

# Selecting the Appropriate Technology Transfer Method to Reach the Technology Localization

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**Abstract**-The aim of technology localization is an important issue, especially in developing countries that try to acquire new technologies by using a technology transfer method. Since these mechanisms may not lead all companies to attain their required knowledge and skills, further investigations must be conducted in order to choose the best method depending upon their criteria and goals. Several approaches exist for technology transfer, each focused on certain factors and objectives. Identifying the proper methods for localization is of great help for companies that plan to access technology to strengthen their knowledge and R&D basis for further innovation. In this research paper, we identify the factors required to localize a technology within the company in various groups including firms, governments, institutes and markets, and verify the factors in a statistical analysis based on a survey in a localization experience within a company. We suggest the appropriate methods with special emphasis on technology localization by comparing the proposed factors in different technology transfer models. To this end, we classify the important factors of each model and methods by comparing them with the localization factors we identify. This will help researchers to classify the technology transfer methods corresponding to their localization goal. The findings of this research could lead firms to select the best method for technology localization in the long-term, and align it with development trajectories and future innovations based on the transferred technology.

**Index Terms:** Localization, Technology Transfer, Transferred Technology

## I. INTRODUCTION

**F**AIRMS choose technology transfer methods for industrial development. They aim to obtain the basis of technology and strengthen scientific and operational skills. Technology transfer is expected to provide competitive advantage and lead companies to further innovation and new products through technology. However, companies need to localize technology within their industrial area to reach this goal. They should promote their scientific and technical knowledge, enhance human skills and develop infrastructure.

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Many factors should be considered in technology transfer to drive companies to localize technology. In this paper, we identify the factors in different groups that affect the success or failure of localization. Comparing the impact factors in different technology transfer methods with localization factors allow companies to find the best way to acquire transferred technology with the aim of localization.

In this paper, the methods of technology transfer and the important factors of each method are described in section two. In section three the localization factors identified in four groups - company, government, market and institutes - are discussed. Sections four and five indicate the methodology of the empirical study and statistical test results to rank the factors based on our survey within the case study. In section six, the technology transfer methods for localization brought about by comparing the localization factors and impact factors on technology transfer methods are analyzed. Finally, a conclusion and suggestions for future studies are described in section seven.

## II. IMPACT FACTORS IN TECHNOLOGY LOCALIZATION

Technology transfer assists companies in obtaining a competitive advantage via received technology. Adaptation and absorption of technology through localization processes help companies develop transferred technology and new products. Several factors influence the localization distributed in the company, government, market and institutes (Kumar and Bhat, 2003; Bennett and Zhao, 2004; Nancy, 2005; Caldera and Debande, 2010). Table I indicates all identified localization factors in four groups.

Companies undertake the major part of technology transfer and need to prepare their infrastructure and human skills for successful localization through technology transfer. Hence, the most frequently identified factors are dependent upon the company (Wikstrom and Norman, 1994; Naito, 1998; Barclay, 2005). Government policies could accelerate localization and aid companies in developing their new products based on transferred technology. On the other hand, lack of government support may cause the failure of technology and the company or create barriers to further development. Government policies providing demands for new products in the market and legislating supportive regulations for the localization of technology are of great importance to companies (Bennett and Zhao, 1997;

Rowlands, 2005; Lewise and Wiser, 2006).

TABLE I  
IMPACT FACTORS ON LOCALIZATION

Group	Factors
<b>Impact Factors in Company Group</b> (Naito, 1998; Wikstrom and Norman, 1994)	• Development Technical Infrastructures
	• Enhancing Human Skills
	• Analyze Internal and External Technology Market
	• Development of R&D Infrastructures
	• Formal and Informal Communications with the Transferor (Gray, 2003)
	• Presentation of the Technology to Market (Kumar and Bhat, 2003)
	• Protection of the Localization Process in Organizational Culture (Shahnavaz, 1997)
	• Development of the Controls of Transferee on Technology during the Transfer Process (Rouach, 2003)
	• Investments in Technology Development (Shahnavaz, 1997)
	• Competitive Capability of the Company
	• Integration Capability of the Transferred Technology with Existent Technologies (Kondo, 2001)
	• Access to Internal and External Financial Resources
	• Proportion of the Tacit and Explicit of the Technology Knowledge (Li-Hua, 2006; Madhok, 1996; Maracotte and Niosi, 2000; Rouch, 2003)
	• The Position of the Company in its Lifecycle ( Farhang, 1997)
	• The Position of the Transferred Technology in its Lifecycle (Cho and Yu, 2000; Maracotte and Niosi, 2000)
<b>Impact Factors in Government Group</b> (Rowlands, 2005; Lewise and Wiser, 2006; Bennett and Zhao, 1997)	• Rules and Regulations of the host country
	• Commercial status of the country
	• Industrial Status of the country
<b>Impact Factors in Market Group</b> (Nancy, 2005; Trich and Lanzoni, 2006)	• Competitors
	• Supply Chains
<b>Impact Factors in Institutes Group</b> (Hankel and Kogan, 2010)	• Universities and Training Institutions
	• R&D Labs for Pilot Manufacturing
	• Engineering and consulting Centers
	• Technical Workshops
	• Informative organizations
	• Supportive Institutes in management, finance and planning

The final products originating from transferred technology are intended to enter the market for

commercial benefit. It is critical for companies to concentrate on competitors within their technology localization. Competitors are a critical factor in the success of products in current markets and in developing new markets. The creation of strong supply chains including manufacturers and distributors with high capabilities also assists a company in attaining a substantial share of the market (Nancy, 2005; Trch and Lanzoni, 2006). Furthermore, attracting other support from different institutes could provide the required knowledge and finance when sufficient resources are not available. These institutes affect the function of companies by supporting, planning, consulting and enhancing their knowledge by various programs and are helpful in the success of the localization (Hankel and Kogan, 2010).

### III. IMPACT FACTORS IN TECHNOLOGY TRANSFER MODELS

Among the different models and factors presented for choosing the technology transfer method, we categorize three models including Chiesa, Ford and Robert & Berry. Each of these models describes impact factors in selecting the specific method for technology transfer and suggests alternatives (Arasti et al., 2008).

#### A. Chiesa Model

This model analyzes the factors that affect companies' decision in choosing a technology transfer method. Since companies can access technology through various modes, all the company's requirements should be considered through various factors. Suggested methods are illustrated in Table II.

TABLE II- SUGGESTED METHODS FOR TECHNOLOGY TRANSFER BASED ON IMPACT FACTORS, CHIESA MODEL (CHIESA AND MANZINI, 1998; ARASTI ET AL., 2008)

Factor	Suggested Method
Objective	Joint Venture- Acquisition- Outsourcing- Alliance
Identifiability	Alliance - Joint R&D
Familiarity with Technology and market	Joint Venture- Alliance- Acquisition
Relevance for competitive advantage	Joint Venture
Technology life cycle	Outsourcing- Minority Equity
Level of Risk	Joint Venture- Alliance
Appropriability of Innovation	Joint Venture- Merger
Phase of the Innovation Process	Alliance- Outsourcing
Assets Specialization / Investment	Acquisition- Merger
Assets Divisibility	Outsourcing- Joint Venture
Link with the Firm	Alliance- Outsourcing- Joint Venture
Original country (Cultural Condition)	Outsourcing
Activity Field of Transferor	Outsourcing
Size or Power	Merger- Joint Venture

Chiesa et al. (1998) mention that the dimension and priority of requirements in each factor are significant in technological partnering. Company strategies can determine the importance of the factors for selecting the best method. Suggested methods are illustrated in Table (2) (Chiesa and Manzini, 1998; Arasti et al., 2008).

**B. Ford Model**

This model proposes methods based on different factors related to transferred technology and the company. The position of technology in the lifecycle and the competitive advantage brought about by technology are technology-based factors. The model suggests the internal development for new technology and purchasing approach for the technologies that are past their maturity stage in the lifecycle. The other methods, including joint venture, outsourcing, R&D contracting and licensing are distributed from the early stages of technology to the maturity phase. It also indicates the role of the company's technology level in achieving the transferred technology and the company's need for rapid achievement (Khalil, 2000; Arasti et al., 2008).

**C. Robert and Berry**

This model emphasizes two factors, technology and market. It suggests the methods through the familiarity matrix of different positions of technology and market ranging from base technology/ market and new familiar to new unfamiliar technology/market. The alternative methods include joint venture, acquisition, licensing, and minority venture capital investment. It also suggests the education and training required when one of the technologies or the market is new and it is expected to develop future market shares (Robert, and Berry, 1985).

**IV. DATA AND METHODOLOGY**

The data used in this paper is based on the localization experience of the technology transfer in hydroelectric power plant equipment in Iran. The statistical survey was accomplished according to the top managers, engineers and all staff related to the localization processes. The sample was drawn from the population of specialists who were asked for technology localization factors for further data analysis. We used the results to support our claim in identifying the factors impacting localization through the survey. The sample size (n) was calculated with a 95% confidence level and the error range between 0.1 and 0.01 with a maximum p= 0.5 to obtain the large (n). The sample formula (equation 1) provided 50 numbers for the survey as an objective sample and we received 49 completed questionnaires. The formula is as follows:

$$n = \frac{N(Z_{\alpha/2})^2(P)(1-P)}{\epsilon^2(N-1) + (Z_{\alpha/2})^2(P)(1-P)} \tag{1}$$

A questionnaire with five Likert scale types was used for gathering the data. Respondents were asked about the importance of the localization factors in the technology transfer process. Additionally, interviews were arranged with top managers of the organization and the response rate was 98%. Friedman Two-Way ANOVA and the

Wilcoxon signed-rank test as non-parametric tests were used to understand the relationship between the factors, which gave us the chance to rank the factors independent of their category. We defined the following hypothesis in a Friedman two-way ANOVA test in equation (2):

$$H_0: \text{There is no significant difference between the factors} \tag{2}$$

$H_1$ : There exists at least one significant difference between two of the factors

We also applied Wilcoxon signed-rank test to achieve the precise ranking of the data in addition to the Friedman test based on the hypothesis in equation (3):

$$H_0: \bar{R}_i = \bar{R}_j$$

$$H_1: \bar{R}_i \neq \bar{R}_j \quad i \neq j \tag{3}$$

**V. FINDINGS AND IMPLICATIONS**

The results obtained by using a Friedman test show possible differences among the factors. The analysis with chi-square= 325.515, df= 26 and P-value=0.000 indicate that since the obtained P-value is less than the significant level of 0.05, the null hypothesis is rejected with 95% confidence level and it can be claimed that there are differences between each pair of factors. The same results rejected the null hypothesis in Wilcoxon signed-rank test and confirmed the differences between the factors for ranking based on their importance. The mean rank brought about by the Friedman test and rank by the Wilcoxon test are given in Table III; note that the groups of factors is not considered in the ranking.

TABLE III  
RANKING OF FACTORS BY FRIEDMAN AND WILCOXON TEST

Factors	Mean Rank by Friedman Test	Ranked by Wilcoxon Test
Development of Technical Infrastructures	20.92	1
Enhancing the Human Skills	20.63	1
Political Support	19.26	1
Analyze the Internal and External Technology Market	17.86	2
Rules and Regulations of the host country	17.24	3
Development of the R&D Infrastructure	16.63	4
Supply Chains	16.28	4
Formal and Informal Communications with the Transferor	16.27	5
Presenting the Technology to Market	16.27	5
R&D Labs for Pilot Manufacturing	15.93	5
Protection of the Localization Process in Organizational Culture	15.51	6
Develop the Controls of Transferee on Technology during the Transfer	15.40	6
Supportive Institutes in management, financial and planning	14.64	6
Investments in Technology Developing	14.53	7

Commercial status of the country	13.67	8
Competitors	13.48	9
Industrial Status of the country	12.99	10
Competitive Capability of the Company	12.86	11
Integration Capability of the Transferred Technology with Existent	12.17	12
Access to Internal and External Financial Resources	11.90	13
Universities and Training Institutes	11.01	14
Proportion of the Tacit and Explicit of the Technology Knowledge	10.73	14
Informative organizations	10.71	14
The Position of the Company in its Lifecycle	9.00	15
Technical Workshops	7.67	16
The Position of the Transferred Technology in its Lifecycle	7.33	16
Engineering and Consulting Centers	7.09	16

Analysis shows that the technical infrastructure of the company, enhancing the human resources within the company and political support in the government group are the three most important factors in technology localization. Technical workshop and engineering and consulting centers also are the least important according to the survey. The tests also confirmed that there are significant differences between factors and they do not overlap. These tests assists the researchers to compare the common factors with the impact factors in models studied.

#### VI. SUGGESTED TECHNOLOGY TRANSFER METHODS FOR LOCALIZATION

Different factors are important in selecting the appropriate technology transfer method associated with the models presented. Since the methods studied are focused on technology and market, common factors were compared for these two critical factors. The factors could prompt the companies to choose the best approach and should be aligned with the existent situations and priorities to achieve the technology. For this purpose, we select the common factors among the localization factors and the three models studied, shown in Table IV.

TABLE IV  
IMPACT FACTORS OF LOCALIZATION IN CONTRAST TO FACTORS OF CHIESA, FORD AND ROBERT & BERRY MODELS

	Localization Factors	Chiesa Model Factors	Ford Model Factors	Robert & Berry Model Factors
Technology	Proportion of the Tacit and Explicit of the Technology Knowledge	Familiarity with Technology		Familiarity with technology
	The Position of the Transferred Technology in its Lifecycle	Technology life cycle	The position of technology in its lifecycle	
	Integration Capability of the Transferred Technology with Existent Technologies	Size or Power		
	Investments in Technology Developing	Assets Specialization / Investment		
Market	Analyzing the Internal and External Technology Market			Familiarity with market
	Presenting the Technology to Market	Familiarity with market		
	Competitive Capability of the Company	Relevance for competitive advantage	Competitive advantage of technology	

Comparing the factors drives us to identify the methods that are suggested in the three models studied. The proposed methods that focus on technology and market-related factors are indicated in Table V. The method is completely dependent upon the position of a company in different areas. In this comparison the joint venture is suggested as a common method by all three models.

TABLE V  
IMPACT FACTORS OF LOCALIZATION IN CONTRAST TO FACTORS OF  
CHIESA, FORD AND ROBERT & BERRY MODEL

	<b>Chiesa Model Methods</b>	<b>Ford Model Methods</b>	<b>Robert &amp; Berry Model Methods</b>
<b>Technology</b>	Joint Ventures- Alliances- Acquisition - Outsourcing- Merger- Minority Equity	Joint Venture- Outsourcing- Licensing- Purchasing	Joint venture- Acquisition- Licensing- Equity investment/ Minor Equity
<b>Market</b>	Joint Venture- Alliances- Acquisition	Joint Venture- Outsourcing- Licensing- Purchasing	Joint venture- Acquisition- Licensing- Equity investment/ Minor Equity

## VII. CONCLUSION

Technology transfer is a known method to achieve technology in companies. Companies need to select the appropriate method that best fits their current position for future development. However, they should enhance their technical infrastructure and capabilities to be prepared for technology transfer. In the absence of required facilities and skilled human resources, companies cannot benefit from the technology transfer. To achieve the further innovation of technology and new products, companies need to focus on many factors distributed within the company, markets, institutes and government policies in order to ensure a successful technology transfer.

Localization of technology within the industry assists the company to be certain of technology absorption, which enables it to experience future development. In this paper, we have identified the localization factors within the technology transfer processes and have used them to select the proper technology transfer method. Since the different methods follow the specific factors, we have aimed to provide an outline by comparing localization factors with the impact factors for selecting the technology transfer method. This could help the companies to choose the appropriate mechanism based on their short term and long-term goals in addition to the primary aim of technology localization. Since limited models were studied in this paper, it could be valuable to find the various models of technology transfer in order to compare them with these localization factors in a detailed analysis in future studies.

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