VOL. 11, NO. 7, APRIL 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

MODELLING INTERNATIONAL TECHNOLOGY TRANSFER PROCESS: EVIDENCE FROM LIBYAN INFORMATION AND COMMUNICATION INDUSTRY

Ali Hassan and Md. Yusoff Jamaluddin
Department of Electrical, Electronics and Systems Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM), Bangi, Malaysia
E-Mail: aliukm2013@gmail.com

ABSTRACT

This study suggests a model that describes the TT process of importing the foreign advanced technology by information and communication technology companies (ICT) and related SME's projects in Libya. The past relevant technology transfer models are reviewed in order to investigate and sort out the most influential international TT factors. These factors are believed to influence the transfer process effectiveness. The suggested model was based on a thorough literature review on a TT studies and the variables which extracted and modified from the past investigated models are classified as factors and sub-factors in a conceptual ICT industry context. These factors defined as TT government support initiatives, transferor characteristics, transferee characteristics, TT environment, learning centres and their respective sub-factors (variables) and outcome factor TT achievements. A questionnaire that conducted recently in the TT process in the Libyan ICT industry was utilized to verify the model. Major statistical techniques are applied to analyse the questionnaire data. These approaches included descriptive statistic and inferential statistics. The model factors and sub-factors are reformed by utilizing exploratory factor analysis (EFA). In addition, the significance of direct and indirect interrelationships between model factors was determined through confirmatory factor analysis (CFA).

Keywords: modelling, international technology transfer (ITT), information and communication technology companies (ICT).

INTRODUCTION

The technology transfer (TT) process from developed to developing countries has a paramount importance to growing countries for it being important a key factor to geting the advanced technologies that necessary for the economic development. International TT process has been investigated by several researchers in different industrial areas. They were recognized that the ITT process is a multifaceted process and influenced by several factors. A surveyed literature on relevant ITT models reveals that none of these researches were consecrated to studying the TT process in the area of ICT-based SME's projects. In addition, these considered models had anunclearassertion to the interactions between TT process enablers and outcome factors in the ICT industry context.

This study suggests a model that describes the TT process of importingtheforeign advanced technology by ICT companies and ICT-based SME's projects in Libya. The ICT industry in Libya is dependent on foreign technology transferred into the country by foreign ICT companies. In this study the TT processes were defined as some form of ICT equipment, materials, or knowledge is transferred from a foreign party (organization) to another local party (Libyan organization). The ITT developed model was specifically designed to be applied to the study of TT from developed countries to the Libyan ICT industry. We believe in the importance and the uniqueness of the Libyan ICT industry TT processes and this ITT process has not been investigated before. The model, shown in Figure 1 was based on a methodical literature review on a TT processes. The variables which extracted and modified from these past investigated studies are classified as in a conceptual ICT industry context model. The model factors and sub-factors are regrouped by utilizing Exploratory Factor Analysis (EFA). To investigate and confirm the model's factor and sub-factors interrelationships, confirmatory factor analysis (CFA) were implemented. The developed TT model presented herein illustrates the influences of TT enablers on the outcome factor. These ITT process influential factors are identified as TT government support initiatives, transferor characteristics, transferee characteristics, TT environment, learning centres and their respective sub-factors (variables). The outcome (achievements) factors are identified and explained through their relevant sub-factors (variables).

LITERATURE REVIEW

A brief literature on relevant TT models is presented here to extract and classify the most influential TTfactors.

The Calan tone *et al.* (1990) model offers a system composed of five elements that describe the TT process (Environment - Actors- Structure - Process - Functions), the framework describes the relationship between the elements and the macro factors underthe elements.

The construction industry of developing countries was the research field in Simkoko (1992) TT model. This research examines the effect of ITT programs and internal and external environment factors on construction project performance.

Kumar (1999) explores the effect of critical elements on the ability of a firm to upgrade its technological capability through imported technology from developed countries. This model shows the relationship between TT process, technological capability, and economic performance. Furthermore, a few factors of the learning capability model are suitable to beincorporated in the model implementation of TT in ICT-based SMEs.

Lin and Berg (2001) primarily explore the major factors that affect the performance of an ITT process. This model categorizes three groups of identified factors: the nature of the technology, previous international experience, and cultural difference between the technology provider and receiver.

Meanwhile Malik (2002) in his study investigates the complex issues involved in the effective management of intra-firm TT within a multinational company (MNC) environment, including the exact contents of the transferred technology, all the actors involved in the process, the mode of transfer, the main barriers to TT, and the project's relative chances of success.

The two-stage model was developed by Wang *et al* (2004) to describe the knowledge transfer process from MNCs to their subsidiaries. In the first stage, the model recommends factors that affect the level of knowledge contributed by the parent company to its subsidiary. In the second stage, the model proposes factors that affect the level of knowledge acquired by the subsidiary from its MNC parent. This study is concerned with the transfer of both management and technical knowledge.

Steenhuis and Bruijn (2005) focus on aircraft production technology. They showed that the process of TTconsists of three phases: preparation, installation, and utilization phases. These three phases are influencedby three sets of factors: technological, organizational, and environmental factors. This model emphasizes that the two individual companies (transferor and transferee) need to be balanced with each other for an efficient transfer.

Thai construction projects were the mean concern of Waroonkun and Stewart (2008) model as it consists offour process enablers: government influence, transferee characteristics, transferor characteristics, and relationship building. It also involves one outcome factor TT value added.

Mohamed *et al*. (2010) categorized the influential factors into enabling and TT outcome factors. This model is especially significant for publicly funded petroleum infrastructure, where the government concerns, whether or not advanced technologies are being willingly and effectively transferred to local petroleum employees and professionals.

Lastly Khabiri *et al*. (2012) identifies the main influential elements in the TT process when an SME wants to acquire a foreign technology. According to this study, the mechanism of TT seems to be a vital component to SMEs in TT process. Therefore, an appropriate mechanism must be assessed and selected among the various mechanisms of the TT process and the SMEsas transferee are able to assess and select the best mechanism of TT.

ICT International technology transfer model

The model shown in Figure-1 defines the significant factors that influence the effectiveness of the ITT process and results (achievements). These relevant factors are modified from the examined literature on TT phenomenon and technology adoption. The model presents the four identified factors and how they impact on the TT process factor, and the outcome factor. The model factors and sub-factors are listed in Table-1.

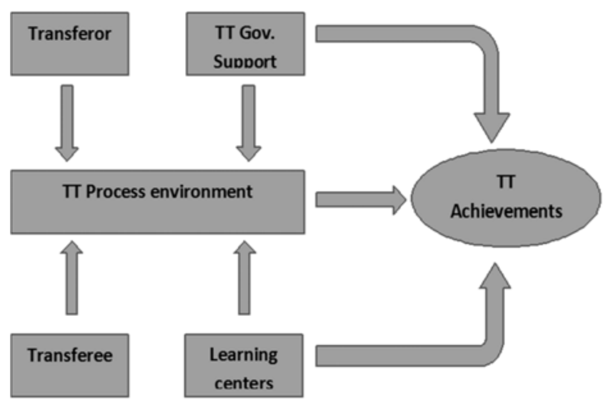

Figure-1. ICT International technology transfer model.

VOL. 11, NO. 7, APRIL 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

Table-1. The model identified factors and sub-factors.

Code	Factor	Sub factor
A2.	**TT government support initiatives**	
A2.1		Government policy that governing the ICT industry.
A2.2		Availability of adequate infrastructure.
A2.3		Government Support.
A2.4		Parent companies encouragement to the skilled workers and entrepreneurs
A2.5		ICT Parent companies supporting to ICT SMEs.
B2	**Learning centers and ICT entrepreneurs learning capability**	
B2.1		The educational systems, training programs, and R&D centers.
B2.2		ICT entrepreneurial training and development.
B2.3		ICT Technology based incubator.
B2.4		Involvement of ICT industry in university programs.
C 2	**Transferor's characteristic**	
C2.1		Transferor's willingness to implement TT initiatives and cooperate with local workers.
C2.2		Transferor's knowledge base and skills.
C2.3		Transferor's ability to transfer technology.
C2.4		Transferor's degree of previous international experience.
D2	**Transferee's characteristic**	
D2.1		Technology absorption capabilities of the recipient firms.
D2.2		The transferee's degree of experience in ITT process.
D2.3		The shortage of a skilled/expert workforce with the recipient company.
D2.4		The transferee's motivation to learn new technologies.
E2	**TT process. (TT environment)**	
E2.1		Complexity level of the technology to be transferred.
E2.2		The mode of technology transfer.
E2.3		The formally planned and well managed TT agreements.
E2.4		The relationship between the transferor and transferee
E2.5		The cultural traits of the both parties.
E2.6		The entrepreneurial agent middleman.

Government policy sub-factor was concerned with the degree to which the government's policies and enforcement practices encourage TT to occur. While the learning centres are obviously an important and influential factor in the TT to the developing countries; this factor related to host country learning capability.

The transferor's characteristic factor is concerned with the transferor's readiness and ability to provide the appropriate technology to the recipient, and transferor's previous experience level in ITT process. On the other hand, the transferee characteristics factor is a significant factor that affects ITT process, among the recipient characteristics that have been identified by literature to influence TT, are absorptive capacity, prior knowledge and experience, learning intent, and technological ability.

The TT process (TT environment) factor explores the effect of technology characteristics, transfer mode and the relationships between transferor and transferee. The management of TT program and the role of the agent middleman in the TT process are also investigated.

In this study, the performance of and interrelationship between, the above-mentioned TT factors contributes to the achievements to the host ICT sector. The model defines four main areas (sub-factors) where

VOL. 11, NO. 7, APRIL 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

potential benefits may be derived from international TT initiatives: economic development, project (firm) performance, knowledge and technological capability improvement, and development and survive of ICT technology SME's.

The model output factor (TT achievement) is explained through 4 sub-factors and these 4 sub-factors were detailed into several items as shown in Table-2.

Table-2. The model output factor (TT achievement) and its related sub-factors and items.

code	Factor	Sub factor
A4	**Economic development**	
A4.1		Host country industrialization and economic development.
A4.2		Local ICT firm's competitiveness in national markets.
A4.3		The financial performance of local ICT firms.
A4.4		Utilization of Libyan natural and human resources.
A4.5		Diversification into new products or markets.
B4	**Project (firm) performance**	
B4.1		Libyan ICT industry overall long term performance.
B4.2		Efficiency, services cost and service quality of the host project.
B4.3		Quality standards in Libyan ICT firms.
B4.4		Mastering the new technology, by the Libyan ICT firms.
B4.5		Functional performance of the products, products cost and quality.
C4	**knowledge and technological capability improvement**	
C4.1		The ICT local firm's technological capabilities and skills base.
C4.2		The recipient's ability to operate, learn, acquire, absorb and apply new external technologies and knowledge
C4.3		Local workers' development.
C4.4		Libyan ICT sector working practices over the long term.
D4	**development and survive of ICT technology SME's**	
D4.1		Develop and surviving of ICT SMEs.
D4.2		Reducing cost of production, maintain consistency in quality, improve productivity for ICT SMEs.
D4.3		The ability to employ a significant amount of the labor.
D4.4		Mastering a new process techniques by ICT based SMEs, and improve its marketing and management procedures
D4.5		The emergence of ICT entrepreneurs and skilled workers in a small scale enterprise.
D4.6		Increasing technological capabilities and capacities for ICT SMEs.

Research approach

A questionnaire survey was carried out on the sample targeting ICT companies' employees (technician's, engineers, supervisors, managers …) who have involved in TT processes.

Respondents were requested to provide the rating for their opinion and the perceived impact on a five-point Likert scale of 43 model factors and sub-factors questions. Respondent's background contains 11 questions. The survey was conducted in the second quarter of 2015. In total 270 questionnaire surveys were distributed, and 162 were returned, representing a response rate of 60%.

The Statistical Package for the Social Sciences (SPSS 21) software was implemented to analyze the receiving data due to its accuracy and effectiveness. Statistical analysis methods which included a descriptive statistics were implemented to create a respondent profile.

ARPN Journal of Engineering and Applied Sciences

EFA was performed. The developed ITT model for the Libyan ICT industry was a confirmed utilizing CFA.

DATA ANALYSIS AND RESULTS DISCUSSION

Data screening

The received questionnaires were checked against missing data, vital missing information that determines the inclusion or exclusion of certain questionnaires is the response towards the participation in TT process with international partners. Also, responses are excluded based on the sampling criteria guidelines. Accordingly, among the 162received answers, 11responses were excluded due to that do not adhere with mentioned specified sampling criteria.

Respondent profile

Gathering the personal characteristics of the respondents was essential to develop a good understanding of their perspective on the TT process and their field of specialization. The evaluation of the position held by respondents was necessary to confirm the validity and reliability of responses. Determining the experience of process participants was decisive for ensuring the validity of results. The greater the experience of the respondent in the ICT industry means a greater understanding of process performance and influences. Respondents were requested to detail their qualifications in order to confirm they are qualified enough to develop an informed perspective on the ITT process. The aim was to develop a greater understanding of the respondent's exposure to ITT and their experience in the local ICT industry sector. Table-3 summarize the respondent profile (position- experience - education). According to the position of the respondents the majority were engineers with a (41.1%); followed by the technician (17.9%); administrative officer (9.9%); academic staff (6.6%). The highest frequency of respondents had a bachelor degree (48.3%) while the Diploma holders come with (28.5%) and Master holders percentage (18.5%) followed by the doctorate (4%). statistics shows that the respondents have various working experience ranging from less than 5 years to more than 20 years. The respondents with experience of 6 to 10 years got the highest frequency (39.1%).

Table-3. Respondent profile.

	Frequency	**Percent**
Position		
Manger	8	5.3
Project Supervisor	13	8.6
Consultant	6	4.0
Academic Staff	10	6.6
Engineer	62	41.1
Technician	27	17.9
Administrative Officer	15	9.9
Others	10	6.6
Total	151	100.0
Experience		
less than 5 years	27	17.9
6-10 years	59	39.1
11-15 years	35	23.2
16-20	20	13.2
more than 20 years	10	6.6
Total	151	100.0
Education		
Diploma	43	28.5
Bachelor	73	48.3
Master	28	18.5
Doctorate	6	4.0
Other	1	.7
Total	151	100.0

Exploratory factor analysis EFA

The EFA analysis showed that all factors and sub-factors in the model satisfy the condition of univariate normality, as all the sub-factors has skewness and kurtosis fall within the recommended range to indicate normality, as a rule of thumb says that, a variable is reasonably close to normal if its skewness and kurtosis have values between -1.0 and +1.0. Furthermore, to ensure the adequacy of sample size, the associated KMO test was examined. Kaiser (1974) recommended the value of KMO to be above 0.5 and Bartlett's Test of Sphericity to be significant (P-value <0.05), to make the statistical inference that there is factorability. The initial inspection of the single factor solution has resulted in poor total variance explained. Therefore, there was a need to improve the statistical figures. Such improvement is achieved through removing sub-factors with low loading. The inspection of factor loadings, suggested the removal of sub-factors, D2.3, E2.4 and E2.6 from Transferee's characteristic and TT process (TT environment) factors respectively, as they were having the lowest factor loadings. With such removal, the assumption of EFA was revisited. Table-4 gives the summary results of the EFA solution.

VOL. 11, NO. 7, APRIL 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

Table-4. Varimax rotated factor loading for the exogenous five factors.

Factor	Items	Loading
TT government support initiatives KMO= 0.767 P value (Sig. = 0.000) Viaernce explained =55.279 Cornabach alpha = 0.794 Eigen value = 2.764	A2.1 A2.2 A2.3 A2.4 A2.5	.628 .695 .689 .848 .833
Learning centres KMO= .775 P value (Sig. = 0.000) Viaernce explained =71.655 Cornabach alpha = .862 Eigen value = 2.866	B2.1 B2.2 B2.3 B2.4	.874 .877 .897 .727
Transferor's characteristics KMO= .731 P value (Sig. = 0.000) Viaernce explained =51.950 Cornabach alpha = .691 Eigen value = 2.078	C2.1 C2.2 C2.3 C2.4	.700 .716 .721 .746
Transferee's characteristic KMO= .597 P value (Sig. = 0.000) Viaernce explained =56.711 Cornabach alpha = .611 Eigen value = 1.701	D2.1 D2.2 D2.4	.752 .669 .830
TT process. (TT environment) KMO= .737 P value (Sig. = 0.000) Viaernce explained =53.238 Cornabach alpha = .698 Eigen value = 2.130	E2.1 E2.2 E2.3 E2.5	.765 .796 .663 .686

For the endogenous factor TT achievements, all sub-factors from A4.1 until D4.6 showed adequate univariate normality. The univariate normality was judged based on the corresponding values of skewness and kurtosis. As shown in Table 6, the KMO test has the value of 0.935, which indicates that the sample size is adequate to perform EFA according to Hair et al. (1998). On the hand, the total variance explained was lower than the minimum acceptable per cent, this necessitates removing some sub-factors in order to improve the total variance explained. Several sub-factors with lowest factor loadings were detected and they were removed, such sub-factors are A4.2, A4.5, B4.2, C4.1, C4.2, C4.3, D4.2, and D4.5. This left the achievement to present with 3 sub-factors, and 12 items only Table 5. The Rotated Component Matrix generate 3 component with 12 items with an appropriate total explained variance of 27.513, 19.640, and 16.501 percent respectively. Moreover, all the retained items have factor loadings that exceed the recommended value of 0.5, and they are ranging from 0.602 until 0.796. The reliability test shows that the factor has a reliability of 0.953.

VOL. 11, NO. 7, APRIL 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

Table-5. Varimax rotated factor loading for TT Achievements factor solution.

Factor and	Sub-Factors	Items	Loading
(TTA)TT Achievements KMO= 0.935 P value (Sig. = 0.000) Cornabach alpha = .953	(TTA1) Firm Performance and Technological Capability Viaernce explained =27.513 Eigen value = 10.640	B4.1 B4.3 B4.4 B4.5 C4.4 D4.1	.724 .785 .656 .749 .698 .694
	(TTA2)Development and Survive of ICT based SME's Viaernce explained =19.642 Eigen value = 1.077	D4.3 D4.4 D4.6	.796 .773 .669
	(TTA3) Economic Development Viaernce explained =16.501 Eigen value = 1.015	A4.1 A4.3 A4.4	.602 .723 .728

Confirmatory Factor Analysis (CFA)

As reported by Schumaker and Lomax (2004), CFA is used to determine the adequacy of the measurement model. Confirmatory Factor Analysis is to validate the relationship between observed and unobserved variables (Diana, 2014). Figure-2 illustrates the pooled measurement model in AMOS Graphic. The output of CFA illustrates the factor loading for every item, every component, and the correlation between the constructs.

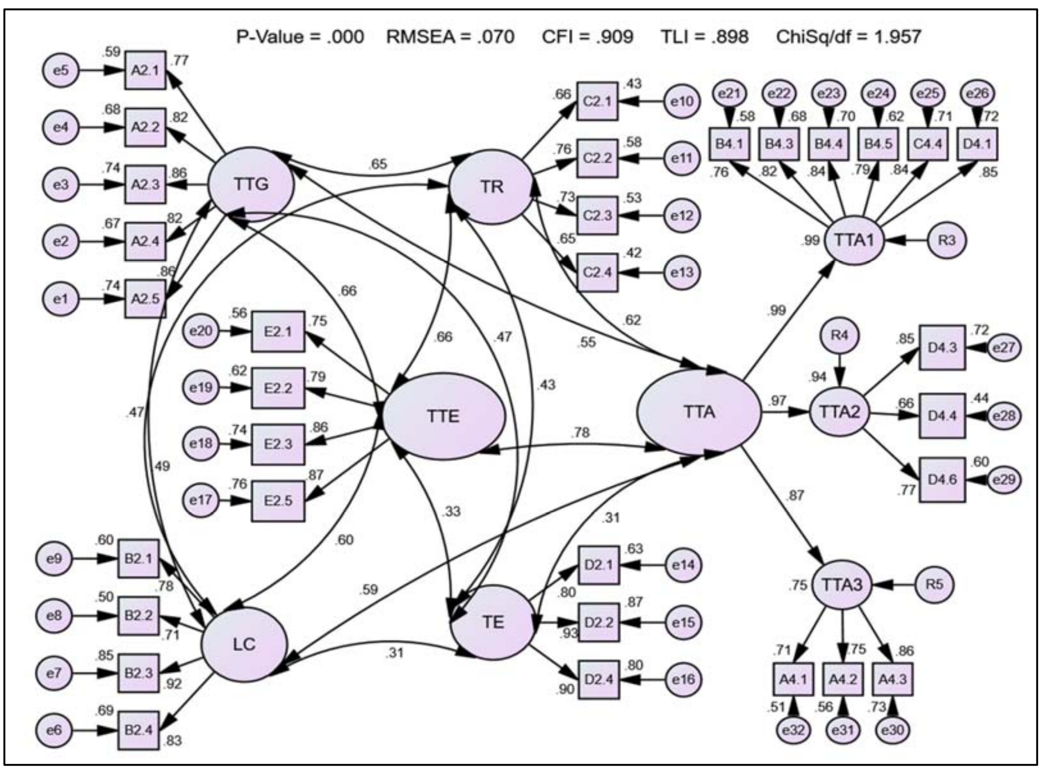

Figure-2. The Pooled CFA for measurement model of all latent constructs.

The model consists of six main constructs (TTA second-order with three sub-constructs). There are five exogenous constructs contributes to TT achievements endogenous construct namely TT government support initiatives (TTG), Learning Centres and ICT entrepreneurs learning capability (LC), Transferor’s characteristic (TR), Transferee’s characteristic (TE), andTT environment (TTE) and three sub-constructs measuring TTA Performance namely firm performance and technological capability improvements (TTA1), development and survive of ICT technology SME's (TTA2), and economic development (TTA3).

Assessing the validity and reliability for a measurement model

To validate the measurement model for Uni-dimensionality, Validity, and Reliability, the study decided to employ the Pooled-CFA whereby the measurement models for all constructs are assessed together at once (Zainudin, 2012).

The model shows adequate factor loading and hence the uni-dimensionality has been achieved. Generally, there are three types of validity that are required for a measurement model, for instance, Convergent Validity, Construct Validity and Discriminant Validity (Zainudin, 2015). Convergent Validity is achieved when the value of Average Variance Extracted is greater or equal to 0.5 Zainudin, (2012).This was clearly satisfied as shown in Table-9. In order to achieve construct validity, several fitness indexes must be achieved to the required level. The indexes shown in Figure-2 namely, RMSEA, CFI, TLI, and Chisq/df show the fitness indexes for the measurement model achieved the required fitness level.

Model reliability

While, in assessing the reliability, of the measurement model, there are three assessments need to be assessed, Internal Reliability, Construct Reliability and Average Variance Extracted.

Table6presented the result of CFA procedure namely the Composite Reliability (CR) and the Average Variance Extracted (AVE) for all latent construct. The Composite Reliability (CR) is used to measure the reliability and internal consistency for a latent construct. The CR value greater 0.60 is required in order to achieve composite reliability for a construct. The Average Variance Extracted (AVE) is measuring the average percentage of variation as explained by the measuring items for a construct. The AVE values exceed 0.5 is required. As a summary, all constructs in this study have fulfilled the internal consistency and the composite reliability criteria.

Table-6. The CFA Report for CR and AVE for all latent construct.

Construct	**CR** (above 0.6)	**AVE** (above 0.5)
TTA	.986	.960
TTA1	.923	.668
TTA2	.806	.583
TTA3	.798	.569
TR	.754	.506
TTG	.915	.683
LC	.886	.662
TTE	.890	.671
TE	.910	.772

The measurement model has achieved the required validity and reliability levels as well as uni-dimensionality and the normality distribution of the data were satisfied.

DISCUSSIONS AND CONCLUSIONS

The ICT international technology transfer model was developed and the affecting factors and sub factors were explored and defined. The developed model was empirically tested in Libyan ICT industry, a questionnaire survey was carried out on the sample targeting ICT companies' employees who have involved in TT processes. The Statistical Package for the Social Sciences (SPSS 21) software was implemented to analyse the receiving data. The analysis included descriptive statistic to create a respondent profile in order to establish reliable and validated measures for the factors under investigation of this study.

The outcome of this analysis is the confirmed model for international TT in ICT projects, which includes a number of refined enabling and achievements variables. Among five enablers (factors) and their 23 sub factors the analysis retains only 20 and ignores 3 sub factors. The (EFA) grouped the following factors (enablers) in the developed model: TT government support initiatives, transferor characteristics, transferee characteristics, TT environment, learning centres, and their respective sub-factors (variables). On the other hand, the outcome (achievements) construct has resulted with only 3 sub factors and 12items.

Utilising EFA, CFA, a five-factor model was developed. The developed ITT model for the Libyan ICT industry was a confirmed and validated utilizing CFA. AMOS Graphic illustrates the pooled measurement model with the all necessary and required indices.

ACKNOWLEDGEMENT

The authors' deep appreciations go to all related and supporting staff at the National University of Malaysia (UKM) for their cooperation provided throughout the study. The authors express gratitude to the Libyan Ministry of Higher Education for their financial support.

REFERENCES

Awang Zainudin. 2012. Structural equation modelling using AMOS graphic. Penerbit Universiti Teknologi MARA.

Awang Zainudin. 2015. SEM Made Simple: A Gentle Approach to Learning Structural Equation Modelling. MPWS Rich Publication.

Calantone R. J., Lee, M. T. and Gross A. C. 1990. Evaluating international technology.

Diana T. 2014. Validating delay constructs: An application of confirmatory factor analysis. Journal of Air Transport Management. 35: 87-91.

Hair Joseph F., *et al.* 1998. Black. 1998. Multivariate data analysis. pp. 577-664.

Kaiser H. F. 1974. An index of factorial simplicity Psychometrika. 39(1): 31-36.

Khabiri N., Rast S. and Senin A. A. 2012 Identifying main influential elements in technology transfer process: a conceptual model. Procedia-Social and Behavioural Sciences. 40: 417-423.

Kumar V., Kumar U. and Persaud A. 1999. Building technological capability through importing technology: the case of Indonesian manufacturing industry The Journal of Technology Transfer. 24(1): 81-96.

Lin B. W. and Berg D.2001. Effects of cultural difference on technology transfer projects: an empirical study of Taiwanese manufacturing companies. International Journal of Project Management. 19(5): 287-293.

Malik K. 2002. Aiding the technology manager: a conceptual model for intra-firm technology transfer. Technovation. 22(7): 427-436.

Mohamed A. S., Sapuan S. M., Ahmad M. M., Hamouda A. M. S. and Baharudin B. H. T. B. 2012. Modeling the technology transfer process in the petroleum industry: Evidence from Libya Mathematical and Computer Modelling. 55(3): 451-470.

Schumacker R. E. and Lomax R. G. 2004. A beginner's guide to structural equation modelling. Psychology Press.

Simkoko E. E. 1992. Managing international construction projects for competence development within local firms International Journal of Project Management. 10(1): 12-22.

Steenhuis H. J. and Bruijn E. J. 2005. International technology transfer: Building theory from a multiple case-study in the aircraft industry transfer in a comparative marketing framework. Journal of Global Marketing. 3(3): 23-46.

Wang P., Tong T. W. and Koh C. P. 2004. An integrated model of knowledge transfer from MNC parent to China subsidiary. Journal of World Business. 39(2): 168-182.

Waroonkun T. and Stewart R. A. 2008. Modeling the international technology transfer process in construction projects: evidence from Thailand. The Journal of technology transfer. 33(6): 667-687.