

# Commercialization of Nanotechnology in Developing Countries

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**Abstract.** During the recent years, despite the fast paces of advancements in many technologies in laboratory environments, the issue of commercialization hinders the further development of such technologies including nanotechnology. Various infrastructural, cultural, managerial, and economic factors are involved in commercialization of a research plan challenging and delaying the process of commercialization. In this paper we define commercialization, present current strategies and methods, and review the commercialization of nanotechnology. Finally, we address the current challenges in commercialization of nanotechnology in developing countries.

**Keywords:** Commercialization, Challenges in Commercialization, Nanotechnology

## 1. Introduction

Value creation is a master key to today's world. The approach to enter today's business world is technology and the master key to technology is commercialization and the value added by this process. In other words, commercialization of technology is a bridge between technology and market emphasizing the last link of value chain. Given the vast penetration of technology and focus of the national plans of developing countries on this concept, and given the key role of newly emerged technologies in creation of wealth, power, and increase in level of welfare, nanotechnology is regarded as one of the most important new technologies in these countries. The overall objective of this paper is to identify methods, strategies, and challenges in commercialization of nanotechnology.

## 2. Commercialization of technology

Commercialization is the process of turning new technologies into successful commercial products. In other words, commercialization covers a wide variety of arrays in technical, commercial, and financial areas which transform a new technology to useful products or services (Reamer et al., 2003). This process includes activities such as obtaining ideas for technology commercialization, fostering those ideas, development of technology, building up a prototype, development of the new process or optimization of the current processes, supply of product to market, promotion, and creation of new infrastructures (APCTT, 2005).

## 3. Methods of commercialization

In the literature of commercialization, two general methods are introduced for commercialization of innovative products. In one of such methods the patent for production or distribution is transferred to another person or organization, while in the other method, innovator takes the risks and responsibilities for the whole work. Other methods are variations of these two general approaches. On the other hand, Del Campo (1999) and a number of members of Management Department at Houston University, US, in their studies on this

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field, considered three methods for commercialization of academic ideas: granting patents and licenses, partnership, and startups (Del Campo et al, 1999).

#### 4. Strategies to marketing

In general, technologies are classified into two major groups based on the innovations used: evolutionary technologies and fundamental technologies. Evolutionary technologies are related to basic technologies of a company. Therefore, commercialization of products based on evolutionary technologies has lower risk compared to those based on fundamental technologies, since company has capabilities and experiences required for such commercialization. For large companies, commercialization of fundamental technologies is riskier, while smaller companies usually involve in commercialization of fundamental technologies because small companies do not have particular customers or capabilities and therefore, they can better develop new technologies for new markets (Oriakhi, 2004).

Thus, two commercialization frameworks will be described here: the technology push and the market pull. Both of which represent market entry strategies. In the technology push strategy, market requirements are secondary to technology development. The market pull approach, on the other hand, uses market requirements to drive product development and commercialization strategy, thus ensuring rapid market penetration (Walsh et al, 2002).

Based on the model developed by Walsh and his coworkers, four commercialization strategies are possible that each of them entails different levels of risks, development cost and failure potentials (Figure 1):

- Evolutionary innovations/ market pull strategies
- Evolutionary innovations/ technology push strategies
- Fundamental innovations/ market pull strategies
- Fundamental innovations/ technology strategies

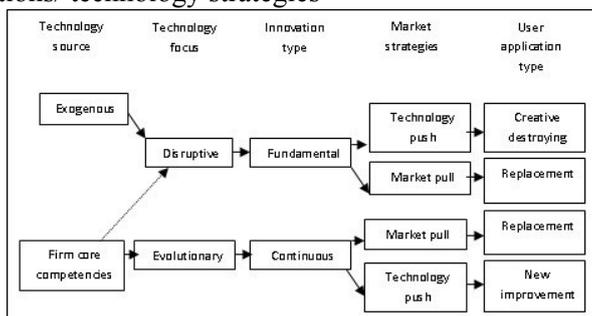


Fig. 1: Disruptive technology model (Walsh and Kirchoff, 1998)

#### 5. Nanotechnology Commercialization

The organization of this paper is to focus on issues that are specific to nanotechnology startups. The reason for this is that much commercialization of nanotechnology will be through this path. Thus, the phases of a nanotech startup are as the following:

##### 5.1. Inception

Most commercialization efforts start with taking steps to protect IP through the filing of patents. Many startups in nanotechnology get at least their initial IP from universities or by government labs. Another way that nanotech startup companies are formed is by a parent company spinning-out a business unit. The final way we see nanotech startups formed is through the independent entrepreneur who generates IP (Waitz & Bokhari, 2003). This case is not a norm and we have not seen any companies likely to make an impact which were started in this firstly manner. One of the key success factor is a strong IP position at this phase. Another success factor is a clear, concise, well thought-out and compelling business plan.

##### 5.2. Funding

There are many source of funding. The ones typically considered for a nanotech startup are: friends and family, angles, venture capitals, government and corporate partners. There are many success factors in funding. In government funding, writing a good proposal is one. For VCs having a strong "done it before

team" addressing a large market opportunity is a good start. But the one thing that seems somewhat unique to nanotechnology is the strategy of having high profile academics who have actually generated some of the IP that the company is based on (Waitz & Bokhari, 2003).

### 5.3. Growth

We have seen a few different strategies that are commonly used by nanotech startup executives to grow their companies. One is to partner with a larger corporation. Partnering can give a company access to manufacturing and sales channels, both of which are expensive to develop for a startup. Another strategy for growth is to spin off technologies from a common underlying technology. The single most important success factor in this phase is having a strong management team that has a market knowledge (Waitz & Bokhari, 2003).

### 5.4. Exit

Very few nanotech companies have had successful exits to date. This is due to a combination of the state of nanotechnology and the state of the economy. For this reason, it is difficult to talk about the success factors regarding exits for nanotech companies (Waitz & Bokhari, 2003).

## 6. Challenges in commercialization of nanotechnology in developing countries

There is no doubt that in order to facilitate the processes of development and commercialization of nanotechnology many obstacles in researches, entrepreneurship, and industries should be removed. However, it seems that some of these obstacles are more limiting than others. In addition, some of these obstacles create the others; removing such main obstacle may automatically solve other related problems. In the following section, four main obstacles are described based on the previous field research in Iran as a developing country:

### 6.1. Infrastructural issue

A major obstacle for manufacture of nano-products is lack of an organization or an institute for developing standards and issuing certificates (Shahverdi, 2007). Organizations which introduce themselves as authorities are not capable of performing these tasks (Moulayinasab, 2007). Another infrastructural problem is lack of financial resources and an appropriate mechanism for gaining public support. In general, achieving a technical knowledge or technology does not necessarily mean successful sales. For being introduced to market, technology requires public support, however an appropriate mechanism for presenting or exhibiting the technology may not exist (Shahverdi, 2007).

In addition to lack of financial resources, inadequate human resources may as well cause problems. Due to the novelty of nanotechnology, there are limited number of skilful human resources for manufacture of such products and training new resources is costly and time-consuming (Shahverdi, 2007).

Furthermore, an important requirement for commercialization of a new product in a company is a reputable brand. Well-known brands create positive attitude toward the product and this can in turn create advantages for the brand owner (Shokrieh, 2007).

On the other hand, a special legal framework is required for growth of new technologies. Patent and copy right are among factors encouraging researchers to innovate and create new products and processes (Moulayinasab, 2007). Another issue faced by industries is lack of technical knowledge or formulations for application of primary nanotechnology products in different industries such as cosmetics, hygiene, or rubber industries. Specialists believe that purposeful research projects can largely affect this and therefore, such projects should be defined based on industrial demands (Rouhbakhsh, 2007). However, due to expensive process of creation of technical knowledge and lack of reliance of industries on universities and research centers, most companies prefer to obtain their required technical knowledge from other countries (Rakhsha, 2007).

### 6.2. Managerial issues

There is no doubt that one of the fundamental issues is weak management. A form of such issue can be observed in lack of interaction between organizations to form a value chain for knowledge (Salehi Vaziri et

al, 2003). Therefore, lack of centralized management over projects as well as absence of objectives can create challenges in process of commercialization. Another managerial issue is inappropriate management of development centers and tech parks.

An important element in business administration and market analysis is business plan. Unfortunately, most new-founded companies do not have a clear, accurate, and suitable business plan or sometimes they are not even familiar with such plans. In addition, a large number of companies merely consider the short-term horizon and do not plan for far futures (Mozaffaripour et al, 2003).

Another managerial challenge is ignoring feasibility studies (Shalchian, 2007). In general, feasibility studies prepare the essential tools for formation of innovative ideas. In this regard, potential markets for each product should be identified through market analysis. In addition, resources (e.g. financial resources, skilful human resources, and experienced advisors) should be available before taking any action regarding the process of development (for ideas or products). Strong ties between industries, universities, and government can guarantee the availability of these resources (Rakhsha, 2007).

### **6.3. Cultural issues**

One of the sociocultural issues is lack of interaction between organizations. However, if we deeply investigate this issue, we can find out that opinion of an organization is largely based on opinions of an individual who does not believe in constructive interactions with other organizations or does not regard lack of interaction as an individual and organizational drawback. In the field of commercialization of technology, this concept is known as lack of constructive interaction between researcher and investor. In general, due to their inadequate understanding and knowledge of market and business affairs, researchers cannot get along with investors. On the other hand, investors, who take the high risk of investment on new products and ideas, ask researchers for more privilege. This lack of mutual understanding can largely hinder the process of commercialization (Shahverdi, 2007).

Another sociocultural issue is inadequate knowledge of consumers and negative attitude toward nanotechnology. Due to lack of information on potential of advantages of nanotechnology, some consumers do not trust nano-products and sometimes they change their mind when they see the term nano. However, if consumers are provided with adequate information on applications of nanotechnology in new products, they will simply buy it for its apparent benefits.

### **6.4. Economic issues**

Financial and credit systems are usually reluctant to invest on new technologies, due to the high risk involved and lack of an appropriate system for measurement of future capabilities of these technologies (Salehi vaziri et al, 2003). Currently, there are many investors who will to take risk; however, many of them find it more cost-effective to invest their money on low tech products or even non-productive businesses.

## **7. Conclusion**

Studies performed in this paper resulted in three findings. First, most activities for commercialization of nanotechnology projects are performed by Startups. On one hand, due to lack effective laws and regulations for supporting right of intellectual properties and absence of an appropriate framework for patent registration in developing countries, granting the ownership of intellectual properties is not an appropriate way of founding new companies. On the other hand, independent entrepreneurship is not a common method for complexity and considerable costs for nanotechnology development and patent registration. In general, challenges in commercialization of nanotechnology can be classified into the following four groups:

- Infrastructural issues
- Managerial issues
- Sociocultural issues
- Economic issues

In general, commercialization of fundamental technologies in developing countries is much riskier than evolutionary technologies. On the other hand, most of the nanotech firms in these countries are startups that adopt technology push strategies for commercialization of their nano products.

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