Model for IP Protection based on an Empirical Study of Iranian Nanotechnology Companies

Sepehr Ghazinoory†
Department of Information Technology Management, Tarbiat Modares University, Tehran, Iran

Sadegh Abedi
Department of Management and Accounting, Islamic Azad University, Qazvin Branch, Tehran, Iran

and

Behnam Mashari
Department of Industrial Engineering, Islamic Azad University, Qazvin Branch, Tehran, Iran

In spite of being a rather recent, emerging area, nanotechnology has seen a flurry of investment in both developed and developing countries. However, protection of innovation from competitors has been an area of concern and important aspect that should be included as a part of strategic plan in companies. In this study, a model is proposed for strategic protection of IP in nanotechnology companies. Accordingly, as a first step, necessary criteria along with factors affecting existing innovation preserving systems are identified and classified. The identified indices are grouped into three classes comprising organizational, environmental and innovation characteristics. A qualitative study on various businesses carried out by nanotechnology companies in Iran allowed prioritization of those indices which are effective. A decision making matrix is proposed by the authors based on two indices, namely, size of company or financial power and organizational learning capacities. An examination of the innovation preservation practices in 45 existing companies in the area of nanotechnology protection in Iran revealed that of all the proposed mechanisms of protecting innovation, only patent protection is made use of and that too to a limited extent. An evaluation of the proposed model is also carried out by studying the companies themselves.

**Keywords:** Nanotechnology, innovation protection, innovation strategy, technological innovation, company size, learning capabilities

Nanotechnology is a versatile technology which can be used effectively to develop applications in diverse areas such as economy, health, environment, education, etc. With a whole lot of manufacturing and commercial businesses venturing into this area, nanotechnology is predicted to play direct role in 15 per cent of all products throughout the world by 2014. Iran implemented its national program on nanotechnology with an aim to rank among the top 15 countries by the year 2015 (ref. 2). In order to achieve scientific and technological progress, developing new technologies, specially nanotechnology rapidly has been one of the key priorities of national policy. According to the latest information from the Iran Nanotechnology Initiative Council, out of 146 registered nanotechnology companies, 103 belong to the manufacturing sector, 11 to the commercial sector and 33 companies to the services sector. Of these, 58 per cent of the registered companies have been set up after 2006 and only 13 per cent were registered before 2000 (Table 1). This is indicative of the fact that the nanotechnology industry is still in its infancy in Iran and working out a strategy to support one’s own innovation should be a vital element in a company’s technology policy.

<table>
<thead>
<tr>
<th>Year of establishment</th>
<th>Manufacturing sector</th>
<th>Services sector</th>
<th>Commerce sector</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 2001</td>
<td>11</td>
<td>6</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>Between 2001-2006</td>
<td>28</td>
<td>13</td>
<td>2</td>
<td>43</td>
</tr>
<tr>
<td>After 2006</td>
<td>64</td>
<td>13</td>
<td>7</td>
<td>84</td>
</tr>
<tr>
<td>Total</td>
<td>103</td>
<td>32</td>
<td>11</td>
<td>146</td>
</tr>
</tbody>
</table>

Source: Iran Nanotechnology Initiative Council, 2010 (data base of 146 registered companies)

†Email: Corresponding author: ghazinoory@yahoo.com
In this context, appropriability, which is a company’s ability to control profits accruing from its innovation, is a very important concept. Generally, the appropriability of an innovation is determined by competitors since imitation would take off a large chunk of the profits of the innovator. The ease of imitating the innovation is a function of the type of technology itself and the efficiency of the mechanisms applied to protect the technology. Appropriability of innovations is very important for companies because it enables them to benefit from the profitability of the innovation in the market. Arrow has described in detail the significance and advantages of appropriation of inventions.5

Only those companies that maintain their intellectual property rights successfully protect their innovations with all their advantages. The ability to protect innovation is considered as a strategic success factor for companies which establish research and development skill for specific use.6 There have been many studies to quantitatively measure the effects of various factors to select the most appropriate protection mechanism.7

Attempts to protect industrial property in Iran dates back to 1924 when the first patents and trademark law was passed and in the recent years awareness regarding patent protection has been rising steadily.8, 9 The system of registering patents and innovations in Iran, its development plans and related policies have been discussed earlier.8,10 Iran ranked 27th in terms of patent applications filed in Europe’s patent registration office. Studies have shown that there is no special mechanism to protect innovations in nanotechnology area other than exclusive patent rights to a limited extent. Strategic planning for innovation protection by nanotechnology companies has remained a challenge. This paper, using a qualitative research, attempts to identify and classify the essential and important factors for selecting a suitable mechanism to protect innovation in the field of nanotechnology in Iran.

Theoretical Framework and Research Background

Preserving competitive superiority depends on the ability of a company to protect ideas and innovations against copying by the competitors. Various strategies for the same have been suggested in studies by Scherer,11 Geroski,12 Dosi,13 Arundel,14 and Cohen.15 Patents, industrial secrets, costs and imitation time, continuous innovation, trademarks, copyright and plans are among the most important innovation preserving mechanisms. According to many of these studies, the most important factors relating to innovation preserving systems are the type of technology and the company size. Nevertheless, there has been no study about the effects of both these factors on the process of selection of the protection mechanism. In addition, the importance of the human resource factor in the ability to own the revenues of innovation is considerable as shown in studies by Maurer and Zugelder,16 Casper and Whitley17 and Hurmelinna18 as also studies on the legislative systems in different countries15,18,19 strategic innovation factors of company18,15,20 and organizational resources.18,20,21 In one of the most important studies performed in this context, Gonzalez and Antolin22 analysed some mechanisms which are applied by companies to monopolize their innovation achievements. According to them, there are two effective classifications to select protection mechanisms in manufacturing companies, (i) characteristics of the innovative products like complexity and specificity and (ii) firm characteristics like size and human resources.

Other studies have cited R&D and learning as the two main channels of technological changes in various industries.23 There are different mechanisms to use the revenues from learning which depends on factors like capabilities of existing work force, skill level and production circulation.24 Among the mechanisms used are ‘learning-by-manufacturing’, ‘learning-by-copying’, ‘learning-by-doing’ and ‘learning by operation’ as mentioned in Argote and Epple25 and Arrow.26 However, identified variables specific to nanotechnology companies have rarely been studied before. Also, most of the research carried out has studied the effect of each identified variable independently and only at the prevailing status of that factor. The studies have not analysed the increase or decrease of that factor in the companies selected for analysis. For instance, few studies proposed the use of continuous innovation preserving mechanism in companies with a strong human resource base, but in others where the human resource team is weak, no argument or proposal was put forward.

This paper proposes a conceptual model based on identified indices which have been classified into three categories, namely, organizational characteristics, non-organizational or environmental characteristics and innovation characteristics (Fig. 1). Accordingly, the effective indicators are first prioritized using a specified methodology comprising identified factors and indices based on the nature of business of nanotech companies in Iran, to propose a suitable model.
Research Methodology

Research undertaken in the current study relates to both qualitative and quantitative aspects but limited to expert and community interviewees’ comments. The purpose is to provide a framework to choose an appropriate mechanism to protect innovation in nanotechnology companies in Iran. The literature survey is mainly from external sources like publications and Internet since the research area is relatively new to Iran and also since Persian literature in the area is inadequate. The steps followed in the study to develop the conceptual model for selection of preserving mechanism are shown in Fig. 2. The indices are derived specifically taking into consideration nanotechnology in Iran.

Identification of Decision Making Indices

In this study, the sampling method is ‘stratified sampling’ and as such nanotechnology related producer companies are divided into nine classes including, car industry, building, energy, oil & gas, medical & veterinary sciences, water & environment, agriculture, composite & paint industry, labware and textile industry. To determine the required sample number for analysis, the following formula is used:

\[
n = \frac{N \times (z_{\alpha}/2)^2 \times pq}{e^2 \times (N-1) + (z_{\alpha}/2)^2 \times pq} = \frac{85 \times (1.96)^2 \times 0.5 \times 0.5}{0.1^2 \times (84) + (1.96)^2 \times 0.5 \times 0.5} = 45
\]

Wherein error level (e) is 10 %, reliability (α) is 95 %, total population (N) is 85 and p = q = 50 %. The statistical sample selected consisted of 45 companies as listed in Table 2.

The results were collated on the basis of questionnaire response from the companies selected and interviews with experts from the Iran Nanotechnology Initiative Council. Among 45 samples only 30 were received completely filled up. Nine decision making indices were selected from a rigorous study of previous studies and were in turn clubbed under three heads: (i) organizational, (ii) environmental and (iii) innovation characteristics. According to Table 3 and based on the statistical results of the Likert spectrum scale, it is clear that the size or financial power index within a nanotechnology
company is a critical factor with an influence rate of 93% and learning capacity follows in second place with an influence rate of 86%.

The Decision Making Matrix

According to the study, the model concept is represented by nine indices which cover a wide range of areas. However, it is necessary that these indices be evaluated in areas unaffected by nanotechnology companies. Two key steps were undertaken for this: (i) prioritize the criteria for adopting innovative strategies in nanotechnology companies of Iran based on what the companies selected for study considered important indices for decision making and (ii) providing the decision matrix to the company for selecting their strategic position so that all important indices are considered. But due to the large number of indices, lack of comprehensive data for analysis of all of them, the complexity of each index in the company and keeping in mind, the proposed simplified model, only two indices, namely, size or financial power and learning capacity were examined since they were inferred to be the most effective ones as seen from Table 3. Considering that nanotechnology is a rather new area of research in Iran, the factor of learning capacity to analyse and develop technology innovation is very important.

The following matrix (Fig. 3) has been derived from the status of the two critical parameters in a company, in turn to determine the position of each company. According to the matrix, from the contrast of two identified indices, considering the range and function of each one in the existing companies in the nanotech area, it is possible to suggest four positions for companies based on which a suitable mechanism to protect innovation may be assigned specifically. Each company, considering their position in learning capacity and financial power, will be able to select one of the four developed strategies in the offered matrix (Fig. 3).

Position A: Large Size and High Learning Capacity

Wherever the size and financial power of a nanotech manufacturing company is high, it means that the company is in its growth stage. In such a case, the company would be in the position of an R & D centre and it can benefit from the innovative products that have led to its empowerment. Such companies can make huge technological strides and leave behind most of the competitors in business because of high learning capacities and low producing costs due to the large scale of manufacture.19 The companies which reduce their costs through learning effects are at an advantage when compared to potential imitators because the benefits of learning effects cannot be gained through imitation. Imitators, hence, avoid innovations of companies which use learning effects. In this case, the imitation cost and time will serve the best hurdle and facilitate preservation of innovation.

<table>
<thead>
<tr>
<th>Indices</th>
<th>Sub indices</th>
<th>Value</th>
<th>Average value</th>
<th>SD</th>
<th>Influence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human resource</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size (financial power)</td>
<td></td>
<td>245</td>
<td>8.16</td>
<td>2.01</td>
<td>81</td>
</tr>
<tr>
<td>Learning capacities</td>
<td></td>
<td>280</td>
<td>9.33</td>
<td>1.16</td>
<td>93</td>
</tr>
<tr>
<td>Competitors</td>
<td></td>
<td>265</td>
<td>8.93</td>
<td>2.13</td>
<td>89</td>
</tr>
<tr>
<td>Industrial structure</td>
<td></td>
<td>255</td>
<td>8.50</td>
<td>0.65</td>
<td>85</td>
</tr>
<tr>
<td>Legal system</td>
<td></td>
<td>244</td>
<td>8.13</td>
<td>1.76</td>
<td>81</td>
</tr>
<tr>
<td>Innovation modality</td>
<td></td>
<td>253</td>
<td>8.43</td>
<td>2.80</td>
<td>84</td>
</tr>
<tr>
<td>Kind of knowledge</td>
<td></td>
<td>198</td>
<td>6.6</td>
<td>1.15</td>
<td>66</td>
</tr>
<tr>
<td>Knowledge distance</td>
<td></td>
<td>240</td>
<td>8</td>
<td>1.90</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Knowledge distance</td>
<td>216</td>
<td>7.2</td>
<td>2.16</td>
<td>72</td>
</tr>
</tbody>
</table>

Statistical sample: 30

*Max value of a variable: 10  Min value: 1

* According to Likert spectrum scale, questionnaire was designed for gathering data of statistical sampling. In that questionnaire, minimum value of each variable was one (less effective) and maximum value was ten (highly effective).
**Position B: Large Company Size and Low Learning Capacity**

In cases where financial power and firm size are large, but the learning and absorbing capacity against competitor companies studied is low, it is inferred that the source of power is from foreign technology products and no resources are being created within the organization. The patent right system protects innovator rights against imitators legally by establishing property rights. This way the company, which owns the patent, will benefit from the monopoly. As Blind mentions, the commercial motivation for patent right is to preserve innovation against imitation. In position B, the company has both, the ability to buy newer technology under legislative protection and also create a patent portfolio if it could develop the technology with R & D. One of the usual problems in the international patent process is the high costs of application and grant and high wages for international lawyers for troubleshooting and following-up the works and the other problem is time consumption. For the firms in this position, given their high financial power, the protective mechanism should take advantage of the legal protection and exploit it to the fullest.

**Position C: Small Company Size and High Learning Capacity**

If the company size is small or it does not have high financial power, the company can use its high capacity to learn for innovation and reduce production costs. In this position, the mechanism of continuous innovation protection is suggested considering the available capabilities. Continuous innovation will keep the company in the forefront by enhanced performance leading to innovation and development before the competitors propose it. The strategy involves more rapid performance of innovation compared to the competitors in a way that when a competitor decides to imitate, a newer innovation should be ready to be offered to the market. If the innovator acquires knowledge and innovates continuously in the minimum possible time available to him, he should be able to preserve his top position in the market. Further, it would assist him to aim for better market position and market share and creation of an exclusive networking with industrial collaborators, suppliers and distributors. Continuous innovation can also be a good instrument for companies to preserve the lead time. Companies can also protect their innovations by creation of an industrial or commercial brand, considering the lower financial costs for brand registration as compared to patent protection. Brand creation and registration is a must since such companies are under constant scrutiny by competitor companies and they need to maintain the reputation of the brand and quality of their products.

**Position D: Small Company Size and Low Learning Capacity**

The fourth status in the suggested decision making matrix is a position in which the company neither has high financial power nor the requisite level of learning capacity. Considering these two identified weak points, the company can neither use the rapid innovation and production development advantages, nor the patent registration system since they cannot afford it. In this position, two mechanisms are suggested.

1. If the created innovation is based on the domestic abilities and is at the creation and formation stage, industrial secrets mechanism should be used. In this status, the company can support its intellectual property by keeping them confidential as ‘industrial or commercial secrets’ instead of disclosing legitimate information about the product or special processes. Industrial secrets basically hide information and prevent the disclosure of its critical elements outside the organization borders. Commercial secrets can involve a very wide range of confidential information such as formulas, techniques, processes, customer information of company, employees, selling strategies and so on and is used widely.

2. If the source of the innovation is due to science and technology transfer from foreign companies, the company can gain intellectual support by way of licence from the foreign side.

In the fourth position, though, it appears that it would be advantageous if the company develops the knowledge base of its human resources. In other words, the company should move to the third position in future or increase the financial and economic power which is the second position because if the company wants to preserve its current position from potential threats by the competitors. Using the industrial secrets will just provide effective protection when they are not achievable through reverse engineering which is also an alternative.

**Assigning Protection Mechanism according to the Position of Company**

To determine the status of each company analysed in this study, two indices namely, company size and learning capacity were determined for selecting the innovation protection mechanism taking into consideration the decision making matrix (Fig. 4). However, precise records for financial potency and
investment power were not available for the nanotechnology companies either from the Nanotechnology Centre of Iran or from the companies themselves. A financial range (average-low and average-high) was therefore used based on the collective agreement decision making method as assessed by the staff experts. From the 45 companies selected for study, only 30 complete questionnaires were received, and the data was used for the initial priority scheme of decision parameters. However, in the latter part, the selection innovation protection mechanism was based only on two parameters, including company size and learning capacities. This analysis included all 45 companies (irrespective of whether a complete questionnaire was submitted by them) and was based on surveys of expert staff.

In the current study, the production companies which in the proposed classification are in the average-high section of financial power, have more initial capital, have other side outputs in production, use international patent protection route and do not need governmental and expert staff support. Whereas, the companies with average-low power are relatively newer companies which cannot sustain their production without support and help from Technology Development Center or other supporting organizations and are generally in the primary stages of technology establishment. Table 4 shows the position of 45 nanotech companies under study classified according to their production sectors. It can be seen from Table 4 that almost 66% companies under study fall in the average-low size category, and just 34% of the companies have large size or in the other words high financial power.

Measuring the second index, namely, the learning capacities, is more challenging because the index is innately qualitative and for its determination, it is necessary to define the sub indices. Hence, after analysing the literature in this area, certain criteria such as research and development capacities, technology localization, amount of lab equipment and the number of patents were identified and using the expert staff views and the qualitative method of collective agreement, the following results were obtained as shown in Table 5.

From Table 5, it is evident that almost 71% of nanotech companies of Iran under study, have lower than average learning capacities since they are relatively new set-ups and just 29% of them have more than average learning and technology attraction capabilities. Position determination of the selected nanotech companies in Iran using the indices of size and learning capacities, based on the proposed suggested decision making matrix in this study, is shown in Fig. 5.

![Fig. 4 — The decision matrix for selecting protection mechanisms for nanotechnology companies in Iran](image1)

![Fig. 5 — The position of each company in the proposed matrix](image2)
Having partitioned 45 companies under study in four positions in the above decision-making matrix, it is possible to assign the most suitable protection mechanisms to each of them accordingly in the following Table 6.

### Conclusion

Nanotechnology is one of the new and strategic technology areas, which has been receiving a lot of attention from commercial and manufacturing companies. The ability to protect innovations is considered a critical factor of success for the companies which are involved in research and development of specific products. Establishing a suitable and effective innovation preservation system allows companies to effectively utilize their innovations which remains an important challenge for nanotech companies in Iran. Accordingly, this study has identified and categorized the essential factors required to select an innovation preservation mechanism. Further, a model is proposed considering the position (of the proposed four) of the nanotechnology companies in Iran according to the effective indices for selection of a suitable innovation preservation system. Each company can therefore, select one of the four proposed strategies in the suggested matrix according to its position in the learning capacity and financial power area. An examination of the data based on the action mechanism of the nanotechnology companies in the current scenario in Iran, revealed that the manufacturers do not use any specific mechanism to protect their innovation. There are just two ordinary methods used in the companies, (i) to create brands from the products and (ii) to register patents. It also revealed that of the domestic products that have applied for patents, only 40 have done so in international patent offices. The results for the selected 45 companies under study in seven work areas, were analysed in two parts. The preliminary results of the study showed that about 66% nanotech companies lie in the average-low section and only 34% of them have large size or high financial capability. Also about 71% of the Iranian nanotech companies analysed have average-low learning capacities and just 29% of them have more than average learning and technology attraction capacities. The secondary results using the suggested matrix for developing innovation preserving mechanisms concluded that: Eight companies should take up patent protection mechanism (major industry: energy), seven companies should utilize the imitation time and cost (major industry: composite and paint), 24 companies should consider holding commercial secrets (major industry: lab equipment) and finally six companies should implement the continuous innovation mechanism (major industry: agriculture). An important limitation of the study is however, that all the indicators could not be used to determine the proposed preservation mechanisms, which shall require further research.

### References