

Evaluating the success of the technology transfer process and determining the best case study method

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Abstract

Technology in today's world is an important factor affecting the development of countries and hence, developing countries are seeking to transfer technology from developed countries. Accordingly, technology transfer can be considered as a very important process in the acquisition of technology that requires prerequisites for its proper operation. Among these prerequisites is choosing the best method of transfer. In this regard, the present review study is conducted aimed at studying and evaluating the success of the technology transfer process and determining the best method. Based on the findings, it can be concluded that the selection of the appropriate method is effective on the rate of technology transfer success; also, criteria such as development, adaptation, dissemination, and application of technology can be considered to measure the success of technology transfer.

Keywords: Technology Transfer Centers, Technology Development, Technology Transfer, Transportation Industry

1-INTRODUCTION

As a major competitive advantage among companies, success in today's world is clearly dependent on the use of technology (Belderbos & Wakasugi, 2008). Technology is an important element in raising a country's technology level and the process of achieving it is a complex and difficult process that without proper study, not only is it not useful, but it may also lead to a loss of national technology in addition to wasting time and money. Industrialization is highly dependent on technology transfer (Henry et al, 2009). On the other hand, inappropriate technology selection has irrecoverable consequences. Technology selection is thus a key issue in technology transfer decisions. Having a broad image of the future horizons is needed to be able to optimally manage technology. Technology transfer is one of the areas of technology management practice that entails this holism and foresight. Technology transfer is the way in which technology or machinery technology is transferred from one company to another, and the technology recipient may be in the same country or other countries (Belderbos & Wakasugi, 2008)

As the technology level of the advanced countries is significantly far from the third world, technology transfer is an indispensable necessity to reduce the technology gap between advanced and less developed countries. In today's world, the competitive advantage of a country depends more on its technological competitive advantage than on its natural resources, industrial equipment and available manpower (Lee et al, 2010).

Because it promotes sustainable product design quality, technology transfer is of great importance. Also, since successful and good transfer leads to development while unsuccessful, non-technical and unstudied transfer leads to failure, loss, and failure, it is a very important and technical issue (Henry et al, 2009).

As developing countries usually import technologies from technology providers, their success is conditioned by the effective transfer of technology. Considering the

implicit and unique aspects of technology, it is necessary to localize and adjust at least the specific local needs. In case of the ability to recognize technology entry opportunities, the capacity to search for and select appropriate technologies, and the ability to adapt to local conditions and the ability to refine and modify technologies, and technical know-how to produce new processes and products in less developed countries, these countries can get advanced and use them more effectively (Shan & Jolly, 2010). Success in technology transfer is one of the most important goals of activities in developing countries that require careful planning and selection. Due to the desire to acquire new technology in developing countries, careful consideration should be given to the method of technology transfer to avoid failure (Lee et al, 2010, Ahamadzadegan et al, 2015). However, because there are no specific strategies for technology transfer and ultimately development in developing countries, what can be seen in these countries is the poor state of technology transfer such that this process involves nothing but technological dependency and slowing the mobility and dynamic power of industries (Henry et al, 2009). Consequently, the success rate of technology transfer is important, and accordingly, the present study aimed to evaluate the success of the technology transfer process and determine the best case study method.

2. LITERATURE REVIEW TECHNOLOGY

The technology literally means the discourse about the way things are gained (Henry et al, 2009). Several definitions are provided for technology:

Technology is the set of knowledge, products, processes, tools, methods, structures, and systems used to create added value in a system (Henry et al, 2009).

Technology can be defined as all the knowledge, goods, processes, tools, methods and systems used to create and construct goods and provide services.

Technology is our way of doing things; a tool by which goals can be achieved, the practical implementation of knowledge, and a tool that comes with the help of human effort. According to Porter (1985), technology, from an economic perspective, is a factor in converting inputs into outputs that results in competitive advantage (Malik & Hattasingh, 2013).

Technology is the knowledge of the system for doing an action.

Technology is the knowledge of how to create useful objects.

Technology is technically the knowledge, skills, techniques, tools, machines, tools and products (Belderbos & Wakasugi, 2008).

Technology is the knowledge that the technology developer makes available to the recipient, to use limited and valuable resources to build goods and provide better services (Ali et al. 2012).

The importance of technology

As technology can increase productivity and efficiency in all areas technology is the key to any development based on the experience of successful developing countries.

In this competitive world, with scarce resources and population growth, we will face many problems if we do not have the technology to manage it well. Technology management makes it possible to gain competitive advantage in the market (Belderbos & Wakasugi, 2008). Floyd (1996) knows technology an important thing for two main reasons:

1. Technology is the basis of business success, product production and many services, and it is not possible to gain a competitive position without effective use of technology. Therefore, technology is a key driver of product differentiation and cost reduction, new business opportunities or threats to replace, facilitate, and support strategic change.
2. Technology-centric innovations are the only way for the long-term growth and development of industry and economics, and technology application management is essential for long-term planning and policymaking.

Successful governments and industries around the world have realized that the future belongs to them in case of the effective use of science and technology to increase their efficiency and competitiveness in global markets. Therefore, the strategies and actions of an organization for the absorption, adaptation, and development of technology form the core of the organization in this process, and it is undoubtedly the basis for success and continuous development if an organization can systematically guide this process. And can hope for survival in today's competitive and turbulent market (Zhang et al, 2013 , Ahmadzadegan et al, 2015).

3. TECHNOLOGY TRANSFER

The technology transfer issue also falls under the category of technology phenomenon which is one of the most important and highly technical issues because successful and good transfers lead to development while unsuccessful, untechnical and unstudied transfers leading to failures and losses. What can be observed in

developing countries is the poor state of technology transfer and the excessive diversity of technology. Because there are no specific strategies for technology transfer and ultimately development in these countries, this process does not have the dynamic power for industries and only causes technological dependency and slowing of mobility (Omar et al, 2011).

The technology transfer conceptually involves selecting the appropriate method and then transferring the technology using the chosen method, and finally, obtaining appropriate information from the technology transferred to modify the method or application (Lee et al, 2010).

Technology transfer is about the application and use of technology in a place other than the original place of creation. In other words, technology transfer is the process that causes moving technology from source to receiver.

Technology transfer is not only the transfer of technology in the form of explicit knowledge but also the transfer of tacit and informal knowledge. Implicit and informal knowledge represents the knowledge of each individual. Implicit knowledge transfer is a process that requires good collaboration and interaction between the entities involved in the process and makes it very difficult to manage (Nicoara, et al, 2013).

Technology transfer is a process that is necessary for one or more users to use technology widely. In other words, it is a process that shapes the flow of technology from the source to receiver. The source is the owner or possessor of knowledge that can be an individual, a company or a country and the beneficiary of such knowledge is the recipient (Belderbos & Wakasugi, 2008).

Technology transfer means the transfer of technical knowledge to meet local conditions, along with its effective absorption and dissemination within or between countries (Henry et al, 2009). Also, according to another definition, technology transfer is a process that flows technology from source to recipient. Technology Transfer is a complex issue involving legal aspects, technical complexities, financial accounting and marketing, which success depends on factors originating from other sources (Guan et al, 2006). Considering the high failure rate in technology transfer projects, identifying the success factors and their sources is one of the major challenges for success in technology transfer projects (Henry et al, 2009). Technology transfer refers to export specific technological factors from developed countries to developing countries so that developing countries can create and operate new production facilities (Belderbos & Wakasugi, 2008). As technology includes four main elements of technical, human, organizational and information, technology transfer is completely done when there is a fit between these four elements (Malik & Hattasingh, 2013).

The technology transfer approach

A) Product technology (production), which is the level of technological learning, depends on the following abilities:

- Investment capabilities

- Production capabilities
- Learning mechanisms (structures that help to raise the level of technology).

B) Transfer as a technology process

Production-related tools or devices that are related to the production of various products or include product parts. Technology transfer is a complex and difficult process that is not useful without the necessary study, but it may cause wasting capital and weakening national technology time. This process has various and continuous steps that can be divided into the following three major parts:

- Technology selection and acquisition
- Technology adaptation, application, and absorption
- Technology development and dissemination (Wang & Zhou, 2013).

Types of Technology Transfer

- 1) International Technology Transfer: at this level, technology transfers across international borders (countries), for example, from developed countries to developing countries.
- 2) Regional technology transfer: in which technology is transferred from one region to another.
- 3) Inter-industries technology transfer: in which technology is transferred from one industrial sector to another, such as the technology transfer from the military to the commercial sector.
- 4) Inter-company technology transfer: in which technology is transferred from one company to another
- 5) Intra-company technology transfer: in which technology is transferred from one location to another within a company, for example, from one branch to another (Zhang et al, 2013).

Generally, the most important ways of technology transfer are:

- 1) Foreign Direct Investment
- 2) Transfer by license
- 3) Joint venture
- 4) Key contract in hand
- 5) Reverse engineering
- 6) Recruitment of technical and scientific staff, conferences and exhibitions, the publication of papers
- 7) International trade and industrial fairs, and import of machinery and capital goods (Lee et al, 2010).

Definition and importance of measuring the technology transfer success

First introduced in 1957, technology transfer was caught the attention of researchers in the early 1960s. Following this, the transfer should be defined as the process by which imported technology is acquired so that it is not only used to produce a product, but also a ground for the creation of new technology (Omar et al, 2011).

Successful technology transfer requires identifying the industry goals, technologies needed, technological resources, methods of transmission and the factors affecting it, how to attract and develop it, and all of them require the involvement of relevant experts. Without the help of experts in the field, technology transfer is usually incomplete, inadequate, and distant from its original purpose. The transition should be seen as a process by

which imported technology is acquired not only to produce a product but also to create new technology (Malik & Hattasingh, 2013). Technology transfer equals knowledge transfer and the ability to use the information and it is realized when the recipient can use transfer technology to meet their needs (Belderbos & Wakasugi, 2008).

There are several ways to measure technology transfer success, the simplest way is the ability of the recipient company to work with technology and the ability of the company to invent new technology in a sophisticated way. Analyzing the culture of the host country can help identify the factors that motivate higher productivity of the workforce, which can increase the success of technology transfer (Malik & Hattasingh, 2013). The technology transfer process has some precautionary scales that must be addressed before considering the technology transfer model. These include awareness of the major barriers and factors required for technology transfer, knowing the failures of technology transfer in the past, and continuous search for appropriate technology (Lee et al, 2010). Efficient technology transfer requires an understanding of its method. Although many countries are transferring technology, they have failed to achieve their goals. This is due to a lack of proper understanding of the concept and methodology that leads to policies designed and implemented to achieve the goal that they do not comply with. In fact, only the surface layers of technology transfer methods in the successful countries are imitated and its deep layers are neglected that causes a mismatch between the characteristics of the technology, the methods of achieving it, and the context of the technology implementation that naturally results in unsuccessful implementation (Salauze, 2010).

All problems occur because technology is not transferred on its own, but involves political, social, economic, and cultural values that can be barriers to the technology diffusion or transfer. In addition, all innovation can face these barriers but some transferences are more affected than others. Successful technology transfer is not achieved by simply moving technology to a new environment, but rather by developing a process and infrastructure that will help technology stay away from various obstacles (Ahmed, 2009).

Technology transfer success measurement criteria

Technology Development: if the process of technology adoption, application and absorption are done correctly, it can be said that the technology transfer has been accomplished, that is, the contractor has been contractually committed, but the technology transfer process is not complete. This process will continue as new technology is created using transferable knowledge, skills, and experience. In this case, we are at the stage of technology development, that is, we have been able to create new technology tailored to the needs of society by combining technology gained with the achievements of our knowledge, skills and experience. Technology development involves the following steps:

- Designing the production of the new product
- Making a training sample

- Experimental production of the product and removing its defects
- Mass production

Technology development would not be possible without R&D institutions and cooperation with the R&D unit is necessary for technology adaptation and absorption stages, especially in the application phase. It is obvious that the technology development is not the development at the production unit level, but development in its general sense and establishment of research institutes in industrial units and educational institutions, expansion of technical and vocational education, continuous communication between industry and universities, and most importantly government commitment and interest in development, technology development will not be possible without it (Branstetter & Chen, 2006).

Technology dissemination: Technology development at the level of a firm, and even at the level of a sector, would not work without extending the entire society's science and technology structure. Technology dissemination refers to the diffusion of technology, the acquisition of acquired technology and new technologies in all its fields, including education, absorption, application, and development. Technology dissemination will take place not only to increase productivity at the society level but also to enhance the level of general knowledge and skill with regional partners beyond one's country (Branstetter & Chen, 2006).

Technology adaptation: The process of adapting technology and linking importing technology to economic and socio-economic conditions such as the ability to invest, the level of manpower skill, infrastructure facilities, weather conditions, economic goals, and policies is technology adaptation.

Using imported technology without considering the above, if possible, will certainly disrupt the regular chain of the technology transfer process, and other stages of absorption, development, and dissemination will not materialize. Modifying and adapting imported technologies will vary according to the degree of its complexity, the needs, and capabilities of the technology recipient but generally, the following actions should be taken:

- Reviewing product design and make necessary changes
- Reforming and changing in production processes and manufacturing techniques
- Adapting the buildings and facilities to production methods and volume
- Studying the organization and management needed and organizing new product modification and change

These actions may occur in the first stage of the technology transfer process, i.e. contracting or after operation (Branstetter & Chen, 2006).

Technology Application: The process of utilizing technology to produce goods and services, as well as achieving production methods and performing pre-operation activities. Design, construction, installation, and commissioning of machinery and deployment of management systems and organizations are carried out at this stage as follows:

- Necessary designs based on adapted technology
- Using management systems such as planning,
- Controlling of production and organization of manpower
- Drawing the organizational chart
- Construction, installation, and commissioning of machinery
- Exploiting the actions taken
- Product marketing and sales (Branstetter & Chen, 2006).

Technology absorption: The process of technology absorption begins with the examination of the design, installation, and commissioning of machinery, leading to the inclusion of technology at the society level so that imported technological know-how becomes part of the general knowledge and skill set of the importing country. The following basic steps must be taken to absorb technology:

- Planning for technology absorption (study of documents and training inside and outside)
- Recruitment of expert human resources
- Having a research unit or team of experts to study technology from contracting to technology utilization
- Studying similar technologies and visiting factories abroad

Of course, education in technology absorption is not about university education, but about learning the technology tricks (Branstetter & Chen, 2006).

Barriers to successful technology transfer

As desirable and necessary as it is, technology transfer is difficult and in practice, there are many obstacles. As a result, using a desirable technology transfer method can be very important. Technology transfer is a complex and difficult process, and without proper study, not only is it not useful, but it may also lead to a loss of national technology in addition to wasting time and money.

According to the studies conducted, the main barriers to effective technology transfer can include the lack of skilled human resources in technology transfer, lack of appropriate contracts, lack of research industries experience, lack of favorable relationship between industry and university, ignoring technology compliance with country or business requirements, lack of appropriate research funding in technology transfer process, lack of specific technology policies in place, lack of specific modeling and meeting country and enterprise needs in effective technology transfer (Lee et al, 2010).

Culture is also one of the affective factors that can influence the success of technology transfer. Cultural and language gaps, inadequate investment in research and development, inadequate infrastructure in developing countries, poor technical capability in developing countries, and especially in relation to technology adaptation are among barriers to successful technology transfer (Malik & Hattasingh, 2013).

There are many barriers to technology transfer in Iran, the following can be mentioned among which:

- 1) Lack of technology transfer organization
- 2) The weakness of industrial research institutes and R&D organizations
- 3) Informational weaknesses

- 4) Weak educational system
- 5) Lack of communication between industries, universities and research centers
- 6) Management (Wang & Zhou, 2013).

The Role of Governments in Successful Technology Transfer

From a macroeconomic perspective, technology transfer takes place between governments, so the first priority of decisions is for governments to determine which areas of technology are needed to achieve economic goals. Three factors must be considered for this purpose:

- 1) similarity, 2) contradiction, 3) compatibility.

Generally, technology can be achieved in three ways:

- 1) Purchasing production techniques
- 2) Transferring production techniques
- 3) Developing own techniques

Companies in developing countries pursue technology transfer to achieve three types of benefits:

- Improving the products and services quality and reducing their costs, which will make them more competitive internally and externally.
- Acquiring new products and markets that lead to the expansion of business activities.

Learning by doing, achieved by collaborating with technologically advanced foreign companies (Ferreira & Alves, 2003).

4. CASE OF STUDY

One of the problems of developing countries industries is the ineffectiveness of imported technology. The most important factor for these problems is the lack of complete technology transfer phases or the lack of proper technology transfer. Today, companies and developing countries resort a variety of methods to reduce their distance from developed countries in terms of innovation and competitive advantage. One of the most important of these methods is the transfer of new technologies through which they have been able to reduce their distance from industrialized countries to some extent due to their speed in progress. There are various ways to transfer technology, depending on the position of the technology provider and the technology receiver. However, despite the potential for opportunities, this approach has the implicit threat that if the technology is not properly selected and not transmitted correctly, it will cause irrecoverable damage (PalMBERG, 2008).

UNIDO defines the innovative technology transfer as follows: Innovative technology transfer focuses on the development of technological capabilities through technology transfer, which results in increased innovation capability. In this sense, technology transfer is defined as a long-term process whereby by gaining the capability to apply, adapt and extend technology and ultimately, the ability to increase its independence in development, design, and sale of technology, it improves its technological capabilities (Salauze, 2010). Technology transfer may be one of the solutions for the growth of the economic and industrial sectors in developed countries. However, the success of technology transfer depends largely on the proper selection of technology from the right sources.

However, the success of technology transfer may largely depend on the appropriate selection of technology from different sources (Wang & Zhou, 2013).

5. DISCUSSION AND CONCLUSION

Based on the results of previous research, it can be concluded that technology is an important factor that plays an important role in countries' and organizations' development. One of the important issues under the technology category is technology transfer. Although the successful and good transfer leads to progress, the unsuccessful and unstudied transfer can lead to failure and loss. Since in developing countries, the poor state of technology transfer and the excessive diversification of technology without regard to specific strategies for technology transfer leads to technological dependence and ultimately slows down mobility, so assessing the success rate of technology to prevent and identifying issues in this area seems important. Among the issues through which the technology transfer success can be realized are issues such as technology development, dissemination, adaptation, and application. Case study selection plays an important role in achieving the above, as the success of technology transfer can depend significantly on the appropriate technology selection from a variety of sources, and it should be noted that each method of transfer has specific features. Particularly, their application should be in accordance with different criteria and conditions. This is because technology is not transmitted on its own, but rather along with political, social, economic, and cultural issues that can influence technology transfer.

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