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INTERNATIONAL TECHNOLOGY TRANSFER MODELS: A COMPARISON STUDY.

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ABSTRACT

Technology transfer (TT) is a way of obtaining advanced techniques to enhance a country's technological development. The International Technology Transfer (ITT) projects involve the cross-border transfer of technology to develop the local technology capabilities. In this work, a survey on valuable ITT studies and deep analysis of the most reliable ITT models have been presented. The aim is to identify the factors and sub-factors that influence the TT process. Analytical comparison of ten relevant models in terms of their objectives, dominant factors, major concerns and model limitations has been conducted. The main focus of this analysis has been on models construct, factors relationship, models contribution, models strength & weakness, and models reliability. The most influential factors of ITT process have been categorized as: Technology provider and technology recipient characteristics, integration of local and foreign actors, government policy, culture difference, transfer environment, nature of technology, mode of transfer, and management of TT program. Meanwhile, the outcomes of ITT process have been represented as economic advancement, knowledge and competency development, and project performance. This study provides a significant reference on ITT modeling process and presents a scholarly critique review on several ITT models.

Keywords: *Technology, International Technology Transfer, Modeling, Influential Factors.*

1. INTRODUCTION

The common forms of technology are: knowledge, ideas, collection of techniques, and methods or approaches that are used in the production of goods or services. Many scholars have concluded that the technology can be embedded in machines, equipment, and devices. Continuous innovation for increased productivity, growth, sustainability, and competitiveness is involved in the process [1,2,3,4]. Chee [5] perceived the technology as the knowledge and machinery that are required to operate an enterprise. Stock and Tatikonda [6] categorized technology as a tool or technique, product or process, equipment or method of doing.

Researchers have defined the TT process in different ways due to their broad fields of study and purpose of their investigations [7]. Wei [8] defines TT as the transfer of skills, technical know-how, machinery and other capital equipment. Putranto et al. [9] defined the TT process as a transfer of capital goods and operating skills to the development of technological capabilities.

To serve the purpose of this study, TT was introduced as a transfer of ideas, practices, objects, know-how, and technical knowledge from developed countries to the developing ones.

The ITT continues to be an important incentive to industrialization and economic advancement for the developing nations [10]. ITT projects include the cross-border transfer of technology with the main purpose to upgrade the local technology capabilities which, according to many researchers need to be enhanced and promoted continuously [9,10,11]. Successful technology transfer process could benefit standing firms in developing countries in many ways, such as enhancing domestic and international competitiveness, expanding business activities and getting "learning by doing", resulting from cooperation with technologically advanced foreign firms [12,13].

The transfer process of advanced techniques into developing countries is a multifaceted process that is influenced by several factors, ranging from

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government support to the mode of transfer, process environment, transferor and transferee characteristics, etc. [14, 15, 16, 17]. The interaction between these factors can impact the level of effectiveness of the TT process, in different fields such as economic advancement, knowledge advancement, and project performance.

This study presents a scholarly critique review on several TT models aiming to identify the factors that influence the ITT process in terms of their respective sub-factors (variables) as well as to clarify the ITT process outcome factors. The road map to accomplish this aim is through exploring, examining and critically reviewing ten ITT models with the focus on model constructs, factors relationship, contribution, strength & weakness, effectiveness, method of data collections, and degree of model reliability. An analytical comparison of these most relevant ten ITT models in terms of their objectives, investigated factors, field of interest, major concerns and model limitations has been carried out to meet the objective of this work. The outcome of this study shows that, the international TT is one of the strategies of acquiring advanced technology to enhance a country's technological capabilities and clearly presents the ITT process influential factors in accordance with the research target previously identified.

2. REVIEWED ITT MODELS AND THEORIES:

There are many models that can describe the process of TT. Some models define TT process as networking arrangements between two parties without relevant formal research. While others deal with a TT process as a linear progression of steps. In the following sections, ten of these TT models are explored, examined, and critically reviewed to derive and classify the most influential TT factors: Calantone [11], Simkoko [18], Kumar [19], Lin & Berg [20], Malik [21], Wang [22], Steenhuis [23], Waroonkun [24], Mohamed [25], and khabiri [26].

2.1 Calantone et al. (1990) Model

The framework drawn by this research is composed of five main elements that describe the TT process. This framework conceptualizes the TT process by describing the relationship between the elements and their macro factors. The five elements of this framework are listed as:

- Environment factors: Affect all stages of the process. These factors include the prior experience of the actors, the cultural background, economic and political structure of the countries involved.
- Actors: Also known as the TT process participants, the technology recipients and suppliers, including government and non-government organizations (NGOs).
- Structure: This element describes the relationships and mechanisms of collaboration between the actors involved in the TT process. The communication channels between the actors are affected by their political, economic, and business relationships.
- Process: This element involves the actual negotiations between the technology recipient and supplier. The negotiations are influenced by communication channels and include the selection of technology, partner, and mode of transfer from the perspective of both recipient and supplier.
- Functions: This element includes the implementation of a conceived ITT project, and covers the evaluation, control, as well as positive & negative feedback on the implementation of ITT.

The macro-level environment factors can serve as the backbone of this model since they have an impact on all the other factors of the ITT framework. The macro-level environment factors are described below:

- Prior experience: The previous experience of both parties impacts the chances of success of the TT processes. The degree of prior experience of the both parties (technology supplier and recipient) and the ratio of experience between both of them has negative and positive effects on the TT process.
- Political factors: Cover political systems, domestic political structure, and relative power between state and NGOs.
- Economic factors: Such as level of economic development and stability, have a great effect on the TT process. Rapid industrialization through TT is an important strategy of economic development, especially in developing countries.
- Cultural factors: Cultural differences between participants may have negative impact on the success of the TT process. Cultural differences must be considered to implement a successful program.

2.2 Simkoko (1992) Model

The main focus of this work was mainly on ITT in the construction industry of developing countries. This research stated that the most important objective of contracting or commissioning construction projects in developing countries is that the projects facilitate the technology acquisition process. The TT and acquisition process enable employees, firms, and institutions in developing countries to master,

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adapt, and develop the acquired design and construction technologies as well as management techniques. To identify the influential factors that affect this process, a case study of 12 international construction projects in developing countries were conducted and formulated during a two-year period (1987 and 1988).

Three selection criteria: Local firm involvement, the technology acquisition objective, and recently completed projects have been chosen to determine the explored projects. Two approaches were used to collect the required data; the first one was the investigation of project files and semi-structured interviews. The second approach included site visits and interviews with project participants. This research examines the effect of ITT programs and internal & external environment factors on construction project performance. The effects of organizational form, management team, and construction technologies on the involvement of local firms were covered. The seven sets of variables that form the model and describe the construction project process are as follows:

- Project delivery system: This factor involves the overall project execution of the organization.
- Project management teams: To investigate the degree of cooperation between local and foreign project managers.
- Transfer programs: These programs involve the training cost and time, the participation of local contractors, the employment of technical staff and the supervision of management.
- Client characteristics: Involve the special requirements of the clients and their personal characteristics, financial status, and degree of involvement in project decision-making.
- Project characteristics: Comprise the project size, complexity, schedule, cost, and risks.
- Design and construction technologies: cover construction methods, materials, equipment, resources, and management techniques.
- Project performance: This variable involves the competence development of local firms which is measured by the degree of involvement and impact on local employment.

Qualitative and statistical approaches are used to analyze the relationships among these seven factors. The results from the statistical analysis support the qualitative results and highlight the following findings:

- The effectiveness of TT process is strongly affected by the method of TT.
- Involvement of local professionals is essential to successfully implement TT programs.
- Project organizational structures that accommodate technology acquisition often have higher local involvement.
- Control and monitoring are necessary to effectively conduct the TT process.

The research considered a TT process as an effective way of gaining the missing technological and managerial competence of employees and firms in developing countries.

2.3 Kumar (1999) Model

The effect of critical elements on the ability of a firm to upgrade its technological capability through imported technology from developed countries was discovered by this study. The Indonesian industrial sector was chosen to study issues, including the parties involved in the process, the methods of transfer, the size and type of the importing firm, its area of activity, product standardization, nature of ownership, employee training, research and development (R&D) capabilities of importing firms, and the social environment. This model studied the relationship between TT process, technological capability, and economic performance. The model presumed that TT contributes to the improvement of technological capability, which enhances economic performance. All three types of capabilities (investment, operational, and dynamic learning capabilities) can, therefore, be obtained from a single transfer agreement, depending on the structure of such agreement. This characteristic is considered to be an important feature of this model. According to Kumar [19], the extent to which technological capability is acquired depends on how the technology is related to the following capabilities: the ability of the host firm to absorb the technology, the learning culture of the firm, the role of the government, and the TT transfer mode. However, the technology infrastructure of the recipient country is critical to the success of a developing country firms to assimilate imported technology.

2.4 Lin & Berg (2001) Model

This research primarily explores the major factors that affect the performance of ITT process. The model focuses on TT projects between companies located in different countries, specifically TT projects involving Taiwanese manufacturing companies. This study categorizes three groups of identified factors: technology nature, transferor & transferee former international experience, and cultural difference between the technology provider and receiver. This research also shows how these factors influence the

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effectiveness of TT. The nature of technology is viewed according to the following three dimensions:

- Complexity: Refers to how the technology can easily be developed, diffused, and exploited.
- Maturity: Determines the age of the developed technology prior to its transfer.
- Codification: Implicates how the technology is sufficiently documented and recorded.

This model considers the culture difference factor as a moderating factor since the effect of cultural difference can interact with the nature of the technology. The argument was that the cultural difference may have an insignificant effect when transferring a modest technology whereas, the cultural difference is considered as a critical factor in transferring complex and novel technology that requires intensive interpersonal communication among working groups from both parties.

Finally, the model measures the effectiveness of the ITT through the final technical performance of the project after the TT process was completed and evaluated based on the technical performance of the technology provider & recipient and technical performance in similar projects.

2.5 Malik (2002) Model

This study investigates the complex issues involved in the effective management of intra-firm TT within a multinational company (MNC) environment. This model includes the components of the transferred technology instruments, knowledge, skills, actors involved in the process, the mode of transfer, the main barriers to TT, and the project's relative chances of success.

Empirical evidence collected from two case studies that were conducted in the UK, 1998 at the largest cable-making company (BICC Cables Ltd.). The empirical data was gathered by conducting 12 semi-structured interviews with different level managers. Furthermore, some information was received from mailed questionnaires, archival records, and BICC factories visits. The model was presented as an "interactive broadcasting model" for TT, where the technology to be transferred is assimilated as a radio-transmitted message. This message is transferred from a source (transferor) to a destination (transferee). However, this model treated TT as one of the most knowledge-intensive and difficult relationships in a firm. Therefore, the TT model is produced in a way to help managers to overcome the process-related difficulties. Although this model deals with manufacturing companies, the influential factors identified can be applied to almost all TT processes. The model demonstrates a number of factors that can impact the TT process in a firm. These factors can simply be divided into two branches: factors that are "likely to help" and that are "likely to inhibit". These two groups of factors are as presented below.

The "likely to help" factors are as follows:

- The "adequate resources" factor is related to the problem of the lack of people transfer.
- The "good listening and communication skills" factor is considered an important factor.
- The "familiarity with technology" factor is related to prior experience.
- The "willingness to transfer staff" factor is related to the theme of developing a "culture of trust" between the organizations involved in the process.
- The "market pull" factor is always likely to help the transfer process.

The "likely to inhibit" factors are as follows:

- The "trust," "people transfer," and "market benefits" factors are listed as common factors across the "likely to help" and "likely to inhibit."
- The "no interest in a project" factor is a barrier to smooth TT, where lack of interest is observed from a number of individuals. This factor is also connected to the "not-invented-here" syndrome. This factor refers to people in firms resisting, embracing, or adopting the knowledge associated with new technological developments.

Although the "threatened by new technology" factor has an indirect effect on the technology flows, this factor can be an inhibiting factor.

- The "language" factor is also a barrier to effective TT.
- The lack of "training" element is linked to the lack of people transfer.

2.6 Wang et al (2004) Model

This research follows extensive previous studies in the field of TT and investigates the transfer of knowledge from an MNC to a subsidiary. The model developed here was based on the existing literature on the transfer of knowledge. The model relies heavily on data collected from interviews within 62 firms, accompanied with observations made from firms interviewed and materials collected from company archives and publications. This study is dealing with the transfer of both management and technical knowledge. For knowledge to be transferred successfully, the transferors required to be both capable and willing to transfer knowledge. On the other hand, the recipients are ought to be capable as well as willing to acquire knowledge.

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This study develops a two-stage model that describes 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 impact the level of knowledge acquired by the subsidiary from its MNC parent. The knowledge contributed by the parent to the subsidiary is influenced by the following two sets of factors:

- The capacity to a transfer of the parent: The parent company ability to transfer refers to the firm-specific knowledge and its ability to convey knowledge in a form that can be assimilated by the recipient.
- Willingness to a transfer of the parent: The willingness of the parent to transfer determines the extent to which knowledge is contributed.

The second stage of the model shows that the knowledge transfer is greatly influenced by the capability and intent to learn of the subsidiary.

- Capability to learn of the subsidiary: this factor focuses on workers qualifications as well as the highly effective training provided.
- Intent to learn of the subsidiary: rewarding subsidiary workers considered as an effective tool to motivate them to learn.

2.7 Steenhuis & Bruijn (2005) Model

This study probes into the process of TT production and understands how the production of TT occurs from the perspective of the recipient company. The aircraft production technology was chosen as an investigated field by this work.

To gain insight into the causes of TT difficulties, four case studies in the aircraft industry were conducted to analyze these problems. The case studies showed that the process of TT consists of three phases: preparation, installation, and utilization. These three phases are influenced by three sets of factors: technological, organizational, and environmental factors. This model emphasizes that both individual companies (transferor and transferee) need to be balanced with each other for an efficient transfer. If the two parties do not show significant matches, the transfer process will be faced with greater difficulties. This consideration led to what is known as the TT balance model.

The most important TT process ideas that gathered by this research were as follows:

The outcome of the TT process is influenced by many factors, which can be grouped into three categories: technological, environmental, and organizational factors. The technological factors consist of the size and maturity of the technology. The environmental factors involve the national business, national environment, and international industry environments. The national environment is formed by the sub-factors: political stability, international political position, type of economy, level of industrialization infrastructure, attitude toward time, and working conditions. The national business environment is determined by the level of related and supporting industries. The (international) industry environment include the following sub-factors: the strategic position of the company, level of concentration in the industry, mandatory industry requirements (such as certification procedures), and market demand. The organizational factors cover the capacity (how much), the capability (how complex), and the efficiency of the organization.

However, the outcome of this research proves that, although industrially developing countries are often interested in TT for technological development, TT process does not necessarily lead to a significant improvement in technological capabilities. Furthermore, the model proved that the technologies are only shared if the receiving companies already have existing capabilities in place. The model has concluded that the efficiency of the installation is influenced by the differences between the source and destination companies.

2.8 Waroonkun & Stewart (2008) Model

This study suggests a conceptual model for TT process that aims to improve the rates of ITT in developing countries. The model contains several factors that are supposed to impact the effectiveness and achievements of the ITT processes. The four key enablers involved are: transferee characteristics, transferor characteristics, government influence and relationship building. However, the TT value added as an outcome factor was also included. These factors and their related variables are briefly described as follows:

- Learning environment: The learning environment involves two sub-factors: the effectiveness of the implemented transfer programs and the relationship between the transferor and transferee.
- Transfer environment: Includes four sub-factors: the complexity of the construction technology utilized by the transferor, TT mechanism, enforcement practices, and government policy.
- Transferor and transferee characteristic: The characteristic of transferor and transferee as a model enablers, measure the degree of their

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contributions to the success of the TT process. The sub-factors include the willingness to implement, the degree of experience, knowledge base, and cultural traits.

- TT-induced value creation: The interrelationship between the previously mentioned TT enablers and their performance contributes to the degree of value added to the host party. The benefits involve three sub-factors: economic advancement, knowledge advancement, and project performance.

2.9 Mohamed et al. (2010) Model

The developed model in this research was focused on TT process in the petroleum industry and identifies all the factors that influence the effectiveness of the TT process. The identified factors are categorized into enabling and TT outcome factors. These factors include TT environment, local company learning capability, TT infrastructure, TT support and TT performance. A testing process was performed to confirm the validity and appropriateness of the model. These influential factors are identified and briefly explained as follows:

- TT Environment: The environmental characteristics of the TT process include five sub-factors: experience, knowledge, the complexity of technology, communications, and teamwork.
- Learning Capability: This factor involves the effects of the sub-factors that facilitate the learning capability of the technology being transferred between transferor and transferee companies. This enabler includes five sub-factors: culture, adoption, absorption, exposure, and supervision of the TT process.
- TT Infrastructure: covers the availability of certain circumstances in the host petroleum industry. This factor involves six sub-factors: information technology, R&D, local sub-contractor, training, standards, and management.
- TT Support: The TT support covers the large-scale level of a country's petroleum industry, which primarily reveals the impact of technology and government support related factors on the TT. Two sub-factors were included: government enforcement practices and the parent company support to implement the TT process.
- TT Performance: the three major sub-factors for the potential benefits of TT in this model are identified as economic accomplishments, knowledge gain, and process performance.

2.10 Khabiri et al. (2012) Model

The main focus of this model was on acquiring foreign technology within the TT process by SMEs. The most important elements in the TT process were identified and utilized by this model. The SMEs limited resources may decrease its opportunities to gain new technologies or innovation. According to Khabiri et al. [26], the mechanism of TT seems to be vital component to facilitate TT process to SMEs. Therefore, an appropriate mechanism must be assessed and selected among the various mechanisms of the TT process.

The model reviewed several TT researches and investigated two specific models: the simple and generic Schlie et al. [27] model and the Malik [21] TT broadcasting model. Then a justified TT broadcasting model was established, where eight elements in the TT process with a specification of the relationship among these elements, were identified. The research presents a justified TT broadcasting model as a new model based on the previously mentioned two models. The model's eight effective elements that describe the TT process to SMEs are classified and briefly explained as follows:

- Transferor: known as the source or knowledge owner, representing an entity in the TT process that transfers the technology to the recipient. The transferor may be an individual, company, or country.
- Transferee: known as the recipient or the beneficiary of technology, representing an entity in the TT process that receives the technology from the source. The transferee may be an individual, company, or country.
- Technology: It is defined as tools, processes, methods, products, and systems employed in the making of goods or in providing services, including all the required knowledge.
- Mechanism of transfer: Should be chosen by the transferee as they are the beneficiary of the TT project.
- The transferor environment: The environment here refers to a set of circumstances in which the transferor proceeds to transfer the technology to the transferee.
- The transferee environment: This environment denotes the set of circumstances in which the transferee proceeds to purchase the technology from the transferor.
- The greater environment: Technology supplier and recipient have a few similar sets of conditions, which can influence the TT process. Specifically, the justified TT broadcasting model covers these

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conditions at the greater environment which involves both the transferor and transferee. The layers of this environment include sub-regional, regional, and global.

This research concluded that SMEs as transferee were able to assess and select the best mechanism of TT. Thus, SMEs are recommended to identify the critical success factors of each existing element in this model to commence a TT project. Therefore, this developed model can be a basis for SMEs in their feasibility study stage when trying to assess and select the best mechanism between all feasible alternatives.

3. ANALYTICAL DISCUSSION OF THE MODELS

3.1 Calantone et al. (1990) Model

The feedback of ITT was the center of this model and the developed framework had compared marketing research and other empirical studies in the field of ITT. The model is able to identify several important factors. However, the five-element system is operational in describing the general constructs that comprise the ITT phenomenon. Although the model includes a number of factors that can be adapted in many contexts, it is mostly relevant as a whole in the marketing and logistics sectors only. On the other, hand the model did not incorporate indicators for recognizing the outcomes of implementing a technology. Furthermore, one of the weaknesses of the framework is the complexity of its design, and not empirically confirmed through a robust statistical analysis approach. Overall, this study introduces the idea that ITT is a dynamic iterative process.

3.2 Simkoko (1992) Model

Was conducted in a period of 1987–1988, this research examines the construction projects completed during that time. The results obtained from the statistical analysis supported the qualitative results. In addition, other relationships between factors were highlighted. The model suggested the following:

- The participation of local employees is vital to the effective implementation of the technology acquisition process.
- Project organizational structures that accommodate technology acquisition often have higher local involvement.
- Effective technology acquisition is strongly affected by technology acquisition methods.
- Managing and monitoring are necessary for effective technology acquisition.

This research was more focused on identifying how the involvement of local employees and firms working on international construction projects, management team, and construction technology. This model examines only the development of technological and management practices in the local industry and does not attempt to model the TT-enabling process. Therefore, it does not provide a comprehensive understanding of the TT process. The influence of the transferee and transferor in the process was not explored in this model. It also ignored the full value added from implementing TT initiatives. Although this study focuses on the capability development of local firms, rather than the entire value added from the TT process implementation, it describes a wide range of competence development benefits, which can be applied to the overall value added through TT. Despite the development of more advanced TT modes, materials, and products, this study presented a significant model which provides several insights into possible enabling and outcome factors.

3.3 Kumar (1999) Model

The TT model proposed here is likely to feed the recipient with three types of technology capabilities: investment, operational, and dynamic learning. The enhancement of technological capability is faced by several factors, including the firm technological absorption ability, learning culture, a role of the government, and mode of TT. This study discovers that the acquisition of technology through licensing makes a greater contribution to technological capability than either joint venture or turnkey operations. This study also suggests that the insufficient existence of a small R&D budget for conducting an adaptive research may not be ample to generate technological capability in developing firms. In this model, the technology absorption capacity of a firm is measured by the level of R&D spending, availability of qualified technical personnel, and degree of local monitoring over the transfer process. The learning culture of a firm is measured by the length of its training programs in TT project. The model generally identifies and statistically confirms several areas where decision makers in developing countries can take actions to improve the benefits from imported technology. Furthermore, a few factors of the learning capability model are suitable to incorporate in different model implementation of TT process.

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3.4 Lin & Berg (2001) Model

The advantage of this model is that the overall concepts are easily determined and simple to implement. An important accomplishment from this study is that the TT research investigations must not be limited to examining the direct effects of the identified factors and linked variables. Examining causal interactions among the factors is equally important to achieve a precise representation of the TT process. The empirical findings of the study show that the nature of the technology and the previous international experience are more important than the cultural differences in the ITT process. Cultural differences are acknowledged as a moderating factor that has the most effect on the TT process because of its strong correlation with other factors. Nevertheless, the factors identified can generally explain a few aspects of the ITT process in all industrial sectors. However, the main drawback of this model is the recognition of only three sets of factors that influence the TT process. These factors insufficiently describe all of the powerful enabling and outcome factors, where important influencing factors such as government support policy and mode of transfer are ignored. The TT assumptions proposed in this research were justified using only two industrial firms, which may have caused the biased empirical findings of the study. Furthermore, the research inadequately addresses all aspects of cultural difference, leaving the framework rather incomplete.

3.5 Malik (2002) model

This model describes and investigates the factors that influence the intra-firm TT. Although the concept is similar to ITT, transferring technology from developed to developing countries involves many factors that must be considered. Despite the identification of a few influential factors of TT presented in the model, other elements that have a significant function in the TT process are ignored in this broadcasting model. For example, no mechanism of TT is proposed to illustrate how the technology should be transferred from the source to the destination. Furthermore, the effects of these identified influential factors of TT on the project success are not well verified and the value added through the TT process is unexplored. The factors that are "likely to help" and "likely to inhibit" could have been categorized based on the transmitter and receiver specifications, given that they mostly represent personal characteristics of both, provider and receiver of the technology. This intra-firm model insufficiently investigates the concerns related to the intent of the transferor to shield its core technology from its competitors and the similarities of different project aims. Furthermore, the empirical findings of this research are based on responses from only one manufacturing company. These results may be regarded as biased empirical supportive evidence. Consequently, the "broadcasting model" needs to be tested with other firms from different industrial sectors to achieve a more reliable model. In this model, the message is sent by the transmitter, and the receiver is the beneficiary of the transferred technology and must be involved right from the beginning of the planning and implementation of the TT projects. The receiver in this model is unable to participate in the feasibility study of the TT project because of the model one-way relationship between the transmitter and the receiver.

3.6 Wang et al. (2004) Model

This model evaluates the transfer of knowledge from a multinational company (MNC) to a subsidiary. The case studies approach implemented in this research has fundamental weaknesses as they are dependent on more general theoretical hypotheses, and the in-depth use of experimental data may produce a theory that is too complicated. The transferor and transferee characteristics limited of the amount of knowledge that a subsidiary of an MNC acquires which resulted in a restricted study scope. Although the two enabler constructs of this model are sufficiently examined, there is no enough investigation of the other influential factors, such as government influence and technology characteristics. Furthermore, performance factors of the TT process, such as economic advancement and competitiveness, are also ignored. Despite the limitations of their case study approach, the knowledge transfer process described in this work could be generalizable to many developing countries.

3.7 Steenhuis & Bruijn (2005) Model

This research employed a combination of data collection methods rather than just survey questionnaires. The focus was on the process by which civil aircraft production technology is transferred from companies in industrialized countries to industrializing ones. This TT model suggests that the transferor and the transferee need to be balanced with each other. If the two bodies have insignificant similarities, the transfer will be highly problematic and the transfer process will be inefficient. This study explored the process of TT by examining how the TT is originally planned and

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then analyzing whether or not the TT was conducted as originally designed. In the four case studies of this research, planning documents were analyzed in advance. The documents were later compared with other documentation, such as progress reports. The data were then compared with the data gained from interviews and other observations.

3.8 Waroonkun& Stewart (2008) Model

This model aims to increase the rates of TT process in developing countries. The proposed model involves several factors that influence the effectiveness and the outcomes of the ITT processes. In this research, TT is defined as the circumstance in which techniques, skills and required knowledge related to the construction field are conveyed from developing to developed countries. This model of ITT which focuses on Thai construction projects can be applied to other developing and newly industrialized countries. Various factors can be extracted from this study, which include statistically confirmed data proving that transferee characteristics and government influence can directly enhance TT process effectiveness. The results of this study confirmed that the appropriate transferor characteristics are vital in relationship building. According to this research, the characteristics of the transferor and transferee were chosen carefully to ensure that the host nation has the best chance of receiving the required knowledge from the TT process.

One way to improve the standardizing method adopted in this research is by applying a quantitative TT performance indicator. As well as the developed TT performance standardizing method could be implemented at a cross-sectional level. Furthermore, the TT model is mainly designed for the construction industry and may be inaccurate for other industries. In addition, the model relies on the host nation technology maturity level.

3.9 Mohamed et al. (2010) Model

This research divided the TT into four main categories (enablers) that can affect the TT process and its outcomes in the oil industry. These categories include TT support, infrastructure, environment, and learning capability. The research provides suggestions for the petroleum industry of developing and newly established oil-producing countries that attempted to develop and approve an effective TT process. The derived ITT model can be utilized to support decision makers in developing countries to enhance the evaluation of TT performance.The developed TT model findings have essential implications for government and enterprises seeking to enhance the characteristics and technology learning capability of the host nation to elevate the rates of TT. This model was designed for publicly funded petroleum infrastructure projects. The model addresses the decision makers concern for effective transfer of advanced technologies to local petroleum employees and professionals.

This research is limited to the development and implementation of a TT model for the Libyan oil industry. Moreover, the research aimed at only the respondents from the relatively small group of Libyan petroleum professionals employed in oil industry projects incorporating TT.

3.10 Khabiri et al. (2012) Model

The main statement of this research is that the mechanism of TT is strongly related to the seven elements that form this model. Furthermore, SMEs (transferee) are enabled to assess and select the best mechanism of TT. Therefore, this model can be developed by SMEs in their feasibility study when they assess and select the best mechanism among all the feasible alternatives.

Khabiri [26], worked on several TT models and investigated two specific models: the simple and generic Schlie et al. [27] model and the Malik [21] TT broadcasting model. A justified TT broadcasting model was then established, with the focus on the relationship between transferee and transferor among these elements. Though the message is a contractual element by nature, in the broadcasting model, the message is sent by the transmitter, representing only one way relationship between the transmitter and the receiver. Whereas in this model, the transferor and the transferee have a two-way relationship and more emphasize was on the transferee because of its critical function in the actual TT process. Technology comprises several issues that should be considered in the message, including some information on specification, process of product or service, technical issues, financial issues, and maintenance operations. A mechanism of transfer should be included in the message, before commencing a TT project. This model investigates the transferee, transferor environment, and greater environment.

4. COMPARISON OF THE MODELS

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The previous TT models identified several factors that may affect the ITT process, such as: the characteristics of technology providers and receivers, characteristics of the technology, TT environment, learning capabilities, and role of governments and organizations. The factors and sub-factors involved in these models have a considerable effect in the success of the ITT process. The investigated models in this study are mostly experimental and provide an understanding of the TT concept. The comparative table (1) summarizes all the important information, including models focus and objectives, major concern and limitations, factors and sub-factors.

5. SUMMARY:

In this study, a survey of the most considerable conducted researches on ITT is presented to identify the influential factors that affect the TT process. In addition a scholarly critique review on several ITT models is introduced where an analytical comparison of these models in terms of their objectives, dominant factors, field of interest, major concerns and model limitations has been carried out. The common factors that influence the ITT process were identified in terms of their respective sub-factors (variables). The factors identified are classified into the following: Technology provider and technology recipient characteristics, integration of local and foreign actors, government policy, culture difference, transfer environment, nature of technology, mode of transfer, and management of TT program. ITT process outcome factors have been categorized as economic advancement, knowledge and competency development, and project performance. A thorough examination and critical review and a detailed analysis have been performed on the ten developed models across several industry sectors to accomplish the objectives of this study. The main focus of this investigation has been on model constructs, factors relationship, model contribution, model strength & weakness, model reliability, method of data collections, and the degree of model adaptability to implement in different industrial field. However, this review could be a helpful reference to future researchers to further identify, conceptualize and formulate the factors that affect the TT process in new models. The reviewed and examined models include the models of Calantone et al. (1990), Simkoko (1992), Kumar et al. (1999), Lin & Berg (2001), Malik (2002), Wang et al. (2004), Steenhuis & Bruijn (2005), Waroonkun & Stewart (2008), Mohamed et al. (2010), and Khabiri et al. (2012).

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REFRENCES:

[1] Wahab, S. A., Rose, R. C., & Osman, S. I. W. Defining the Concepts of Technology and Technology Transfer: A Literature Analysis. International Business Research, 2012 5(1), p61.

[2] Rooney, D. A contextualizing, socio-technical definition of technology: Learning from Ancient Greece and Foucault. Prometheus, 1997 15(3), 399-407.

[3] Reisman, A. A taxonomic view of illegal transfer of technologies: A case study. Journal of Engineering and Technology Management, 2006 23(4), 292-312.

[4] Tihanyi, L., & Roath, A. S. Technology transfer and institutional development in Central and Eastern Europe. Journal of World Business, 2002 37(3), 188-198.

[5] Chee, P. L. EEC Investment in ASEAN and the Transfer of Technology. A Malaysia Case Study. In makalah, Conference on ASEAN-EEC, Economic Relations, Singapura.1981, August.

[6] Stock, G. N., & Tatikonda, M. V. A typology of project-level technology transfer processes. Journal of Operations Management, 2000. 18(6) pp.719-737.

[7] Bozeman, B.. Technology transfer and public policy: a review of research and theory. Research policy, 2000, 29(4), 627-655.

[8] Wie, T. K. The major channels of international technology transfer to Indonesia: an assessment. Journal of the Asia Pacific Economy, 2005. 10(2), 214-236.

[9] Putranto, K., Stewart, D., & Moore, G. International technology transfer and distribution of technology capabilities: the case of railway development in Indonesia. Technology in Society, (2003). 25(1), 43-53.

[10] Wang, T. Y., & Chien, S. C. The influences of technology development on economic performance—the example of ASEAN countries. Technovation, 2007. 27(8), 471-488.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[11] Saad, M., Cicmil, S., & Greenwood, M. Technology transfer projects in developing countries—furthering the project management perspectives. International Journal of Project Management, 2002. 20(8), 617-625.

[12] Calantone, R. J., Lee, M. T., & Gross, A. C. Evaluating international technology transfer in a comparative marketing framework. Journal of Global Marketing, 1990. 3(3), 23-46.

[13] Phillips, L. A., Calantone, R., & Lee, M. T. International technology adoption: Behavior structure, demand certainty and culture. Journal of Business & Industrial Marketing, 1994. 9(2), 16-28.

[14] Kedia, B. L., & Bhagat, R. S. Cultural constraints on transfer of technology across nations: Implications for research in international and comparative management. Academy of Management Review, 1988 13(4), 559-571.

[15] Lee, J., Bae, Z. T., & Choi, D. K. Technology development processes: a model for a developing country with a global perspective. R&D Management, 1988 18(3), 235-250.

[16] Madu, C. N. (1989). Transferring technology to developing countries—Critical factors for success. Long Range Planning, 22(4), 115-124.

[17] Cusumano, M. A., & Elenkov, D. Linking international technology transfer with strategy and management: a literature commentary. Research policy, 1994 23(2), 195-215.

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

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

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

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

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

[23] Steenhuis, H. J., & Bruijn, E. J. International technology transfer: Building theory from a multiple case-study in the aircraft industry. 2005

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

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

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

[27] Schlie, T. M., Radnor, A., & Wad, A. Indicators of international technology transfer. Centre for the Interdisciplinary Study of Science and Technology, North Western University, Evanston, 1987, 23, 32-36.

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Table (1) The Comparative Summary Of The Important Information Of All The Ten Models.

Model	Focus and objectives	Major concern and limitations	Factors and sub-factors
1.Calantone (1990)	Designed mainly to obtain feedback on the TT process.	Based on comparative marketing research, no TT performance indicators, very complex in design, and not empirically verified.	*Environment*: prior experience, culture, economic, and political. *Actors*: technology recipient, technology supplier, and government and non-government organizations. *Structure*: relationships and interaction mechanisms between the actors. *Process*: negotiations between the technology recipient and provider. *Functions*: evaluation, control of implementation, and feedback.
2.Simkoko (1992)	Designed to assess the involvement of local firms in the TT process and development of competencies. Concerned with the organization and interaction of management teams.	Mainly concerned with the construction industry. Outdated model, with a limited understanding of the TT process and no TT performance indicator.	*Project delivery system:* organization methods and overall project execution. *Project management*: integration of local and foreign project managers. Influenced by organization forms and acquisition programs. *Transfer programs*: training cost and time, local contractors, technical staff, and supervision management. *Client characteristics*: requirements of clients, personal characteristics, and financial status. *Project characteristics*: project size, complexity, schedule, cost, and risks and uncertainties. *Design and construction technologies*: construction methods, materials, equipment, resources, and management techniques and past performance of construction technology. *Project performance*: competency development.
3.Kumar (1999)	Investigates the critical elements that affect the ability to cultivate technological capability through import technology.	Designed for small-scale manufacturing industries. Small sample size.	*Technological absorption ability*: culture, learning, government role, and mode of TT. Investment capability, operational capability, and dynamic learning capability.
4. Lin & Berg (2001)	Explores the effect of culture difference on the TT process. Describes the effect of technology complexity and the level of experience in detail.	Based on only two Taiwanese manufacturing companies; thus, findings may be considered biased. No sufficient description of important TT factors. Designed to study long-term management practice.	*Nature of technology*: complexity, maturity, and codification. *International experience*: transferee and transferor. *Culture difference:* between the technology provider and receiver.

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5. Malik (2002)	TT interactive broadcasting model provides good insights on the TT process. The model is useful in terms of its characteristics.	Intra-firm TT. Model is tested on one company, which may be considered empirically biased.	*Factors likely to help:* market pull, adequate resources, willingness to transfer staff, good listening and communication skills, and familiarity with technology. *Factors likely to inhibit:* no interest in a project and not-invented-here syndrome, threatened by new technology, language, and lack of training. *Common factors:* trust, people transfer, and market benefits.
6. Wang (2004)	Concerned with the transfer of knowledge from a multinational company to a subsidiary.	The model scope is confined to the amount of knowledge that a subsidiary of an MNC acquires as a result of the transferor and transferee characteristics. The model fails to examine other influential factors, such as government influence and technology characteristics. The other performance factors of the TT process, such as economic advancement and competitiveness, are also unexplored to develop a complete model of TT	*Knowledge contributed by MNC:* -*Capacity to transfer:* knowledge base and expatriate competencies. -*Willingess to transfer:* importance of subsidiary, ownership type, and inter-partner relationship. *Knowledge acquired by subsidiary:* -*Capacity to learn:* qualifications of employees and emphasis on training. -*Intent to learn:* learning intent of employees and link between learning and reward.
7. Steenhuis & Bruijn (2005)	The model is called the TT balance to emphasize that the two individual companies need to be balanced with each other to ensure an efficient transfer.	The research focuses on one particular production technology, the aircraft production technology.	*Technological factors:* size and age of technology. *Organizational factors:* capacity (how much), capability (how complex), and efficiency of the organization. *Environmental factors (national environment):* political stability, type of economy, level of industrialization, infrastructure, attitude toward time, and working conditions.
8. Waroonkun & Stewart (2008)	The model attempts to improve the rates of TT in developing countries. The model identifies most of the influential factors and is statistically verified.	Designed mainly for the construction industry and may be inaccurate for other industries. The model depends on the maturity level of technology of the host nation.	*Transfer environment: complexity of technology, mode of transfer, government policy, and enforcement practices.* *Learning environment: relationship between transferor and transferee, communication between transferor and transferee, management of TT program, and transfer program.* *Transferor characteristics: willingness to transfer technology, level of experience, culture traits, and knowledge base.* *Transferee characteristics: intent to learn technology, level of experience, culture traits, and knowledge base.* *TT values add: economic advancement, knowledge advancement, and project performance.*

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9 Mohamed et al. (2010)	Captures the significant factors that influence the effectiveness of the TT process and its outcomes for the oil industry.	Designed for the petroleum industry of developing and newly established oil-producing countries.	*TT Support:* organization of Libyan oil companies and government policy and enforcement practices. *TT Infrastructure:* information technology (IT), R&D, local sub-contractor, training, standards, and management. *TT Environment:* experience, knowledge, complexity of technology, communications, and teamwork. *Learning Capability*: culture, adoption, absorption, exposure, and supervision of the TT process. *TT Performance*: economic accomplishments, knowledge gain, and process performance.
10. Khabiri et al. (2012)	The model is a combination of the TT broadcasting and generic models. The model is named justified TT broadcasting model. Identifies the main influential elements in the TT process when SMEs wants to acquire a foreign technology.	Focuses on decision making, particularly on how to transfer technology and which mechanism is useful and can bring more benefits to the transferee. Provides a basis for SMEs in assessing and selecting the best TT mechanism.	*Transferor:* may be an individual, a company, or a country. *Transferee:* may be an individual, a company, or a country. *Technology:* tools, processes, methods, products, and systems employed in the creation of goods or in providing services. *Mechanism of transfer:* should be chosen by transferee. *Three sorts of channels:* general channels, reverse-engineering channels, and planned channels. *The transferor environment.* *The transferee environment.* *The greater environment:* sub-regional, regional, and global.