

# Enhancing Supply Chain Management for the Universities: ITESCM Model Perspective

Bishwajit Banik Pathik\*, Dr. Md. Mamun Habib#,

\*Dept. of Electrical and Electronic Engineering, American International University-Bangladesh (AIUB)  
83/B, Road 4, Kemal Ataturk Avenue, Banani, Dhaka, Bangladesh

\*bishwajit.b.pathik@gmail.com

#Dept. of Operations Management, American International University-Bangladesh (AIUB)  
83/B, Road 4, Kemal Ataturk Avenue, Banani, Dhaka, Bangladesh

#mamunhabib@gmail.com

**Abstract**— This exploratory research addresses the application guidelines of ITESCM (Integrated Tertiary Educational Supply Chain Management) model for better Supply Chain Management in Universities. This study encompasses education supply chain, research supply chain and educational management as major constituents of ITESCM. Four main activities, includes education development, education assessment, research development, and research assessment in four aspects, namely Programs Establishment, University Culture, Faculty Capabilities, and Facilities were investigated at three decision levels. The ITESCM model was formulated based on the secondary data, i.e. analysis of the literature, and primary data, i.e. interviews with stakeholders of tertiary academic institutions. Model structures were defined and confirmed by 493 respondents, representing University administrators of world-ranking universities, faculty and staffs, employers, and graduates. The resulting structure was subsequently evaluated for accuracy and validity by multiple linear regression (MLR) analysis and the structural equation modeling (SEM) technique. This empirical study represents two contributions in terms of human resource contribution and research contribution to the end customer, i.e. the society. Model evaluation by actual implementation is suggested for prospective investors or current university administrators.

**Keywords**—ITESCM, supply chain management (SCM), educational management, graduates, research outcomes, education supply chain, research supply chain.

## 1. Introduction

Supply chain management (SCM) contributes the business organization to compete in the dynamic global market. Amidst fierce competition in all industries, SCM has gradually been embraced as a

proven managerial approach to achieving sustainable profits and growth. This is accomplished primarily by focusing on the whole SCM process to deliver the right products or services, in the right quantity, to the right place, at the right time and with the maximum benefits. Numerous literatures suggest a need to examine the phenomena of SCM more closely to define clearly the term and concept, to identify those aspects that contribute to effective SCM, and to suggest how the adoption of an SCM approach can affect corporate strategies, plans, operations and performance.

The goal of SCM is to integrate activities across and within organizations for providing the customer value. This would also be applicable to the academia, which represents a type of non-profit organizations. One of the main goals of an educational supply chain is to the betterment of the end customer or the society. To achieve this goal, educational institutions need to have a certain degree of knowledge about the partners in their supply chains including suppliers, customers, and the society. The performance of the supply chain management depends on the seamless coordination of all supply chain stakeholders to ensure attainment of desirable outcomes.

The ITESCM (Integrated Tertiary Educational Supply Chain Management) model represents supply chain management for the academia [20], [28], [29]. This model depicts the integrated form of educational supply chain and educational management for the Universities. Educational supply chain also consists of education supply chain and research supply chain. This paper mainly focuses on application guidelines of ITESCM model for the universities those intend to enhance their supply chains.

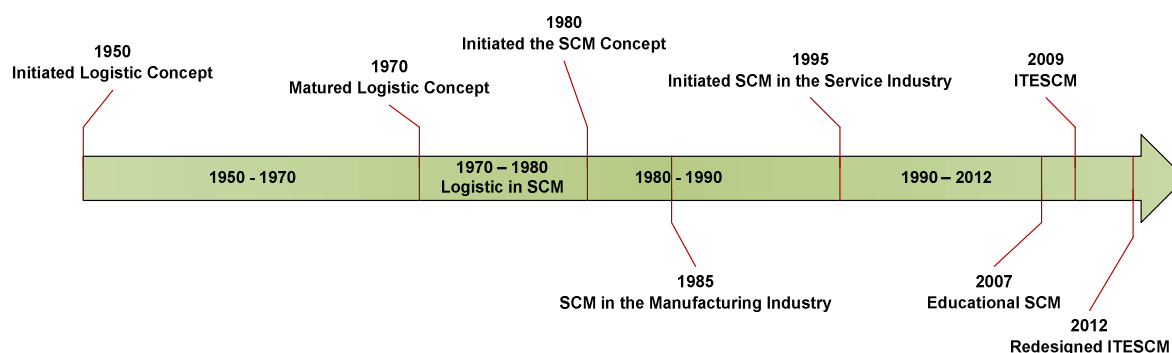


Figure 1. Evolutionary Timeline of Supply Chain Management

## 2. Literature Review

The researchers investigate numerous literatures on SCM to shed lights on educational supply chain components and how they may be operated and integrated to achieve the goals. Though the researchers found a large number of papers and articles in SCM, however, most of them investigated supply chain management in the manufacturing sector [2], [13], [36], [37], [39], [43], [44], [49]-[53], [57]. Only a few addressed issues regarding SCM for the service industry [35], [42], [54]-[56], [59]. Very few focused on educational supply chain management. Just two papers [11], [41] were found to be relevant to the educational supply chain management. Consequently, ITESCM (Integrated Tertiary Educational Supply Chain Management) model was the first empirical study on educational supply chain management for the universities [9], [14].

### 2.1 Three Decision Levels of SCM

According to the concept of three decision levels in SCM, this concept would be adopted in ITESCM model [34]. In educational management, three decision levels are involved in the process of the university:

- Phase 1: Strategic Level
- Phase 2: Planning Level
- Phase 3: Operating Level

**i. Strategic Level (SL):** Strategic level decisions are the highest level. Strategic level decision concerns general direction, long-term goals, philosophies and values. These decisions are the least structured and most imaginative; they are the most risky and of the most uncertain result, partly because they attain so far into the future and partly because they are of such significance.

**ii. Planning Level (PL):** Planning level decisions support strategic decisions. They tend to be

medium range, medium importance, with moderate outcomes.

**iii. Operating Level (OL):** Operating level decisions are every day decisions, used to support planning level decisions. They are often made with little thought and are structured. Their impact is immediate, short term, short range, and usually low cost. The outcomes of a bad operating level decision will be minimal, although a series of bad or sloppy operating level decisions can cause harm. These decisions can be pre-programmed, pre-defined, or set out clearly in policy manuals.

### 2.2 Different Aspects in the Universities

To accomplish proper teaching and research works in the universities; different aspects have to need analyzed. Four aspects, namely faculty capabilities, facilities, programs establishment, university culture [23], [17], [18], [45], [46] would be demonstrated in this section.

**Programs Establishments (PE):** Programs establishment would be occurred for the education and research in terms of development and assessment in the universities. Universities design different programs, to enhance the diversification in education development and establish various programs to assess the development. Universities also intend different programs to increase the diversification in research development and research assessment. Universities have to attempt product differentiation, i.e. programs establishment. Hands-on experience, industrial placements, social demand, provision of IT facilities, and innovative academic methods all demonstrate attempts to differentiate programs establishment [29].

**University Culture (UC):** The concept of organizational culture would be applicable for the universities by the name of University Culture. However, the type of the university culture will fully depends on the university management or administrator. In fact, university culture is the personality of the university [24].

**Faculty Capabilities (FC):** Faculty members

establish good communication, provide rich environment for classroom observation, model best practices, create opportunities for reflection, and support students' participation in curriculum planning, teaching and research. Traditionally, university faculty members are evaluated according to the three major criteria: teaching, research, and services [25].

**Facilities (FA):** Universities offer a wide range of modern facilities to their students. These include state of the art lecture halls, libraries, laboratories and IT services to ensure that students are provided

with an environment in which they can learn, both successfully and comfortably. Lecture rooms are principally conducted using state-of-the-art distance learning technology, online education, e-learning via Internet. Online databases, e-journal, digital library, etc. represents modern research facilities in the universities [27].

Researchers identified four main activities for the universities namely Education Development, Education Assessment, Research Development and Research Assessment in order to produce quality graduates and research outcomes.

**Table 1.** Examples of Education Development ( $E_d$ ) for the Universities [16], [20]

Decision Level	Programs Establishment (PE)	University Culture (UC)	Faculty Capabilities (FC)	Facilities (FA)
Strategic (SL)	School of Engineering, School of Business, School of Arts	Academic good governance by University council	Professors, associate professors	University's academic and supportive facilities
Planning (PL)	Department of Electrical Engineering, Department of Finance, Department of Linguistics	Academic good plans by deans/program directors	Professors, associate professors, assistant professors, senior lecturers	School's academic and supportive facilities
Operating (OL)	Majors in power systems, instrumentation and control, robotics	Academic good operations by faculty members	Assistant professors, lecturers	Department's academic and supportive facilities

**Table 2.** Examples of Education Assessment ( $E_a$ ) for the Universities [16], [20]

Decision Level	Programs Establishment (PE)	University Culture (UC)	Faculty Capabilities (FC)	Facilities (FA)
Strategic (SL)	University's academic assurance program	Management by objectives (MBO), University's academic excellence	University's academic faculty performance evaluation	University's academic and supportive facilities quality assessment
Planning (PL)	School's academic assurance program	School's academic excellence	School's academic faculty performance evaluation	School's academic and supportive facilities quality assessment
Operating (OL)	Department's academic assurance program	Department's academic excellence	Department's academic faculty performance evaluation	Department's academic and supportive facilities quality assessment

**Table 3.** Examples of Research Development ( $R_d$ ) for the Universities [16], [20]

Decision Level	Programs Establishment (PE)	University Culture (UC)	Faculty Capabilities (FC)	Facilities (FA)
Strategic (SL)	Engineering research programs, business research programs, social research programs	University's research orientation	Professors, associate professors	University's research and supportive facilities
Planning (PL)	Electrical engineering, mechanical engineering, finance, operations research projects	School's contract research programs and joint research programs	Professors, associate professors, assistant professors, researchers	School's research and supportive facilities
Operating (OL)	Research topics - supply chain management, artificial intelligence	Innovative academic research projects enrollments by departments	Assist. professors, lecturers, researchers	Department's research and supportive facilities

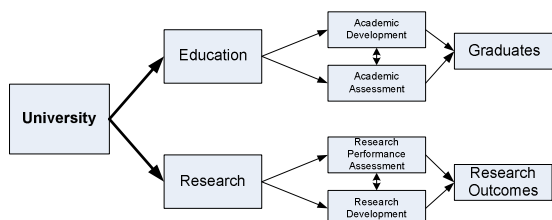
**Table 4.** Examples of Research Assessment ( $R_a$ ) for the Universities [16], [20]

Decision Level	Programs Establishment (PE)	University Culture (UC)	Faculty Capabilities (FC)	Facilities (FA)
Strategic (SL)	University's research quality assurance program	University's research findings quality assessment, research excellence	University's research faculty performance evaluation	University's research and supportive facilities quality assessment
Planning (PL)	School's research quality assurance program	School's research environment assessment	School's research faculty performance evaluation	School's research and supportive facilities quality assessment
Operating (OL)	Department's research quality assurance program	Department's research excellence	Department's research faculty performance evaluation	Department's research and supportive facilities quality assessment

**2.3 Education & Research Activities in the Universities**

*2.3.1 Education Development ( $E_d$ ) and Education Assessment ( $E_a$ )*

Education development could be performed in terms of four aspects, namely programs establishment, university culture, faculty capabilities and facilities through launching the new programs based on the local and global demands, values of the university, faculty enrichment by teaching, research and community service, state of the art teaching facilities.



**Figure 2.** Education & Research Activities in Universities

The overall goal of assessment is to improve student learning in terms of education. Assessment provides students, parents or guardians, and teachers with valid information concerning student progress and their attainment of the expected curriculum.

Assessment measure whether or not learning and/or learning objectives are being met. Assessment requires the gathering of evidence of student performance over a period to measure learning and understanding. Effective faculty members will use assessment techniques regularly and on a daily basis to improve student learning and to guide instruction.

*2.3.2 Research Development ( $R_d$ ) and Research Assessment ( $R_a$ )*

Research development would be occurred through launching innovative internal and external research projects, promoting research environment by the university key personnel, recruiting research expertized faculty members, modern research facilities.

Assessment for research would be a review of conference and journal entries, written work, presentation, research papers, essays, story writing, tests, exams etc. and will display a sense of more permanent learning and clearer picture of a student's ability.

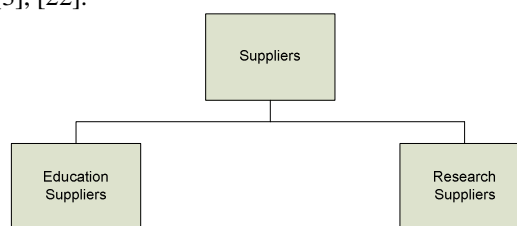
For assessing university education and research quality, different performance indicators may be developed to give information about the performance of an educational institution in different aspects of input, process, and outcome. Fig. 2 represents education and research development and assessment activities in the universities.

**2.4 Modules of ITESCM Model [20]**

In ITESCM model, students as well as internal and external projects are identified as raw materials. In contrast, graduates and research outcomes are recognized as finished products [10]. An integrated supply chain for the universities is illustrated in Fig. 3.

*2.4.1 Suppliers*

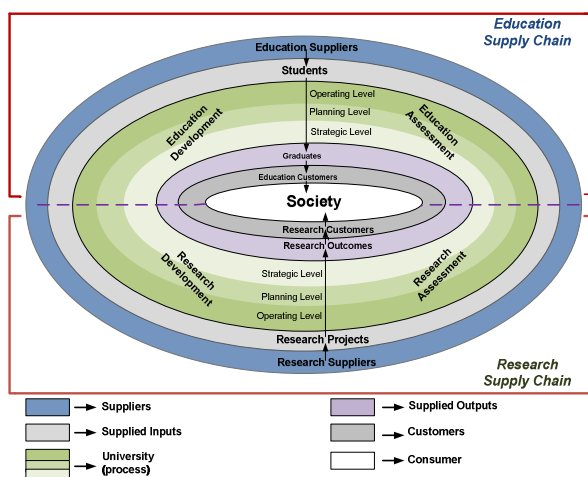
In the conceptual model, the researcher identified two major parts in the suppliers, namely education suppliers and research suppliers for the universities [3], [22].



**Figure 3.** Suppliers of the Universities

**Education Suppliers:** Suppliers of the student (High school/college), suppliers of the faculty (other universities), self-funding students, source of fund family (parents, siblings), relatives, etc. government and private organizations (scholarship), suppliers of assets or equipment (furniture, computer, networking equipment, etc.), suppliers of educational materials (stationery, instruction materials, etc.).

**Research Suppliers:** Suppliers of internal research projects (university self-funding), suppliers of external research projects (external research funds, Ministry of education, private organizations, etc.).



**Figure 4.** An Integrated Supply Chain for the Universities

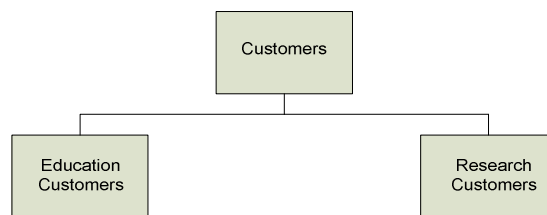
2.4.2 Service Provider

A university is regarded as a service provider in this paper. The researcher identified two major wings including development and assessment for both education and research in the university. Fig. 4 represents educational supply chain for the universities in four aspects, including programs establishment, university culture, faculty capabilities, and facilities, are considered for development and assessment in both education and research segment. The final outcomes of the university, i.e. graduates and research outcomes are delivered to the society [21].

2.4.3 Customers

In the conceptual model, the researcher identified two major parts in the customers namely education customers and research customers for the universities [11], [23].

**Education Customers:** Graduates, family (parents, siblings, relatives, etc.), employers of government and private organizations



**Figure 5.** Customers of the Universities

**Research Customers:** Funding organizations of research projects, research outcomes (researchers, research publications, findings etc.), Others (research professional organizations - IEEE, INFORMS, ACM, Society of manufacturing engineers etc. and Trade associations -American trade association, Grocery manufacturers association, etc.).

2.4.4 Consumer

The researcher identifies the society as the end customer or the consumer in this educational supply chain. As universities are the part of the society, the final outcomes of this supply chain, including graduates with desirable quality and quality research outcomes are delivered to the society [1], [8], [9], [18].

Fig. 6 illustrates an education supply chain and a research supply chain, which together form the tertiary educational supply chain for the universities to produce quality outcomes. The three decision levels including strategic, planning and operating level in the university have been explored in this research model. These three decision phases build up an integrated form of educational supply chain for the universities.

2.4.5 Final Outcomes

(i) Graduates with Desirable Quality

Graduates with desirable quality is one of the final outcomes in the educational supply chain management. Benchmarking and value enhancement determinants are identified and incorporated in the process of the university to produce graduates with desirable quality.

(a) Graduates benchmarking includes knowledge (tacit or explicit), skills, competencies, capabilities, ethics, career development programs, etc.

(b) Graduates value enhancement includes source of fund (self-funding, scholarship, etc.), wisdom, faculty capabilities, facilities, Information & Communication Technology (ICT), research involvements, etc.

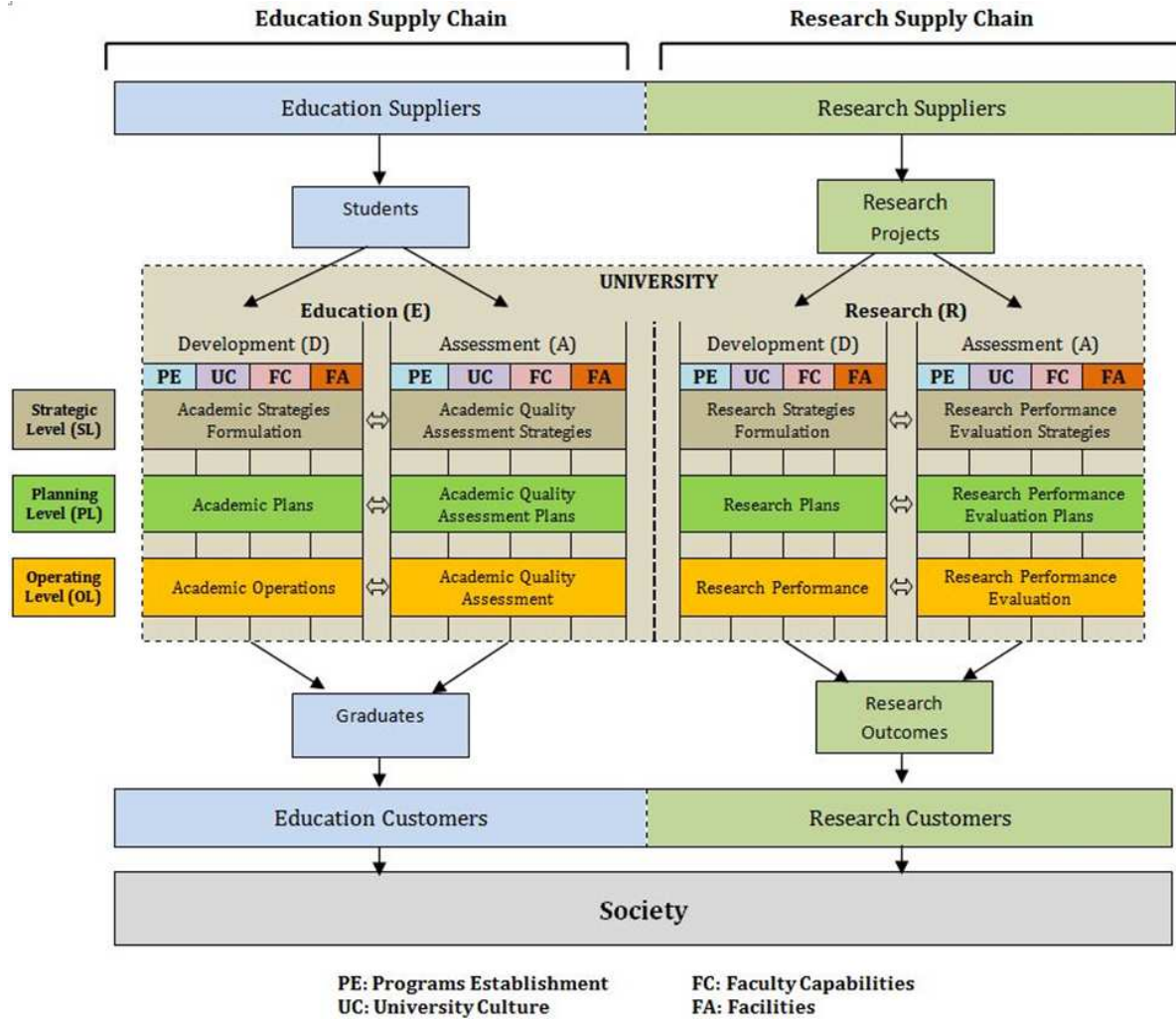


Figure 6. The Redesigned ITESCM Model [48]

(ii) Quality Research Outcomes

The authors defined another final outcome of the educational supply chain management is quality research outcomes. The university develops strategic plans for multidisciplinary research to maintain an emphasis on research as an important component of the academic mission of the university. Research outcomes may include problem solution, pure theory, internal and external projects applications, thesis findings, research publications, or research findings, etc.

2.5 Multiple Linear Regression (MLR) Equations of ITESCM [16], [48]

The ITESCM consists of 8 separate models, namely Education Development, Education Assessment, Graduates, Research Development, Research Assessment, Research Outcomes, Supplied Inputs, and Supplied Outputs. The following Multiple Linear Regression (MLR)

equations have been come up from there through AMOS (Analysis of Moment Structure).

2.5.1 Model A - Education Development (E<sub>d</sub>)

$$E_{dPE} = 0.52E_{dPE_{SL}} + 0.49E_{dPE_{PL}} + 0.46E_{dPE_{OL}} \tag{1}$$

$$E_{dUC} = 0.63E_{dUC_{SL}} + 0.59E_{dUC_{PL}} + 0.57E_{dUC_{OL}} \tag{2}$$

$$E_{dFC} = 0.58E_{dFC_{SL}} + 0.63E_{dFC_{PL}} + 0.60E_{dFC_{OL}} \tag{3}$$

$$E_{dFA} = 0.55E_{dFA_{SL}} + 0.54E_{dFA_{PL}} + 0.50E_{dFA_{OL}} \tag{4}$$

Where,

- $E_{dPE}$ : Programs Establishment in Educational Development
- $E_{dPE_{SL}}$ : Strategic Level decisions at Programs Establishment in Educational Development
- $E_{dPE_{PL}}$ : Planning Level decisions at Programs Establishment in Educational Development
- $E_{dPE_{OL}}$ : Operating Level decisions at Programs Establishment in Educational Development

- $E_{dUC}$ : University Culture in Educational Development
- $E_{dUC_{SL}}$ : Strategic Level decisions at University Culture in Educational Development
- $E_{dUC_{PL}}$ : Planning Level decisions at University Culture in Educational Development
- $E_{dUC_{OL}}$ : Operating Level decisions at University Culture in Educational Development
- $E_{dFC}$ : Faculty Capabilities in Educational Development
- $E_{dFC_{SL}}$ : Strategic Level decisions at Faculty Capabilities in Educational Development
- $E_{dFC_{PL}}$ : Planning Level decisions at Faculty Capabilities in Educational Development
- $E_{dFC_{OL}}$ : Operating Level decisions at Faculty Capabilities in Educational Development
- $E_{dFA}$ : Facilities in Educational Development
- $E_{dFA_{SL}}$ : Strategic Level decisions at Facilities in Educational Development
- $E_{dFA_{PL}}$ : Planning Level decisions at Facilities in Educational Development
- $E_{dFA_{OL}}$ : Operating Level decisions at Facilities in Educational Development

**2.5.2 Model B - Education Assessment ( $E_a$ )**

$$E_{aPE} = 0.64E_{aPE_{SL}} + 0.57E_{aPE_{PL}} + 0.56E_{aPE_{OL}} \tag{5}$$

$$E_{aUC} = 0.60E_{aUC_{SL}} + 0.60E_{aUC_{PL}} + 0.55E_{aUC_{OL}} \tag{6}$$

$$E_{aFC} = 0.49E_{aFC_{SL}} + 0.51E_{aFC_{PL}} + 0.484E_{aFC_{OL}} \tag{7}$$

$$E_{aFA} = 0.63E_{aFA_{SL}} + 0.60E_{aFA_{PL}} + 0.58E_{aFA_{OL}} \tag{8}$$

Where,

- $E_{aPE}$ : Programs Establishment in Educational Assessment
- $E_{aPE_{SL}}$ : Strategic Level decisions at Programs Establishment in Educational Assessment
- $E_{aPE_{PL}}$ : Planning Level decisions at Programs Establishment in Educational Assessment
- $E_{aPE_{OL}}$ : Operating Level decisions at Programs Establishment in Educational Assessment
- $E_{aUC}$ : University Culture in Educational Assessment
- $E_{aUC_{SL}}$ : Strategic Level decisions at University Culture in Educational Assessment
- $E_{aUC_{PL}}$ : Planning Level decisions at University Culture in Educational Assessment
- $E_{aUC_{OL}}$ : Operating Level decisions at University Culture in Educational Assessment
- $E_{aFC}$ : Faculty Capabilities in Educational Assessment
- $E_{aFC_{SL}}$ : Strategic Level decisions at Faculty Capabilities in Educational Assessment
- $E_{aFC_{PL}}$ : Planning Level decisions at Faculty Capabilities in Educational Assessment
- $E_{aFC_{OL}}$ : Operating Level decisions at Faculty Capabilities in Educational Assessment
- $E_{aFA}$ : Facilities in Educational Assessment

- $E_{aFA_{SL}}$ : Strategic Level decisions at Facilities in Educational Assessment
- $E_{aFA_{PL}}$ : Planning Level decisions at Facilities in Educational Assessment
- $E_{aFA_{OL}}$ : Operating Level decisions at Facilities in Educational Assessment

**2.5.3 Model C - Graduates**

$$E_d = 0.63E_{dPE} + 0.70E_{dUC} + 0.65E_{dFC} + 0.65E_{dFA} \tag{9}$$

$$E_a = 0.68E_{aPE} + 0.74E_{aUC} + 0.69E_{aFC} + 0.66E_{aFA} \tag{10}$$

$$Graduates = 0.97E_d + 0.92E_a \tag{11}$$

**Table 5** Summary of Education Development ( $E_d$ )

Activities	Aspects	Regression Coefficient
Education Development ( $E_d$ )	University Culture (UC)	0.70
	Faculty Capabilities (FC)	0.65
	Facilities (FA)	0.63
	Programs Establishment (PE)	0.63

**Table 6** Summary of Education Assessment ( $E_a$ )

Activities	Aspects	Regression Coefficient
Education Assessment ( $E_a$ )	University Culture (UC)	0.74
	Faculty Capabilities (FC)	0.69
	Programs Establishment (PE)	0.68
	Facilities (FA)	0.66

**2.5.4 Model D - Research Development ( $R_d$ )**

$$R_{dPE} = 0.59R_{dPE_{SL}} + 0.47R_{dPE_{PL}} + 0.50R_{dPE_{OL}} \tag{13}$$

$$R_{dUC} = 0.64R_{dUC_{SL}} + 0.61R_{dUC_{PL}} + 0.62R_{dUC_{OL}} \tag{14}$$

$$R_{dFC} = 0.66R_{dFC_{SL}} + 0.62R_{dFC_{PL}} + 0.65R_{dFC_{OL}} \tag{15}$$

$$R_{dFA} = 0.63R_{dFA_{SL}} + 0.63R_{dFA_{PL}} + 0.63R_{dFA_{OL}} \tag{16}$$

Where,

- $R_{dPE}$ : Programs Establishment in Research Development
- $R_{dPE_{SL}}$ : Strategic Level decisions at Programs Establishment in Research Development
- $R_{dPE_{PL}}$ : Planning Level decisions at Programs Establishment in Research Development
- $R_{dPE_{OL}}$ : Operating Level decisions at Programs Establishment in Research Development
- $R_{dUC}$ : University Culture in Research Development
- $R_{dUC_{SL}}$ : Strategic Level decisions at University Culture in Research Development
- $R_{dUC_{PL}}$ : Planning Level decisions at University Culture in Research Development

- $R_{dUC_{OL}}$ : Operating Level decisions at University Culture in Research Development
- $R_{dFC}$ : Faculty Capabilities in Research Development
- $R_{dFC_{SL}}$ : Strategic Level decisions at Faculty Capabilities in Research Development
- $R_{dFC_{PL}}$ : Planning Level decisions at Faculty Capabilities in Research Development
- $R_{dFC_{OL}}$ : Operating Level decisions at Faculty Capabilities in Research Development
- $R_{dFA}$ : Facilities in Research Development
- $R_{dFA_{SL}}$ : Strategic Level decisions at Facilities in Research Development
- $R_{dFA_{PL}}$ : Planning Level decisions at Facilities in Research Development
- $R_{dFA_{OL}}$ : Operating Level decisions at Facilities in Research Development

**2.5.5 Model E - Research Assessment ( $R_a$ )**

$$R_{aPE} = 0.64R_{aPE_{SL}} + 0.60R_{aPE_{PL}} + 0.67R_{aPE_{OL}} \tag{17}$$

$$R_{aUC} = 0.66R_{aUC_{SL}} + 0.63R_{aUC_{PL}} + 0.65R_{aUC_{OL}} \tag{18}$$

$$R_{aFC} = 0.53R_{aFC_{SL}} + 0.65R_{aFC_{PL}} + 0.62R_{aFC_{OL}} \tag{19}$$

$$R_{aFA} = 0.53R_{aFA_{SL}} + 0.68R_{aFA_{PL}} + 0.53R_{aFA_{OL}} \tag{20}$$

Where,

- $R_{aPE}$ : Programs Establishment in Research Assessment
- $R_{aPE_{SL}}$ : Strategic Level decisions at Programs Establishment in Research Assessment
- $R_{aPE_{PL}}$ : Planning Level decisions at Programs Establishment in Research Assessment
- $R_{aPE_{OL}}$ : Operating Level decisions at Programs Establishment in Research Assessment
- $R_{aUC}$ : University Culture in Research Assessment
- $R_{aUC_{SL}}$ : Strategic Level decisions at University Culture in Research Assessment
- $R_{aUC_{PL}}$ : Planning Level decisions at University Culture in Research Assessment
- $R_{aUC_{OL}}$ : Operating Level decisions at University Culture in Research Assessment
- $R_{aFC}$ : Faculty Capabilities in Research Assessment
- $R_{aFC_{SL}}$ : Strategic Level decisions at Faculty Capabilities in Research Assessment
- $R_{aFC_{PL}}$ : Planning Level decisions at Faculty Capabilities in Research Assessment
- $R_{aFC_{OL}}$ : Operating Level decisions at Faculty Capabilities in Research Assessment
- $R_{aFA}$ : Facilities in Research Assessment
- $R_{aFA_{SL}}$ : Strategic Level decisions at Facilities in Research Assessment
- $R_{aFA_{PL}}$ : Planning Level decisions at Facilities in Research Assessment
- $R_{aFA_{OL}}$ : Operating Level decisions at Facilities in Research Assessment

**2.5.6 Model F - Research Outcomes**

$$R_d = 0.60R_{dPE} + 0.71R_{dUC} + 0.63R_{dFC} + 0.67R_{dFA} \tag{21}$$

$$R_a = 0.67R_{aPE} + 0.72R_{aUC} + 0.64R_{aFC} + 0.69R_{aFA} \tag{22}$$

$$Research\ Outcomes = 0.99R_d + 0.89R_a \tag{23}$$

**Table 7** Summary of Research Development ( $R_d$ )

Activities	Aspects	Regression Coefficient
Research Development ( $R_d$ )	University Culture (UC)	0.71
	Facilities (FA)	0.67
	Faculty Capabilities (FC)	0.63
	Programs Establishment (PE)	0.60

**Table 8** Summary of Research Assessment ( $R_a$ )

Activities	Aspects	Regression Coefficient
Research Assessment ( $R_a$ )	Faculty Capabilities (FC)	0.74
	University Culture (UC)	0.72
	Facilities (FA)	0.69
	Programs Establishment (PE)	0.67

**2.5.7 Model G - Supplied Inputs**

$$F_{University} = 0.41\ Students + 0.38\ ResearchProjects = 0.41\ [0.13\ EducationSuppliers] + 0.38\ [0.23\ ResearchSuppliers] = 0.05\ EducationSuppliers + 0.09\ ResearchSuppliers \tag{25}$$

**2.5.8 Model H - Supplied Outputs**

$$F_{Society} = 0.61\ EducationCustomers + 0.61\ ResearchCustomers = 0.61\ [0.34\ Graduates] + 0.61\ [0.15\ ResearchOutcomes] = 0.21\ Graduates + 0.09\ ResearchOutcomes \tag{26}$$

**2.5.9 Overall Model**

The equation of overall model (27) of ITESCM has been evolved after combining all equations (1 to 26) of eight separate models.

$$F_{Society} = 0.61\ EducationCustomers + 0.61\ ResearchCustomers = 0.61\ [0.34\ Graduates] + 0.61\ [0.15\ ResearchOutcomes]$$



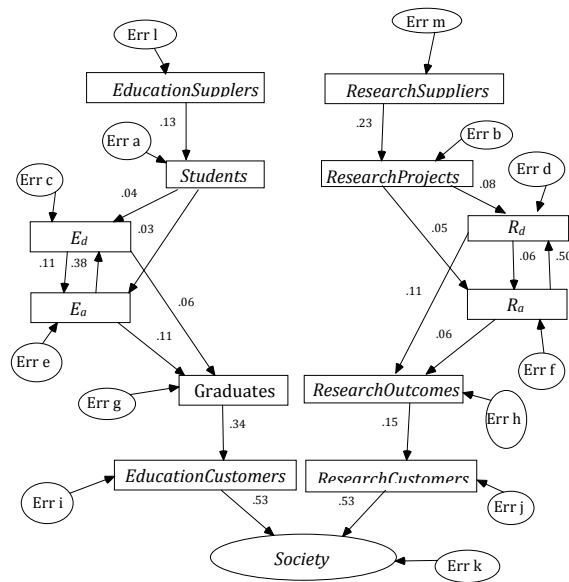


Figure 7. AMOS Graphics Output of Overall Model (Standardized Estimates)

$$= 0.21Graduates + 0.09ResearchOutcomes$$

$$= 0.21 [0.97E_d + 0.92E_a] + 0.09 [0.99R_d + 0.89R_a]$$

$$= 0.20E_d + 0.19E_a + 0.09 R_d + 0.08R_a$$

$$F_{Society} = [0.126E_{dPE} + 0.14E_{dUC} + 0.13E_{dFC} + 0.126E_{dFA}] + [0.129E_{aPE} + 0.141E_{aUC} + 0.131E_{aFC} + 0.125E_{aFA}] +$$

$$[0.054R_{dPE} + 0.064R_{dUC} + 0.057R_{dFC} + 0.06R_{dFA}] + [0.054R_{aPE} + 0.058R_{aUC} + 0.059R_{aFC} + 0.055R_{aFA}]$$

$$F_{Society} = [0.067E_{dPE_{SL}} + 0.063E_{dPE_{PL}} + 0.059E_{dPE_{OL}} + 0.074E_{dUC_{SL}} + 0.069E_{dUC_{PL}} + 0.065E_{dUC_{OL}} + 0.078E_{dFC_{SL}} + 0.084E_{dFC_{PL}} + 0.08E_{dFC_{OL}} + 0.071E_{dFA_{SL}} + 0.069E_{dFA_{PL}} + 0.065E_{dFA_{OL}}] + [0.084E_{aPE_{SL}} + 0.076E_{aPE_{PL}} + 0.074E_{aPE_{OL}} + 0.086E_{aUC_{SL}} + 0.086E_{aUC_{PL}} + 0.076E_{aUC_{OL}} + 0.065E_{aFC_{SL}} + 0.067E_{aFC_{PL}} + 0.063E_{aFC_{OL}} + 0.08E_{aFA_{SL}} + 0.078E_{aFA_{PL}} + 0.074E_{aFA_{OL}}] + [0.032R_{dPE_{SL}} + 0.024R_{dPE_{PL}} + 0.026R_{dPE_{OL}} + 0.041R_{dUC_{SL}} + 0.039R_{dUC_{PL}} + 0.039R_{dUC_{OL}} + 0.037R_{dFC_{SL}} + 0.034R_{dFC_{PL}} + 0.036R_{dFC_{OL}} + 0.038R_{dFA_{SL}} + 0.038R_{dFA_{PL}} + 0.038R_{dFA_{OL}}] + [0.034R_{aPE_{SL}} + 0.032R_{aPE_{PL}} + 0.036R_{aPE_{OL}} + 0.038R_{aUC_{SL}} + 0.036R_{aUC_{PL}} + 0.038R_{aUC_{OL}}$$

$$0.032R_{aFC_{SL}} + 0.039R_{aFC_{PL}} + 0.037R_{aFC_{OL}} + 0.029R_{aFA_{SL}} + 0.037R_{aFA_{PL}} + 0.029R_{aFA_{OL}}] \quad (27)$$

Modification Indices (MI) should be considered only if it makes theoretical or common sense, chi-square value between 2 and 3, GFI (Goodness Fit Index) and CFI (Comparative Fit Index) value between 0.9 and 1 and significant relationships [1]. Therefore, we can improve the overall model by using the highest Modification Indices (MI) that would make sense.

Table 9 Highest Modification Indices in Overall Model

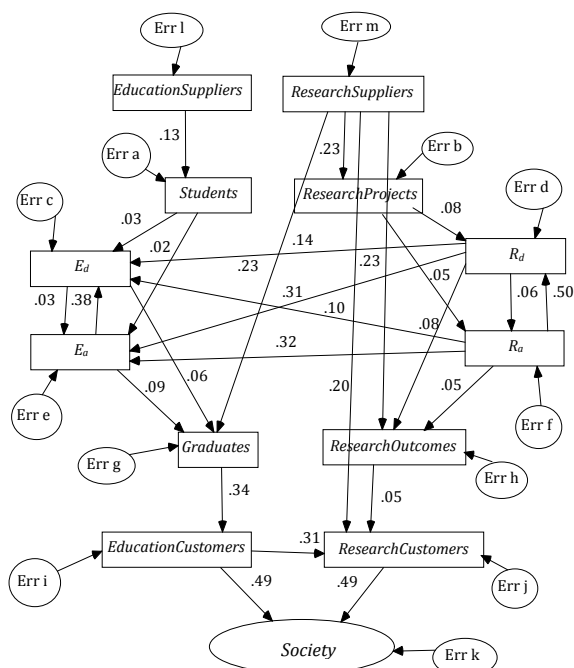
Suggested Relationships of ITESCM	Modification Indices (MI)
Education Assessment & Research Assessment	102.394
Education Assessment & Research Development	98.128
Research Customers & Education Customers	59.42
Education Customers & Research Customers	51.395
Research Customers & Research Suppliers	32.4
Graduates & Research Suppliers	25.54
Research Outcomes & Research Suppliers	23.939
Education Development & Research Development	23.783
Education Development & Research Assessment	20.051

MLR equations of eight separate models of ITESCM were mathematically formulated and eventually synthesized into an overall model. Fig. 5 illustrates overall model of ITESCM. By using Modification Indices (MI) of AMOS, different relationships were added that was formed into updated overall model. [20]

Fig. 8 denotes overall updated model after modification through highest modification indices as of Table 8.

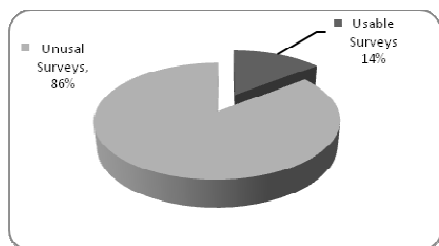
### 3. Methodology

Model development and analysis was based on both primary and secondary data. Once the existing body of literature has been thoroughly investigated, a conceptual framework, i.e. original ITESCM model is proposed. In full launch survey, total 493



**Figure 8.** AMOS Graphics Output of Updated Model (Standardized Estimates)

respondents were participated through email and self-administered process. Among of them, 174 respondents were experts (35%) in university administration, faculty, staff, 166 respondents were graduates (34%), and 153 respondents were employers (31%). Totally 493 respondents from all stakeholders, including experts, faculty, staffs, graduates and employers, out of 3421 respondents are usable (14.41%).



**Figure 9.** Percentage of Usable Surveys

Based on the survey research techniques, the resulting model was evaluated for accuracy and validity by the Structural Equation Modeling (SEM) technique through AMOS. The findings of the ITESCM model have been formulated through the application guidelines for real life application that would be fruitful for the prospective investors and current university administrators.

**4. Application Guidelines from Research Findings** [20], [30]

In this research, the ultimate goals of the study are the quality graduates and quality research

outcomes. SEM technique was applied to define aspects that affect the integrated educational supply chain management model. This research is focused on the universities and all stakeholders, including experts in university administration, faculty members, staff, employers and graduates, accomplished the survey. As per Equation (28), regression coefficients and ITESCM aspects were descended in the Table 10.

**Table 10.** Ranked Order of Significant Aspects in ITESCM [20]

ITESCM Aspect	Regression Coefficient
University Culture in Educational Assessment ( $E_{aUC}$ )	0.141
University Culture in Educational Development ( $E_{dUC}$ )	0.14
Faculty Capabilities in Educational Assessment ( $E_{aFC}$ )	0.131
Faculty Capabilities in Educational Development ( $E_{dFC}$ )	0.13
Programs Establishment in Educational Assessment ( $E_{aPE}$ )	0.129
Programs Establishment in Educational Development ( $E_{dPE}$ )	0.126
Facilities in Educational Development ( $E_{dFA}$ )	0.126
Facilities in Educational Assessment ( $E_{aFA}$ )	0.125
University Culture in Research Development ( $R_{dUC}$ )	0.064
Facilities in Research Development ( $R_{dFA}$ )	0.06
Faculty Capabilities in Research Assessment ( $R_{aFC}$ )	0.059
University Culture in Research Assessment ( $R_{aUC}$ )	0.058
Faculty Capabilities in Research Development ( $R_{dFC}$ )	0.057
Facilities in Research Assessment ( $R_{aFA}$ )	0.055
Programs Establishment in Research Development ( $R_{dPE}$ )	0.054
Programs Establishment in Research Assessment ( $R_{aPE}$ )	0.054

The recommendations of this study are as follows:

- To foster good governance in the tertiary educational institutions, selection of key executives is very important. In order to develop the university as center of excellence in the society, key executives must possess some characteristics like visionary, ethical, high potentiality, high capability, etc. In fact, university culture is the prime mover for other aspects, including programs establishments, faculty capabilities, and facilities in the universities.
- From research findings, university culture enhances education development and assessment in the universities to produce quality graduates.

Therefore, university management or university council would be revised to review their performance for further improvements. In that case, good governance would be highly recommended for the universities.

- From research findings, University culture in education development and assessment is highly contributed to the society. In other words, graduates are highly contributed to the society. By the good governance, university culture could produce quality graduates through proper academic development and academic quality assessment for the well-being society.
- Faculty members' recruitment is the key factor in the universities to produce quality graduates. The office of human resource management could select the faculty members not only based on the academic performance, but also provide attention towards other capabilities like potentiality, ethical, motivation, controlling, knowledgeable, research involvements, etc.
- Different programs establishment in the universities depends on the demand of the society. In that case, universities must have provision for regular monitoring the feasibility of different new programs based on the respective country and global perspectives. Diversification in programs establishment would be fruitful for the students to build up their careers in different fields, which they like.
- From the research findings, university culture and facilities are highly contributed to the research development, and faculty capabilities enhance research assessment in the universities to produce quality research outcomes. Therefore, university management must provide all facilities, including online databases, digital libraries, journals, etc. for the research projects and engage those faculty members who have expertise in research.
- University must ensure modern teaching facilities for the students. Libraries, classroom facilities, laboratory facilities, online facilities, international publications, etc. are mandatory for any university, however, admission center for the new students, recreation center, refreshments, residence hall, etc. are also recommended for the universities.
- As ethics is the identified as benchmarking for the graduates in this study, therefore, university must have Ethics Center. This center will circulate ethics seminar, ethics courses, etc. to the students as the mandatory to complete the graduation.
- To produce quality graduates, education assessment would evaluate the students through proper academic development. Quality assurance center would assess the quality of the graduates in terms of different performance indicators through quality assessment strategies and plans.
- As research involvements are one of value enhancements for the graduates, however, research suppliers have to be related with the graduates to ensure the type of the research projects that able to enhance the quality of the graduates. Different research projects of internal and external research suppliers would enlighten the quality of the graduates.
- Universities, specially teaching based universities, would provide high priority to the research projects. Universities could arrange different international conferences in the universities through various professional organizations, which would enhance the students to involve in the research.
- From the findings, students and research suppliers are highly contributed to the universities. Therefore, universities should have prerequisite, like entrance exam or admission test, to justify the quality of intake students. Universities must have good communication with internal and external research suppliers to receive research projects in order to produce quality research outcomes. Different professional organizations, one of the external research suppliers, would be fruitful as research suppliers for the universities.
- In research supply chain, the relationships between research suppliers and research outcomes will enhance research projects in the university. In order to produce quality research outcomes, research suppliers monitor research development and consequently research outcomes. Therefore, universities must set up research center to coordinate the different entities in the research supply chain. Universities research center would follow up the research developments to make sure the quality research outcomes for the research customers.
- To produce quality research outcomes, research assessment would evaluate the research projects through proper research development. Therefore, universities should have strategies and plans to assess the performance of the internal and external research projects through research center.
- As research development, education development, research assessment and education assessment could influence each other, therefore, these activities would be monitored concurrently in the universities to produce the quality outcomes.
- The mutual relationships would be developed between research development and education development, research assessment and education assessment, research assessment and education development, research development and education assessment. These components could influence each other to produce quality graduates and research outcomes by the universities.

- The relationship between education customers and research customers would be possible since they have significant influence on each other. In fact, these relationships among the variables would develop the link between education supply chain and research supply chain in the universities. As university’s performance depends on the quality graduates and quality research outcomes, therefore, the mutual interaction between different components of education supply chain and research supply chain would be highly appreciated.
- University should arrange the survey in order to justify the stakeholders’ satisfaction in the education supply chain. Universities could invite employers, one of the education customers, to convey their requirements to the prospective graduates. Different career development programs, one of the components in graduates benchmarking, including seminars, workshops, industrial tour job fair, etc. would be fruitful in that case.

**5. Implications of ITESCM Model**

Integrated Tertiary Educational Supply Chain Management (ITESCM) model was developed by Habib in 2009 [8], [9]. Due to receiving feedback from academicians and practitioners, the researchers attempt to revise ITESCM model to comply it in real-life application for different universities in the world. Redesigned model is user friendly and easy to understand for current university administrators and prospective investigators.

If the researcher chooses the highest value (5, strongly agree of 5 point Likert Scale) for each function in equation (27), in that case, the maximum value of  $F_{Society}$  will equal to **7.545**. On the other hand, if the author selects the lowest value (1, strongly disagree of Likert Scale) for each function in the equation, in that case, the minimum value of  $F_{Society}$  will equal to **1.509**. [45], [46]

According to the ITESCM model university administrator could find out their university outcomes by the following equation. From equation (27), the value of  $F_{Society}$  would come up [45], [46].

$$F_{UniversityOutcomes}(\%) = \frac{F_{Society}-1.509}{7.545-1.509} * (100 - 0) \tag{28}$$

The resulting suitability index,  $F_{UniversityOutcomes}$  in equation (28) ranges from 0% to 100% with 100% being the most suitable (excellent) and 0% being the least favorable (worst). The researchers defined

$F_{UniversityOutcomes}$  in terms of different scale like excellent, very good, good, moderate, bad, very bad, worst through percentages that was defined in Table 11. The index of at least 50% may serve as a rough acceptance criterion for the well-being society. [9], [46].

**Table 11.** Suitability index of  $F_{UniversityOutcomes}$

Range of $F_{Society}$	$F_{UniversityOutcomes}$ (%)	Scale
$F_{Society} = 7.545$	100	Excellent
$6.3378 < F_{Society} < 7.545$	Above 80 to below 100	Very Good
$5.1306 < F_{Society} \leq 6.3378$	Above 60 to 80	Good
$3.9234 < F_{Society} \leq 5.1306$	Above 40 to 60	Moderate
$2.716 < F_{Society} \leq 3.9234$	Above 20 to 40	Bad
$1.509 < F_{Society} \leq 2.716$	Below 20	Very Bad
$F_{Society} = 1.509$	0	Worst

**6. Conclusion**

It is an amazing fact that researchers develop supply chain management models mostly for improving business operations in profitable organizations. Few, particularly academic researchers, do not realize that the research on academic SCM may also be conducted for their own educational institutions [20], [28]. ITESCM, Integrated Tertiary Education Supply Chain Management, model links educational management with general business management. From a managerial point of view, this research provides a novel approach to developing and assessing supply chain management application in the academia.

The applicability of the model can be confirmed empirically. However, model evaluation by actual implementation is suggested for prospective investors or current university administrators. University outcomes would be derived by the University management through equation (28) and expressed in terms of different scale for further improvement. The current decision makers may apply the research equations of Integrated Tertiary Educational Supply Chain Management (ITESCM)

model for their universities to enhance their supply chain operations.

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## References

- [1] Arbuckle, J. L. (2005). Amos™ 6.0 User's Guide, Amos Development Corporation, USA
- [2] Ballou, Basic Business Logistics, Prentice-Hall, Englewood Cliffs, NJ, 1978
- [3] Barnett, R., "The idea of quality: voicing the educational", in Doherty, G.D. (Ed.), Developing Quality Systems in Higher Education, Routledge, London, 1994, p. 68
- [4] Bentler, P. M., Comparative fit indexes in structural models. *Psychological Bulletin*, 1990, 107: 238–246.
- [5] Centra, J.A., "Research Report: Research Productivity and Teaching Effectiveness", Educational Testing Service, Princeton, NJ, 1981
- [6] Cheng, Y.C., "School education quality: conceptualization, monitoring, and enhancement", Quality in Education: Insights from Different Perspectives, Hong Kong, 1995a, pp. 123-47
- [7] Comm, C.L. and Mathaisel, D.F.X. (1998). "Evaluating teaching effectiveness in America's business schools: implications for service marketers", *Journal of Professional Services Marketing*, Vol. 16 No. 2, pp. 163-70
- [8] Comm, Clare L. and Dennis F.X. Mathaisel (2003), "Less is more: a framework for a sustainable University", *International Journal of Sustainability in Higher Education*, Vol. 4 No. 4, pp.314-323
- [9] Cutler, Bob D., Christopher R. Moberg, Andrew Gross and Thomas W. Speh, "Identifying antecedents of Information exchange within supply chains", *International Journal of Physical Distribution & Logistics Management*, UK, Vol. 32, No. 9, 1998, pp.755-770
- [10] Dent, H.S. Jr, "Corporation of the future - how strategic alliances and networking will reshape the 90s", *Small Business Reports*, May 1990.
- [11] E.M. O'Brien and Kenneth R., "Educational supply chain: a tool for strategic planning in tertiary education?" *Marketing Intelligence & Planning*, Vol. 14 No. 2, 1996, pp.33-40
- [12] Ebel, R. L. (1951). Estimation of the reliability of ratings, *Psychometrika*, 16: 407-424
- [13] G. Gripsrud "Supply chain management – back to the future?" *International Journal of Physical Distribution & Logistics Management*, Vol. 36 No. 8, 2006, pp.643-65
- [14] Habib, M. and C. Jungthirapanich, "Research Framework of Educational Supply Chain Management for the Universities", *IEEE International Conference on Engineering Management and Service Sciences EMS*, China, Sep., 2009, ISBN 978-1-4244-4638-4.
- [15] Habib, Dr. Mamun, "An Exploratory Research on Educational Supply Chain Management", *The IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*, Singapore, December, 2011, ISBN 978-1-4577-0738-4.
- [16] Habib, Dr. Md. Mamun and Pathik, Bishwajit B. "An Investigation of Education and Research Management for Tertiary Academic Institutions" *International Journal of Engineering, Business, Management (IJEEM)*, Croatia, 2012, ISSN 1847-9790.
- [17] Habib, Dr. Md. Mamun, "An Exploratory Analysis of Educational Management for the Universities", *International Journal of Engineering, Business, Management (IJEEM)*, Croatia, Vol. 3, No. 3, September, 2011, ISSN 1847-9790.
- [18] Habib, Dr. Md. Mamun, "An Exploratory Study of Supply Chain Management for Tertiary Educational Institutions", *IEEE International Technology Management Conference (ITMC) 2011a*, San Jose, California USA, June, 2011, ISBN 978-1-61284-950-8.
- [19] Habib, M. "An Empirical Study of Tertiary Educational Supply Chain Management", *International Conference on Knowledge globalization, 2010*, Bangladesh, May, 2010, ISBN 978-984-33-1691-2
- [20] Habib, M. "An Integrated Educational Supply Chain Management (ITESCM)", Ph.D. Dissertation, Graduate School of Information Technology, Assumption University of Thailand, December, 2009.
- [21] Habib, M. and C. Jungthirapanich, "An Empirical Research of Educational Supply Chain for the Universities", *The 5th IEEE International Conference on Management of Innovation and Technology*, Singapore, June, 2010, ISBN: 978-1-4577-0738-4.
- [22] Habib, M. and C. Jungthirapanich, "An Empirical Research of Integrated Educational Management for the Universities", *The 2nd IEEE International Conference on Information Management and Engineering*, China, April, 2010, ISBN 978-1-4244-5263-7.
- [23] Habib, M. and C. Jungthirapanich, "An Empirical Study of Educational Supply Chain

- Management for the Universities*", *INFORMS International Conference on Industrial Engineering and Operations Management*, Bangladesh, January, 2010, ISBN 978-984-33-0989-1.
- [24] Habib, M. and C. Jungthirapanich, "An integrated framework for research and education supply chain for the Universities", *IEEE International Conference on Management of Innovation and Technology*, Thailand, Sep., 2008, pp. 1027-1032, ISBN 978-1-4244-2329-3.
- [25] Habib, M. and C. Jungthirapanich, "Integrated educational management for the Universities", *The Journal of China-USA Business Review*, David Publishing Company, USA, Vol. 8, No. 8, pp. 25-38, 2009, ISSN 1537-1514.
- [26] Habib, M. and C. Jungthirapanich, "Integrated Educational Supply Chain Management (IESCM) for the Universities", *Sixth AIMS International Conference on Management*, India, Dec., 2008.
- [27] Habib, M. and C. Jungthirapanich, "International Supply Chain Management: Integrated Educational Supply Chain Management (IESCM) Model for the Universities", *International Retailing: Text and Readings*, S L Gupta (Ed.), India, 2010, ISBN 978-81-7446-859-8.
- [28] Habib, M. and C. Jungthirapanich, "Research Framework of Education Supply Chain, Research Supply Chain and Educational Management for the Universities", *International Journal of the Computer, the Internet and Management (IJCIM)*, Thailand, Vol. 17, No. SP1, 2009a, pp.24.1-8, ISSN 0858-7027.
- [29] Habib, M., "An Empirical Research of ITESCM (Integrated Tertiary Educational Supply Chain Management) Model", *Management and Services*, Sciyo.com, October, 2010, ISSN 978-953-307-118-3.
- [30] Habib, M., "Supply Chain Management for Academia", LAP Lambert Academic Publishing, Germany, December 2010, ISBN 978-3-8433-8026-3.
- [31] Habib, Md. Mamun and Goncharuk, Anatoliy G., "Performance Measurement through Supply Chain Management: A Case Study on Academia", LAP Lambert Academic Publishing, Germany, January 2012, ISBN 978-3-8473-7021-5
- [32] Habib, Md. Mamun, "Supply Chain Management (SCM): Theory and Evolution" Dr. Md. Mamun Habib (Editor), "Supply Chain Management – Applications and Simulations", InTech Open Access, Croatia, September 2011, ISBN 978-953-307-250-0.
- [33] Han, S.L., Wilson, D.T. and Dant, S.P., "Buyer-supplier relationships today", *Industrial Marketing Management*, No. 22, 1993, pp. 331-8
- [34] Harris, R. "Decision Making Techniques", July 3, 1998, Available: www.virtualsalt.com, April, 2009
- [35] J. Fernie and Clive Rees, "Supply chain management in the national health service", *The International Journal of Logistics Management*, Vol. 6 No. 2, 1995, pp. 83-92
- [36] J. Heskett, Ivie, R. and Glaskowsky, N., "Business Logistics, Management of Physical Supply and Distribution", the Ronald Press Company, New York, NY, 1964
- [37] J.L.Heskett, Glaskowsky, N.A. Jr and Ivie, R.M., "Business Logistics", 2nd ed., The Ronald Press, New York, NY, 1973, pp. 14-21
- [38] Jones, C., (1989), "Supply chain management – the key issues", *BPICS Control*, pp. 23-7
- [39] K.C. Tan, Steven B. Lyman and Joel D. Wisner, "Supply chain management: a strategic perspective", *International Journal of Operations & Production Management*, Vol.22 No.6, 2002, pp. 614- 631
- [40] Kotler, P. and Bloom, P. (1984). *Marketing Professional Services*, Prentice-Hall, Englewood Cliffs, NJ
- [41] Lau, A.K.W. (2007). "Educational supply chain management: a case study", *Emerald Group Publishing Limited*, ISSN 1074-8121, Vol. 15 No.1, pp.15-27
- [42] M. Nixon, "Innovations in logistic technology: generating top-line value and bottom-line ROI", *World Trade*, June, Vol. 14 No.6, 2001, pp.62-4
- [43] P. Udomleartprasert, C. Jungthirapanich, "The Supportive Infrastructures Enhancing the Supply Chain Performance", *IEEE International Engineering Management Conference*, Vol. 3, Singapore, 2004
- [44] P. Udomleartprasert, C. Jungthirapanich, "The Operational Infrastructure Enhancing the Supply Chain Management", *International Conference of Electronic Business*, Singapore, 2003
- [45] Pathik, B. B., Habib, Md. M., and Chowdhury, M. T., "A Descriptive Study on Supply Chain Management Model for the Academia", Submitted, *The 6<sup>th</sup> IEEE Conference of Management of Innovation and Technology*, Indonesia, June 2012.
- [46] Pathik, B. B., Habib, Md. M., and Chowdhury, M. T., "Analysis of Educational Supply Chain Management Model: A Case Study Approach", *Proceedings of the 2012 International Conference on Industrial Engineering and Operations Management*, Turkey, July 2012.
- [47] Pathik, B. B., Habib, M., "Academic Supply Chain Management for Tertiary Educational Institutions", *Proceedings of the 2012 IEEE International Conference on Industrial*

- Engineering and Engineering Management, Hong Kong, 2012.
- [48] Pathik, B. B., Habib, M., “Redesigned *ITESCM Model: An Academic SCM for the Universities*”, International Journal of Supply Chain Management (IJSCM), Vol. 1, Issue 1, pp 12-26, ExcellingTech Publishing Company, London, UK, 2012, ISSN: 2050-7399.
- [49] R. Ballou, “The evaluation and future of logistics and supply chain management”, European Business Review, Vol.19 No.4, 2007, pp. 332-348
- [50] R. Ballou, Basic Business Logistics, Prentice-Hall, Englewood Cliffs, NJ, 1978
- [51] R. Cigolini, M. Cozzi and M. Perona, “A new framework for supply chain management”, International Journal of Operations & Production Management, Vol. 24, No. 1, 2004, pp. 7-41
- [52] R. Lummus and Robert, J. Vokurka, “*Defining supply chain management: a historical perspective and practical guidelines*”, Industrial Management & Data System, Vol.99 No.1, 1999, pp.11-17
- [53] R.K. Oliver, and Webber, M.D., “*Supply-chain management: logistics catches up with strategy*”, in Christopher, M. (Ed.), Logistics: The Strategic Issues, Chapman & Hall, London, 1992
- [54] S. Dibb and Simkin, L., “*Strategy and tactics: marketing leisure facilities*”, The Services Industries Journal, Vol. 13, No. 3, July 1993, pp. 110-24
- [55] S. E. Sampson, “*Customer-supplier duality and bidirectional supply chains in service organization*”, International Journal of Service Industry Management, Vol. 11 No. 4, 2000, pp.348-364
- [56] S. Sengupta and Turnbull, J. (1996), “*Seamless optimization of the entire supply chain*”, IIE Solutions, Vol. 28, No. 10, 1996, pp.28-33
- [57] Stevenson, W. J., Operations Management, 7th ed., McGraw- Hill/Irwin, NY, 2002
- [58] Wheaton, B. Muthén, D. F. Alwin, and G. F. Summers (1997), Assessing reliability and stability in panel models in *Sociological methodology*, D. R. Heise, ed. San Francisco: Jossey-Bass, pp. 84–136 R.
- [59] Y. Kathawala and Khaled Abdou, “*Supply chain evaluation in the service industry: a framework development compared to manufacturing*”, Managerial Auditing Journal, Vol. 18 No. 2, 2003, pp.140-149.