

Review of technology management and technology management models and the role of technology spillover in the growth of Iranian fisheries products market

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Abstract: Given that Iran is among the developing countries and has set the industrial development strategy as its top priority, this country requires massive imports of intermediate and capital goods that technology also comes with them. It is obvious that specification the dimensions of technology management and also the effects of international technology spillover resulting from the import of these goods into the country on economic growth are of great importance. Since technology, technical expertise, and human capital are considered key factors for the development of countries in recent decades, the factors affecting the increase in knowledge and technology as variables affecting the economic growth are necessary to be specially analyzed and evaluated which the objective of the present study. [Seyyed Amirmohsen Fazeli. **Review of technology management and technology management models and the role of technology spillover in the growth of Iranian fisheries products market.** *Researcher* 2014;6(5):76-83]. (ISSN: 1553-9865). <http://www.sciencepub.net/researcher>. 13

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1. Introduction

Technology is the main platforms of wealth creation and wealth encompasses a broader concept than money which can include factors such as knowledge promotion, intellectual capital, effective use of resources, preservation of natural resources, and other effective factors in improving the standard and quality of life. Technology management is the management of a system that makes it possible to create, acquires, and uses the technology and includes the responsibility that puts these activities in a way to serve humanity and customer needs.

Research, invention, and development are considered the most fundamental components of technology creation and occurrence of technological advances; But there is a more important component in the process of wealth production which the application or commercialization of technology.

In other words, an advantage of technology is achieved when the customer benefits from its results. Customer can be a person, company, or governmental agency like defense organizations, an invention that is archived on the shelf doesn't generate wealth and an idea which occurs but is not applied will have no financial returns, even if it is patented as an invention.

Technology is leading to the production of wealth when it is commercialized or applied to achieve the strategic or operational goals of an organization (Kropsu-Vehkaperä, H.2009).

Although in the topic of technology management it is believed that technology is the most important factor in wealth creation, other factors are involved in this system. For instance, capital formation and investment play an important role in economic growth.

Another effective factor in economic growth is the labor force. Social, political, and environmental considerations also affect the process of wealth production. Technology is considered the initial seed to generate wealth in technology management. This initial seed is converted into a huge tree if it is cultured properly and kept in a suitable environment. Other effective factors in the production of wealth, including capital, labor, natural resources, public policies, etc. actually provide the fertile environment and other necessities of this plant. Each of these factors has its own specialty, training, and research.

Technology management, as an interdisciplinary topic, combines the existing knowledge in all these disciplines with each other. An advanced course on technology management deals with the in-depth study of each of these factors.

Technology management has national, organizational, and individual dimensions. At national or state level (macro level), technology management helps the development of public policies. At the enterprise level (micro level), it leads to establishment and consolidation of competitive firms and helps the promotion of individuals' values in society at individual level.

1.1. Technology management at enterprise level:

National Research Council of America defines the technology management as an interdisciplinary field which is dealing with the planning, development, and implementation of technological capabilities to shape and achieve strategic and operational objectives of an organization.

Technology management is considered an interdisciplinary field because it combines the knowledge from the disciplines of sciences,

engineering, and executive management.

Technology management affects many functional parts of an organization such as research and development, design, production, marketing, finance, personnel, and public relations. This field covers both strategic and operational issues of an organization. Operational aspects deal with everyday activities of an organization and strategic aspects are focused on long-term issues.

An organization should consider both aspects. Studies have shown that most engineers and managers merely concentrate on operational aspects and short-term results and are oblivious to the strategic issues. This shortsightedness has caused them to ignore the effects of their today's measures on the future of the organization. Emphasizing on strategic goals of organization, technology management helps to eliminate these failures from the system.

For example, American industries gradually lost their competitive position against Japanese products and also the products of some other Asian countries in the 1970s and 1980s. This event affected many American organizations and made them adopt various approaches in order to help American industries and recover their competitive position. National Research Council, National Academy of Engineering, National Science Foundation, many industrial organizations, and educational institutions of the US can be cited among these organizations.

It was suggested in National Research Council report published in 1987 that the gap of knowledge and performance between engineering and sciences and also business should be changed into wealth production by bringing the technology to the market in the form of products and services.

It seemed that the relationship between technology and business had been ignored in industrial paradigms, governmental policies, and educational institutions. Educational programs in engineering and management fields and relevant structures and institutions had lost their efficiency and needed a major revision. Additionally, it was found that first-hand educational programs are required to prepare managers and engineers to deal with technological developments and influence in the global markets.

New ways of thinking about these programs and their contents have been proposed. The emergence of new specialized applications in the field of technology management is one of the achievements of this self-assessment (Dieng, R.1999).

1.2. Technology management at the national or state level:

From a macro perspective, technology management needs a more general definition as follows:

"A field of knowledge which deals with determining and implementing the required policies for the development and application of technology and nature which aims to encourage innovation, create economic growth, and promote the responsible use of technology for human welfare."

At the national level, technology management is focused on the role of public policy in advancing the science and technology and discusses the overall impact of technology on society and especially its role in sustainable economic development.

Technology management, at this level, includes issues such as the impact of technological developments on people, people's educational needs in relation to technology, the impact of technology on health and safety, and environmental outcomes of technology. Technology policies at state and organization level are actually a framework for the use of technological changes in the interest of the community and employees (Sharif, N., 1992).

1.3. Conceptual framework of technology management:

Technology management creates a link between the disciplines of science, engineering, and management. Academically, traditional disciplines in science and engineering are involved in scientific discoveries and technology creation. Traditional disciplines of management also deal with the issues of business management and economic, financial, and market discussions and also public policies (Pilkington, A., Teichert, T., 2006).

1.4. History of technology management models:

Economists since Adam Smith until now have tried to propose a model by which the factors of wealth production in a country can be identified in large scale. Adam Smith, as one of the pioneers of these efforts, has emphasized on capital in wealth production.

He has provided an analysis of this issue in his book "The Wealth of Nations". Schumpeter, another celebrity of economy, has introduced "Innovation" as an effective factor in wealth production.

In classical models of economy, economic growth is considered a function of capital and labor. Robert Solow comprehensively studies this issue. He managed to show that technology development is an important or, in other words, the most important factor in economic growth. His research on America's economy from 1909 to 1949 confirmed this claim.

He won the Nobel Prize in Economics in 1987 for this finding. Studies conducted in other countries and by other researchers indicated that technology development the most important factor of economic growth; for instance, a research by Booskin and Lao on France, Germany, Japan, and England in 1992.

These studies highlighted the importance of technology and its role in economic growth. On the other hand, competitiveness and competitive conditions made firms pursue capabilities other than financial and marketing ones; capabilities that make them more competitive in this arena. Technological capabilities gave this opportunity to them.

Technology management developed in such atmosphere in the 1980s. The impact of technology as a source of competitive advantage for manufacturing industries is now generally accepted by governments and actors of this field. Hence, understanding the technology and how to manage it has become a key issue (University of Pretoria.2006).

Table1: framework of technology management

Discipline-based knowledge	Interdisciplinary knowledge	Discipline-based knowledge
Science disciplines	Long-term strategic issues associated with technology	Accounting
Material technology	Science and technology policy	Financial
Product technology	The process of technological innovations	Management
Production or process technology	Research & Development management	Marketing
Information Technology	Research & Development infrastructures and technology developments	Economics
Environmental technology	Technological entrepreneurship and establishment of new companies	Business law
	Process and product cycle	
	Technology forecasting and planning	
	Technology Transfer (Within the firm)	
	International transfer of technology and the role of multinational companies	
	Analysis and assessment of the risk of technology	
	Economic Analysis of Technology	
	Human, social, and cultural issues related to technology	
	Education and training in technology management	
	Technology management in manufacturing industries	
	Technology management in service industries	
	Information technology and other emerging technologies	
	Construction of Marketing and Communication after the sale	
	Technological developments and organizational structure	
	Management of technical projects	
	Technology finance	
	Quality and productivity issues	
	Methodologies of Technology Management	
	Efficiency and environmental sustainability	

1.5. Various models of technology management:

1.5.1. Maureen model:

One of the oldest and still most widely recognized models that have been provided for the implementation process of technology management belongs to Maureen. The following four models as four main steps in technology management are raised:

A) Technologies identification: Technologies that are associated with the activities of the organization or the technological needs of the organization are identified in this section.

B) Technology Assessment: In this step, identified technologies are evaluated. Technology

forecasting and identification of their life cycle is also done in this step.

C) Technology improvement and development: The selected technology is acquired in this step and its development and improvement is done within the organization.

D) Optimal use: The improved and adapted technology with the organization is optimally used in this step.

2.5.1. Gregory model:

Gregory model has been regarded by many in technology management literature and many activities have been conducted around this process framework.

Gregory presented a general and five-step process in 1995. These five stages are as follows:

- A) Identification of technologies that are or can be important for business.
- B) Selection of technologies that should be supported by organization.
- C) Acquisition of technologies that have been selected
- D) Exploitation of technologies to produce benefit
- E) Protection of knowledge and expertise in products and production system

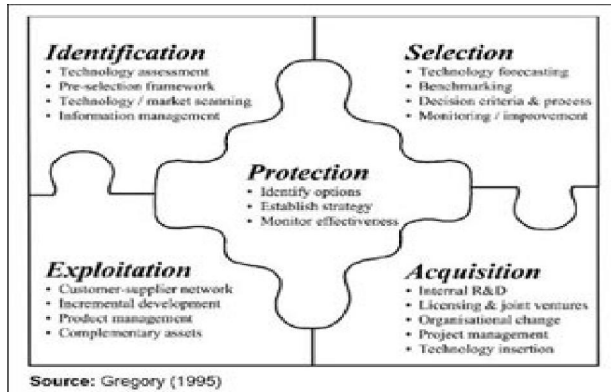


Figure 1: Gregory model

3.5.1. Fall and colleague’s model:

Fall and his colleagues used the model of Gregory and developed it by resorting to two other concepts. This model has been schematically shown in the following figure.

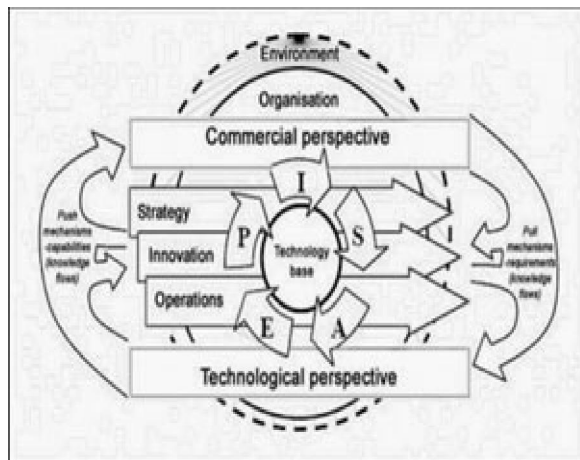


Figure 2: Technology management process of Fall and colleagues

4.5.1. These two concepts are as follows:

1.4.5.1. Difference between firm's strategy and technology strategy:

Many believe that the main duty of technology management is to integrate strategies of firm-oriented state and other firm's strategies such as performing an activity or assignment to contractors are done. The separation of these strategies in many firms reduces the effective support of strategies.

Hence, two types of commercial and technological perspectives have been proposed in fall model. These two perspectives are related to each other through the process of technology management.

2.4.5.1. Technology management process can be fit in 3 levels as follows:

A) Strategy level: This level is more associated with general and business perspective of firm and more consistent with firm's strategy. Technology identification lies at this level, although the selection and protection of technology is also partly associated with this general strategy.

B) Innovation level: This level is between the two strategy and operational levels and steps to select and protect the technology are mostly taken at this level. Some sort of selection and protection steps can be found among the innovative activities of many companies.

C) Operational level: At this level of activities of a firm which are mainly based on technological prospect and is designed under the influence of technological factors, Acquisition and utilization of technology is done. As shown in figure, this level and both commercial and strategic prospects are influenced by the organization and its environment.

D) Demand pull vs. technology push: Fall also used this concept in order to strengthen his process framework. According to this framework, demand pull that is obtained from a commercial perspective affects the technological prospect. Hence, firm's technology strategy is influenced by demand.

On the other hand, technology and technology strategy make the commercial prospect to be affected by technological prospect, and thereby technology push is created. Altogether, schematic model of fall and colleagues can properly depict the framework of technology management process in a firm.

According to this model, dialogue and interaction between commercial and technological factors in a business are emphasized in order to effectively support the technology management.

A correct technology management requires create the flow of knowledge between business and technological perspectives in the company in order to achieve an interaction between market pull and technology push.

The nature of these knowledge flows is depended both on internal and external environment. For example, Business goals, market dynamics, and

organizational culture can be mentioned in this regard (Nicholas Bloom, et.al2013).

5.5.1. Other models:

Other processes of technology management plan can be briefly described:

Wang (1993) stated that technology management process includes four steps as follows:

A) Planning: This step is done to develop the technological capabilities of an organization.

B) Identification: Key technologies for the firm and other relevant field with development are identified in this step.

C) Acquisition of identified technology: In this step, it will be determined that how the identified technology in step 2 is acquired. Technology acquisition can be done through technology purchase, construction, collaboration with other firms, etc.

D) Development of technological capabilities: A proper institutional mechanism for mobilizing and coordinating the development of technological capabilities is launched in this step. Survey and control policies of capability development are also designed in this step.

In this regard, Sament proposed the following -stage model in 1996:

A) being aware of technologies that is important to the organization

B) Technology acquisition

C) Compatibility with the organization

D) Technology promotion

E) Release of technologies that the organization should forsake them

Julie also proposed the following 5-stage model in 1997:

A) Illustration

B) Growth

C) Presentation

D) Promotion

E) Maintenance

These models are often designed in association with innovation and product development.

6.1. Technology spillover:

Technology dissemination and transfer play a central role in the process of economic development. Interaction between foreign direct investment (FDI) and technology is one of the most important and serious considerations of FDI.

Additionally, technology transfer is the dominant issue multinational companies and their relation with developing countries.

This is because that technology is considered a vital resource for economic growth, capital accumulation, trade, and even changes in organizing the social and production relations. It should be noted that technology is the fruit of activity in the field of research, development, and innovation of production

and each new technology brings benefit and advantage for the author that one of the most important of them in the field of competition is the monopoly in the ownership of technology.

However, technology owners can sell the technology to others or directly use it in production. Hence, technology transfer is now one of the most important objectives of developing countries in investment and capital transfer. Consequently, technology, information, skills, expertise, and experience that a person owns in a specific industry are transferred to other one as a recipient or applicant who lacks them.

Since the technology is in the monopoly of its owner as a valuable commodity, it cannot be simply accessed and various ways have been predicted in this regard. Foreign direct investment (FDI) is one of the important methods of technology transfer.

Technology transfer using this method is called "Technology spillover" that success or failure of the host country in obtaining the technology by using this method depends on several factors.

This article discusses this and effective factors in the process of technology spillover and finally an analytical model introducing the factors affecting the technology spillover will be proposed.

Two definitions of technology spillover are closer its goal:

1) Technology spillover is the process of technology acquisition (direct or indirect) resulting from the presence of multinational companies in the host country.

This process is usually achieved through attracting foreign investment by these companies.

2) Enjoyment of the host country from knowledge spillover and technology transfer to affiliated companies by multinational companies resulting from foreign direct investment is called "Technology spillover".

This can be achieved through many ways including the transfer of skilled labor from multinational corporations to local institutions, technical assistance, supporting the suppliers and customers, and influencing managerial behavior and managerial policies.

7.1. History of technology spillover:

Although this is rooted in human history in general sense and each type of human interaction and learning can be considered as spillover, raising this topic as currently it is and in relation to foreign direct investment goes back to the early 1960s.

Mc Dugal is the first intellectual who systematically discussed the topic of spillovers resulting from FDI.

He has analyzed the welfare effects of foreign investment. Additionally, Cordon has

mentioned the effect of FDI in optimization of desired tariffs and Keeves proposed industrial patterns and welfare issues arising from FDI.

Common goal of these studies was to identify the benefits and costs of FDI and discussed spillovers were considered as indirect effects of FDI. Effects such as the welfare state, increased government revenue, financial policy, business activities, and pay levels were discussed.

Issues were mainly analyzed from a theoretical perspective in these discussions. Since the late 1970s that this issue was also reviewed from the aspect of analytical patterns, initial analyses made it clear that entry of multinational corporations into the host country can lead to improved efficiency of local institutions optimal use of resources by elimination of monopoly creating the competition.

These studies also showed that the presence of multinational corporations (MNC) can lead to increased technology transfer and dissemination.

The followings have been introduced as the results of these studies:

1) Helping the increased efficiency by eliminating the production bottlenecks (Providing efficient methods in technical and managerial field).

2) Introduction of new technical knowledge by offering new technologies and training the workers of domestic institutions.

3) Elimination of the market monopoly and stimulation of competition which will improve the efficiency of domestic institutions.

4) Transfer of new methods for managing warehouses and quality promotion to domestic suppliers and distributors.

5) Competitive pressure from multinational corporations to local firms to increase managerial efforts and compatibility with some marketing techniques at the international level.

8.1. Empirical evidence of technology spillover:

In order to provide empirical evidence about the occurrence of technology spillover resulting from foreign direct investment, some of them are mentioned in this section:

Katz believes that foreign investment (in the 1950s) has led to important technological effects in the manufacturing sector of industries in Argentina.

He also states that technological advances have taken place not only in the affiliated institutions of multinational corporations but also domestic industries have been obliged to comply with and improve minimum standards of quality, delivery date, cost, raw materials, and intermediate goods due to pressures. Keeves, Globerman, and Bloomstorm & Persson conducted studies on Australia, Canada, and Mexico respectively and concluded that foreign investment has increased the productivity of labor of

domestic institutions of the host countries.

A large number of recent studies are also consistent with the initial analyses. For example, Wolf and Bloomstorm found that foreign investment among 1965 to 1982 caused the occurrence of spillover and improved the productivity of manufacturing industries in Mexico. This is one of the positive effects of the presence of foreign companies.

Nadiri obtained the same results in his studies on the impact of American direct investment on establishment of plants and providing the equipment of manufacturing sectors of industries in France, Germany, Japan, and England in the period 1968-1988.

He found that increased investment of multinational corporations, as a positive effect of FDI, has caused the growth of productivity of manufacturing sectors of the host countries.

However, some evidence also indicates that host countries have not always benefited from the presence of foreign investors.

For example, Harrison & Haddad concluded that foreign direct investment in the 1989-1985 periods could not lead to technology spillover in all industrial sectors of Morocco.

Bloomstorm also conducted a similar study and concluded that the presence of foreign companies in Morocco only limited to increased productivity at the levels that domestic companies were capable in and didn't lead to the transfer of new technologies to domestic industries of Morocco.

Hence, they didn't manage to observe a significant case of productivity rate growth resulting from the presence of multinational companies and concluded that technology transfer has not occurred. The presence of Thai and Indian companies to invest in shrimp culture industry of Iran can be mentioned here that neither have nor led to positive results after several years. Kenthiol & Coco stated that technology spillover may do happen in all industries.

In their studies on Mexico, they found that there is no important evidence of the occurrence of technology spillover in industries in them the ability of foreign companies in productivity and having the market share is higher. Studies of Coco, Tincity, and Zjan (1996) on Uruguay also confirm this.

In general, it can be said that the more the direct competition between foreign companies and domestic institutions is, the more the likelihood of the occurrence of technology spillover would be.

Otherwise, domestic institutions are forced to cede their market share to foreign parties.

9.1. Factors affecting technology spillover:

As it was stated in the definition, technology spillover is basically resulting from the presence of foreign investor and multinational corporations that

have a high technological, financial, research activities capability. Although this a necessary condition for the realization of technology spillover, it is not considered the sufficient condition.

Some factors are involved to achieve this goal that host countries to foreign investors should try to identify them and provide substrates necessary for their realization. But what are these factors and how they can be met?

According to studies of experts, technology spillover from multinational corporations to domestic industries and enterprises of the host country will happen if the three followings are achieved in the presence of foreign investors and multinational corporations:

- 1) Presentation of the latest manifestations of technology
- 2) Workforce learning (through circulation)
- 3) Relationship between technology owners (foreign investors) and domestic institutions

Each of the above factors is described below.

1.9.1. Presentation of the latest manifestations of technology

Providing modern and superior technologies to host countries by multinational corporations is one of the easiest ways for adaptation of the host country with new technology.

In the absence of foreign direct investment and multinational corporations, it is difficult and costly for domestic institutions to access to the information of new technologies. So, FDI makes it possible for the host country access to a set of available technologies and also provides substrates necessary for competition.

In these circumstances, the host country can access the technology of manufacturing the product by using the imitation or reverse engineering.

However, having accepted technological bases, the lack of a deep gap of technology level between the industries of the host country and multinational corporations, existence of strong research and development centers, and presence of skilled and qualified labor are considered the main requirements to do so.

It is noteworthy to say that problems such as copyright and intellectual property rights are one of the limitations in this regard.

The host country's policies can be also mentioned in relation to acquisition of new technologies which can provide the substrate for offering products with advanced technology by creating an atmosphere of competition between various multinational corporations and increasing the capabilities of domestic industries.

2.9.1. Workforce learning

As mentioned before, the role of skilled and efficient manpower in technology transfer and acquisition is undeniable.

This is true to both leading institutions in innovative technologies that have invested significantly in research and development and countries that are the follower and user of technology.

Given the competitive environment in the global business environment, training, updating, and deepening the knowledge of the workforce are of great importance. Workforce learning is done in two ways:

A) Learning through planned education like holding seminars, specialized courses, and on-the-job trainings by multinational corporations.

B) Turnover of workforce: The presence of foreign investors and multinational corporations in the economy of the host country (developing countries), given the relatively low salary levels of domestic workers compared to labor in industrialized countries, can create the adequate incentives to attract domestic labor and training the necessary skills to them.

This can lead to the acquisition of knowledge hidden in affiliated institutions to foreign investor by the host country's labor.

Consequently, the return of this trained labor to domestic institutions and industries and the use of their acquired skills can lead to technology spillover. However, some factors such as government incentive policies, motivation of work force to acquire the necessary skills and return to domestic institutions, type of technology, and terms of agreements between multinational corporations and the host country are also effective in this regard.

These cases may vary in different countries. For instance, it has been shown in studies done in 2003 that about 50% of engineers and 63% of skilled workers that were attracted to multinational corporations returned to Taiwan's domestic institutions, but this figure decreased to 16% in Kenya indicating different conditions of two countries.

This situation is frequently seen in Iran and among the Iranian professionals. Paying more salary to local staff by multinational corporations is one of the barriers to the realization of this issue which prevents the attraction of skilled workforce by domestic companies.

The host government's policy on granting financial and other facilities can be useful in this regard.

3.9.1. Relationship between technology owners (foreign investors) and domestic institutions

Vertical relationship between multinational corporations as owners of advanced and modern technology and domestic suppliers is another effective factor in technology spillover which can occur in two ways:

A) Leading vertical relationship: Due to advantages in sales and after sales service system of desired industry in the host country, Multinational Corporation finds the adequate incentive to communicate with local agencies. Establishment of this connection can underlie the transfer of advanced technical and managerial technology to local institutions.

B) Backward vertical relationship: If competitive advantages in the host country are taken into account, the relationship between domestic suppliers and multinational corporations will be considered an ideal opportunity for technology transfer in terms of learning new methods of production, management practices, increased productivity, and even access to global markets.

Cheaper labor, primary sources, the host country's incentive policies such as tax activities or granting appropriate facilities, and familiarity of domestic suppliers with the cultural and economic characteristics of the host country are positive features to develop and strengthen this relationship.

On the other hand, low technical knowledge, incompatibility with international standards, low quality, cultural problems, and shortage of skilled labor in domestic suppliers are weakening factors of vertical relationships between these institutions and multinational corporations.

However, it should be noted that if this relationship is not created and multinational corporations are willing to have a relationship with foreign suppliers, the risk of degradation and destruction will threaten the domestic industries and institutions.

This can be followed by negative economic and social consequences.

2: Discussion

Finally, according to what mentioned in this article, the importance of technology management and its dimensions in the economy and market of various industries, including aquaculture can be found.

It should be also noted that the contents of this article were mentioned according to global studies done on this topic and as developed and developing countries were involved in the range of these studies,

constituent elements of the model can be basically used for all countries with different economic diversity.

In order to use the technology management and also technology spillovers, type of industry and its role in the economy must be specified. Application of foreign investors in aquaculture must be done with planning and setting the economic priorities and also with regard to sustainable development

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