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Full Length Research Paper

Modeling technology transfer for petroleum industry in Libya: An overview

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The purpose of this study was to review and criticize the accessible literature of technology transfer (TT). To reduce the literature to convenient proportions, the focus would be on literature on modeling of technology transfer in the diverse industry sectors. The foremost purpose of the paper was to put forward an appropriate conceptual TT model in the context of Libyan oil industry. Uncertainly, foreign companies operating in Libyan petroleum industry may possibly transfer technology provided certain conditions. However, imported petroleum technology might not essentially be transferred flawlessly . The paper begins by examining the factors accommodated in each model believed to influence the TT process effectiveness. Based on our review, the conceptual model derived to include key factors of TT to evaluate TT performance, and examine interrelations between TT government support, TT infrastructure, TT environment, and TT learning capability.

Key words: Technology transfer, petroleum industry, Libya, modeling.

INTRODUCTION

When oil was discovered in Libya, 1959 and oil exports began in 1961, the country then had very little human resources to manage and operate a sizeable modern petroleum industry. The foreign oil companies not to mention a very weak government then played major role in establishing the prerequisites for the establishment of linkage and minor change capabilities, especially in developing human resources for the petroleum industry. Technology Transfer (TT) continues to be a key energizer to industrialization and economic expansion in developing countries, mostly in the fast growing oil producing countries such as Libya, Algeria, Nigeria, etc. Several researchers have defined the TT term in a different ways due to their individual areas of study. Chacko (1986) described TT in a scientific manner as converting physical or mental matter or energy into directly usable alternate form, and transfer means from one pocket into another pocket. Williams and Gibson (1990) defined TT as the shared responsibility between the source and the destination by ensuring that the technology is accepted, or at least understood, by someone who has the knowledge and the resources to incorporate and utilize the technology. In the construction sector, Simkoko (1992) tried to build on this definition by recognizing individual construction assets, as either materials or permanent equipment (steel beam, elevators, material) or construction applied resources such as information, skills. For the purpose of this study, TT process in petroleum industry

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has been defined as when some form of knowledge, material, or equipments are transferred from one foreign party such as person or organization to another local party as a person or organization that arrange to receive it. In this study, the host industry refers only to Libya petroleum companies fully owned by National oil association (NOC) or joint ventures and the foreign refers to the foreign company or organization working with Libyan petroleum companies to perform TT process or acquire projects. As anticipated, most foreign petroleum companies had origins in developed nations such as the United States, United Kingdom, Italy, Germany, France, etc.

LITERATURE REVIEW

Over the last 20 years, numerous studies have attempted to examine or model the TT process (Calantone et al., 1990; Lin and Berg, 2001; Malik, 2002; Waroonkun et al., 2005). The majority of these studies were typically concentrated on the business and manufacturing sectors. Some of these studies outlined models of the TT processes. Nevertheless, only small number of these models was backed by empirical data analysis and none of them was failed to relate the TT process enablers to the broader range of constraint outcomes. Furthermore, these considered models had inexplicable vindication to the interactions between TT process enablers and outcome factors in the petroleum industry context. In an attempt to construct up a more comprehensive TT model, which works out causal paths between most key and micro leading TT enabling factors; in which the performance for the petroleum industry, a TT model was conceptualized. However, the constructs descriptions sustaining the conceptual model are broad enough to clarify TT across a wide array of industries; the particulars of the petroleum industry were accommodated through variables, which attempt to explain industry unequivocal concerns. Several factors influence the performance of the TT process and eventually the extent of performance of local petroleum industry. This is particularly accurate in companies from the petroleum industry in oil producing countries, who in recent years assumed that they could more quickly progress their management and technical capabilities through TT plans with foreign firms (Nordas, 2003). These factors can be broadly defined as enablers and include the TT support, TT infrastructure, TT environment and TT learning capability. The interaction between these enablers can influence TT performance of the host petroleum industry, in areas such as economic advancement, knowledge advancement and project performance. The developed TT model presented herein illustrates the connections between TT enablers and the outcome factor. The study encapsulates the undertaken scholarly assessment and critique on existing TT models reported in the literature.

Inconsistency, while the petroleum industry is at the front position for technology progress in supercomputing, materials research, and in a number of other areas, it has a reputation as being slow to adapt new technologies (Knight, 1984). This fact explained that the petroleum industry takes the issue from a long-term perspective. Even if some of the hesitation is generational as well, the industry needs to understand how the technology will be maintained despite disruption; there is a modification period, and petroleum industry wants to understand what a change will mean. This reluctance to new technology caused by the fact that petroleum industry consists mostly of a group of companies engaged in a specific number of functions. A closer look at the petroleum industry, it is important to note that they have a variety of non-centralized activities. Most petroleum companies operating several thousands of tasks that require exploration, development, refining, distribution, and marketing and other services. The literature did not find any modeling or study research specifically related to the TT in the petroleum industry. This review will look at the petroleum industry and technology transfer models; to develop the model identifies factors that influence the performance of technology transfer.

The importance of TT in the world economy arises from its capacity to provide developing countries with new technology that can improve efficiency and hence contribute to world economic growth. TT is an imperative and controversial issue in the world economy (Calantone et al., 1990). TT controversy is a consequence of attitudes of factions involved in the TT process. In the past two decades, many petroleum developing countries have undergone unprecedented change in many aspects. This is especially true in companies from the petroleum industry, who in recent years assumed that they could more rapidly improve their management and technical capabilities through TT initiatives with foreign firms (San, 2004a). In order to improve management and technical capabilities the process of TT is considered to be a valuable approach of obtaining the necessary resources and technology, which include management resources, petroleum processing technology, and petroleum marketing resources. The implementation of petroleum technology into developing countries is a complex process that is influenced by factors including TT level of government or parent organization support, TT infrastructure, TT environment, and learning capabilities of the company or industry. The benefits to implementing advanced petroleum technology into developing countries are often quite significant and can be grouped into factors such as economic improvements, knowledge gain and project performance.

To identify and explain the factors that influence and benefit the TT process a review of existing literature has been undertaken and was presented in this Study. The review of existing literature also identified limitations to existing understanding of the TT process that can be fur-

ther explored. The three objectives of this study were; first, to provide a critical review on past and current research into TT models in the industry. Secondly, to identify the issues covered in existing study and its effectiveness in accurately describing the TT process. Thirdly to develop a conceptual model for TT process for the petroleum industry in the fields of management, planning, engineering, operating and manufacturing of petroleum developing countries. The factors, which influence the TT process, will be clearly defined in terms of their respective sub-factors (variables). Similarly, the outcome factors will be clearly defined and explained by their relevant sub-factors (variables). These factors will be arranged into a conceptual model that shows the theoretical relationship between the factors that represents the TT process.

Calantone et al. (1988) TT framework

Based on comparative marketing research concept developed by (Boddewyn, 1966; Boddewyn, 1981) a TT comparative marketing framework was developed by (Calantone et al., 1988). The study adopts and applies Boddewyn's (1981) principles for comparative marketing research to the field of TT. In addition, it incorporates other experimental studies. Calantone et al. (1988) frame work is considered as the most integrated marketing framework of TT process. Calantone et al. (1988) frame work is considered as the most integrated marketing framework of TT process. Calantone et al., (1988) model consisted mainly of five components that confine TT process. The model has framework to examine the relationships between different components, which in turn would be conceptualized as the TT process.

Environment: A major factor includes technology provider environment, technology receiver environment, cultural factors, political factors, and economic factors. Environment components identify sub factors that effect TT process in both transferee and transferor involved in the TT process.

Actors: This component defines the principle partners engaged in a TT process. This would include technology suppliers, recipients and the organizations. Actors will involve any elements that influence TT process like governments and parent organization or rules and regulations.

Structure: In this macro factor, a description of relationships and interaction mechanism between actors involved in TT process. The information and communication channels between actors are impacted by the political and economical or business relationships among them.

Process: This factor describes the negotiation process between technology recipient and technology providers. Information and communication channels are the main factor that influences technology selection. In addition, it guides to the selection of TT mode and the partner selection from both perspectives of technology provider and recipient.

Function: This construct concerns with the implementation of TT, which mean the evaluation process, control of implementation, and feedback process on the success of the TT implementation.

In Calantone et al. (1988) model, the environment component would impact most factors in the TT model. The important contribution of this factor is explained below:

Prior experience: The factor is concerned with prior experience of the host and technology recipient. The success of TT process is highly likely affected by prior experience of both parties. The level of both parties experience in TT process would contribute either negatively or positively to the process.

Cultural factors: In order to achieve successful TT process, the cultural differences must be considered especially for TT implementation. Culture may have undesirable effect on TT process.

Economic factors: It has been understood that economic developments would not occur unless economic stability and rapid industrialization situated. In developing countries, these factors must be considered before any TT process implemented.

Political factors: These factors include political systems, domestic political structure, and relative power between state and non-government organization.

The actors in Calantone et al. (1988) model are those parties that have interest in TT process. This includes local participants and their government, their parent organization, suppliers, state and international organizations involved. Interaction between host and provider is subjective to the political, economic, and business relationship between their governments. The relationship would also influence the international organization that works with both parties. Overall, the interaction would affect the limits of TT to occur. The drift of TT process along with communication process between host and provider would decide the TT partner and TT mode. Negotiation with selected partners will then permit an appropriate mode of transfer to be selected. Once the partner, technology and mode of transfer have been selected, their suitability should be assessed by inspection of their possibility of success subject to the interactions between NGO and state government interactions. This iterative process reviews all aspects influencing the chosen TT mechanisms before implementation of TT. Once the appropriate TT process has been

selected, the implementation of international TT can take place. This implementation was described in the functions element of the framework. It comprises of evaluation and control by both recipients and suppliers. The outcomes from TT would be channeled back to the macro-level factors as feedback through the model. Outcomes will directly affect the prior experience factors and in some cases will have affect on cultural, economic and political factors. The effect on these factors will have a direct relationship with the level of success experienced. For example, if the process was highly unsuccessful, economic policies may be introduced which discourage participation in TT programs. These factors will then again influence the transfer process creating a continuous cycle of TT development. Several important factors had been recognized that were adopted from this framework to produce the conceptual model for TT in petroleum projects. In particular, this study adds value by introducing the concept that TT is a dynamic process. Moreover, the five-element system is effective in describing the general constructs that make up the TT phenomenon.

In conclusion, Calantone et al. (1988) model was constructed based on Boddewyn's (1981) study on comparative marketing research and other TT related studies. The model main objective was to get feedback on TT process. However, the model was unsatisfactory of not including any indicators of the performance of TT process. Furthermore, the model was designed for marketing and logistics sector; in general, the design is complex and has not been empirically verified. Nevertheless, some factors of the model are essential for the development of any TT process. Some elements of the model would be suitable to be adapted to the petroleum industry TT model.

Simkoko (1992) TT model

Simkoko (1992) study which focused on TT in the construction industry of developing countries. Competence development through TT was closely examined to determine the influential factors that affect this process. This study was based on case studies of 12 international construction projects in the developing countries of Africa, South America and Asia in 1987 and 1988. The selection criteria for the projects to be investigated were as follows: local firm involvement; technology acquisition objective explicitly or implicitly expressed by clients; and projects completed recently or currently under construction. The data collection was separated into two sections. Section one aimed to the examination of project files and semi-structured interviews. Section two involved with site visits and further interviews with all project member. The objective of this study was to examine the impact of TT programs and other internal and external environment factors on construction project performance.

The technology acquisition process was identified as one of the main mechanisms for building up the missing technological and managerial proficiency of firms within developing countries. The study also investigated the effect of organizational form, the management team and construction technologies on the involvement of local firms. Specifically, this study identified the seven sets of variables that describe the delivery process of a construction project. These factors have been presented in Simkoko (1992) study model with seven factors descrybed below:

Project delivery system: Consists of organization methods used and overall project execution.

Project management teams: Concerned with the degree of integration of local and foreign project managers Influenced by organization forms and acquisition programs.

Transfer programs: Concerned with training costs and time, involvement of local contractors, employment of technical staff and supervision from management.

Client characteristics: Concerned with special requirements of clients, client personal characteristics, financial status, degree of involvement in project decision-making, and objectives.

Project characteristics: Concerned with project size, complexity, schedule, cost, risks, and uncertainties.

Design and construction technologies: Concerned with construction methods, materials, equipment, resources, management techniques and past performance of construction technology.

Project performance: Concerned with competence development of local firms and was measured by the degree of involvement and impact on local employment.

Analysis on the relationship between these seven factors was undertaken at both qualitative and statistical levels. The qualitative analysis suggested that high involvement of local firms occurred where management contracting was the dominant project delivery system. Well defined project objectives by the client as to their intentions to acquire specific construction and industrial engineering technologies was also identified to contribute to a high level of involvement of local firms. Overall, project performance was found to be a function of project management teams, technology acquisition programs and the form of project organization. The statistical analysis of results involved Chi-squared tests and ranked correlation coefficients. The results obtained from statistical analysis supported the qualitative results but also highlighted other relationships between factors such as:

- Effective technology acquisition was strongly affected by technology acquisition programs.
- Participation of local professionals was essential for successful implementation of technology acquisition programs.
- Project organizational structures that accommodate technology acquisition often had higher local involvement.
- Control and monitoring were necessary for effective technology acquisition.

This study model has given some insight into possible enabling and outcome factors to be used for the conceptual model for international TT in construction projects. Although this research was focused on competence development of local firms, rather than the entire value added from the TT process, there are a broad range of competence development benefits described which could be applied to overall value added through TT.

This study was undertaken during 1987 - 1988 through examination of previously completed construction projects and represented one of the few studies addressing TT in. However, this study is now somewhat outdated considering the development of more advanced TT mechanisms, materials and products. The study is more directed at identifying how the involvement of local firms and personal working on international construction projects was a function of project organization form, management team and construction technology. This study provides only a limited understanding of the TT process, as it only investigates the development of technological and management practices in the local industry, rather than attempting to model the TT enabling process. The model does not examine the impact of the transferee and transferor in the process and the full value added from implementing TT initiatives other than competence development.

Kumar et al. (1999) TT model study

The third TT model investigates the critical elements affecting the ability of firms in developing countries to cultivate their technological capability through imported technology (Kumar et al., 1999). The study identified key elements that affect the ability of firms in developing countries. The study examined the Indonesian manufacturing sector and it developments in recent decades. The Indonesian manufacturing sector, which hardly existed two decades ago, has become the largest segment of the economy and is growing by nearly 10% annually. Statistics from the World Bank indicate that manufacturing output growth is the highest of all middle income countries, exceeding that of well known success stories such as Korea, Thailand, and Singapore (Hill, 1995). This transformation is due to the emergence of a dynamic manufacturing sector, the introduction of new products and technologies, and export oriented industrial development. Further, foreign firms play a significant role in a wider range of industries where technology is crucial. These firms provide enormous investments in infrastructure and private production facilities that provide technology to increase the productivity and technological capabilities of the local economy. Kumar et al., (1999) indicated that many studies show that the economic conditions of the importing economy or firm may exert a strong influence on the type and extent of technology transferred. International technology transfer research provides various typologies of technological capability, the synthesis of previous research findings regarding the strengths and weakness of the various technology transfer modes was provided. Kumar et al., (1999) presented an extensive review that identified a host of factors influencing the ability of developing countries to improve their technological capability through technology transfer. The factors include the type of agents or parties involved in the transfer, the resource endowments they control, the public policies by which they are affected over time, the modes of transfer, the size of the importing firm, its fields of activity, type of productive organization, degree of product standardization, type of ownership, employee training, in-house R and D capabilities of importing firms, and the social environment. The model was largely based on (Lall, 1982) book that consists of proposed functional categorization of technological capabilities based on the tasks facing a manufacturing firm. The tasks and associated capabilities were grouped into two broad categories: investment capabilities and production capabilities. These were further classified into three levels. One important characteristic of the model is that technological capability is an ongoing process of learning broken arrow and the extent of the learning depends on the particular mix of technology obtained. That is to say that all three types of capabilities, investment capabilities, operational capabilities and dynamic.

Learning capabilities could be obtained from a single transfer agreement depending on the structure of the agreement. In essence, the extent to which technological capability was acquired depends on how the technology is packaged; the recipient's ability to absorb the technology, the firms' learning culture, the role of government, and the technology transfer mode. The recipient country's technology infrastructure is, however, critical to the success of a developing country firm to assimilate imported technology. Three types of capabilities, investment capabilities, operational capabilities and dynamic learning capabilities, are considered to be critical in the transfer process (Bell, 1987; Desai, 1984; Lall, 1982).

- Investment capabilities are the skills and information needed to identify feasible investment projects, locate and purchase suitable technologies, design and engineer the plant, and manage the construction, commissioning

and start-up (Bell, 1987; Lall, 1982; Wei, 1995).
- Operational capability generally consists of the skills, information and the knowledge needed to operate, maintain, repair and adapt the technology for increased production and efficiency. These may be transferred through training, personnel exchange, or managerial and technical support from suppliers (Bell, 1987).
- Dynamic learning capability consists of the skills and information needed to generate dynamic technical and organizational changes and to man- age the changes (Bell, 1987; Mytelka, 1985; Wei, 1995).

In this model, the level of R&D expenditure, the availability of technical personnel and the extent of local control over the transfer process measure a firms' technology absorption capacity. The firms' learning culture was measured by the duration of its training programs in preparation for the technology transfer project.

Government role: Government could play a positive role in the cultivation of technological capabilities of local firms through various policy instruments and programs (Madu, 1989; Santikarn, 1981). These include raising R&D spending; upgrading the country's science and technology infrastructure education, training, equipment, facilities, reforming laws, bureaucratic rules, procedures, and organizational cultures that interfere with the transfer process; improving public institutions; fostering linkages among technology institutions in developing and developed countries; setting up incentive schemes; and providing information and expertise to help 'bundle' the technology package.

Technology transfer modes: Technology was transferred through several channels and formal and informal organizational modes. The amount of technological capability transferred depends on the particular mode chosen (Contractor and Sagafi-Nejad, 1981; Cusumano and Elenkov, 1994; Reddy and Zhao, 1990).

Technology infrastructure: The level of technology infrastructure refers to the existence of higher educational institutions and training facilities for science and technology, R&D institutes, research laboratories, testing facilities, the availability of skilled workers, scientists and engineers, technical training programs, and R&D spending within the importing economy. These facilities are critical to developing countries because without them local firms would be dependent on foreign sources (Lall, 1982; Lee et al., 1988).

The results of the study show that the contribution of the technology transfer projects on technological capability was minimal and were mainly at the operational level. The cultivation of technological capability was affected by several factors including the firm's existing technological absorption ability, learning culture, government's role, and the mode of technology transfer. The study revealed that the acquisition of technology through licensing makes a far greater contribution to technological capability than either joint venture or turnkey operations. An additional insight provided by this study is that the mere existence of a small R&D budget for conducting adaptive research may not be enough to generate technological capability in developing firms. In general, the model identified and statistically verified several areas where managers and policy makers in developing countries can take actions to improve the benefits from imported technology.

In conclusion, Kumar et al. (1999) proposed that technology transfer is likely to provide the receiver with all three types of technology capabilities, namely investment capabilities, operational capabilities, and dynamic learning capabilities. However, the extent of the technology capabilities acquired will depend, among others, on the receiver's learning culture. Furthermore, Kumar et al study concluded that technology transfer which involved simple and mature technologies resulting in minimal improvement of the receiver's technology capability. This is a major hinder as petroleum industry in most cases involves large-scale technological changes. Nevertheless, some of the learning capability model is suitable to be incorporated in the petroleum industry TT model; these factors namely are government role and sub factors in the learning capability that include training and R&D.

Lin and Berg (2001) TT model

Lin and Berg (2001) undertook an exploratory study into the effects of cultural difference on TT projects. The aim of this study was to provide empirical evidence that confirms the conceptual models developed by other researchers in the field of TT. The Lin and Berg study focused on TT projects involving Taiwanese manufacturing companies. Three groups of factors, previously examined in conceptual studies were investigated: nature of technology; previous international experience; and the cultural difference between the technology provider and receiver. These factors were investigated to determine their individual and combined impact on the effectiveness of TT. The model presents the three groups of identified factors and how they affect the effectiveness of TT.

The nature of technology factor is concerned with:

Complexity: How complex the technology was and how easily it could be learnt.

Maturity: How long the technology had been developed and used prior to its transfer.

Codification: How well the technology was documented and recorded.

Codification is also known as explicit knowledge and is much easier to transfer than tacit knowledge.

The international experience factor is concerned with:

- The level of international experience of the technology receiver; and
- The level of international experience of the technology provider.

The cultural difference factor acts as a moderating factor in the model. This factor is concerned with the cultural differences of the technology receiver and provider.
The effectiveness factor of technology transfer was concerned with measuring final technical performance and comparing it to four technical benchmarks:

- The technical performance of the technology provider, which indicates how much the transferee has learnt;
- Whether the transferee achieves technical performance as planned at the beginning of the TT project;
- Technical performance of competitors; and
- Technical performance on similar projects.

An important conclusion made in this study was that TT research investigations should not be limited to only examining the direct effects of identified factors and associated variables. It was also important to examine causal interactions between factors to achieve an accurate representation of the TT process. Many of the factors and associated variables identified in this investigation were utilized to develop the conceptual model for TT in petroleum industry described later.

This research was focused on TT in Taiwanese manufacturing firms. Only two firms were used to confirm the hypotheses developed in this study, which may have resulted in biased empirical findings. The study identifies only three sets of factors that influence the TT process. For the petroleum industry, this does not sufficiently describe all of the influential enabling and outcome factors. Important influences such as government policy, mode of transfer, to name a few, had been neglected. However, it should be noted that the factors identified could generally explain some aspects of the international TT process in all industries. Cultural difference was identified as a moderating factor that has the most influence on the TT process as it has strong interaction effects with other factors. However, the study does not adequately address all aspects of cultural difference leaving the framework somewhat incomplete. This study also failed to effectively describing the link between the TT process and the outcomes it may derive.

Malik's (2002) TT broadcast model

The fifth model in this literature was developed by Malik (2002). In his study, he concentrated on intra-firm TT. The model considers inter-firm TT as one of the most dominant factor affecting the progress of the industrial nations. The broadcasting analogy was adapted in the model where by the technology to be transferred is understood as a radio transmitted message. According to the model, the message was transferred from a transmitter to a receiver. The strength of this transmitted message was affected by both factors that might facilitate and factors that might hinder the transmission. The model was conceptualized from a review of existing literature in TT field. Empirical research into the TT operations of a leading UK cable producing multi-national company (BICC Cables Ltd.) confirmed the conceptual model. BICC cables was made up of several cable companies based in Europe who had been purchased by BICC Plc Group. BICC cables employed approximately 10,000 people at its' peak so effective communication and a robust TT process were essential for efficient operation. The main form of data collection for the Malik (2002) study was semi-structured interviews with management personal. There were also postal questionnaires to management personal, review of archival records and visits to BICC factories undertaken to achieve an un-biased data range. The 'broadcasting analogy' was adopted into the model where by the technology to be transferred is assimilated to be a radio transmitted message. This message was transferred from a transmitter (transferor) to a receiver (transferee). The strength of this transmitted message was affected by both factors likely to help and factors likely to inhibit. However, Malik (2002) identified TT as one of the most knowledge intensive and problematic relationships within a firm. To account for this, the TT model was produced to act as an aid to managers to overcome some of the difficulties associated with the process. Although this model is specific to manufacturing companies, the influential factors identified are broad enough to be applied to all TT processes within multi-national companies. Malik (2002) model is presented as an interactive broadcasting model for TT. The interactive broadcast model presented is not meant as a formalized operational type model, but is more of an expanded conceptual framework of the intra-firm TT process (Malik, 2002). The model was divided into two components that had significant influence on the TT process. These factors were named "likely to help" and "likely to inhibit" and could be described as all of the characteristics of the participants and company that were likely to influence the TT process. Some important factors identified include communication, understanding and trust. The transmitter and receiver aspects of the model described the ability of both parties to transmit and receive the technology and the intent to use it. The link between transmitter and receiver showed that successful TT depends on the abilities of both parties. The mode of transfer factor described the actual process used to communicate the knowledge between the two parties. The mode of transfer was concerned with contract types used to transfer the knowledge and makes distinction between the transfer of tacit and explicit knowledge. Explicit knowledge was based on universally accepted objective criteria. Explicit

knowledge could be easily coded and transferred and was most commonly in the form of manuals, guidelines etc. Tacit knowledge was encoding knowledge and resides in the firms system. Tacit knowledge was important but difficult to interpret and transfer as it does not take on any form. Relatively, it was understood by firms personal through shared experiences (Cavusgil et al., 2003; Robinson et al., 2005).

The feedback mode element of the model shows that for successful TT to occur the transferor must receive feedback from the receiver to ensure that the technology was understood and could be easily implemented.

In conclusion, the feedback mode was also concerned with the long-term management practices that are essential for the success of TT process. Because the model was tested only on one manufacturing company, the supporting empirical evidence may be having some biased testing. To accomplish a reliable outcome, model should have been tested on different range of manufacturing companies. In summary, Malik (2002) model provides some good insights into the TT process. The identification of the interactive nature of the communication process in this model was useful in developing the conceptual model for TT in petroleum industry projects

Wang et al. (2004) TT model

The study of Wang et al. (2004) followed from extensive previous study in the field of TT. Wang et al. study was primarily concerned with the transfer of knowledge from a multinational company to a subsidiary. The model was developed from semi-structured interviews with 62 multinational companies operating in China. Archives and publications on the firms operations were also examined in the model development and validation stages. The transfer of both management and technical knowledge were the focus of this study. There are also distinctions made between the transfer of tacit and explicit knowledge. Explicit knowledge has been described as knowledge that could be formalized and expressed in the form of data, technical specifications, manuals, universal princepals, patents, etc. Tacit knowledge however is knowledge that is non-codifiable, and is deeply rooted in action, procedures, routines, commitment, ideals, values, and emotions (Nonaka, 1994). The transfer of tacit knowledge often requires a process of demonstration, facilitated through face-to-face interaction and shared experiences between the transferor and the recipient (Roberts, 2000). The model developed in this study identified two stages in the transfer process. The first stage was focused on the parent's contribution of knowledge and the second stage on the subsidiary's acquisition of knowledge. Factors affecting the extent of knowledge contributed by the parent were categorized into two groups:

Parents' capacity to transfer: The capacity of the parent to transfer refers to the firm-specific knowledge and the ability to impart that knowledge in a form that could be assimilated by the recipient. Such a capacity was primarily determined by the knowledge base of the parent and the competencies of those involved in the transfer process expatriates.

Parents' willingness to transfer: The willingness of the parent to transfer determines the extent to which knowledge would be contributed. The willingness to transfer would be affected by the importance of the subsidiary and the ownership type.

Knowledge transfer is a process that requires commitment from both the transferor and the recipient. Therefore, the second stage of the model showed that, holding constant the extent of knowledge contributed by the parent, the result of knowledge transfer would also be greatly impacted by the subsidiary's capacity and intent to learn.

Subsidiary's capacity to learn: The subsidiary's capacity to learn was affected by the qualification of its employees and the emphasis on training.

Subsidiary's intent to learn: The learning intent of a subsidiary was affected by the intent of the employees and the link between learning and reward.

The main concerns with this research pertain to its foundation based on case studies of multinational companies that were generalisable to theoretical propositions and not to the general population.

Another weakness is that the intensive use of empirical evidence may have produced of theory that was over complex rather than economical. To counteract this quantitative analysis, methods such as regression analysis could be employed. The Wang et al. (2004) model also was limited by the scope of the TT process that was examined. Scope was confined to the amount of knowledge that a subsidiary of a multinational company acquires because of the transferor and transferee characteristics. Although these two enabler constructs were examined in sufficient detail, the model fails to examine other influential factors such as government influence, technology characteristics, etc. The other outcome factors of the TT process such as economic advancement, competitiveness, etc. were also not explored in enough detail to result in a complete model for TT for the petroleum industry.

Waroonkum and Stewart TT model study (2007)

The most comprehensive TT model in this literature was published recently by (Waroonkun and Stewart, 2008). Their model attempts to improve rates of TT in developing countries, the study proposes a conceptual model for TT that accommodates the several factors thought to

impact on the processes effectiveness and derived outcomes. Waroonkun and Stewart (2008), for the purpose of their study, TT has been defined as when all types of knowledge relating to the construction field (e.g. design, construction process, material use, equip-ment utilization, etc.) are transferred from a foreign party (transferor) to a host party (transferee) that arranges to receive it. In this research, the transferee refers only to Thai Architectural, Engineering and Construction (AEC) firms and the transferor refers to the foreign AEC firms working with Thai firms to procure projects. As expected, transferor firms had origins in developed nations such as the United States, Japan, Germany, United Kingdom, France, Australia, etc. These factors could be generally defined as enablers and include the transfer environment, learning environment, transferor characteristics and transferee characteristics. The performance of and interaction between these enablers can influence the degree of value added to the host construction. The development of the conceptual model for TT process in construction projects intends to denote all of the significant factors that influence the effectiveness of the TT process and the resulting value added. These relevant factors have been adapted from the examined leading studies into the TT phenomenon with the objective to develop a model, which explains the international TT process in construction projects.

The classification of variables resulted in five definable factors (constructs), namely, Transfer Environment, Learning Environment, Transferee Characteristics, Transferor Characteristics and TT Value Added. The structure and links between the model constructs had also been conceptualized based on some experimental understanding and therefore require testing to confirm their appropriateness and validity.

The model main factors are mainly:

Transfer environment: The transfer environment was focused at the macro level of a country and its respective AEC sector, and was predominately concerned with the impact of country and project related factors on the TT process. The host government's policies, regulations and enforcement practices could impact greatly on the effectiveness of TT initiatives, especially their international political system and domestic political structure (Calantone et al., 1990).

Learning environment: The learning environment was concerned with the relationship and communication between the transferor and transferee, and the effectiveness of implemented transfer programs. Cultural characteristics and the distance between the technology provider and receiver was a major concern when managing international technology transfer (Fisher and Ranasinghe, 2001; Ganesan and Kelsey, 2006; Kumaraswamy and Shrestha, 2002; Lin and Berg, 2001). TT programs on construction projects, which were formally planned and managed, were more likely to transfer a greater degree of knowledge to the host workers (Saad et al., 2002; Simkoko, 1992).

Transferor and transferee characteristics: The remaining two enablers were related to the characteristics of the transferor (foreigner) and transferee (host). These enablers were concerned with the degree to which the characteristics of the transferor and transferee encourage the TT process (Kumaraswamy and Shrestha, 2002). One of the essential elements to achieving successful TT is that the transferor was willing to transfer the appropriate technology and the transferee has every intention to adopt it (Ganesan and Kelsey, 2006; Malik, 2002). In addition, the degree of international experience of both the transferor and transferee and the nature of this experience can affect significantly on the TT process. Moreover, the capacity to transfer and adopt technology will also depend on each individuals existing knowledge base and the gap between this knowledge level and the level required to utilize the transferred technology (Saad et al., 2002; Wang et al., 2004).

TT-induced value creation: The performance of, and interrelationship between, the above-mentioned TT enablers contributes to the degree of value added to the host AEC sector. One of the predominant reasons why governments in developing countries encourage international TT initiatives was because they believe such initiatives can improve their living standards and economic prospects (San, 2004a; Schnepp et al., 1990). This factor was concerned with the impact of TT programs on the performance of AEC projects. Specifically, this factor examines any improvements in the performance of financial, schedule and quality indicators.

The statistical verified data proved that Government influence was determined to be the only predictor of transferee characteristics. However, the results confirmed that transferee characteristics and government influence could directly promote enhanced transferor characteristics. The results confirmed that appropriate transferor characteristics were essential for relationship building. Also, Transferor and transferee firms with idealistic characteristics for TT need to be carefully selected to ensure that the host nation had the best chance for receiving the most tacit and implicit knowledge from the process. Waroonkun and Stewart (2008) acknowledged that the developed structural equations might not be as accurate when applied in another context the strength of the relationship would depend on the maturity of the host nation and its construction sector, in relation to the development continuum. The core constructs or factors of the model were generically named in design for easy adaptation for utilization in other industry sectors. With some minor modifications to the derived TT enabling and outcome sub factors presented herein, the developed

international TT model could be applied to a wide range of industrial settings.

COMPARATIVE ANALYSIS

Although there have been many TT studies, the seven models discussed in this literature has not been considered as a comprehensive models that describes the TT process for petroleum industry. Nonetheless, there have been several previous studies that have identified many of the important factors that need to be incorporated when developing a conceptual TT model for petroleum industry. Even though some these studies may not have been specific to the petroleum sector, they have identified issues that are generic and valid for several different industries. However, the similarities and differences of existing models to the proposed model were discussed.

Similarities

Most of factors that were considered in the literature are summarized for the proposed model similarities. Calantone et al. (1988) framework designed mainly to get feedback on TT process. The environment sub factors were considered influential in any model. The Simkoko (1992) model was mainly designed for assessing the local firms involvement in TT process. Furthermore, the model was concerned of management teams' organization and interaction. In Kumar et al., (1999) learning model, the learning culture in integrated in the capability assessment model. Lin and Berg (2001) have detailed description of the effect of technology complexity and the level of experience that considered important components of TT model. The "broadcasting" model of Malik (2002) provided good insights on TT process; the model was useful in terms of its characteristics. Wang et al. (2004) based on two enablers that were knowledge and the parent organization effect. Finally, the modeling of Waroonkun et al., (2008) which was statically verified has identified most of the influential factors and the model overall is easy to adopt to any other industry TT process.

Differences

The models explored in the literature mostly were experimental studies that give an insight to the TT concept. Nevertheless, some differences in models that were indicated acknowledge the differences in aims, especially in the petroleum industry. Calantone et al. (1988) model was based on comparative marketing research which has no indicators for TT performance, very complex in design, and not empirically verified. Simkoko (1992) model was an outdated model that has a limited understanding of TT process and has no indicator on the TT performance impact. Kumar et al., (1999) model was designed for small scale manufacturing industries and the model's sample size was small. Lin and Berg (2001) model findings might be considered biased because it was based on two Taiwanese manufacturing companies only. The model failed to detail sufficient description of important factors. Designed to study long term management practice, Malik's (2002) model was tested on one company which may be too considered biased empirically. Wang et al. (2004) was limited by its scope that confined to knowledge factor for a subsidiary. The model failed to examine important factors such as government role and complexity of technology. Finally, Waroonkun and Stewart (2008) TT model was designed for construction industry and might not be accurate to other industries. In addition, the model depended mainly on the maturity level of the host nation level of technology.

CONCEPTUAL MODEL OF TECHNOLOGY TRANSFER IN PETROLEUM INDUSTRY

The development of conceptual model for TT in the petroleum industry has been pointed toward the capture all of the significant factors that influence the effectiveness of the TT process and the resulting performance. These relevant factors have been adapted from the examined leading studies into the TT phenomenon with the objective to develop a model which explains the TT process in petroleum industry. Through a process of categorizing variables taken from the previous studies and conceptualizing their relationship with one another in the petroleum industry context a number of factors were identified. The factors identified were classified as enabling and TT outcome factors (Table.1). The classification of variables into their relevant factors; namely, TT support, TT infrastructure, TT environment, Libyan company learning capability, and TT performance has not been solely based on other studies but rather is a conceptualization based on understanding of TT and the petroleum industry. The structure and links between the model constructs have also been conceptualized based on some empirical understanding and therefore require testing to confirm their appropriateness and validity. Figure 1 illustrates the conceptual model on how the developed enabling factors interact to create value for the host petroleum sector. The four main TT enabling factors are shown at the left and middle of the model as the constructs TT support TT infrastructure, TT environment, and Libyan company learning capability. The outcome factor, TT performance, has been presented at the right of the model. The hypothesized causal paths between each enabling and the outcome factor are represented by the arrows. Each of these causal paths is described. The variables contained in the TT support factor were found to have direct impact on those variables contained within the TT Infrastructure factor. Therefore, the link from TT

Table 1. TT process enabling and performance factors and variables.

Factors	Variable description	References
TT support	Parent organization support Government support	(Benedetto et al., 2003; Bozeman, 1994; Calantone et al., 1990; Hoekman et al., 2004; King and Nowack, 2003; Kwon and Zmud, 1987; Lin and Berg, 2001; Nanoka and Takeuchi, 1995; Robinson, 1988; Saggi, 2000; Simkoko, 1992)
TT infrastructure	Information Technology (IT) Research and Development (R&D) Local Sub-Contractor Training Standards Management	(Aoki, 1986; Barton, 2007; Blomstrom and Sjoholm, 1999; Coninck et al., 2008; Gander, 1987; Holsapple and Joshi, 2000; Lee and Win, 2004; Meredith, 1982; Muniagurria and Nirvikar, 1997; Nazmun et al., 2006; Nazmun and Vesa, 2000; Pueyo, 2007; Rath, 1976; Sanchez and Tejedor, 1995; UN, 1974)
TT Environment	Experience Knowledge Complexity Communications Teamwork	(Carolynn et al., 2000; Grant, 1996; Inkpen, 2000; Kumaraswamy and Shrestha, 2002; Kusunoki et al., 1998; Lin and Berg, 2001; Love and Roper, 2009; Madeuf, 1984; Michie and Sheehan, 2005; Milgrom and Roberts, 1992; Milgrom and Roberts, 1995; Nanoka and Takeuchi, 1995; Nonaka, 2001; Robinson, 1991; Saunders, 1977; Stamm, 2003; Topkis, 1978; Wei, 1995; Williams and Gibson, 1990; Wu, 1993; Zeller, 2002)
TT Learning Capability	Culture Adoption Absorption Exposure Supervisory	(Arbose and Bickerstaffe, 1982; Bell, 1987; Cusumano and Elenkov, 1994; Escribano et al., 2009; Feldman and Bercovitz., 2008; Fisher and Ranasinghe, 2001; Kaplinsky and Raphael, 1990; Kedia and Bahgat, 1988; Kumar et al., 1999; Lall, 1987; Lin and Berg, 2001; Liu, 2007; Lynn, 1985; Madu and Christian, 1992; Miles, 1995; Mytelka, 1985; Susan E. Cromwell, 2004; Wei, 1995; Zhao, 1997)
Economic accomplishments	Competitiveness Performance	(Alam and Langrish, 1981; Benedetto et al., 2003; Calantone et al., 1990; Fisher and Ranasinghe, 2001; Madeuf, 1984; Mason, 1980; Mytelka, 1985; Salami, 2001; San, 2004b; Schnepp et al., 1990; Schwarz, 1982; Teece, 1981; Zakariya, 1982)
Knowledge gain	Knowledge and practice gain Skills gain	(Bubshait and Almohawis, 1994; Cavusgil et al., 2003; Devapriya and Ganesan, 2002; Ettlinger and Patton, 1996; Gilbert and Cordey-Hayes, 1996; Gold et al., 2001; Nanoka and Takeuchi, 1995; Robinson et al., 2005; Simkoko, 1992; Spann et al., 1995)
Process Performance	Financial performance Schedule and quality Standards Performance	(Bubshait and Almohawis, 1994; Devapriya and Ganesan, 2002; Ettlinger and Patton, 1996; Simkoko, 1992; Spann et al., 1995)

Support to TT Infrastructure was constructed in (Figure 1).

Similarly, the literature provided some evidence that the following causal relationships also existed: TT support TT environment; TT Support, petroleum industry learning capability; TT Infrastructure TT environment; TT infrastructure TT performance; TT infrastructure TT petroleum industry learning capability; TT environment petroleum industry learning capability; TT Environment TT performance; and petroleum industry learning capability TT Performance. Although these links were described in past literature, this does not mean that every variable contained in each factor impacts on every variable in another, rather that the factor when considered as a

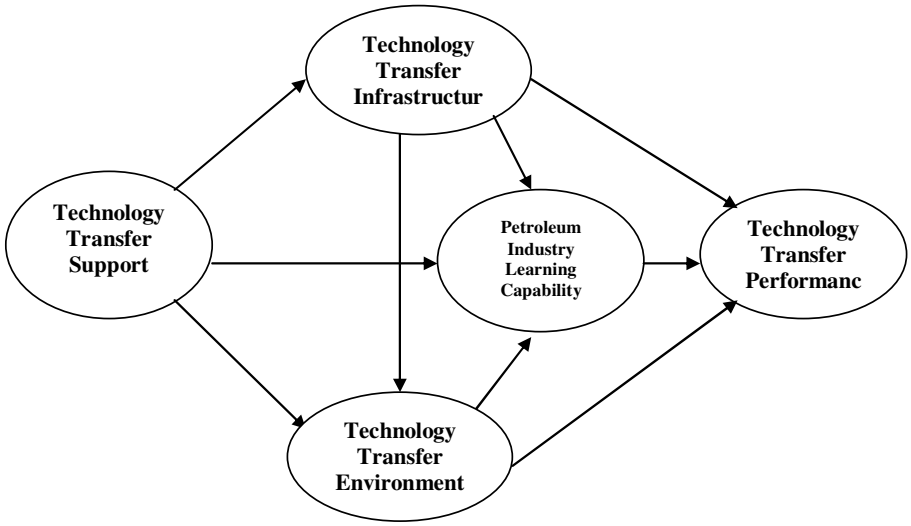

Figure 1. Conceptual model for technology transfer in Libyan petroleum industry

whole has impact on another. The four links from TT Support to TT infrastructure, TT environment and petroleum industry learning capability were insufficiently supported in the literature and therefore their validity was closely examined in both the pilot and main studies. These links have been largely conceptualized from an understanding of the TT process and petroleum industry. For example, the impact of the TT support onto TT infrastructure is one such link that has good theoretical background as it is likely that factors such as IT and government support will influence the preparation of the host to adopt new technology. Many enablers have been identified as having potential to impact on the effectiveness of the TT process and have been divided into four main categories in this study: transfer support; transfer infrastructure; transfer environment; and petroleum industry learning capability. The performance of, and interrelationship between, these TT enablers contributes to the degree of performance to the host petroleum sector. The benefits achievable from TT process can be derived from three main areas: economic improvements; knowledge gain; and project performance. The following sections describe the persuasion for including each variable in the aforementioned enabling and outcome factors. Each factor included in (Table 1) along with the sub-factors, associated descriptions, and references

TT support

The TT support is focused at the large-scale level of a country and its respective petroleum industry. This factor is predominately concerned with the impact of technology and government support related factors on the TT process. According to (Kwon and Zmud, 1987), the availability of financial resources for the petroleum manufacturing industry technology (advanced manufacturing systems and engineering design, operating methods, management techniques and technology, etc.) must be considered during the TT process. The government support in terms of financial sub factor has been recognized in several studies as an influential factor that impacts on the effectiveness of TT process (Robinson, 1988). The organization's strategy towards the technology to be transferred affects the efficiency and interaction pattern between the holding and its sub companies during TT process (Lin and Berg, 2001). The business strategy is concerned with the overall purpose and long term direction of the parent organization and its financial viability (Nanoka and Takeuchi, 1995). Bozeman (1994) stated that government should not compete with private sector in innovation and technology but to complete it. A TT process supported by government can decrease the technological gap between local and foreign companies by establishing innovation system and policies that encourage technology R&D (Hoekman et al., 2004). Government policies need to improve the investment climate and reduce costs of captivating technology (Saggi, 2000).The impact of regulated and forced licensing includes shifting the distribution of innovation from foreign to domestic companies by limiting ownership of specialized assets (King and Nowack, 2003). There is also a direct link between the level of government support to the industry R&D and training to apply TT process. The expected costs and time involved in its implementation should be reduced, leading to a greater intention to adopt (Benedetto et al., 2003). The government must plan ahead ahead of time in global petroleum industry to make the industry competitive and investor friendly in the world (Ozighbo, 2008). Government support of petroleum industry technology has been identified as an important consideration in the success of a TT process as it has

impact on several other influential factors. This variable has been adopted from the previous studies of (Calantone et al., 1990), (Simkoko, 1992) and (Lin and Berg, 2001) and has been incorporated into the conceptual model.

TT infrastructure

The availability of certain conditions in the host petroleum industry is the main concern of TT infrastructure factor. The IT and its impact on the TT process is unquestioned a major concern when managing TT process. The innovative uses of a variety of IT tools maybe provide benefits to facilitate TT process (Nazmun and Vesa, 2000). IT can support complicated tasks associated with TT process. According to (Nazmun et al., 2006) IT can increase capacity as well as decrease expenditure of information handling which will in turn enhances the success of TT process. Typically, TT from more advanced foreign companies to the local industry are realized only when the local industry conducts its own R&D (Muniagurria and Nirvikar, 1997). Furthermore, local industry should have an interaction with local R&D centers and universities (Sanchez and Tejedor, 1995; UN, 1974). R&D and other functional areas should be in order to ensure the transfer of skills and technology (Aoki, 1986). The involvement of industry in R&D activities of research centers provides high probability of successful TT process (Lee and Win, 2004). However, The TT may not be materialized if technology gap between foreign company and local is too large, its generally believed that local participation with foreign firms reveals the proprietary knowledge in that way facilitate TT to domestic industry (Blomstrom and Sjoholm, 1999). Notwithstanding, training is important component of TT process. TT through training could be in the form of practical training where local employees are exposed to working methods and required to work at highly developed industry environment to adopt new skills and techniques (Gander, 1987). Growing attention has been turned to the possible role of TT agreements as part of the architecture of TT process (Coninck et al., 2008). The foreign company shall take all viable steps to promote, facilitate, and finance as appropriate the transfer or access of sound technologies and know-how to local industry (Barton, 2007). It's also important that technologies are adapted to the needs of the host countries (Pueyo, 2007). Management as an important sub factor can take actions to develop an infrastructure that is supportive of TT process. Management approach would significantly contribute to low or high TT process performance. Holsapple and Joshi (2000) suggested that managerial influence emanate from organizational participants responsible for administrating the management of knowledge. TT process is basically a learning process, any delineation and exercise of authority is not as beneficial as an advisory approach (Rath, 1976). This would involve leadership quality that is high achievers, risk takers innovative, creative, perceptive and original thinkers (Meredith, 1982).

TT environment

The other two important enablers are concerned with the host's environment and the learning capability. However, a major concerns of managing TT is the environment in which the interaction between the foreign technology provider and the host industry and its effect on the success of TT process performance (Kumaraswamy and Shrestha, 2002; Lin and Berg, 2001). Williams and Gibson (1990) suggested that TT should be conceptualized as communication processes where gaps between foreign and local environment will affect efficiency of inter firm communication and the overall effectiveness of TT process. Wei (1995) reported that prior international technology experience on international operations is helpful for the host to gather relevant information from different sources and mange communications and conflicts during the TT process. On the contrary, (Lin and Berg, 2001) suggested that previous foreign experience of the host can increase its capability to preserve core technology from the foreign and eventually resulting in the host becoming a serious competitor of the foreign company. The understanding of knowledge transfer and local capability formation is limited. International knowledge transfer has been extensively studied. Among all the resources of a firm, knowledge is the most strategically important resource (Grant, 1996). Knowledge provides the capacity for organizational action and new knowledge provides the capacity for organizational renewal (Inkpen, 2000). They all agree that the increasing complexity of contemporary projects makes the definition of and the agreement about the criteria for project performance measurement in a specific project situation, equally complex. Nonaka (2001) for instance argues that tacit knowledge accounts for three quarters of all knowledge used by firms. A complex system or technology may need a longer time, more technical people, and higher capital investment to be transferred. Madeuf (1984) therefore suggests that nature of technology will affect TT effectiveness and need to be carefully investigated in managing a TT process. Researchers suggested that some technologies could be easily transferred with embodied TT forms, such as direct purchase of equipment and turnkey plant transactions. Yet, most technologies are very difficult to transfer because they include a large portion of tacit knowledge. According to (Nanoka and Takeuchi, 1995) tacit knowledge is not easily visible; not easily expressible; highly personal; hard to formalize; and difficult to communicate. Several dimensions are proposed to characterize the nature of a technology to describe its transferability (Wu, 1993). Robinson (1991) proposes that the skill and education level required to adopt a technology by the

technology receiving team is an indicator of the complexity of a technology. To transfer a complex technology usually requires the host to change its organizational structure in order to respond to the adaptation of the new technology. Therefore, a TT process to transfer a complex technology is likely to have a lower success rate. Achieving success in TT process will require the information to be conveyed clearly and effectively in a total error free communication setting. Successful TT process requires many factors in particular a high level of commitment to shared goals. Saunders (1977) provides a model that is characterized by frequent communication both formally and informally, open sharing of information. Carolynn et al. (2000) indicated that effective communications was given a very high rating by all categories and by both organizations involved in the process. Poor communication may result in major problems. Recent studies indicated that teamwork has emerged as fundamental factor towards successful TT process. However, (Stamm, 2003) mentioned that most research on cross functional teamwork has focused on the effectiveness of individual project teams, and the role of either compositional, leadership or environmental factors. The work of (Milgrom and Roberts, 1992; Milgrom and Roberts, 1995) developed the formal analysis of complementarities in organizational design, building on the work of (Topkis, 1978). The use of teamwork and their effect on TT process output have been considered in number of studies. Zeller (2002) describes the introduction of cross functional teams as part of the reorganizing of R&D activities within pharmaceutical companies in response the increasing globalization of R&D. In addition, (Kusunoki et al., 1998) stress the importance of communication between groups and multi functional teams has significant positive impact on innovativeness. More recently, (Michie and Sheehan, 2005) consider firms with high levels of participation in teamwork as part of their examination of the impact of alternative systems TT process. One reason is that cross-functional team working may enhance intra-functional stage communication and knowledge sharing at the expense of cross-functional stage communication and knowledge sharing (Love and Roper, 2009).

Petroleum industry learning capability

The learning capability is concerned with the affects of the sub-factors that facilitate the learning capability of the technology that being transferred between host and local companies. The issue of culture in TT process has been studies by (Kedia and Bahgat, 1988) and concluded that if foreign and host companies did not emphasis the issue of culture, the result maybe ineffective TT process. The importance of recognizing the apparent and hidden components of the host country culture involved in TT process depends on several factors such as attitude towards foreigners and the company reputation (Zhao, 1997). The cultural traits of the two parties can have a significant impact on the effectiveness and hence the success of TT process (Fisher and Ranasinghe, 2001). A TT process where cultural gap between host and foreign is high is expected to result in unsuccessful TT process (Lin and Berg, 2001). Adoption of new technology requires some modification to fit with changes in the working environment by controlling the working environment variables or making an adjustment to synchronize between host and foreign company policies (Madu and Christian, 1992). In TT process, it's necessary to adjust equipments and policies to the match with the conditions and circumstances of the host country. The conditions can be physical or climatic conditions or temperature (Kaplinsky and Raphael, 1990). The importance of adoption is crucial because maybe the inputs from host is not the same as for those the equipments was designed. The ability of any company to absorb the advanced technology depends on the organizational and technical capabilities of the company (Bell, 1987; Cusumano and Elenkov, 1994). Structural systems should adopt the measure of quality, performance and promote learning within the company (Lynn, 1985). The company's current absorption capacity will be determined to what extent their ability to participate in the transfer of technology (Lall, 1987; Mytelka, 1985; Wei, 1995). Third world countries need to develop their technological capacity, but the abilities of these countries is limited by its reliance on low level of absorption of technology (Kumar et al., 1999). Recent research by (Escribano et al., 2009) suggested that the capacity for absorption is in fact a source of competitiveness. In other words, absorption capacity of the local company plays a crucial and important role in technology transfer process. In TT process, exposure occurs when employees become informed and educated about the technical and manufacturing systems and their applications that was not diffused or applied in their industry environment previously. This exposure could be the formal training such as workshops and Seminars or non-formal training and travelling, and self educated. In their research, (Arbose and Bickerstaffe, 1982) argues that many of the users who have an earlier exposure to technology have a greater capacity to accept TT process. Recently, (Liu, 2007) suggested that employees of technological knowledge had not been exposed to external expertise will need to expose to foreign knowledge. Meanwhile, those employees who are already being exposed to high foreign exposure will require less foreign expertise. Respectively, the company which had been exposed to foreign expertise will develop methods for local R&D, meanwhile the company, which has not been exposed, has to depend and more foreign expertise. More recently, Feldman and Bercovitz (2008) in their study on university technology transfer using data on individual researchers from the Medical Schools of Duke University and Johns Hopkins University. They found that a high percentage of supporters of TT process and new organizational strategic

initiatives were the more recently trained the staff members, the more likely encountered an environment supportive of commercialization activity.

There is little information on the role and impact of the supervisory in the TT process. However, (Miles, 1995) suggested that one of the reasons for the failure of TT process is incautious choice of the supervisors for the TT process, without considering the required knowledge for TT process. Susan E. Cromwell (2004) suggested that supervisors who did not have the proper setup and their management support and has participated previously in TT processes would excel in future TT process. In contradiction, supervisors who reported less participation and did not have time and enough support in previous TT processes would be considered a real barriers to TT process.

TT performance

Performance of TT process could be examined from numerous attributes in the literature. From the viewpoint of efficiency, (Teece, 1981) tried to measure the effectiveness of TT process through the calculation of the cost of TT. Viewing From the perspective of TT process within the organization, (Schwarz, 1982) defined by the effectiveness of TT as an adequate R&D in the local organization. Similar foundations evident in the work by (Alam and Langrish, 1981). From the standpoint of the host country, (Madeuf, 1984) the control of imported technology suggested as a measure to effectiveness of TT process. Zakaria (1982) discusses the transfer of technology to the petroleum industry on the bearing capacity of the country to purchase or lease of the best technological equipment for exploration and development of global markets at a reasonable cost. Manson (1980) determined that the effective transfer of technology must be measured if it facilitates to develop the methods and the acquisition of new skills of the host country. Mytelka (1985) suggested that the incorporation of technology is the best and only way to possibly modify, improve and extend it later.

Salami (2001) argued that more than 50 of the economic development of industrialized countries is formed by the technology changes which improved the economic development and lead to the creation of new industries or products. One of the leading motivations for developing countries to adopt and apply TT programs is the expectation that involvement in TT programs would enhance the standard of living and bring prosperity to the host country (San, 2004b; Schnepp et al., 1990). However, the performance of high level of high quality of products, the development of quality services and better management skills as well as the diversity of manufacturing techniques and products lead eventually to a large economic development (Benedetto et al., 2003; Fisher and Ranasinghe, 2001). Economic development sub-factor is concerned with the extent of competitiveness between the Libyan petroleum industry companies in local markets and global markets. Knowledge could be categorized into two types of knowledge, tacit and explicit (Nanoka and Takeuchi, 1995). Tacit knowledge is achieved through cooperative experiences and the understanding of procedures and dealings and could be said that tacit knowledge is complicated to illustrate or trace in logical terms, also difficult to identify ways to deliver it. On the contrary, explicit knowledge has a detailed structure and set of rules that can be transferred and communicated in formal and systematic plain methods (Cavusgil et al., 2003). In addition, to the economic benefits expected to be obtained by the transfer of technology, the local petroleum industry could also benefit from cognitive development at the level of individual users, as well as at the enterprise level (Gilbert and Cordey-Hayes, 1996; Robinson et al., 2005).

Preliminary results of TT process are the transfer to the individual employee the tacit knowledge to explicit knowledge (Gold et al., 2001). Knowledge gain sub-factor is concerned with the improvement cause by TT process in the knowledge of local industry employees, improvements caused by the TT process and its impact on the methods and technical skills of the employees. The difficulties of measuring the performance of the achievements of TT process due to the difficulty of measuring the results of the multiple TT process outcomes. As well as the nature of the technology in overlapping operations within the organization involved in TT process. The TT process has a number of results at each stage and between stages and at the final stage, which sometimes delayed because of the length of the development process (Spann et al., 1995). According to Devapriya and Ganesan (2002) the key motivations of the TT process in any industry are: highly effective financial performance, efficient schedule performance, and significant quality operating performance. Enhanced commendable performance must be the key outcome of the TT process. The project performance factor main objective is to measure the impact of TT effectiveness on the industry (Ettlinger and Patton, 1996). In particular, from an evaluation perspective of performance it would be in terms of progress of financial, schedule, and quality assessment. The output of TT process is measured in comparison with the objectives identified in advance with most emphasis on time, cost and quality (Simkoko, 1992). Traditionally, the success of TT process objectives will include the cost of TT process, the time of TT process implementation, the performance quality of the required functions to the petroleum industry, as well as the safety and efficiency in the performance (Bubshait and Almohawis, 1994).

Summary

The primary objective of this review is to explore the effectiveness of previous literature and the impact of preceding studies that described the TT process and to

develop a conceptual model for TT process in the Libyan petroleum industry. In addition to the critical review of previous seven leading TT process models, a number of other studies were investigated and studied to identify, define every significant factor that have an impact on TT process, and influence the outcome and performance of TT process. Models which have been reviewed and examined in this literature are the main seven models of TT include, (Calantone et al., 1990), (Simkoko, 1992), (Kumar et al., 1999), (Lin and Berg, 2001), (Malik, 2002), (Wang et al., 2004) and (Waroonkun and Stewart, 2008). Each of these studies had contributed to the development of the conceptual model; none of the reviewed studies provided a comprehensive approach the issue of TT process in the petroleum industry. Nevertheless, with some modifications, these factors became essential components in building the developed conceptual model. This model is consisted of a set of enablers including: TT support, TT infrastructure, TT environment, and Learning capability. The model also includes the TT outcome, which includes TT performance factors: economic improvements, knowledge gain, and project performance.

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