MEASURING AND ANALYZING SUCCESS OF TECHNOLOGY TRANSFER IN IRANIAN RUBBER INDUSTRY AND PRIORITIZING TECHNOLOGY TRANSFER PHASES USING AHP

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ABSTRACT

One of the problems in industries of developing countries is lack of effectiveness of the Rubber transferred imported technology. The main factor of this issue is lack of passing total phases of technology transfer or lack of using appropriate technology transfer method. Today in the developing companies and countries, various methods are used in order to reduce gap to developed countries in innovation and creating competitive advantage. One of them is transferring new technologies through which they can reduce this gap considering speed of industrial countries. Technology transfer is possible through various methods, which is determined considering situation of the technology transferee and receiver. Technology transfer includes 6 main phases. Commercialization of the transferred technology is achieved if all phases are completed successfully. In this work, it is attempted to investigate success of technology transfer projects in Yazd Rubber industry (Yazd Tire), 6 phases of technology transfer will be prioritized in this company using AHP(Analytical Hierarchy Process) model and some recommendations are given for improvement.

KEYWORDS: Technology, Technology Transfer, Technology Transfer Process, AHP

The developing country can achieve the technology by passing technology transfer process. However, the important point is that perfect and successful transfer of the technology occurs when all phases of technology transfer process are passed perfectly and successfully. Also, by comprehensive evaluations it is possible to select the best technology transfer method which is compatible to the receiver country so that it leads to knowledge transfer to the receiver country’s institutions.

REVIEW OF LITERATURE

Technology can be defined as all knowledge, processes, tools, methods and systems used in construction of the products and services. In other words, technology is the way of implementing and a tool which we can achieve the goals using it. also, technology transfer according to NASA is applied to process which in which it is possible to utilize technology of one organization (or country) which is compatible to developed organization (or country) in the other organization (or country) with other goals (Khalil, 2000).

Technology transfer the trend of systematic transfer of information related to product producer, technical application of products and offering services. Technology transfer channel refers to two aspects: foreign technology imports, and application of domestic technology. Through foreign technology, economic institutions in developing countries can recue research and development risk and shorten distance to developed countries (Li, Wei, 2012).

Sexton (1992) defines knowledge transfer as a path of knowledge and technology which is focused on ideas and results of research from the organization, flourishing user organization and initiation of technological cooperation. Technology transfer in both approaches includes achievement of innovation from an external source and sharing technical knowledge for the products or processes (Park, Lee, 2011).

Process model of technology transfer includes 6 main phases (Radfar, 2008):

Phase I: Selection and Acquisition of technology: technology selection process and contracting and negotiating for the acquisition of existing technologies

Phase II: Adaptation of Imported technology: a process of close link between imported technology and resource needs and conditions of the country

Phase III: Absorption of Imported technology: process full awareness of the receiver toward all components of the received technology.

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Phase IV: Application of technology transfer: The process of using technology

Phase V: Imported Technology Development: the process during which, using acquired technology, the knowledge of adaptation, assimilation and application, experience, skills and internal research findings, technologies for better and new processes and products are developed.

Phase VI: Diffusion of Imported Technology: The process of deepening and expanding acquired technology component at the organizational and national level.

Table 1 suggests several models for technology transfer and their features. Of course, these models emphasize on specific aspects of transfer mechanism. It is clear selection of a specific model or combination of available models depends on such factors as respective industry, conditions of technology receiver, etc.

<table>
<thead>
<tr>
<th>Table 1: Technology transfer models</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model Title</strong></td>
</tr>
<tr>
<td>general model of technology transfer</td>
</tr>
<tr>
<td>(R. Phoal 2001)</td>
</tr>
<tr>
<td>Tenkasi&amp;Mohraman models</td>
</tr>
<tr>
<td>(Tenkasi&amp;Mohraman 1995)</td>
</tr>
<tr>
<td>conceptual model for technology transfer (Johnson, Foster &amp; Satchwell)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>model of university-industry interaction (Industry &amp; University Interaction Model)</td>
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</tbody>
</table>
Center for Technology Transfer is the best means of establishing this relationship which are conducted at the University and can be used in industry research and innovation

4 – Researchers should be aware of the technical opportunities in the industry that are effective in promoting research

5 - Center for Technology Transfer as a link between the two sections should:
Continue to communicate with the industry to get familiar its problems
Provide direct technical services to facilitate the development in industry and solve technology needs by communication with industry executives
Provide advisory assistance to the industry and finding different partners for new projects
Assess ongoing research projects and ensure efficiency and updating them to optimize future product and its commercialization

### Rutten&Hayami Model (Rutten&Hayami Model 2001)

According to these authors, technology transfer is done in three phases: 1. Transferring products of technology such as machineries, tools and techniques for using it, 2. Transferring design and maps including transfer of maps and oxalis for using transferred technology, 3. Transfer of technical knowledge.

Emphasis of the authors is on the phase of technical knowledge transfer of the technology. That is, the phase in which the receiver should acquire knowledge of new technology designing and building from the technology owner. The main obstacle in effective technology transfer is often in this phase for different reasons.

### Malik Model (Malik Model 2002)

In this model, technology transfer is similar to sending a message and success of its effective transfer depends on the mutual understanding and message receiver and sender.

The model emphasis on the point that the transfer is effective if both parties’ play role in effectives of the message both in terms of expertise (technology level) and motivation aspect.

### General model of technology transfer to developing countries (Moor 1999)

In this model, 6 main activities are considered for technology transfer:
- Acquiring forms of technology transfer as goods or product such as machineries, tools, maps or mere information which are necessary for optimal use of product.
- Technology application areas
- Technology transfer types
- Technology transfer ways
- Effective factors (all environmental characteristics and technology gap between receiver and sender)
- Technology inference (technology transfer, that is, cultural, political, etc. differences)

The model emphasizes on the point that technology transfer is a mutual process. For its effectiveness, both parties should reach to the interests and goals and both parties’ values should be supported.

### Canadian International Development Agency model for technology transfer (Canadian International Development Agency 2004)

In this model, after technology transfer, the organization continuously continues its relationship with the market in order to get familiar with the customer need. In this interaction, the institution acquires technological capabilities after acquiring software and hardware sectors of technology and market feedbacks.

1 - The proposed model is specifically focused on industrial processes

2 – The model emphasizes need to be familiar with the customer and performing customer changes in technology

3 - This model is shaped with its emphasis on market-oriented approach

4 – The model is surrounded by macro factors influencing the whole process such as cultural, social and technological factors
**Effective technology transfer model**

The customer is in the center of this model and it is surrounded by technology transfer phase to market. These phases include: marketing sale, implementation and follow-up, good communication with the customers (market) is important in this model.

**general model of technology transfer (R. Phoal 2001)**

Evaluate, identify and select technology

Choosing the appropriate method or methods.

Negotiating and drafting contracts and final negotiations

Technology acquisition

Adaptation and assimilation and naturalization

Development and Innovation

Release

The model focuses on the following five steps in process of technology transfer:

1. Technology determination
2. Selecting Technology
3. Absorption of technology
4. Application of Technology
5. Development of technology

**RESEARCH GOALS AND QUESTIONS**

Current work aims at investigating success of technology transfer in Yazd tire industry.

**A. Research Questions**

1. To what extent technology transfer process phases is successful in Yazd tire industry and how I gap in each of technology transfer process phases?

2. How technology transfer process phases are prioritized in Yazd tire industry?

What are strategies for improvement in compensating current gap and its application in future projects of technology transfer in Yazd tire industry?

**RESEARCHMODEL**

Fig 1 shows conceptual model of technology transfer, which is basis for this research.

**Figure 1: Conceptual process model of technology transfer**

**METHODOLOGY**

This research is an applied research study and considering presence in organization and obtaining information from inside organization using questionnaire for collecting data from experts, it is field study. Since this research was conducted in Yazd Tire Co., it is a case study.

On the other hand, considering limit number of experts, total counting method was used and experts were
weighted based on skill, knowledge, and experience of them.

Considering technology transfer process model, indexes of the questionnaire were designed. Validity of the questionnaire was confirmed by experts and its reliability was confirmed using Cronbach's alpha test (0.92).

STATISTICAL POPULATION

Yazd Tire Co. was established in 1985 with the aim of establishing a factory for producing types of tire for bicycle, motorcycle, automobile and pickup. It is located in Yazd city near to its industrial town in an area of 40 hectares. In recent years, considering new needs of market and change in type and size of tires of imported and manufactured cars, production of wired radial tires was put at the top of strategic programs of the company and first phase of wired radial tires project was initiated in 2005 with capacity of 7000 tons per year.

In wired radial tire sectors, technical knowledge was taken from Netherlands Verdestein Company with a contract and related machineries were bought from reliable European sources. The products are under license of Netherlands Verdestein Co.

Technology transfer of tire and tube of bicycle and motorcycle was done officially in the form of a mutual contract with IRC Co. of Japan, and products were provided for the users according to Japan’s JIS standard.

In order to produce truck and pickup tires, technical knowledge in Kian Tire Co. was used.

Educational level ad working experience of the subjects is given in Table 2 considering their weighting.

<table>
<thead>
<tr>
<th>Education</th>
<th>Working experience</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>MA</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>PhD</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Sum</td>
<td>17.3</td>
<td>32</td>
</tr>
</tbody>
</table>

FINDINGS

Findings for Q1

Status of technology transfer process phases and its gap to optimal level (100% or maximum score of measurement tool) is specified according Table 3. The lowest gap was related to selection and acquisition phase with 7.64 percent and highest gap was in release phase with 40.36 percent.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Current status success (%)</th>
<th>Gap to optimal level (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection &amp; acquisition</td>
<td>92.36</td>
<td>7.64</td>
</tr>
<tr>
<td>Adaptation</td>
<td>90.54</td>
<td>9.46</td>
</tr>
<tr>
<td>Absorption</td>
<td>88.96</td>
<td>11.04</td>
</tr>
<tr>
<td>Application</td>
<td>90.56</td>
<td>9.44</td>
</tr>
<tr>
<td>Development</td>
<td>87.38</td>
<td>12.62</td>
</tr>
<tr>
<td>Diffusion</td>
<td>59.64</td>
<td>40.36</td>
</tr>
<tr>
<td>Total Average</td>
<td>86.53</td>
<td>13.47</td>
</tr>
</tbody>
</table>

Diagram 1: Status of technology transfer process phases in Yazd tire industry

Diagram 2: Prioritization of technology transfer phases with AHP
Findings for Q2

In order to answer Q2, pair wise comparison and AHP method was used. In this method, priority of the phases is specified. For obtaining pair wise comparison matrix, idea of the related managers and experts were taken from AHP questionnaires. Collected data were analyzed by Expert Choice and technology transfer phases were prioritized according diagram 2.

Findings for Q3

Strategies for improvement in technology transfer process phases considering the gap are suggested as follows:

Selection and acquisition phase:

Considering the highest gap of this phase is related to indexes of utilizing consulting organizations and consistency of goals and strategies with transferred technology, it is recommended the company shows more sensitivity in consistency of goals and strategies with technology transfer process and use more consulting organizations.

Adaptation phase:

Considering highest gap of this phase is related to indexes of designing and reorganization appropriate to imported technology and modification and changes in production methods with transferred technology, it is recommended the company attempts more in adaptation of structure and processes proportionate to the transferred technology and also more adaptation in change in production and construction methods appropriate to imported technology.

Absorption phase:

Considering that highest gap in this phase is related to indexes of internal and external training and use of research organizations in absorption and application of technology, it is suggested the company uses consistent educational planning appropriate to imported technology and uses universities and research organizations more for absorbing and optimal application of transferred technology.

Improvement and development phase:

Considering the highest gap in this phase is related to indexes of lifecycle curve of transferred technology and customer feedbacks, it is suggested the company shows more sensitivity to changes in transferred technology and its updating and use costumer feedbacks for promoting transferred technology.

Diffusion phase:

Considering the highest gap in this phase is related to indexes of transferring technology achievements to other countries and its dissemination in journals and conferences, it is suggested the company enjoys patent of its transfer and release to other companies and countries in making future contracts for technology transfer.

RESULTS

Results show that

- The highest index score in selection and acquisition phase is related to index of evaluating suppliers’ network and supply chain and lowest score was in release phase for technology transfer to other countries. It should be noted low level of this index is due to type of contract and limitation of technology transfer to other countries by the contractor country. Lowest index score in selection and acquisition phase was related to use of consulting organizations.
- In adaptation phase, highest index score was related to making prototype and modifications and lowest score was related to index of reorganization appropriate to technology.
- In the absorption phase, highest index score was for accurate investigation of received documents and lowest index score was related to use of research organizations in technology application.
- In application phase, highest index score is related to production and commercialization of product with imported technology and lowest score was related to index of using managerial structures appropriate to imported technology and identification of available market.
- In development and improvement phase, the highest index score is for commercialization of product produced with improved technology and lowest index score was for use of customer feedbacks in product improvement.
- In release phase, highest score is related to index of providing findings related to technology transfer to research centers and universities and lowest score is related to type of contract and limitation of technology transfer to other countries.
• Considering Table 3, in the whole technology transfer process, highest score is related to selection and acquisition phase (92.36%) and lowest scores is for release phase (59.64%). Findings of diagram 1 shows asymmetry in release phase compared to other phases.

• According to prioritization of technology transfer phases with AHP in Diagram 2, selection and acquisition phase has the highest priority and development phase has the lowest priority in technology transfer process in Yazd tire industry.

REFERENCES


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