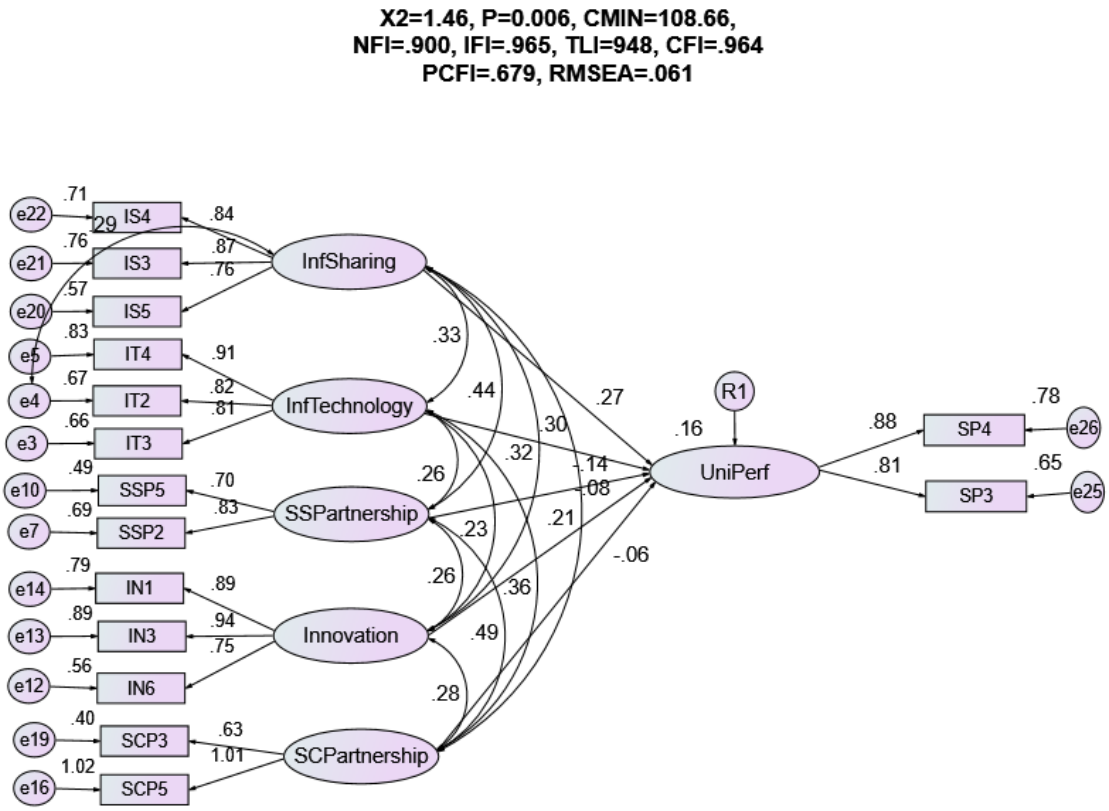

Figure 3: Structural Model of University Performance

Table 4: Structural Model Fit Results

Model	NPAR	CMIN	DF	P	CMIN/DF	RMSEA	IFI	TLI	CFI
Default	46	108.399	74	0.006	1.465	0.061	0.965	0.948	0.964
Saturated	120	0	0	0	0	0	0	0	0
Independence	15	1050.939	105	0	10.009	0.268	0	0	0

Table 5: Testing Hypotheses Using Standardized Estimates (Hypothesized Model for University Performance)

Hypothized Path			Estimate	S.E.	C.R.	P	Support
UniPerf	<---	InfTechnology	0.457	0.175	2.612	0.009	Yes
UniPerf	<---	SSPartnership	-0.193	0.195	-0.99	0.322	No
UniPerf	<---	Innovation	-0.106	0.135	-0.787	0.431	No
UniPerf	<---	SCPartnership	-0.059	0.122	-0.478	0.633	No
UniPerf	<---	InfSharing	0.355	0.164	2.161	0.031	Yes

Notes: * p<0.05, ** p< 0.01 (two-tailed test).

5.0 Discussion

This study examined the interactions between key components of SCM practices and their influence on university performance (UP). The test results provide support for the proposed linkages among the model's variables as well as valuable insights through which SCM practices influence UP. For instance, it confirmed the existence of a medium level relationship between information sharing and information technology. An obvious implication is that the severity of SCM practices attributed to such outcomes as performance failure of chosen

universities, and poor customer and supplier relationship will have a profound effect on the relationship between the SCM practices which can give rise to undesirable consequences in the universities overall performance.

Also, information sharing was found to have a significant relationship with information technology, implying that these two factors could have a dual impact on university performance. It is probably because of any noticeable lapse on the side of the supplier and customer strategic relationship. Furthermore, a strong path coefficient between SSP and SCP (β0.49) suggests that it is not impossible to have a harmonious relationship with university performance.

This is further verified by another proposition supported by the findings. SCP factors had a weak influence on university performance with a path standardized loading of (β0.06). This indicated that respondents had reasonable concerns about issues related to SCM practices.

Overall only two hypotheses were moderately supported by the result. They are information sharing (β=0.36) and information technology (β=0.46). It is informative to particularly observe that only these two factors out of five components showed a significant impact on UP. This is however in line with the works of [12].

These findings could be attributed to the fact that respondents who were mainly academicians and staff in the private universities perceive communication factors associated with an organization as the most critical concern to affect the overall performance of such universities. The practice of SCM is relatively new in Malaysian higher education making it more difficult to understand the full implications of SCM. However, the result indicates that SCM and its related practices have medium level of impact on UP. Additionally, the correlation between SCM relationship and UP showed a minimal significance as only16 per cent (R^2.16) of variance in UP could be explained by the SCM factors. Although UP is not considered as project performance within the context of university performance, the findings were consistent with the study by [10].

6.0 Conclusion

This study addressed the importance of SCM and its related practices towards universities performance. Few studies have however recognized the need to examine the hidden relationships between SCM variables and their impact on organizational performance. Most of these studies focused on manufacturing and some on service industries. This study exclusively focused on the education sector . A hypothesized model was developed based on the outcome of a previous study and tested using SEM techniques. It was discovered that only information sharing and information technology out of five SCM components used for the research had a high impact on university performance. It was also found that virtually all the SCM components were related to one another with varying degrees of relationship. However, the results confirmed that all these factors had a medium level of relationship among them.

The final structural model has a number of implications for research and practice. First, the study proposed and tested a structural equation model that examined the interdependent relationships between SCM practices associated with university performance. Thereby extending knowledge contributed in previous studies on the application of the factor analysis approach. Second, the findings confirmed the existence of a relationship between information technology and information sharing and highlight the importance of these key constructs which may help in further studies in the field of education SCM. This is currently being explored in an on-going research. Third, the results of this study extend previous knowledge about university performance by using data generated from Malaysian private universities performance, meaning that the outcome could be used to compare findings from other parts of the world. The findings also have implication for private university practitioners particularly in Malaysia.

Reference

[1]. Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. Multivariate Data Analysis: Overview of Multivariate Methods (Seventh Ed.). Pearson Prentice Hall: Upper Saddle River, New Jersey: Pearson, Education International, 2010.

[2]. Benjamin T. Hazen, Robert E. Overstreet, Christopher A Boone, (2015) "Suggested reporting guidelines for structural equation modeling in supply chain management research", The International Journal of Logistics Management, Vol. 26 Issue: 3,pp. 627-64.

[3]. Carvalho, J and Chima, F. "Application of Structural Equation Modeling in Social Science Research", American International Journal of Contemporary Research, Vol.4 (1), 2014.

[4] Hui, E.C.M. and Zheng, X. (2010), "Measuring customer satisfaction of FM service in housing sector: a structural equation model approach", Facilities, Vol. 28 Nos 5/6, pp. 306-320.

[5] Ibrahim and Hamid. Supply Chain Management Practices and Supply Chain Performance Effectiveness. International Journal of Science and Research (IJSR), Vol.3, No. 8, 2014.

[6] James, W. H. Supply chain management practices in small retailers. International Journal of Retail and Distribution Management, Vol. 40, No. 6, pp. 427-450, 2012.

[7] Stock, J., Boyer, S. and Harmon, T. Research Opportunities in Supply Chain Management. Journal of the Academy Marketing Science, Vol. 38, No. 1, pp. 32-40, 2010.

[8] Chong, A. Y. L., Chan, F. T. S., Ooi, K.B. and Sim, J. Can Malaysian firms improve organisational / innovation performance via SCM? Industrial Management and Data Systems, Vol.11, No.3, pp. 410-431, 2010.

[9] Williams and Lim. Private Higher Education in Malaysia: Are we heading towards a crisis? Think-tank, Penang Institute, Making Ideas Work, 2015.

[10] Govindaraju., John, J., Mamun, H., Uvarani, L. and Ravindran. R. The Impact of Supply Chain Management Practices on the Performance of Private Universities of Malaysia. International Journal of Supply Chain Management, Vol.6, No.3, 2017.

[11] Dandagi,S., Bhushi, U., Bagodi, V. and Sinha, D. Strategic management of technical university:structural equation modeling approach, Journal of Modelling Management, Vol.1 No.1, pp.75 – 90, 2016.

[12] Basu. "Integrated education supply chain management model to achieve sustainability among Malaysian private universities". Ph.D Thesis, 2018.

[13] Basu G., John, J., Habib, M., Uvarani, L, (2019), "The Significance of Reliability and Validity analysis on Education Supply Chain Management Practices" International Journal of Supply Chain Management. Vol. 8, No. 4, 2019.

[14] Byrne, B. M. Structural Equation Modeling with Amos. Basic concepts, Application and Programming. 3rd Edition. Routledge, 2016.

[15] Bian, H. Structural Equation Modeling with AMOS II, 2011.

[16] Schumacker, R. E., and Lomax. A Beginner's Guide to Structural Equation Modeling, 4th Edition. New York: Routledge Taylor and Francis Group, LLC, 2013.

[17] Gerbing, D, and Anderson, J. "An updated paradigm for scale development incorporating uni-dimesionality and its assessment", Journal of Marketing research, pp. 186-192, 1998.

[18] Henseler, J. (2011), "Why generalized structured component analysis is not universally preferable to structural equation modelling", Journal of the Academy of Marketing Science, Vol. 40, pp. 402-413.

[19] Doloi, H, Sawhney, A. and Iyer, K.C. (2012). Structural equation model for investigating factors affecting delay in Indian construction projects. Construction Management and Economics,iFirst, 2012, 1-16.

[20] Kline, R. B. Assessing statistical aspects of test fairness with structural equation modelling.Educational Research and Evaluation: An International Journal on Theory and Practice, Vol.19(2-3), pp. 204-222, 2013.

[21] Senthikumar, N. and Arulraj, A. (2011). SQM-HEI determination of service quality measurement of higher education in India. Journal of Modelling in Management, 6(1),60-78.

[22] Tabachnik and Fidel. Using Multivariate Statistics, 6th Edition- Pearson, 2013.

[23] Umasekaran, Roger, J. and Bougie. Research Methods for Business: A skill Building Approach, 7th Edition, Paperback, 2016.

[24] Hamdan Said, Badru, and Shahid. "Confirmatory factor analysis (CFA) for testing validity and reliability instrument in the

study of education". Australian Journal of Basic and Applied sciences,Vol. 5, No.12, pp.1098-1103, 2011.

[25] Zainudin, A. (2012). Research Methodology and Data Analysis, 5th Edition, Shah Alam: University Technology MARA Publication Centre, UitM Press.

[26] Bagozzi, R. P., & Yi, Y. Evaluation of Structural Equation Models. Journal of the Academy of Marketing and Science, Vol. 16(1), pp. 74-94, 1988.

[27] Kline, R. B. Assessing statistical aspects of test fairness with structural equation modelling. *Educational Research and Evaluation: An International Journal on Theory and Practice, 19*(2- 3), 204-222.

[28] Raykov, T., and Marcoulides, G. A .A first course in structural equation modeling, 2nd ed. Mahwah, NJ: Lawrence Erlbaum-Research Gate, 2006.

[29] Arbukle, J. L. IBM, SPSS - AMOS, Users' Guide, Version 22, Chicago: Small Waters, 2013