

An empirical research of ITESCM (integrated tertiary educational supply chain management) model

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1. Introduction

In the service industry, service providers have an incentive of getting better quality inputs from customer-suppliers, and customer-suppliers have an incentive of getting better quality outputs from the service provider. Supply Chain Management (SCM) is needed for various reasons: improving operations, better outsourcing, increasing profits, enhancing customer satisfaction, generating quality outcomes, tackling competitive pressures, increasing globalization, increasing importance of E-commerce, and growing complexity of supply chains (Stevenson, 2002).

Supply chain management helps the business organization to compete in the dynamic global market. The goal of supply chain management is to integrate activities across and within organizations for providing the customer value. This should also be applicable to the academia, which represents a type of non-profit organizations. The goal is to provide the society value by producing high quality graduates and quality research outcomes. (Habib & Chamnong, 2008a).

Supply Chain Management (SCM) in the manufacturing industry is a very common scenario. However, SCM in the service industry especially in higher educational institutions is receiving more attention. This exploratory study addresses the education supply chain, the research supply chain, and educational management as major constituents in an Integrated Tertiary Educational Supply Chain Management (ITESCM) model. Its applicability was successfully verified and validated through survey data from leading tertiary educational institutions around the world. The proposed model was developed based on the analysis of literature, past theoretical frameworks, interviews with stakeholders. Model constructs were identified and confirmed by 493 respondents, representing university administrators, faculty and staffs, employers, and graduates. The resulting model was subsequently evaluated for accuracy and validity by multiple linear regression (MLR) analysis and the structural equation modeling (SEM) technique.

The study revealed education development, education assessment, research development, and research assessment as four main activities in educational management. Four aspects of each activity, namely programs establishment, university culture, faculty capabilities, and

facilities were investigated at strategic, planning, and operating levels. MLR equations of different separate models were mathematically formulated and eventually synthesized into an overall model.

The ITESCM model furnishes stakeholders of the supply chain with appropriate strategies to review and appraise their performance toward fulfillment of ultimate goals, i.e. producing high-caliber graduates and high-impact research outcomes, which represent two main contributions, for the betterment of the society.

This chapter attempts to develop a model for successful educational supply chain. The research focuses on the universities. The researcher investigates numerous literatures on supply chain management to shed lights on educational supply chain components and how they may be operated and coordinated to achieve the goals. The desirable goals may be quality graduates and quality research outcomes. The ultimate goal of a successful educational supply chain is, however, the improved well-being of the society (Habib & Chamnong, 2008b).

2. Literature Review

Based on findings from literature review, the researcher found a large number of papers and articles in supply chain management. Most of them investigated supply chain management in the manufacturing sector (Udomleartprasert & Jungthirapanich, 2004; Ballou, 1978; Ballou, 2007; Heskett, 1964; Heskett, 1973; Stevenson, 2002; Cigolini, 2004; Oliver, and Webber, 1992; Lummus and Robert, 1999; Gripsrud, 2006; Tan and et al., 2002; Udomleartprasert and Jungthirapanich, 2003, Hart, 2004; Jones and Riley, 1985; Jones, 1989; Houlihan, 1988; Stevens, 1989; Scott and Westbrook, 1991; Watts and et al. 1992; Lee and Billington, 1992; Inman and Hubler, 1992; Cooper and et al. 1993; Londe and et al. 1994; Londe and Bernard, 1997; Lee and et al. 2007)

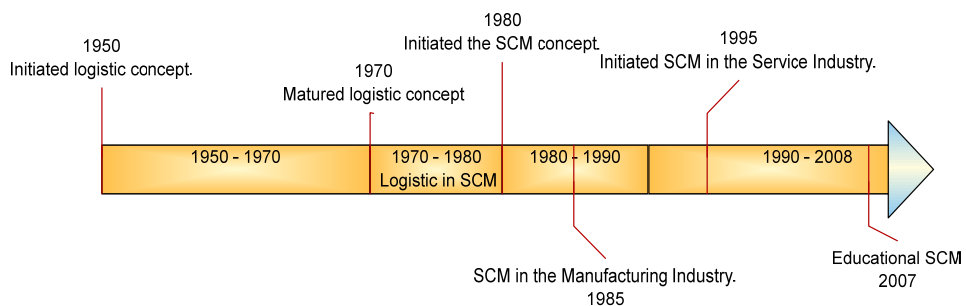


Fig. 1. Evolutionary timeline of supply chain management

Only a few addressed issues in SCM for the service industry (Dibb and Simkin, 1993; Sampson, 2000; Nixon, 2001; Sengupta and Turnbull, 1996; Fernie and Clive, 1995; Kathawala and Khaled, 2003). Very few focused on educational supply chain management. Just two papers (Lau, 2007; O'Brien and Kenneth, 1996) were found to be relevant to the educational supply chain management. The evolutionary time line of supply chain management has been depicted in Figure 1.

Education, being part of the service industry, is characterized differently from the manufacturing industry as its product, i.e. knowledge, is intangible. Effective education relies much on its personnel's knowledge, experience, and ethics. Supply chains are quite easy to define for manufacturing organizations, where each participant in the chain receives inputs from a set of suppliers, processes those inputs, and delivers them to a distinct set of customers. With educational institutions, one of the primary suppliers of process inputs is customers themselves, who provide their bodies, minds, belongings, or information as inputs to the service processes. We refer to this concept of customers being suppliers as "customer-supplier duality." The duality implies that educational supply chains are bi-directional, which is that production flows in both directions (Sampson, 2000).

In educational supply chain, a university works in close collaboration with schools, further education colleges, its current students, university staff, and employers of its graduates in designing curricula (Heskett, 1964) to ensure that the needs of all stakeholders are satisfied. Educational supply chain has customer driven vision that can produce a number of competitive advantages for the supply chain by helping improve productivity, boosting customer satisfaction, producing quality outcomes. Increasingly, many end products are recognizing the potential benefits of partnering with their suppliers in managing quality in their supply chains.

In the educational supply chain, there are direct and indirect student services to process the raw material, i.e. the student. Direct student services include student design and development, student sourcing and selection, student academic and non-academic trainings, student practical trainings, student result testing and finally student further development. The indirect student services are campus advancement and maintenance, IT infrastructure, hostel, clearances, bookstore, security, restaurants and sport facilities, etc. (Lau, 2007).

Every student should be designed and developed critically. A student should be assigned a faculty member, who supervises the student development process throughout the supply chain. It is because the student is non-identical and the university cannot set up one supply chain process for all the students. In the integrated SCM, customized supply chain processes for each student is suggested to ensure the student quality (Habib, 2009b).

Research is expensive and long-term requiring customized and responsive supply chain to satisfy the customer. For example, if there is an applied research to develop a specific IT system for an industry, the supply chain should be used to search for all the relevant operators, who are professional in developing the IT system, and the facilitates, which can execute the research faster. On the other hand, if there is a basic research to develop a few social observations through survey as a mean to gather relevant data, the supply chain should be managed to communicate the professionals and facilities in the university so as to prevent duplicated research scope and to streamline the survey time and cost (Habib & Jungthirapanich, 2009a).

According to the concept of three decision levels in SCM, this concept would be adopted for the higher educational institutions (Harris, 1998).

1. Strategic Level: Strategic level decisions are the highest level. Here a 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 outcome, partly because they reach so far into the future and partly because they are of such importance.

2. Planning Level: Planning level decisions support strategic decisions. They tend to be medium range, medium significance, with moderate consequences.

3. Operating Level: 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 consequences of a bad operational decision will be minimal, although a series of bad or sloppy operational decisions can cause harm. Operational decisions can be pre-programmed, pre-made, or set out clearly in policy manuals.

To accomplish proper teaching and research works in the universities; different factors have to need analyzed. Four factors, namely faculty capabilities, facilities, programs establishment, university culture (Lau, 2007; Habib and Jungthirapanich, 2008b, 2009a, 2009c, 2010a) will be illustrated 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. With the growing number of establishments attaining university status, this issue should be appearing on each program director's agenda. Hands-on experience, industrial placements, social demand, provision of IT facilities, and innovative academic methods all demonstrate attempts to differentiate programs establishment (Kotler and Bloom, 1984).

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 (Comm and Mathaisel, 1998).

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 (Habib, 2009b).

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 (Habib, 2009b)

One of the main goals of an educational supply chain is to improve the well-being 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 consumer. The performance of the supply chain management depends on the seamless coordination of all supply chain stakeholders to ensure attainment of desirable outcomes (Habib and Jungthirapanich, 2010b).

3. Research Methodology

The questionnaire was developed and analyzed to determine reliability and validity of the tools. Reliability is the correlation of an item, scale, or instrument with a hypothetical one, which truly measures what it. Fifty-seven variables were identified and studied to assess the extent to which academicians and the practitioners are practiced in the academia. Supply chain relationships among model constituents, e.g. suppliers, the universities, customers, and the society were also investigated. In the scale reliability test, the Cronbach's alpha value is 0.961, which means the scale is excellent reliable (Ebel, 1951) and could be used to test the content validity. Validity of the variables was confirmed by experts, as well as academicians. The researcher applied non-probability sampling techniques based on the judgment (purposive) sampling. This judgment sampling depends on the personal judgments from all stakeholders of the universities, including university administrators, faculty, staffs, graduates, employers, etc.

The respondents were asked to indicate the level of significance after supply chain implementation using five-point Likert scale (1 = strongly disagree, 5 = strongly agree) (Cutler, 1998). The researcher used interval scale, statistical parametric scale, for the survey research questionnaire. The researcher conduct a survey among all stakeholders, including experts in university administration, employers, graduated students, etc. The questionnaires were pre-tested to check the content validity and revised where necessary to ensure the content validity.

In pretest, all the respondents were academicians of top ranked different universities in the world. The 54 filled questionnaires are analyzed, the result shown the excellent in reliability questions as all constructs reliability result are higher than 96%. For the large-scale research, the surveys were collected, totally 493 from all stakeholders through email and self-administered, out of 3421 respondents (14.41% are usable) to obtain maximum likelihood estimates of standardized regression weights, correlations (Arbuckle, 2005) etc. Among them, 174 respondents were experts, faculty, staff of the Universities, 166 respondents were graduates, and 153 respondents were employers.

From the hypotheses, the Structural Equation Modeling (SEM) has been utilized to answer the research questions. The growing interest SEM techniques and recognition of their importance in empirical research are used to test the extent to which the research meets recognized standards for high quality statistical analysis (Strub and et al., 2002; Udomleartprasert and Jungthirapanich, 2003). The interrelationships among all educational supply chain components are investigated and confirmed by SEM technique. The researcher used latest statistical powerful software AMOS (Analysis of Moment Structures) for SEM.

4. ITESCM Model Development

This study attempts to develop an empirical research model based on both primary and secondary data. Once the existing body of literature has been thoroughly investigated, a conceptual framework is proposed. The conceptual model is developed based on the analysis of past theoretical frameworks. O'Brien and Kenneth (1996) reported the results from a survey conducted among students and employers. There was no research model in that paper. Lau (2007) performed an in-depth case study approach to developing an educational supply chain as the 'student' and the 'research' supply chain for the City University of Hong Kong. This case study was weak to generalize through a single case approach.

The researcher develops a conceptual framework of educational supply chain for the universities. The resulting model is finally evaluated for accuracy and validity through the Structural Equation Modeling (SEM) technique (Habib, 2009; Habib & Jungthirapanich, 2010b). For providing the clear conception of the conceptual framework, the researcher depicts holistic view of educational supply chain in Figure 2. In this supply chain, raw materials are students as well as internal and external projects. Finished products are graduates and research outcomes (Habib and Jungthirapanich, 2009d). In this framework, single-level, bi-directional simplified form of supply chain management has been formulated for the universities, as shown in Figure 3. In the higher educational institutions, since a single party is unable to do anything, the researcher involves different parties to achieve final outcomes. Customers can closely monitor the value added by service providers. When customers supply major inputs, they know exactly what condition those inputs are. Then, when they subsequently receive the output from the service provider, they can easily assess the amount of value added by the service provider.

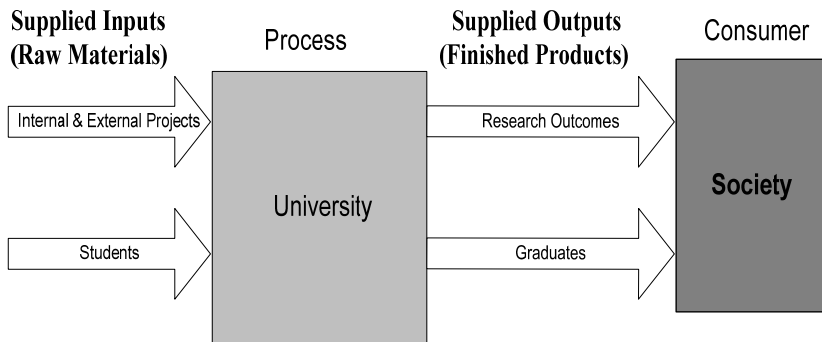


Fig. 2. Holistic view of educational supply chain

However, it is very difficult to determine the supplier and customer of the intangible product in the service industry. Suppliers, the service provider, customers, and the consumer have been identified in this research. This exploratory study also identifies supplied inputs, customer-consuming output (O/P), customer-supplying input (I/O) and finally supplied outputs (Habib and jungthirapanich, 2010e).

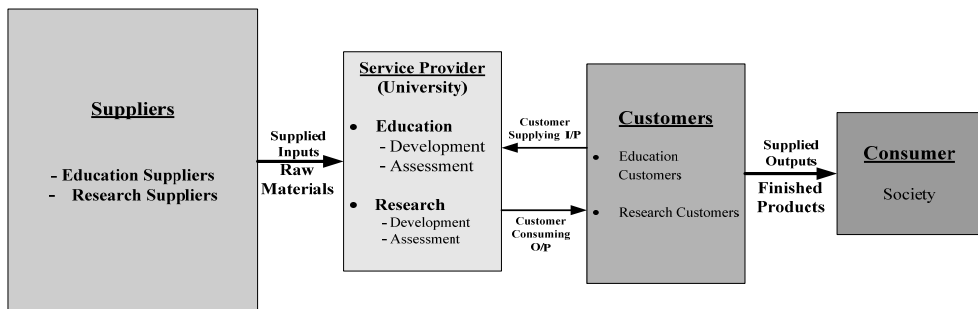


Fig. 3. Simplified form of supply chain management for the universities

Figure 4 illustrates an education supply chain and a research supply chain, which together form the integrated 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. The performance of this supply chain depends on the quality of the graduates with desirable quality and quality research outcomes of the university.

A. Suppliers

In the conceptual model, the researcher identified two major parts in the suppliers, namely education suppliers and research suppliers for the universities (Habib and Jungthirapanich, 2009e; Habib, 2010b; Habib and Jungthirapanich, 2010d).

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.).

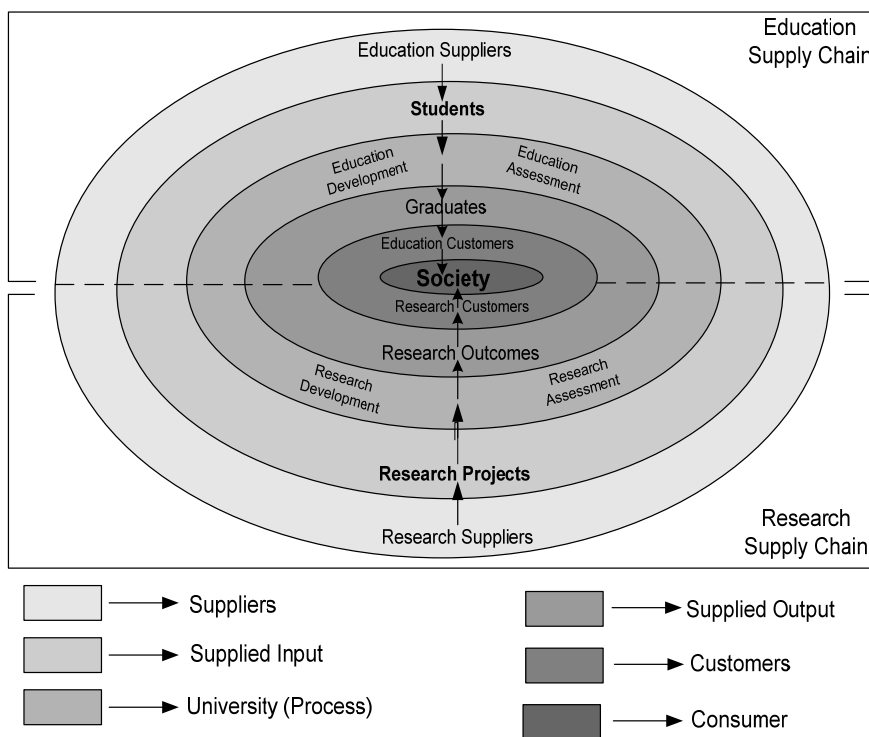


Fig. 4. An integrated supply chain for the universities

B. A 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. 3 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 part. The final outcomes of the university, i.e. graduates and research outcomes are delivered to the society (Habib and Jungthirapanich, 2010c).

C. Customers

In the conceptual model, the researcher identified two major parts in the customers namely education customers and research customers for the universities (Habib and Jungthirapanich, 2008b; Habib, 2009). Some of the graduates would be added in the service provider as the supplied input. On the other hand, some graduates would be acted as the supplied output to the end customer. Therefore, the researcher also identified graduates as the supplying input customer in this supply chain.

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

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.).

D. 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 (Habib and Jungthirapanich, 2008a, 2009c, 2009e).

4.1 Final Outcomes

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.

Quality Research Outcomes

The author 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.

4.2 ITESCM Model

From the literature review, the researcher develops the proposed ITESCM (Integrated Tertiary Educational Supply Chain Management) model for the universities. This model depicts the integrated form of educational supply chain and educational management for the universities in the following Figure 5. Educational supply chain also consists of education supply chain and research supply chain.

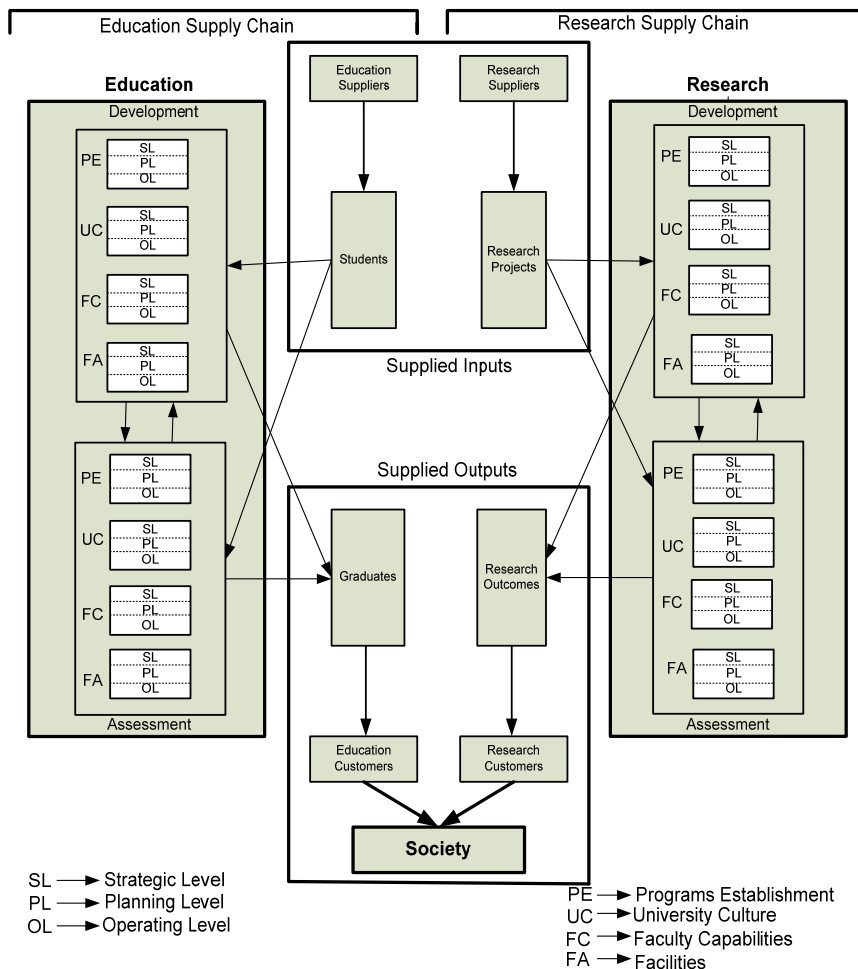


Fig. 5. Integrated Tertiary Educational Supply Chain Management (ITESCM) model for the universities

5. ITESCM Model Evaluation

The proposed ITESCM (Integrated Tertiary Educational Supply Chain Management) model is the integrated form of educational management and educational supply chain for the universities. There are two main contributions of the universities to the society, namely education and research. Both contributions are further categorized into development and assessment. Each category is analyzed in four different aspects, namely programs establishment, university culture, faculty capabilities, facilities at three decision levels, including strategic, planning, and operating levels. To enhance customer satisfaction, generating quality outcomes for the betterment of the end customer, i.e. the society, the author developed this research model for the universities.

5.1 Educational Management

In the educational management, the researcher defines education development, education assessment, research development and research assessment for the universities to provide the conclusion of research issue items. From the research results, they show the significant relationships among four aspects in educational management to produce quality graduates and quality research outcomes. The authors represent model A and B in this section. Model A stands for graduates and model B represents research outcomes. From the research model, the following hypotheses are established. Hypotheses 1 and 2 stand for graduates and hypotheses 3 and 4 for research outcomes.

H₁: There is a relationship between education development and graduates.

H₂: There is a relationship between education assessment and graduates.

H₃: There is a relationship between research development and research outcomes.

H₄: There is a relationship between research assessment and research outcomes.

5.1.1 Model A: Graduates

The researcher identified graduates as final outcomes of the education part in the university. Education part is divided into two segments including education development and education assessment. Model 3 contains group 1 and group 2. Group 1 is defined as the education development in the model 3. There are four subgroups, including subgroup 1, subgroup 2, subgroup 3 and subgroup 4 those are representing programs establishment, university culture, faculty capabilities and facilities respectively.

On the other hand, group 2 stands for the education assessment in the model 3. There are 4 subgroups, namely subgroup 5, subgroup 6, subgroup 7 and subgroup 8 those are representing programs establishment, university culture, faculty capabilities and facilities respectively. Figure 6 illustrates the inter relationships among different variables to justify the hypothesis 1 and 2 by SEM through AMOS.

Multiple Linear Regression (MLR) Equations

$$F_{\text{Group 1}} = 0.63 f_{\text{subgroup 1}} + 0.70 f_{\text{subgroup 2}} + 0.65 f_{\text{subgroup 3}} + 0.63 f_{\text{subgroup 4}} \quad (1)$$

$$F_{\text{Group 2}} = 0.68 f_{\text{subgroup 5}} + 0.74 f_{\text{subgroup 6}} + 0.69 f_{\text{subgroup 7}} + 0.66 f_{\text{subgroup 8}} \quad (2)$$

$$F_{\text{Graduates}} = 0.97 F_{\text{Group 1}} + 0.92 F_{\text{Group 2}} \quad (3)$$

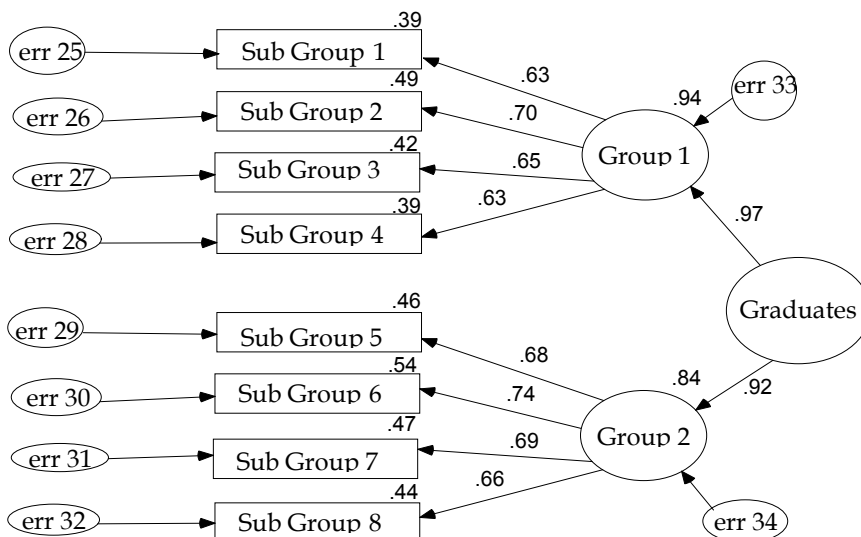


Fig. 6. AMOS Graphics Output of Model A (Standardized Estimates)

From the research findings, equation (1) states that university culture (sub group 2) is the most significant factor in education development. On the other hand, equation (2) represents that university culture (sub group 6) is highly contributed to education assessment. Finally, equation (3) depicts that education development is highly contributed to produce quality graduates in the universities. From equation (1), (2) and (3),

$$\begin{aligned}
 F_{\text{Graduates}} &= 0.97 F_{\text{Group 1}} + 0.92 F_{\text{Group 2}} \\
 &= 0.97 [0.63 f_{\text{subgroup 1}} + 0.70 f_{\text{subgroup 2}} + 0.65 f_{\text{subgroup 3}} + 0.63 f_{\text{subgroup 4}}] \\
 &\quad + 0.92 [0.68 f_{\text{subgroup 5}} + 0.74 f_{\text{subgroup 6}} + 0.69 f_{\text{subgroup 7}} + 0.66 f_{\text{subgroup 8}}] \\
 &= 0.61 f_{\text{subgroup 1}} + 0.68 f_{\text{subgroup 2}} + 0.63 f_{\text{subgroup 3}} + 0.61 f_{\text{subgroup 4}} + 0.63 f_{\text{subgroup 5}} + \\
 &\quad 0.68 f_{\text{subgroup 6}} + 0.63 f_{\text{subgroup 7}} + 0.61 f_{\text{subgroup 8}} \tag{4}
 \end{aligned}$$

The above equation shows the significant relationship among all factors namely programs establishment, university culture, faculty capabilities, and facilities in education development as well as education assessment to produce the graduates. University culture at education development and education assessment is highly contributed to produce the graduates in the universities.

Model Fit Index

Chi-square = 169.792, Degrees of freedom =19, Probability level = 0.000, CMIN/DF = 8.936 (Ratio of relative chi-square close to 5 indicates reasonable fit) (Wheaton and et al., 1997), RMSEA (Root Mean Square Error of Approximation) = 0.127, NFI (Normed Fit Index) = 0.880, CFI = 0.891 (NFI and CFI (Comparative Fit Index) values close to 1 indicate a very good fit) (Bentler, 1990).

The equation (3), (4), graphics output and above all statistical discussion on AMOS magnifies that hypotheses 1 and 2 fail to reject and states that there are significant relationship between education development and graduates as well as education assessment and graduates.

5.1.2 Model B: Research Outcomes

The author identified research outcomes as final outcomes in the research wing of the university. This part is divided into two segments including research development and research assessment. The model 6 contains two groups including group 3 and group 4. Group 3 is defined as the research development in this model. There are four subgroups, namely subgroup 9, subgroup 10, subgroup 11 and subgroup 12, those are representing programs establishment, university culture, faculty capabilities and facilities respectively. On the other hand, group 4 stands for the research assessment in this model. There are four subgroups, namely subgroup 13, subgroup 14, subgroup 15 and subgroup 16, those are representing programs establishment, university culture, faculty capabilities and facilities respectively.

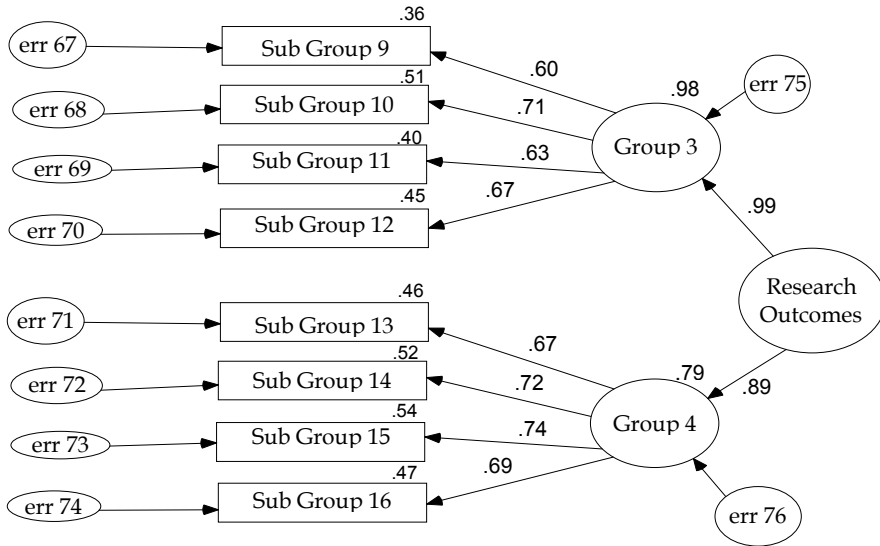


Fig. 7. AMOS Graphics Output of Model B (Standardized Estimates)

Figure 7 illustrates the inter relationships among different variables to justify the hypothesis 3 and 4 by SEM through AMOS.

Multiple Linear Regression (MLR) Equations

$$F_{\text{Group 3}} = 0.60 f_{\text{subgroup 9}} + 0.71 f_{\text{subgroup 10}} + 0.63 f_{\text{subgroup 11}} + 0.67 f_{\text{subgroup 12}} \tag{5}$$

$$F_{\text{Group 4}} = 0.67 f_{\text{subgroup 13}} + 0.72 f_{\text{subgroup 14}} + 0.74 f_{\text{subgroup 15}} + 0.69 f_{\text{subgroup 16}} \tag{6}$$

$$F_{\text{Research Outcomes}} = 0.99 F_{\text{Group 3}} + 0.89 F_{\text{Group 4}} \tag{7}$$

From the research findings, equation (5) states that university culture (sub group 10) is the most significant factor in research development. On the other hand, equation (6) represents that faculty capabilities (sub group 15) are highly contributed to research assessment. Finally, equation (7) depicts that research development is highly contributed to produce research outcomes in the universities.

From equation (5), (6) and (7),

$$\begin{aligned}
 F_{\text{Research Outcomes}} &= 0.99 F_{\text{Group 3}} + 0.89 F_{\text{Group 4}} \\
 &= 0.99 [0.60 f_{\text{subgroup 9}} + 0.71 f_{\text{subgroup 10}} + 0.63 f_{\text{subgroup 11}} + 0.67 f_{\text{subgroup 12}} \\
 &\quad + 0.89 [0.67 f_{\text{subgroup 13}} + 0.72 f_{\text{subgroup 14}} + 0.74 f_{\text{subgroup 15}} + 0.69 f_{\text{subgroup 16}}] \\
 &= 0.59 f_{\text{subgroup 9}} + 0.70 f_{\text{subgroup 10}} + 0.62 f_{\text{subgroup 11}} + 0.66 f_{\text{subgroup 12}} + \\
 &\quad 0.60 f_{\text{subgroup 13}} + 0.64 f_{\text{subgroup 14}} + 0.66 f_{\text{subgroup 15}} + 0.61 f_{\text{subgroup 16}} \quad (8)
 \end{aligned}$$

From the research results of equation (8), they show the significant relationships among four aspects, namely programs establishment, university culture, faculty capabilities, and facilities in research development as well as research assessment to produce the research outcomes in the universities. University culture and facilities in research development as well as faculty capabilities in research assessment are highly contributed to produce the research outcomes in the universities.

Model Fit Index

Chi-square = 189.828, Degrees of freedom = 19, Probability level = 0.000, CMIN/DF = 9.991, RMSEA = 0.135, NFI = 0.872, CFI = 0.883 (NFI and CFI values close to 1 indicate a very good fit) (Bentler, 1990).

The equation (7), (8), graphics output and above all statistical discussion on AMOS rectifies that hypotheses 3 and 4 fail to reject and states that there are significant relationship between research development and research outcomes as well as research assessment and research outcomes.

5.2 Educational Supply Chain

The author represents model C and D in this section. Model C stands for supplied inputs and model D represents supplied outputs. Hypotheses 5 and 6 stand for supplied inputs and hypotheses 7 to 10 for supplied outputs.

H₅: There is a relationship between education suppliers and students in the universities.

H₆: There is a relationship between research suppliers and research projects in the universities.

H₇: There is a relationship between graduates and education customers.

H₈: There is a relationship between research outcomes and research customers.

H₉: There is a relationship between education customers and the society.

H₁₀: There is a relationship between research customers and the society.

In the educational supply chain, the researcher defines supplied inputs to the university, supplied outputs of the universities to provide the conclusion of research issue items. From the research results, they show the significant relationships among different variables in educational supply chain to produce quality graduates and quality research outcomes for the betterment of the society.

5.2.1 Model C - Supplied Inputs

In model C, there are two main inputs for the universities, namely students and research projects that have been evolved from education suppliers and research suppliers respectively. Figure 8 illustrates the inter relationships among different variables to justify the hypotheses 5 and 6 by SEM through AMOS. **MLR equations:**

$$F_{University} = 0.41 f_{ST} + 0.38 f_{RE_PROJ} \tag{9}$$

$$= 0.41 [0.13 f_{ED_SUPP}] + 0.38 [0.23 f_{RE_SUPP}]$$

$$= 0.05 f_{ED_SUPP} + 0.09 f_{RE_SUPP} \tag{10}$$

From the research findings, university consists of students as well as research projects. The factor that highly contributed to the university is students. Refer to (10) also depicts the relation of education suppliers and research suppliers with the university. Research suppliers are the most significant factor in the university.

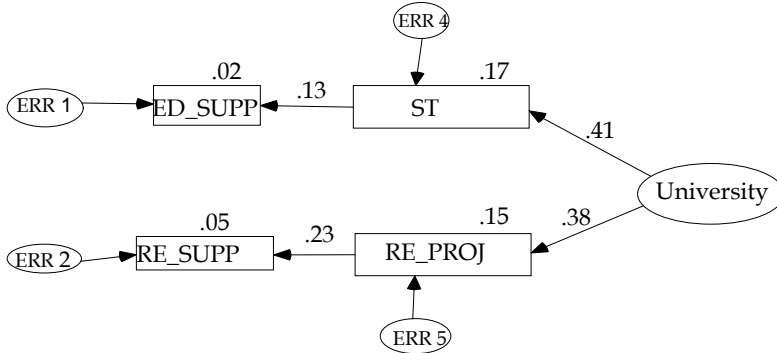


Fig. 8. AMOS graphics output of model C (standardized estimates)

Model Fit Index: Chi-square = 17.886, Degrees of freedom = 3, Probability level = 0.000, CMIN/DF = 5.962 (Ratio of relative chi-square close to 5 indicates reasonable fit), NCP = 14.886, FMIN = 0.036, RMSEA = 0.100, NFI = 0.720, CFI = 0.743 (NFI and CFI values close to 1 indicate a very good fit).

Equation (9), (10) graphics output and above all statistical discussion on AMOS 6 states that there are significant relationships between education suppliers and students, and research suppliers and research projects in the universities. Therefore, research hypotheses 5 and 6 fail to reject.

5.2.2 Model D - Supplied Outputs

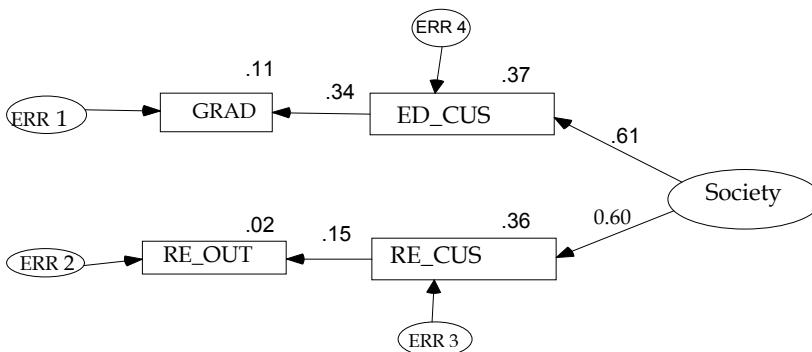


Fig. 9. AMOS graphics output of model D (standardized estimates)

In model D, the main outputs of the universities, including graduates and research outcomes will be delivered to the education customers and research customers respectively. Finally, all outcomes will be generated for the betterment of the society. Figure 9 illustrates the inter relationships among different variables to justify the hypothesis 7 to 10 by SEM through AMOS.

MLR equations

$$F_{\text{Society}} = 0.61 f_{\text{ED_CUS}} + 0.60 f_{\text{RE_CUS}} \quad (11)$$

$$= 0.61 [0.34 f_{\text{Grad}}] + 0.60 [0.15 f_{\text{RE_OUT}}] \quad (12)$$

$$= 0.21 f_{\text{Grad}} + 0.09 f_{\text{RE_OUT}}$$

From the research finding, the society consists of graduates and research outcomes. Refer to (12) represents that graduates are highly contributed to the society. Refer to (11) also depicts that education customers and research customers are included in the society. The most significant factor in the society is education customers.

Model Fit Index

Chi-square = 16.481, Degrees of freedom = 3, Probability level = 0.001, CMIN/DF = 5.494 (Ratio of relative chi-square close to 5 indicates reasonable fit) (Wheaton and et al., 1997), NCP = 13.481, FMIN = 0.033, RMSEA = 0.096, NFI = 0.896, CFI = 0.911 (NFI and CFI values close to 1 indicate a very good fit) (Bentler, 1990).

Equation (11), (12), graphics output and above all statistical discussion on AMOS states that there are significant relationships between graduates and education customers, research outcomes and research customers. There are also significant relationships among education customers, research customers and the society. Therefore, hypotheses 7, 8, 9 and 10 fail to reject.

From Equation (4), (8) and (12),

$$F_{\text{Society}} = 0.21 f_{\text{Grad}} + 0.09 f_{\text{RE_OUT}}$$

$$F_{\text{Society}} = 0.21 [0.97 F_{\text{Group 1}} + 0.92 F_{\text{Group 2}}] + 0.09 [0.99 F_{\text{Group 3}} + 0.89 F_{\text{Group 4}}] \\ = 0.20 F_{\text{Group 1}} + 0.19 F_{\text{Group 2}} + 0.09 F_{\text{Group 3}} + 0.08 F_{\text{Group 4}}$$

The above equation represents the relationship between the society and education development, education assessment, research development, research assessment. Education development and then education assessment are highly contributed to the society.

5.3 Overall Model Fit Analysis in AMOS

Overall research model represents education supply chain, research supply chain, and educational management in terms of education development, education assessment, research development and research assessment. AMOS graphics output for overall model is illustrated in Figure 10. All are significant relationships (significant at the 0.05 level – two tailed) in the overall model.

Model Fit Index

CFI (Comparative Fit Index) = 0.509, GFI (Goodness Fit Index) = 0.863, CMIN/DF = 8.751

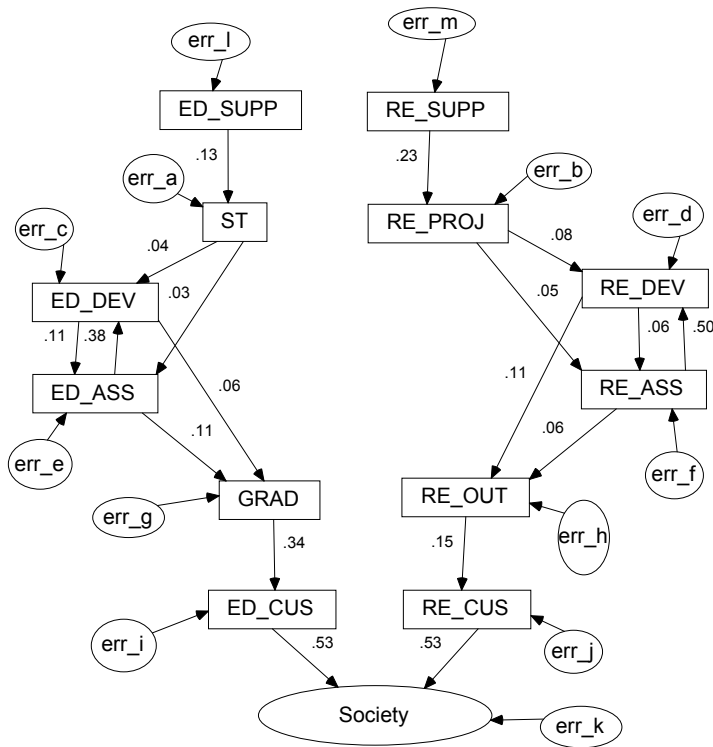


Fig. 10. AMOS Graphics Output of Overall Model (Standardized Estimates)

Modification indices should be considered only if it makes theoretical or common sense, chi-square value between 2 and 3, GFI and CFI value between 0.9 and 1 and significant relationship (Arbuckle, 2005). We can improve the overall model by using the highest Modification Indices (MI) that will make sense.

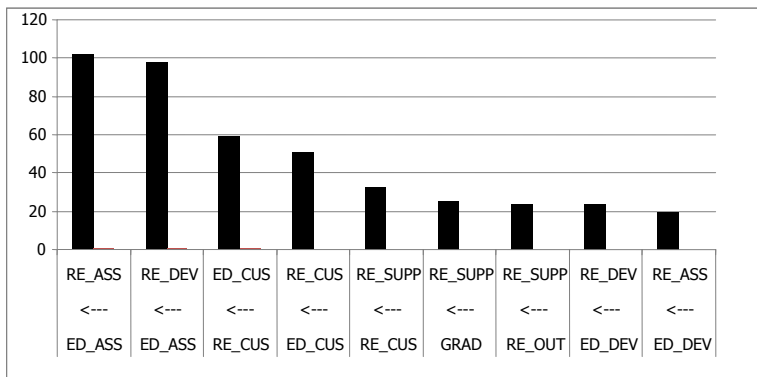


Fig. 11. Highest Modification Indices (MI) of Overall Model

5.3.1 Updated Model

By using AMOS highest Modification Indices (MI) of overall model in Figure 11, the researcher adds the relationship between RE_ASS and ED_ASS, RE_DEV and ED_ASS, ED_CUS and RE_CUS, RE_CUS and ED_CUS, RE_DEV and ED_DEV, RE_ASS and ED_DEV, RE_SUPP and RE_CUS, RE_SUPP and RE_OUT, RE_SUPP and GRAD.

As there is an insignificant relationship between RE_CUS and ED_CUS at the level 0.05 (two-tailed), we can remove this relationship. Updated model has been illustrated in Figure 12.

Model Fit Index: CFI = 0.908, GFI = 0.958, CMIN/DF = 2.864

In updated model, the value of GFI and CFI is more than that of overall model. Based on CFI, GFI, CMIN/DF, updated model represents a very good fit.

The current university administrators or prospective investors could apply this updated model as actual implementation to produce quality outcomes, i.e. graduates and research outcomes, for the betterment of the society.

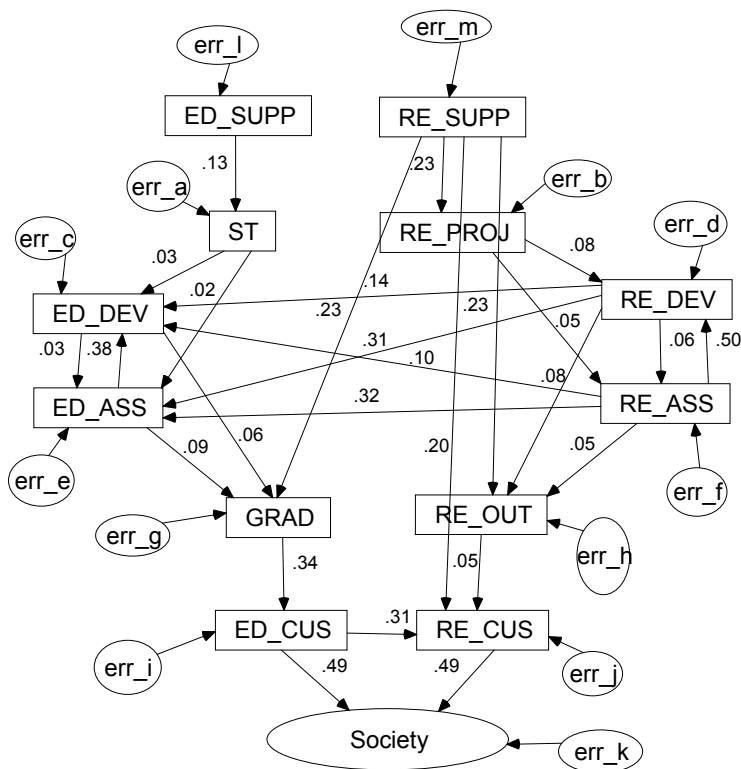


Fig. 12. AMOS Graphics Output of Updated Model (Standardized Estimates)

6. Discussion

6.1 Educational Management

In the educational management, the researcher defines education development, education assessment, research development and research assessment for the universities to provide the conclusion of research issue items. From the research results, they show the significant relationships among four aspects in educational management to produce quality graduates and quality research outcomes.

From the literature review and conceptual model, quality graduates will be produced through proper education development and proper education assessment.

$$\text{Graduates} = 0.97 \text{ ED_DEV} + 0.92 \text{ ED_ASS}$$

From the research results, education development is highly contributed to the graduates in the universities.

$$\begin{aligned} \text{Graduates} = & 0.61 (\text{Prog. Estab_ED_DEV}) + 0.68 (\text{Univ. Cult_ED_DEV}) + 0.63 (\text{Fac.} \\ & \text{Capab_ED_DEV}) + 0.61 (\text{Facilities_ED_DEV}) + 0.63 (\text{Prog. Estab_ED_ASS}) + 0.68 \\ & (\text{Univ. Cult_ED_ASS}) + 0.63 (\text{Fac. Capab_ED_ASS}) + 0.61 (\text{Facilities_ED_ASS}) \end{aligned}$$

From the research findings, university culture in education development and university culture in education assessment are highly contributed to the graduates in the universities.

From the literature review and conceptual model, quality research outcomes will be produced through proper research development and research assessment concurrently.

$$\text{Research Outcomes} = 0.99 \text{ RES_DEV} + 0.89 \text{ RES_ASS}$$

From the research results, research development is highly contributed to the research outcomes in the universities.

$$\begin{aligned} \text{Research Outcomes} = & 0.59 (\text{Prog. Estab_RE_DEV}) + 0.70 (\text{Univ. Cult_RE_DEV}) + \\ & 0.62 (\text{Fac. Capab_RE_DEV}) + 0.66 (\text{Facilities_RE_DEV}) + 0.60 (\text{Prog. Estab_RE_ASS}) \\ & + 0.64 (\text{Univ. Cult_RE_ASS}) + 0.66 (\text{Fac. Capab_RE_ASS}) + 0.61 (\text{Facilities_RE_ASS}) \end{aligned}$$

From the research findings, university culture in research development, facilities in research development and faculty capabilities in research assessment are highly contributed to the research outcomes in the universities.

6.2 Educational Supply Chain

In the educational supply chain, the researcher defines supplied inputs to the university, supplied outputs of the universities to provide the conclusion of research issue items. From the research results, they show the significant relationship among different factors in educational supply chain to produce quality graduates and quality research outcomes for the betterment of the society.

There are significant relationship between education suppliers and students as well as research suppliers and research projects to enhance the universities.

$$\begin{aligned} \text{University} &= 0.41 \text{ ST} + 0.38 \text{ RE_PROJ} \\ \text{University} &= 0.05 \text{ ED_SUPP} + 0.09 \text{ RE_SUPP} \end{aligned}$$

From the research findings, students and research suppliers are highly contributed to the universities.

There are significant relationship between education customers and graduates as well as research customers and research outcomes to enhance the society.

$$\text{Society} = 0.61 \text{ ED_CUS} + 0.61 \text{ RE_CUS}$$

This equation depicts that education customers and research customers have equal contribution to the society.

$$\text{Society} = 0.21 \text{ Grad} + 0.09 \text{ RE_OUT}$$

From the research findings, graduates are highly contributed to the end customer, i.e. the society. From the research framework, the society consists of graduates and research outcomes.

$$\text{Society} = f(\text{Graduates, Research Outcomes})$$

The authors defined the society as the function of graduates and research outcomes; therefore, well-being society depends on the quality graduates and the quality research outcomes. The following equation states that education development and consequently, education assessment in the university are highly contributed to the society.

$$\text{Society} = 0.20 \text{ ED_DEV} + 0.19 \text{ ED_ASS} + 0.09 \text{ RE_DEV} + 0.08 \text{ RE_ASS}$$

The different aspects in the educational management affect educational supply chain to produce the quality graduates and quality research outcomes for the end customer, i.e. the society.

6.3 Application Guidelines

In this research, the ultimate goals of the study are the quality graduates and quality research outcomes. SEM technique was applied to define factors 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.

- 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.
- 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 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.
- 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.
- 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.
- 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.
- 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.
- University's quality assurance center would assess the quality of the graduates and research outcomes in terms of performance indicators through quality assessment strategies and plans.
- University must ensure the modern teaching facilities for the students. Libraries, classroom facilities, laboratory facilities, online facilities, international publications, etc. are mandatory for any university.
- Universities, specially teaching based universities must have reviewed their students' research involvements. Universities could arrange different international conferences in the universities through various professional organizations, which would enhance the students to involve in the research.
- 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.
- 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.
- 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.

7. Conclusion

In summary, this research represents the first large scale empirical study that systematically investigate input of the university, output of the university through educational supply chain. This empirical study of 493 respondents from all stakeholders including experts and administrators of the university, employers, graduates, etc. are applied. The hypotheses testing and structural equation modeling (SEM) through AMOS are also applied.

One of the main goals of an educational supply chain is to improve the well-being of the end customer or the society. Improved Well-being society would be possible if we could able to produce quality graduates and quality research outcomes by implementing proper educational supply chain for the universities from the raw materials, i.e. students and research projects to finished products, i.e. graduates and research outcomes.

It is a surprising fact that researchers develop supply chain models mostly for improving business operations. Few, particularly academic researchers, do not realize that the research on academic supply chain management may also be conducted for their own educational institutions (Habib & Jungthirapanich, 2008a). This empirical research will fulfill that space. The applicability of the model can be confirmed empirically. However, model evaluation by actual implementation is suggested for prospective investors or current university administrators. The current decision makers who need to improve their management can apply the research equations of educational supply chain management model to their universities. This study provides educational management a new dimension to understand how supply chain management contributes to successful university operations. This model for the universities provides two main contributions to the end customer, i.e. the society, including human resource contribution and research contribution.

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Management in all business areas and organisational activities are the acts of getting people together to accomplish desired goals and objectives. Service is intangible, therefore, it is not too easy to define the theory application in varieties of service industries. Service Management usually incorporates automated systems along with skilled labour; it also provides service development. Due to enormous demand of service industries and management development, the book under the title "Management and Services" would create a milestone in management arena for all categories of readers including Business Administration, Engineering and Architecture. This book covers educational service development, service-oriented-architecture and case research analysis, including theory application in network security, GRID technology, integrated circuit application. The book is comprised of five chapters and has been divided into two parts. Part A contains chapters on service development in educational institutions and it depicts the application of supply chain management concept in service industries like tertiary educational institutions and multiple ways of web 2.0 applications transforming learning patterns and pathways. To understand the subject in a practical manner, Part B of this book consists of noteworthy case studies and research papers on management and services and represents theory application of Data mining, Fuzzy Cluster, Game theory, GRID Technology, simulation of Operational Amplifier and Current Controlled Conveyor II in network security, architecture, and integrated circuit application.

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