Developing a Technology Transfer Model for Information and Communication Technology

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الملخص

يعتبر نقل التكنولوجيا الدولية (ITT) طريقة فعالة للحصول على التقنيات المتقدمة التي تتطلب تعزيز القدرات الإدارية والفنية للمؤسسات والموظفين في الدول الناشئة. يهدف هذا البحث إلى تحديد العوامل والعوامل الفرعية التي تؤثر على عملية ITT وتصنيف نتائج العملية. تمت صياغة هذه العوامل في نموذج يلخص عملية نقل التكنولوجيا (TT) لتكنولوجيا المعلومات والاتصالات (ICT) من البلدان المتقدمة إلى البلدان الناشئة. اجريت عملية استقراء العلاقات المتبادلة بين عوامل النموذج و إثبات صحته من خلال النظر في عملية نقل التكنولوجيا في قطاع تكنولوجيا المعلومات والاتصالات في ليبيا. نموذج TT المصاغ ينتقي أهم العوامل ذات الصلة التي تؤثر على فعالية عملية نقل التكنولوجيا الدولية في سياق تكنولوجيا المعلومات والاتصالات. يتكون النموذج الناتج من أربعة عوامل تمكين أصلية وبنية خارجية واحدة وهي إنجازاتITT. تتيح العناصر الأربعة الأصلية الدعم الحكومي ، وخصائص الناقل ، وبيئة ITT ، وقدرة تكنولوجيا التعلم. استخدمت تقنيات إحصائية متعددة لتقييم أهمية عوامل التمكين و النتائج ذات الصلة وقدمت النموذج المصاغ في صناعة تكنولوجيا المعلومات والاتصالات. تكشف النتائج أن المتنبئين الخارجيين الأربعة في النموذج ، وهي: مبادرات دعم حكومة لنقل التقنية (TTG) ، ومراكز التعلم (LC) ، وخصائص المحول (TR) ، وبيئة نقل التقنية (TTE) جيدة بما يكفي لتقييم نجاح عملية نقل التقنية. يوضح النموذج أن بيئة TT المناسبة تؤدي إلى نجاح عملية TT. كما بينت الدراسة الآثار الإيجابية لعامل مراكز التعلم (LC) على انجازات نقل التقنية (TTA). بناءً على هذا البحث ، يمكن أن يضيف TT قيمة إلى صناعة تكنولوجيا المعلومات والاتصالات المحلية في أربعة مجالات رئيسية ، وهي: التنمية الاقتصادية – أداء (الشركة) المشروع – تحسين المعرفة والقدرة التكنولوجية – تطوير الشركات الصغيرة والمتوسطة في مجال تكنولوجيا المعلومات والاتصالات واستمرارها.

Abstract

International Technology Transfer (ITT) considered as a powerful approach of obtaining the advanced technologies that required enhancing the management and technical capabilities of the institutions and employees in emerging nations. This research aims to determine the factors and sub-factors that impact the ITT process and classify the process outcomes. These factors are formulated in a model which outline the TT process of information and communication technology (ICT) from the advanced to emerging countries. The model is substantiated and the interrelations between the model's factors are scrutinised by considering the TT process in Libya's ICT sector. The formulated TT model captures the most relevant factors that influence the effectiveness of the international TT process in the ICT context. The resultant model consists of four indigenous enablers and one exogenous construct namely ITT achievements. The four

indigenous enables government support, transferor characteristics, ITT environment, and learning technology capability.
Multiple statistical techniques was utilised to audit the significance of enabling and resulting factors involved and provided the formulated model of the international TT in the ICT industry. The outcomes disclose that the four exogenous predictors in the model, namely: TT government support initiatives (TTG), learning centres (LC), transferor's characteristics (TR), and TT environment (TTE) are good enough to estimate the success of the TT process achievements. The model shows that the appropriate TT environment leads to a successful TT process. The study stated the positive effects of the TT learning centres (LC) factor on TT achievements (TTA). Based on this research TT can add value to the local ICT industry in four main areas, namely: Economic development - Project (firm) performance - Knowledge and technological capability improvement - Development and survive of ICT technology Small and Meduim Enterprise (SME).
Keywords: International Technology Transfer (ITT); Modeling; Information and communication technology (ICT).

1. Introduction

Over the years, information and communication technology ICT has helped businesses create the most rapidly growing industrial sectors, driven competence in government and business activities. The evidence obtained from different emerging countries pointing that, ICT as a sector, can contribute vastly to the national Gross Domestic Product (GDP) of nations. Furthermore, ICT could efficiently support international economic integration, narrow the digital divide, and improve living standards of the mass. One of the means to impart the advanced technologies to the developing countries is through the Technology Transfer process (TT). The technology transfer (TT) process from developed to developing countries was investigated by several researchers in different industrial areas. They acknowledged that the ITT is a multifaceted process influenced by several factors. The inter-relationships among these factors can affect the TT process successes [1][2][3]. Intensive literature survey on relevant TT models reveals that most of these studies were focusing on the business and manufacturing perspectives [4]. Nevertheless, among these studies only limited models was empirically supported. Moreover, none of these researches consecrated to study the TT process in the area of ICT industry and its related SME's projects. In addition, these considered models had a vague assertion to the interactions between TT process enablers and outcome factors in the ICT industry environment.

Like most developing countries, Libya recognizes the importance of ICT as a catalyst for sustainable socio-economic development. The study believes in the importance, and the uniqueness of the Libyan ICT industry TT processes and the research on TT is still lacking. The study aims to develop a model describing the TT process embracing from foreign advanced ICT companies to ICT projects in Libya. The developed TT model, designed specifically for transfer the technology from developed countries to the Libyan ICT industry. In this work, the TT processes defined as some form of ICT equipment, materials, or knowledge transfer from foreign organizations to local organizations. The results of the evaluation study of TT process and outcome factors in the Libyan ICT industry were gathered from a recently conducted survey. The developed TT model, shown in Figure 1 illustrates the proposed hypothesis links between TT enablers and the outcome factors. The constructs extracted and modified from the previous studies classified as factors and sub-factors in a conceptual ICT industry model to examine their interrelationships, and to seek the evidence supporting these recognised relationships. To investigate the relationships, the study employed the most common statistical techniques

such as correlation and regression between factors and sub-factors. The structural equation modelling (SEM) technique is performed to test the structural model for the significance of these inter-relationships. This study identified the influential factors of ITT process namely government initiatives, transferor characteristics, transferee characteristics, TT environment, learning centres and their respective sub-factors. The study would also identify the achievements factors through their associated sub-factors.

2. ICT International Technology Transfer Model

The model shown in Figure 1 defines the factors that influence the effectiveness of ITT process and its achievements. These factors are restructured from the examined literature on TT phenomenon and technology adoption. The comparison of the models is presented in detail by the author in previous work [4]. The model indicates how the four identified factors affect the TT process and the outcome factor.

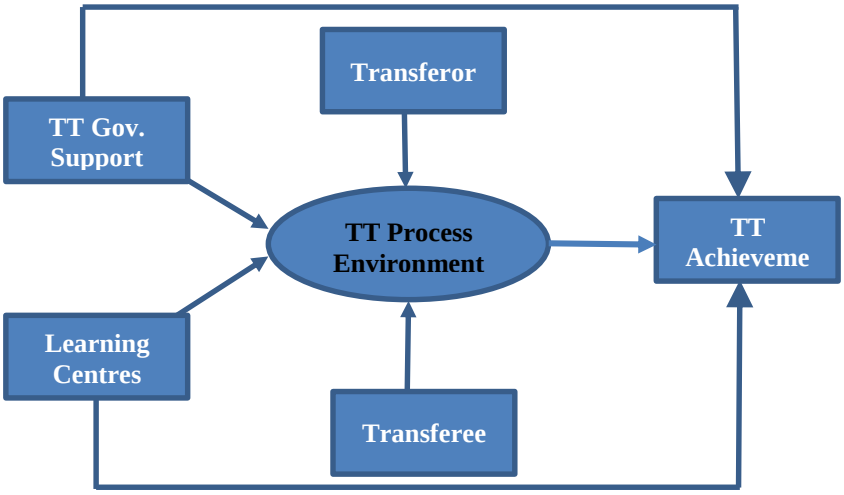

Figure 1. ICT International Technology Transfer Model

2.1 TT Government Support Initiatives

As stated by [5], the policies, regulations, and enforcement practices of the host government can significantly influence the effectiveness of TT process. Several studies have recognized the financial factor as a significant element affects the success of the TT process. As argued by [6] and [7] that the success of any TT process require adequate infrastructure, which is a government-related concern.

According to the literature, the government initiative support policy is strongly related to the capability of the local projects to effectively source, evaluate, and adapt new technologies. Meanwhile, parent companies through sub-contracting can provide the sub-contractors (medium enterprises) with the designs of the products and the required training [8]. Also, parent companies help with the emergence of entrepreneurs and skilled workers, who in turn can initiate similar industries on a smaller scale.

2.2 Learning Centers and ICT Entrepreneurs' Learning Capability

The learning ability is concerned with the effects of the sub-factors that facilitate the learning ability of the technology being transferred between foreign and local firms.

According to the surveyed literature, the ability of developing countries to receive, transfer, adapt, develop, and manage technologies depends on the development of endogenous technological capability and human resources, local industry and university cooperation, and existing of technology incubators [9][7].

2.3 Transferor Characteristics

This factor is concerned with transferor's willingness to transfer technology, knowledge base and transfer capacity, and prior experience. The transferor that is willing to transfer the proper technology is one of the vital elements in attaining successful TT process [10] and [11]. Knowledge is hard to transfer when motivation is lacking and when transferors are highly protective [12]. The ability of the technology provider to transfer refers to the firm-specific knowledge and the capability to impart that knowledge.

2.4 Transferee Characteristics

Among the recipient characteristics that have been acknowledged in the literature as influencing TT are absorptive capacities, prior knowledge, and learning capacity. The previous international experience of the transferee is expected to improve the learning capability and efficiency of the transferee in the technical communication process. The operational capabilities, dynamic learning capacity and investment capabilities of transferees, as well as intent to learn and learning ability, are supposed as critical issues in the transfer process [5][13].

2.5 TT Process (TT Environment)

This factor is concerned with the technology properties. It covers the following: technology characteristics, TT mechanism, management of the TT program, the relationship between the supplier and the recipient, culture differences, TT agent, and relationships between the transferor and the [14][10][15].

All the enabling factors and their relevant sub factors are summarized in Table 1.

Table 1. the model identified factors and sub-factors

Code	Factor	Sub-Factor
A2.	**TT government support initiatives**	
A2.1		**Government policy that is governing the ICT industry.**
A2.2		**Availability of adequate infrastructure.**
A2.3		**Government Support.**
A2.4		**Parent companies encouragement to the skilled workers.**
A2.5		**ICT Parent companies are 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 firm.**
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.**

2.6 TT Achievements

Based on the objectives, the present study identifies four main areas where potential achievements may be derived from ITT initiatives. These benefits are represented as sub-factors: economic development, project (firm) performance, knowledge and technological capability improvements, and development & survival of ICT-based SMEs. According to the literature, firms in developing countries can increase productivity through access to technological know-how, management techniques, and technical skills from industrial countries. TT process also could enhance the utilization of natural and human resources. The recipient mastering the imported technology has been proposed as a measure of the efficiency of the TT process; the improved project performance results from the effective ITT.

The TT achievements explained through four subfactors, and the detail of four subfactors into several items shown in Table 2.

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

Code	Factor	Subfactor
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 absorb, and apply imported technologies.**
C4.3		**Local workers' development.**
C4.4		**Libyan ICT sector is 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 new 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.**

3. Research Approach

The preliminary objective of the work is to validate the measurement model of latent constructs involved in the study. Once validated, the study intends to model the inter-relationship among these leading from TT process to TT achievements. Finally, the study would develop the TT model describing the TT process embracing from foreign advanced ICT companies to ICT projects and ICT-based SME in Libya.

The population of the study consists of employees of ICT companies such as technicians, engineers, supervisors, and managers in Libyan ICT industry. Thus, the selected respondents representing the population under study considered appropriate to evaluate adoptions and the importance of factors linking the TT process and its outcomes. Respondents can rate how strongly they agree or disagree with every statement regarding TT process and its achievement.

Prior to conducting the main study, the researcher obtained the Pilot Study data and performed the Exploratory Factor Analysis (EFA) for all constructs. The EFA produced single factor solution for all exogenous constructs [4]. Once the data from the main study obtained, the researcher performed the Confirmatory Factor Analysis (CFA) to validate all latent constructs in the study. With the validated latent constructs, the study modeled the interrelationships among these constructs into the structural model. The structural model was analyzed through Structural Equation Modeling (SEM) procedure in IBM_SPSS-Amos 21.0.

4. Data analysis and results discussion

4.1 Respondent Profile

Respondents were requested to detail their qualifications to confirm that they are qualified enough to develop an informed perspective on the ITT process. The aim was to develop a larger understanding of the respondent's exposure to ITT and their experience in the local ICT industry sector. Table 3 summarizes the respondent profile (position-experience -education).

Table 3. Respondents Profile

	Frequency	%	Valid %	Cumulative %
Position				
Manger	**4**	**2.1**	**2.1**	**2.1**
Project Supervisor	**28**	**14.4**	**14.4**	**16.4**
Consultant	**17**	**8.7**	**8.7**	**25.1**
Academic Staff	**32**	**16.4**	**16.4**	**41.5**
Engineer	**74**	**37.9**	**37.9**	**79.5**
Technician	**18**	**9.2**	**9.2**	**88.7**
Administrative Officer	**19**	**9.7**	**9.7**	**98.5**
Others	**3**	**1.5**	**1.5**	**100.0**
Total	**195**	**100.0**	**100.0**	
Experience				

less than 5 years	**41**	**21.0**	**21.0**	**21.0**
6-10 years	**93**	**47.7**	**47.7**	**68.7**
11-15 years	**38**	**19.5**	**19.5**	**88.2**
16-20	**19**	**9.7**	**9.7**	**97.9**
more than 20 years	**4**	**2.1**	**2.1**	**100.0**
Total	**195**	**100.0**	**100.0**	
Education				
Diploma	**26**	**13.3**	**13.3**	**13.3**
Bachelor	**81**	**41.5**	**41.5**	**54.9**
Master	**46**	**23.6**	**23.6**	**78.5**
Doctorate	**34**	**17.4**	**17.4**	**95.9**
Others	**8**	**4.1**	**4.1**	**100.0**
Total	**195**	**100.0**	**100.0**	

4.2 Rating the TT model factors (Mean and Standard Deviation)

The results shown in Table 4 reveals high mean values and low standard deviations for most model factors (as the means were 4 or near to 4). These results indicated that the respondents had similar perceptions about factors within this model and the factors identified in this study are accurate in describing the influential factors of the TT process and showing that these factors have an importance and significant effect on the successful of the TT process.

Furthermore, the respondents had agreed largely (as the means near to 4) that the execution of TT programs was necessary for economic development, upgrading knowledge and technological capabilities, enhance the performanceof the host firm, and survive the ICT-based SME's

Table 4, The Mean and Standard Deviation of the model factors

Code	Description	Mean	Std. Deviation
A2	**TT government support initiatives**	**3.8887**	**.76998**
B2	**Learning centers and Learning Capability**	**3.8957**	**.90846**
C2	**Transferor's characteristics**	**4.1043**	**.60371**
D2	**Transferee's characteristics**	**4.0905**	**.62055**
E2	**TT process. (TT environment)**	**3.8841**	**.65114**
A4	**Economic development**	**3.8570**	**.73878**
B4	**Project (firm) performance**	**3.8954**	**.78819**
C4	**Knowledge and technological capabilities**	**3.8510**	**.79329**
D4	**Development and survive of ICT-based SME's**	**3.8477**	**.76617**

4.3 Confirmatory Factor Analysis (CFA)

The Confirmatory Factor Analysis (CFA) is required to validate the measurement model for uni-dimensionality, validity, and reliability of all latent constructs [16][17][18]. Figure 2 illustrates the pooled measurement model of latent constructs in AMOS Graphic.

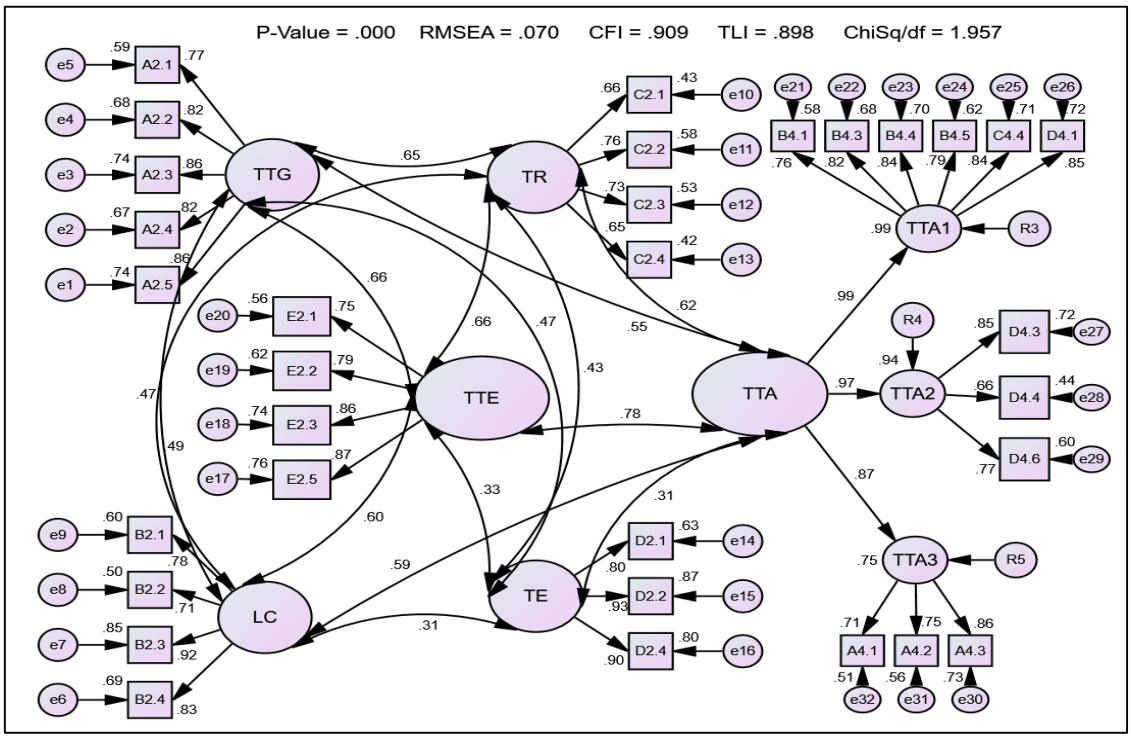

Figure 2. The Pooled CFA for measurement model of all latent constructs

The output of CFA shows the factor loading for every item, the factor loading for every component, and the correlation between the constructs. There are four 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), and Transferee's characteristic (TE). The TT environments (TTE) construct acts as a mediator between TTG, LC constructors, and TTA.

Three sub-factorsused to measure the endogenous construct TT achievements TTA are,Firm performance and technological capability improvements sub-factor TTA1, Development and survive of ICT technology SME'ssub-factor TTA2, and economic development sub-factor TTA3.

4.3.1 Assessing the validity and reliability of a measurement model

As mentioned above, before modelling the structural model, the study needs to validate the measurement model for Uni-dimensionality, Validity, and Reliability. Themethod forassessing the measurement model for all constructs together at once, which called Pooled-CFA suggested by [16] is implemented. The measurement model pooled-CFA is shown in Figure 2.

A- Unidimensionality

The purpose of uni-dimensionality is to determine whether a set of indicators shares only a single construct [19]. Uni-dimensionality confirmed through goodness of fit indexes, the standardized residuals and the modification indices generated by AMOS software. Zainudin [16][17][18] add that the uni-dimensionality can be attained if the measuring items obtain adequate factor loadings for the particular latent construct. Assessing the uni-dimensionality is necessary before develop reliability and validity of respective construct [20].

B- Model validity

Validity is referring to the capability of the instrument to measure what it supposed to be measured for a construct [16]. Three types of validity are required for a measurement model, for instance, Convergent Validity, Construct Validity and Discriminant Validity [17][18].

- **Convergent Validity**

Hair [20] posit that items Composite Reliability (CR) and Average Variance Extracted (AVE) are among the required report form CFA. Convergent Validity is achieved when the value of Average Variance Extracted is greater or equal to 0.5 [16].

- **Construct Validity** (Measurement model evaluation)

Construct Validity demonstrates that the instrument used in study measure the construct that it intended to measure [21]. Several fitness indexes must be achieved to the required level to attain construct validity. The most common fitness indexes that highly reported in the literature are RMSEA, CFI, TLI, and Chisq/df [16]. Table 5 shows the results of the fitness indexes for the measurement model have been achieved the required fitness level for all three categories.

Table 5. The three category of model fit

Name of Category	Name of Index	Level of Acceptance	Model index result	Comment
1. Absolute fit	**Chi-square**	**P-value (x2) P > 0.05**		
	RMSEA	**RMSEA < 0.08**	**.070**	**Fitness Level Achieved**
	GFI	**GFI > 0.90**		
2. Incremental fit	**AGFI**	**AGFI > 0.90**		
	CFI	**CFI > 0.90**	**.909**	**Fitness Level Achieved**
	TLI	**TLI > 0.90**	**.898**	
	NFI	**NFI > 0.90**		**Fitness Level Achieved**
3.Parsimonious fit	**Chisq/df**	**Chi square/ df< 5.0**	**1.957**	**Fitness Level Achieved**

- **Discriminant validity**

Table 6 presented the Discriminant Validity Index Summary for all latent constructs in the study. The discriminant validity of the construct is achieved if the diagonal values (in bold) is higher than the values in its row, and column. Another condition for discriminant validity is the correlation between exogenous constructs must not exceed 0.85 [16]. As it clearly shown from Table 6, the discriminant validity of the constructs in the model is achieved.

Table 6. The Discriminant Validity Index Summary for all constructs

	TTA	TR	TTG	LC	TTE	TE
TTA	**.99**					
TR	.63	**.71**				
TTG	.56	.65	**.82**			
LC	.59	.49	.47	**.81**		
TTE	.79	.66	.66	.60	**.81**	
TE	.32	.43	.47	.32	.33	**.87**

C- Model Reliability

When assessing the reliability of the constructs, there are two assessments need to be evaluated namely Composite Reliability and Average Variance Extracted.

Table 7 presented the Composite Reliability (CR) and Average Variance Extracted (AVE) for all latent construct. The Composite Reliability (CR) measures the reliability and internal consistency for a latent construct. As stated by [16] the CR value greater 0.60 is requiredto achieve composite reliability for a construct. The Average Variance Extracted (AVE) indicates the average percentage of variation as explained by the items measuring the construct. The AVE value exceeding 0.5 indicate the achievement of convergent validity for the construct [17]. As a summary, all constructs in this study have fulfilled the Composite Reliability and Convergent Validity criteria.

Table 7. The CFA Report for CR and AVE for all latent construct

Construct	Item	Factor Loading	CR (above 0.6)	AVE (above 0.5)
TTA	TTA1	.98	.986	.960
	TTA2	.99		
	TTA3	.97		
TTA1	B4.1	.77	.923	.668
	B4.3	.82		
	B4.4	.84		
	B4.5	.78		
	C4.4	.84		
	D4.1	.85		
TTA2	D4.3	.84	.806	.583
	D4.4	.66		
	D4.6	.78		
TTA3	A4.1	.74	.798	.569
	A4.2	.72		
	A4.3	.80		
TR	C2.1	.65	.754	.506
	C2.2	.76		
	C2.3	.72		
	C2.4	.65		
TTG	A2.1	.77	.915	.683
	A2.2	.82		
	A2.3	.86		
	A2.4	.82		
	A2.5	.86		
LC	B2.1	.78	.886	.662
	B2.2	.71		
	B2.3	.92		
	B2.4	.83		
TTE	E2.1	.75	.890	.671
	E2.2	.79		
	E2.3	.86		
	E2.5	.87		
TE	D2.1	.80	.910	.772
	D2.2	.93		
	D2.4	.90		

D- Normality distribution

Normality assessment is made by assessing the measure of skewness for every item. The absolute value of skewness should be lower than 1.5 to indicate the data is normally distributed [17][18]. The absolute values of skewness for all items are smaller than 1.5, which indicate the measuring itemsare normally distributed.

Once the uni-dimensionality, Validity, and Reliability of all constructs achieved, the study could move into modelling the structural model to estimate the interrelationships among the constructs using Structural Equation Modelling (SEM) and test the stated hypotheses in the study.

4.4 Structural equation modelling (SEM)

Structural Equation Modelling is powerful and flexible multivariate data analysis technique, which permits researchers to examine several relationships among manifest and latent variablessimultaneously [22][23].

According to [24], the Structural Equation Modelling enables the researcher to answer a set of interrelated research questions using a single, systematic and comprehensive analysis by modelling the relationship between multiple and dependent constructs simultaneously.

4.4.1 Analysing the structural model

The structural equation modelling procedure estimates the standardized path coefficients as well as the regression path coefficient between constructs of the model. The AMOS Graphic output shows the results in Figure 3 and Figure 4 respectively. The Coefficient of Determination R^2 is 0.61; it is estimated that the predictors of TTE explain 61.1% of its variance. Whereas R^2 for TTA is 0.63, meaning the predictors of TTA explain 63% of its variance.

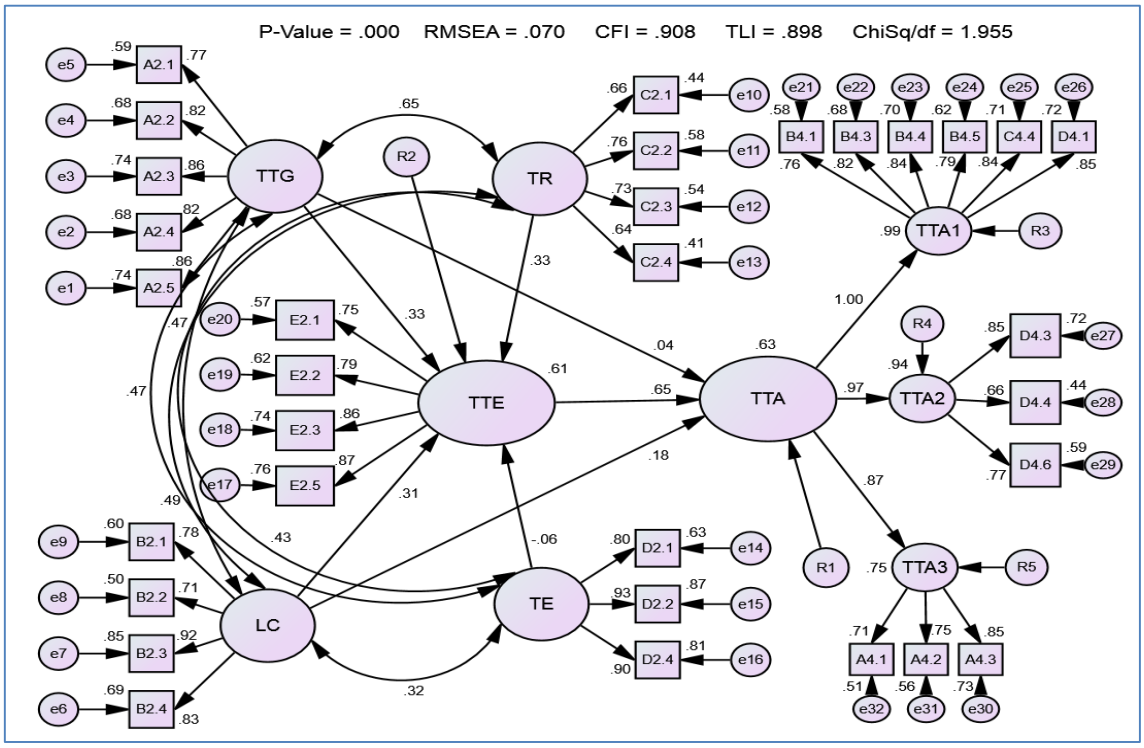

Figure 3. The Standardized Path Coefficient between constructs in the model

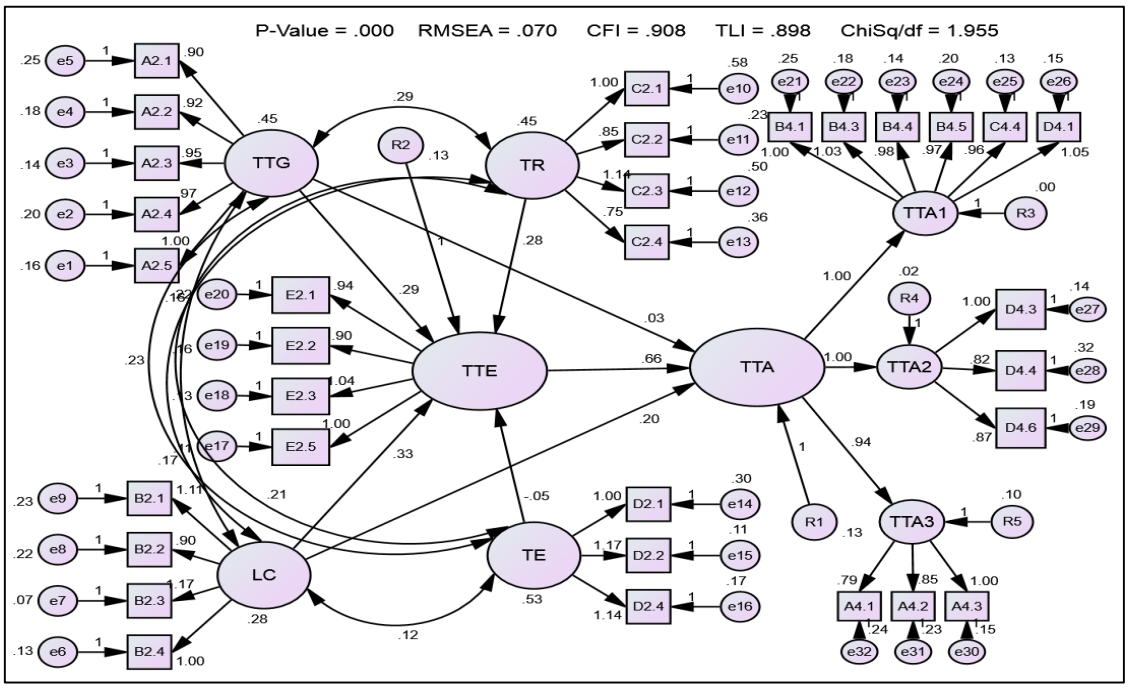

Figure 4. The Regression Path Coefficient between constructs in the model

Table 9 shows the regression path coefficients for all five exogenous constructs towards the endogenous construct that extracted from Figure 3.

Table 9. The regression path coefficient and its significance

			Estimate	S.E.	C.R.	P	Result
TTE	**<---**	**TR**	**.281**	**.083**	**3.410**	**.001**	**Significant**
TTE	**<---**	**TE**	**-.048**	**.052**	**-.925**	**.355**	**Not Significant**
TTE	**<---**	**TTG**	**.288**	**.074**	**3.871**	**.001**	**Significant**
TTE	**<---**	**LC**	**.333**	**.077**	**4.318**	**.001**	**Significant**
TTA	**<---**	**TTE**	**.660**	**.101**	**6.546**	**.001**	**Significant**
TTA	**<---**	**TTG**	**.033**	**.066**	**.497**	**.619**	**Not Significant**
TTA	**<---**	**LC**	**.203**	**.079**	**2.578**	**.010**	**Significant**

The analysis continues to test the study's hypothesis. The results are presented in Table 10.

Table 10. the hypothesis testing for every path and its conclusion

	Hypothesis Statement	P-Value	Result
1	**TR** has a significant effect on **TTE**	.001	Supported
2	**TE** has a significant effect on **TTE**	.355	Not Supported
3	**TTG** has a significant effect on **TTE**	.001	Supported
4	**LC** has significant effect on **TTE**	.001	Supported
5	**TTE** has a significant effect on **TTA**	.001	Supported
6	**TTG** has a significant effect on **TTA**	.619	Not Supported
7	**LC** has a significant effect on **TTA**	.010	Supported

4.5 Testing Mediation effects in the Model

The study would employ the method proposed by [16] to test the mediation effects in the model. The model shows that the (TTE) mediator has a mediation effect on (TTA) from two constructs, (TTG) and (LC) constructors respectively. The testing process needs to be conducted in two separate steps to investigate and confirm these two effects.

Table 11. Testing the hypothesis for Mediator 1

	Hypothesis Statement	P-Value	Result
H1	TTE mediates the relationship between TTG and TTA		
H1a	TTG has a significant effect on TTE	.001	Supported
H1b	TTE has a significant effect on TTA	.001	Supported
H1c	TTG has significant effect on TTA	.619	Not Supported

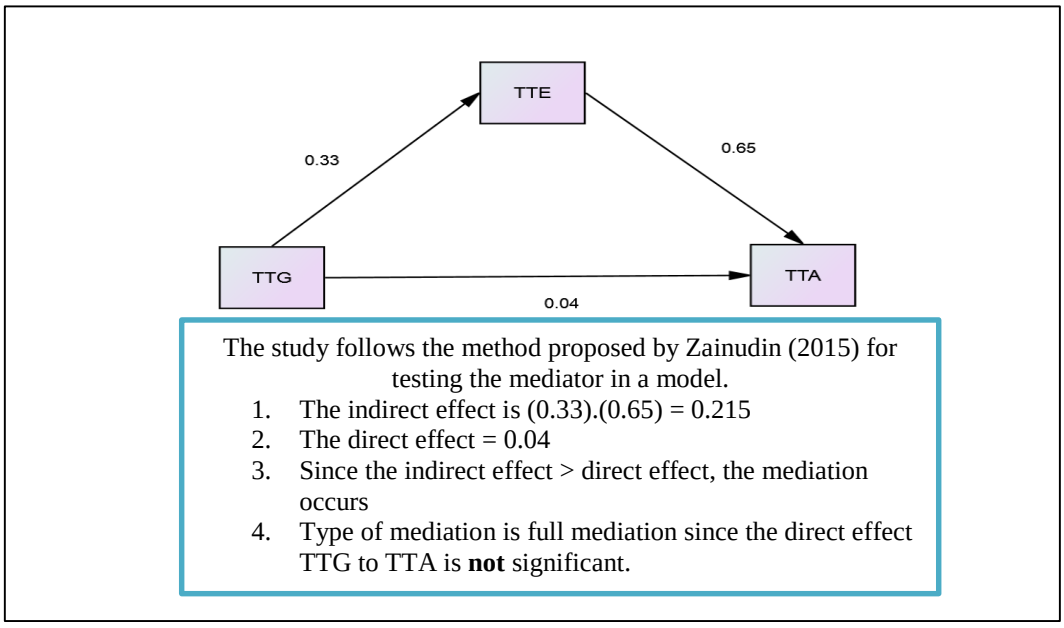

Figure 5. Direct and indirect calculation of mediator 1 effect.

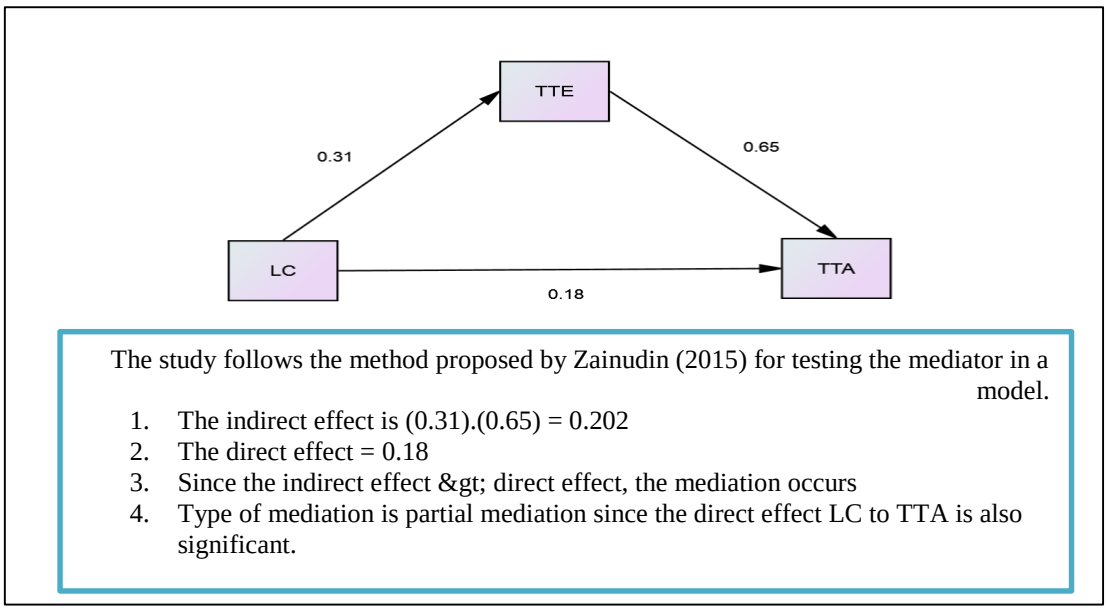

Figure 6. Direct and indirect calculation of mediator 2effect.

Table 12. testing the hypothesis for Mediator 2

	Hypothesis Statement	P-Value	Result
H1	**TTE mediates the relationship between LC and TTA**		
H1a	**LC has a significant effect on TTE**	**.001**	**Supported**
H1b	**TTE has a significant effect on TTA**	**.001**	**Supported**
H1c	**LC has significant effect on TTA**	**.010**	**Supported**

4.5.1 Confirming the results through bootstrapping

The researcher would reconfirm the results of the mediation tests using the resampling procedure called bootstrapping. This is especially so far testing the indirect effect.

Bootstrapping is the method of sampling with replacement whereby one instructs the algorithm to take the sample size n from the existing dataset. The number of resampling is 1000 times. The algorithm would compute the mean and standard error for every sample. From resampling process, the algorithm develops sampling distribution for the estimates.

From the sampling distribution, the total effect, the direct effect, and indirect effect between constructs are estimated. Finally, the 95% confidence interval values for total effect, direct effect, and the indirect effect will be tabulated. The confirming process of the mediation test through bootstrapping results is shown in Table 13.

Table 13. confirming the Mediation 1&twotests through bootstrapping

		Indirect Effect	**Direct Effect**
Mediator 1	**Bootstrapping Results**	**.190**	**.033**
	Bootstrapping P-Value	**.009**	**.594**
	Result	**Significant**	**Not Significant**
	Type of Mediation	**Full Mediation since the direct is not significant**	
Mediator 2		**Indirect Effect**	**Direct Effect**
	Bootstrapping Results	**.220**	**.203**
	Bootstrapping P-Value	**.001**	**.010**
	Result	**Significant**	**Significant**
	Type of Mediation	**Partial Mediation since direct is also significant**	

Table 13 shows the standardized **indirect** effect together with its significance level and also the standardized **direct** effect together with its significance level. The table present the results for both mediators 1&2. According to [18], the significance of indirect effect indicates the mediation exists, and the significance or insignificance of direct effect indicates the type of mediation.

By comparing the bootstrapping test results with the results of the mediation test conducted using the conventional procedure, it could conclude that the results of bootstrapping are consistent with the results of mediation test shown in Figures 5 and 6.

4.6 The Final Resultant Model

The structural equation modeling procedure confirmed only five significant paths exist in the final model. The Standardized Path Coefficients are shown in Figure 5.

Table 14 shows the regression path coefficients for the four exogenous constructs towards the endogenous construct that extracted from Figure 7.

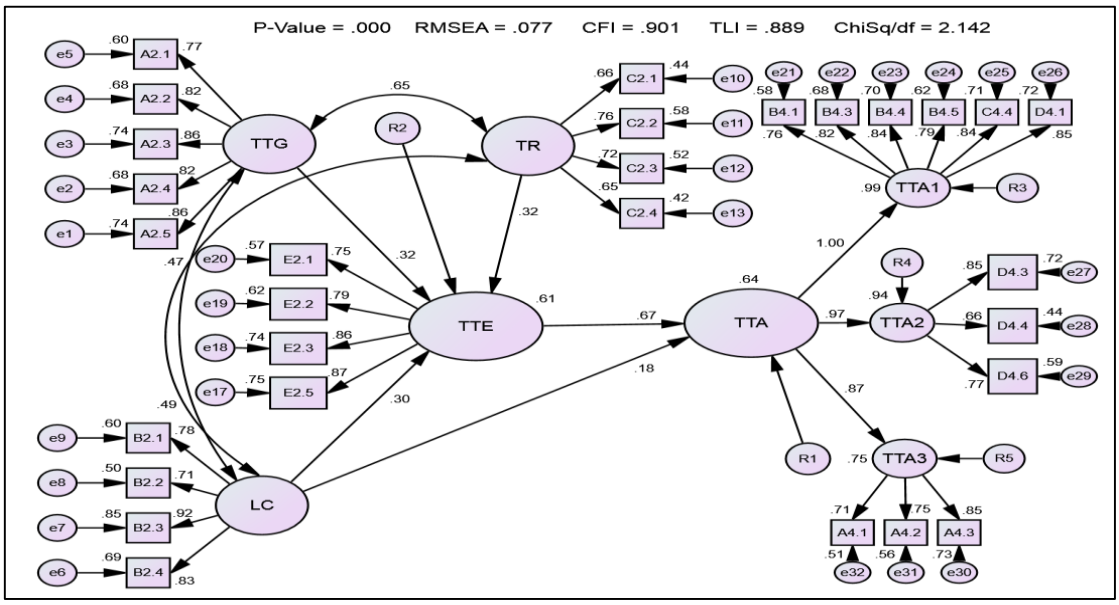

Figure 7. The resultant model (Final Model) – Standardized Path Coefficient

Table 14. the Regression Path Coefficient and its Significance

			Estimate	S.E.	C.R.	P	Result
TTE	<---	TR	.275	.081	3.382	***	Significant
TTE	<---	TTG	.272	.072	3.776	***	Significant
TTE	<---	LC	.324	.076	4.241	***	Significant
TTA	<---	TTE	.688	.087	7.903	***	Significant
TTA	<---	LC	.204	.079	2.592	.010	Significant

The final resultant confirmed path model for international TT in ICT projects confirm that the TT government support initiatives, transferor characteristics (TR) and learning centers (LC) directly promote enhanced TT environment (TTE). The resultant path indicates that the TT environment (TTE) is essential in attaining the outcome achievements from the TT process.

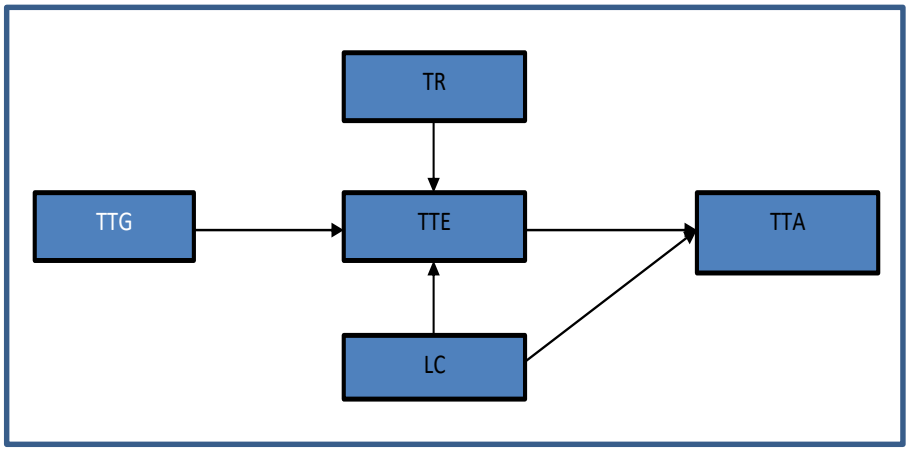

Figure 8. Path model for international TT in ICT projects

5. Discussion and Conclusion:

The ICT international technology transfer model was developed. The proposed model defines the factors, which are assumed to affect the TT process. These identified factors were classified as enabling and TT achievement constructs.

Multiple statistical techniques was utilised to audit the significance of enabling and resulting factors involved and provided the formulated model of the international TT in the ICT industry. In the validation process, the CFA has been performed to validate all latent constructs in the study. Through the process of CFA, the three requirements of validity assessment have been achieved to the recommended levels. The Composite Reliability (CR) and Average Variance Extracted (AVE) for all latent construct in the model have fulfilled the required reliability standards. The results of the goodness-of-fit indices have been achieved the required fitness level, and the factor loading for all items is acceptable. With the validated latent constructs, the study modelled the interrelationships among these constructs into the structural model. The structural model was analysed through SEM procedure in IBM_SPSS-Amos 21.0 software package. The SEM technique was employed for determining significant causal paths between factors. Furthermore, SEM procedure estimates the standardised path coefficients as well as the regression path coefficient between constructs of the model.

The analysis of the mediation effect in the model proves that the TT process environment factor (TTE) mediates the relationship between TT government initiative (TTG) and TT achievements (TTA) with a full mediation while mediates the relationship between learning center factor LC and TT achievements TTA with a partial mediation. These results were confirmed by bootstrapping technique.

Altogether, the research confirms that the four exogenous predictors in the model, namely: TT government support initiatives (TTG), learning centers (LC), transferor's characteristics (TR), and TT environment (TTE) are good enough to estimate the success of the TT process achievements. The model shows that the appropriate TT environment leads to a successful TT process. The study stated the positive effects of the TT learning centres (LC) factor on TT achievements (TTA). Based on this research TT can add value to the local ICT industry in four main areas, namely: Economic development - Project (firm) performance - Knowledge and technological capability improvement - Development and survive of ICT technology SME.

6. Contribution of the Study

This research offers noteworthy contributions to the existing body of knowledge. These contributions could be summarised in the following points:

1. The study developed a new TT model. The model captures the most relevant factors that influence the effectiveness of the international TT process in the ICT context.
2. The developed model has been validated with state of the art statistical techniques (SEM).
3. This research fills the gap in knowledge of non-availability of a study that describes the international TT process in the field of ICT.
4. The derived TT model could form the foundations to develop a methodology for standardisation of ICT industry TT performance in developing countries.
5. The obtained results could be used to provide a reference line standardisation index of TT performance in the Libyan ICT industry.

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