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The Use of Nano-Filtration Metaphor in Extracting Technology Strategy for Nanotechnology-Based Enterprises

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Technology strategy extraction models have been regarded as one of the most important tools for managers who are investigating new factors about firm performance and survival. This study looked into TSs of high-nanotech companies, or new technology-based firms. The environmental conditions imposed to these entrepreneurial firms separate the technology strategy development process into two parts, selection stage of TS model and adjusting stage of this model regarding to moderators, thus in this research, one of TS models has been chosen as its fundamental model for Iranian nanotechnology-based enterprises' TS. In addition, four key environmental moderators (sustainable technology development, developing country, high nanotechnology industry, and information availability) adjusting this model, have been determined. To make the understanding of TS extraction model easier for engineers and other technical people, this study presents a filtration metaphor including four main stages along with four key environmental moderators. This metaphor, which compares selective filtration process with a technology strategy extraction under environmental moderating conditions, helps to bridge the gap between managers and engineers.

Keywords: *technology strategy, Iranian nanotechnology-based enterprises, nano-filtration metaphor, developing country.*

Introduction

In an era of rapidly changing technology, intense global competition and patent system that offers incomplete protection (Goel, 1995; Balezentis & Balezentis, 2011), the need to develop and implement an internationally inclusive technology strategy is increasingly important for business success. Technology strategy (TS) is one of the most important aspects of any firm's strategic posture especially in dynamic environments such as the nanotechnology-based industry (Zahra & Bogner, 1999).

Traditional views on technology strategy have emphasized two different perspectives: hierarchical and resource-based. From the "hierarchical view", a company's competitive strategy and internal capabilities jointly determine its technological choices. The second perspective views technology as a subset of organizational resources and one of several vital strategic tools a company can use to pursue its competitive goals. Unfortunately, both perspectives are static in nature (Zahra & Bogner, 1999).

The hierarchical and resource perspectives are inadequate in today's business environment because they ignore the dynamic links that exist between company's technology and its strategy (Ubius & Alas, 2012). They also ignore the learning that occurs as the firm implements its technology and competitive strategies. Therefore, a third perspective, 'dynamic view', was presented which allows the firm to capitalize on the dynamic interplay between a firm's technological capabilities and strategic initiatives (Chiesa & Manzini, 1998).

Various models have been developed for the dynamic view but in this study, by reviewing the literature and assessing different dynamic models, finally, Chiesa's model of TS was selected as the best choice for developing countries (Ghazinoory & Farazkish, 2010).

The main aim of this study is to present a nano-filtration metaphor which can provide a fruitful vision for engineers to understand TS. The metaphor would be helpful in bridging the gap between engineers and managers. The study also focuses on the key environmental moderators that affect the selected fundamental model in research conditions. Researchers continue to disagree on the best way to conceptualize the environmental factors (Boyd *et al.*, 1993). Fortunately, the literature suggests four points that guided the design of the study about key environmental moderators. At the first point, due to the ongoing increase of knowledge and changing flows of information, the criteria for environmental sustainability cannot be set once and for all. Moreover, the development of technological knowledge can only partly be foreseen. Therefore, as is argued in this paper, flexibility in sustainable technology development is important (Knot *et al.,* 2001). Also, since environmental conditions vary significantly from one country to another, especially for developing countries (Hipkin, 2004), controls for these variations are necessary. This study accomplishes this by focusing on Iran conditions at one point in time. Moreover, the nature of the environmental conditions is inextricably linked to the kind of the industry (Smith *et al.*, 1993). To minimize the confounding effects of these variations, the present study examines the nanotechnology-based industry as a high-tech industry. In addition, the specific conditions of the nanotechnology-based firms which have distinctive differences with other high-tech firms are acknowledged. Finally, according to literature reviews, it is necessary to consider four important environmental moderators:

1. Government's Sustainable development strategies (Ghazinoory, 2005);
2. Developing countries conditions (Hipkin, 2004);
3. Nanotechnology as a high technology (Staggers *et al.*, 2008);
4. Information Availability.

In summary, the problem of the article, its aim, object, etc. can be determined using a scientific routine proposed by Snieska *et al.*, (2011). *The problem of the article:* How to help technical people working in nanotechnology area to have a better understanding of managerial issues such as technology strategy? *The importance of the problem:* Engineers who have established nanotechnology firms have a lack of proper vision about managerial issues. *The aim of the article* is to bridge the gap between engineers and managers by presenting a metaphor of nano-filtration process. *The methods of the analysis* are as follows: firstly, a comprehensive literature review was done to extract different TS models. After selecting Chiesa's model and determining 4 moderating variables, qualitative and quantitative methods (interview and questionnaire) were used.

Key Environmental Moderators imposed to Technology Strategy Extraction

This study looked into technology strategies of high-tech enterprises, or new technology-based firms. Such firms are technology-based because they exploit advanced technological knowledge developed in-house or acquired from external sources to create new technical solutions, and they are entrepreneurial because they are managed by the individual or a group of owners (Autio, 1997). Environmental conditions imposed to these entrepreneurial firms separate the technology strategy extraction process into two parts, selection stage of technology strategy model and adjusting stage of this model regarding to moderators.

Chiesa's dynamic model is one of the suitable items as the fundamental TS model for Iranian nanotechnology-based enterprises (NBEs), but it is necessary to adjust this model under environmental moderating conditions (Ghazinoory & Farazkish, 2010).

Sustainable Development Effects on Technology Strategy Extraction

Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. In fact, at the national level, not only actual economic growth but also the process of such growth is of significance. Experience has shown that through protection of environmental resources, economic development can be accelerated. However, poverty reduction programs often falter when development initiatives are not conceived and implemented in the framework of sustainability, and this issue is of greater importance for the developing countries (Ghazinoory, 2005). According to the necessity for implementing a cleaner production strategy, one of the important works on sustainable development for Iran's industries proposed a framework for the national program to promote cleaner production. Moreover, a national program for nano-technology development is one of the most important national programs in recent years (Ghazinoory & Huisingh, 2006).

Technology Strategy in Nanotechnology-based Enterprises

A number of studies have stressed the importance of organizational flexibility in high-tech firms (Berry & Taggart, 1998). In this respect, Dodgson and Rothwell (1991) argue that small firms possess considerable potential advantages over large firms because they have less organizational rigidity than large multidivisional firms, which results in an ability to facilitate effectively information and communication flows within the organization and to respond quickly to marketplace stimuli. Extensive empirical investigations by (Covin *et al.*, 1990; Bahrami & Evans, 1987) have led them to conclude that small firms operating in high-tech industries tend to have entrepreneurial management styles and structures which are characterized by informal control mechanisms, adaptability, flexibility, and open communication channels. Bahrami and Evans (1987) argue that in the high-technology arena, the time lag between decision and action is typically short. Therefore, the planning and formulation of strategy should be tightly coupled with its implementation in a dynamic feedback loop. Nanotechnology as one of the high-technologies promises significant improvements of advanced materials and manufacturing techniques, which are critical for the future competitiveness of national industries (Miyazaki & Islam, 2007). Due to the far-ranging claims that have been made about potential applications of nanotechnology, a number of serious concerns have been raised about what differences these will have in comparison with other high-technologies such as Information Technology or Biotechnology (Staggers *et al.*, 2008). At the first area of concern, nanotechnology is a highly multidisciplinary field, drawing from a number of fields such as applied physics, material science, interface and colloidal science, device physics, supramolecular chemistry, self-replicating machines and robotics, chemical engineering, mechanical engineering, biological engineering, and electrical engineering. On the other hand, other high-technologies focus on the limited fields of science and technology (Miyazaki & Islam, 2007).

Nano-Filtration Metaphor in Technology Strategy Extraction

For this research a model that represents different effects of environmental moderators was established and a survey questionnaire was prepared accordingly.

Research methodology

A sample of nanotechnology-based firms was investigated to determine the significance of moderators related to technology strategy extraction. Inasmuch as most of these companies' managers' education is related to technical fields, we decided to use an industrial general process in order to

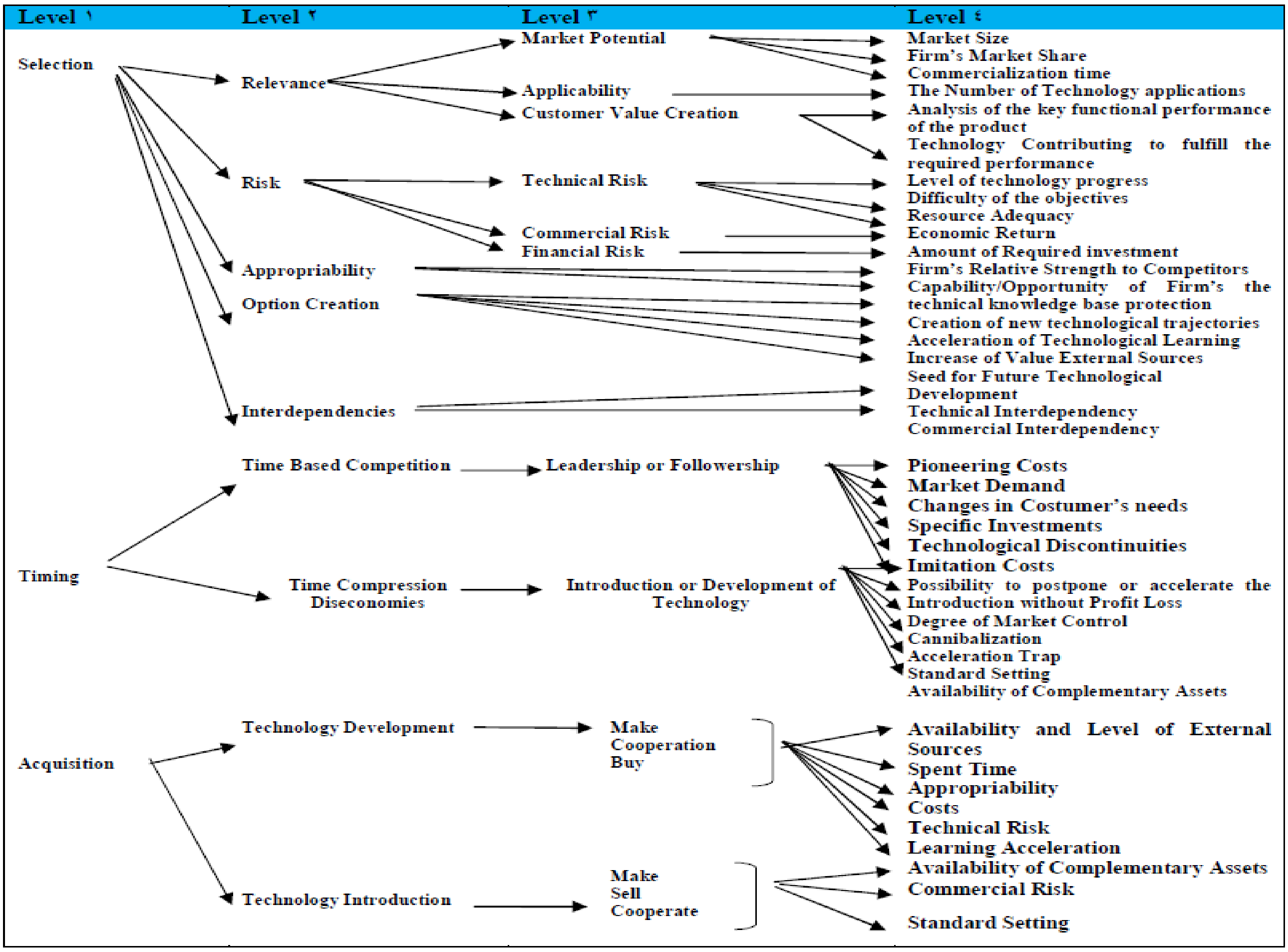

Figure 1. Levels and factors of Chiesa's tree model

clarify moderating process of TS model. One of the most popular processes in nano science and technology is a selective filtration membrane which can be applied in removing or conversing particles. The conceptual framework of this process is applied for illustrating moderating process of Chiesa's model for this research such a filtration metaphor.

Figure 2 demonstrates different stages of our research. Parallel with studying the concept of technology strategy, we scrutinized the industry of the case study. After selecting Chiesa's model and 4 moderators, we conducted a survey to improve Chiesa's model. During the process of revising the model using the results of the survey, we used the nano-filtration metaphor to explain the model to technical people.

Data were collected through a questionnaire survey of ten nano-materials enterprises listed in the 2008 INBN database[1] which contains management information on over 100 NBEs. Among a total of 50 high-tech nanotechnology-based enterprises meeting the study's criteria, nano-materials enterprises were selected because of their great background and number[2]. In this research, a combination of interviews and questionnaire surveys were used to reduce the potential for observer bias. As a result of these requirements, the methodology finally used was exploratory and standardized. It utilized a combination of a questionnaire to produce quantitative data and in-depth interviews to produce rich qualitative data, which complemented each other. In order to boost the recovery rate, interviewers first confirmed the names and titles of R&D department executives or project managers by mail or telephone, and then sent questionnaires to those individuals. The formal questionnaire was issued in January and February of 2008. A total of 65 questionnaires were sent out for senior managers of these enterprises, of which 45 were recovered with a rate-of return of 69 %. The questionnaire was developed and refined as follow: 1) Arranging forty indicators of Chiesa's TS model from its last level (fourth level), 2) Describing why these indicators must be changed for this sample according to the environmental moderators literature, and 3) a five-point Likert-type scales about the degree of respondent's agreement (1= very low, 2= low, 3= medium, 4= high and 5= very high).

Selective Filtration Membranes (SFMs)

Selective filtration processes are finding wide applications in several 'wet' industries such as water/wastewater treatment, water re-use, textile industry, dairy, etc. (Schofer *et al.*, 2005).

[1] Iranian Nanotechnology Business Network is a main department of NINI that supports Iranian nanotechnology-based companies. http://inbn.ir/PagesList.php?sub_category_id=131

[2] In order to accurate gathering and analyzing of data, it was necessary to select one of the fields of nanotechnology. In INBN database nano-materials had the greatest number and background.

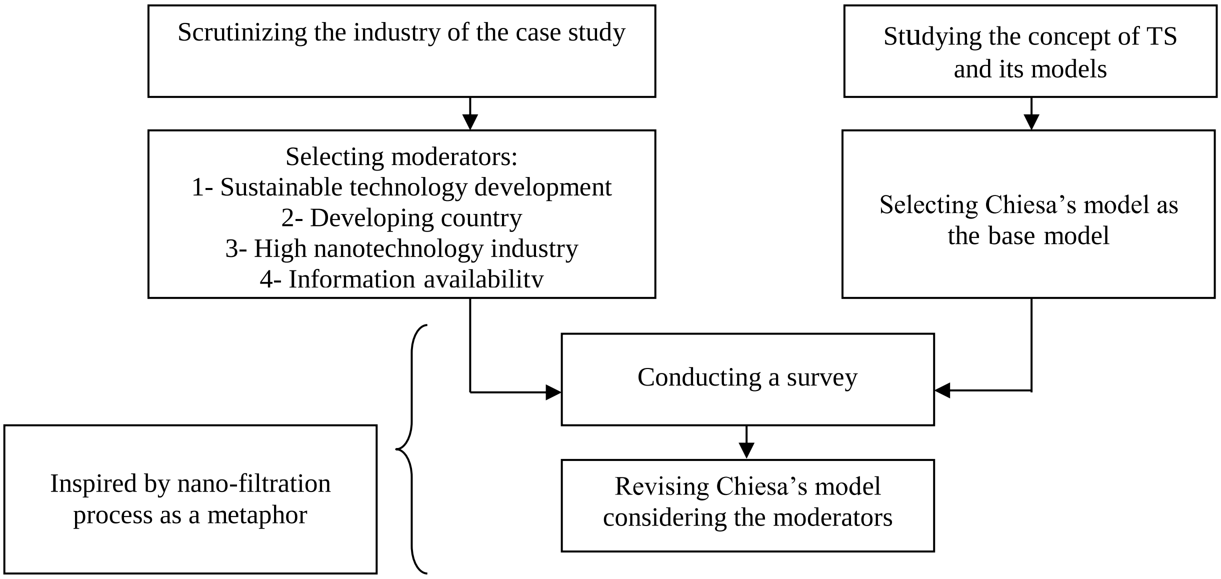

Figure 2. Research Framework

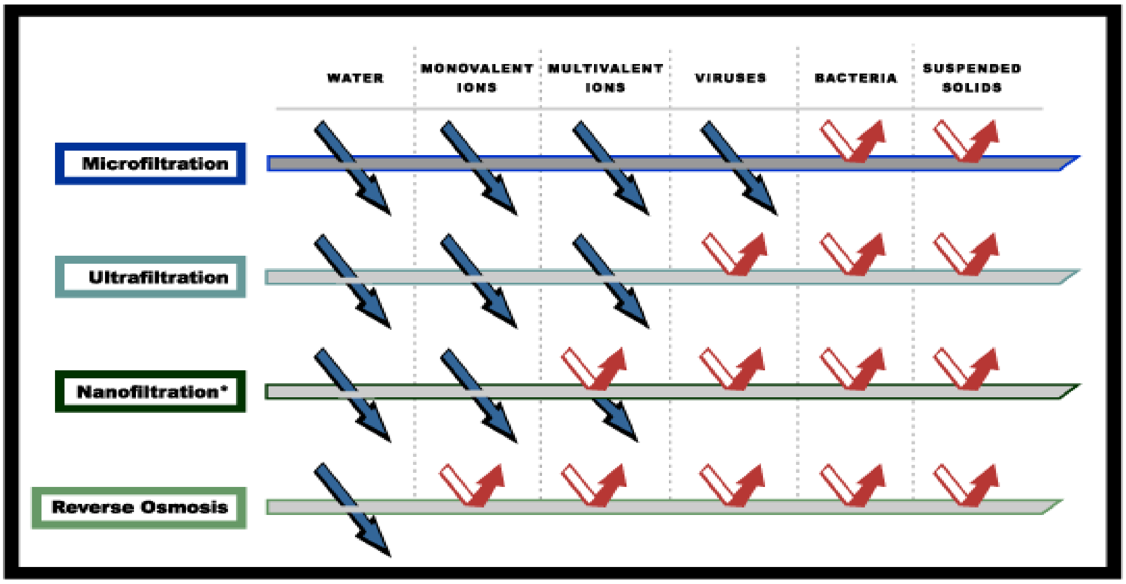

Figure 3. Selective filtration membranes (Schofer *et al.*, 2005)

Microfiltration (MF) is a low-pressure cross-flow membrane process for separating colloidal and suspended particles in the range of 0.05-10 microns. Ultrafiltration (UF) is a selective fractionation process utilizing pressures up to 145 psi (10 bar). It concentrates suspended solids and solutes of molecular weight greater than 1,000. Reverse osmosis (RO) is a high-pressure, energy-efficient technique for dewatering process streams, concentrating low-molecular-weight substances in solution, or purifying wastewater. It has the ability to concentrate all dissolved and suspended solids. Nanofiltration (NF) is a membrane liquid separation technology that is positioned between reverse osmosis and ultrafiltration. While RO can remove the smallest of solute molecules, in the range of 0.0001 micron in diameter and smaller, nanofiltration removes molecules in the 0.001 micron range. As such, nanofiltration is especially suited to treatment of well water or water from many surface supplies like rivers or lakes (Schofer *et al.*, 2005).

Use of Selective Filtration in Moderating Process of TS Model

There are some similarities (Table 1) between moderating process of TS model and selective filtration process. First, both of them include four complementary stages. Second, the sequence of these stages from general to specific items is similar. Third, their final goals are efficiency and flexibility.

Finally, we named this moderating process as Nano-filtration model of TS because of two reasons: 1) there are some strong similarities between this moderating process and selective filtration model in chemical process, and 2) this moderating process of Chiesa' TS model is devoted to NBEs, so we can separate it from other filtration stages with this name. Figure 4 shows a schematic view of final moderating process compared to selective filtration model.

Table 1

Similarities of selective filtration model and Nano filtration model of TS

Kind of Similarity	Selective Filtration Model	Nano filtration Model of TS
Application	Filtering Solutions for special applications such as water/wastewater treatment	Filtering Chiesa's technology strategy model for NBEs
Goal	High efficiency and flexibility	High efficiency and flexibility
The number of stages	4	4
First stage	Microfiltration	First moderator: Sustainable technology development
Second stage	Ultrafiltration	Second moderator: Developing country
Third stage	Nano filtration	Third moderator: Nanotechnology-based industry as a high technology industry
Fourth stage	Reverse osmosis	Fourth moderator: Information availability
Mechanism	Based on particle size: large to small	Based on moderator's importance: general to specific
Process	Multi stages	Multi stages
Results	Obtaining pure water for special applications such as food industry	Obtaining adjusted model of TS for special industries such as NBEs

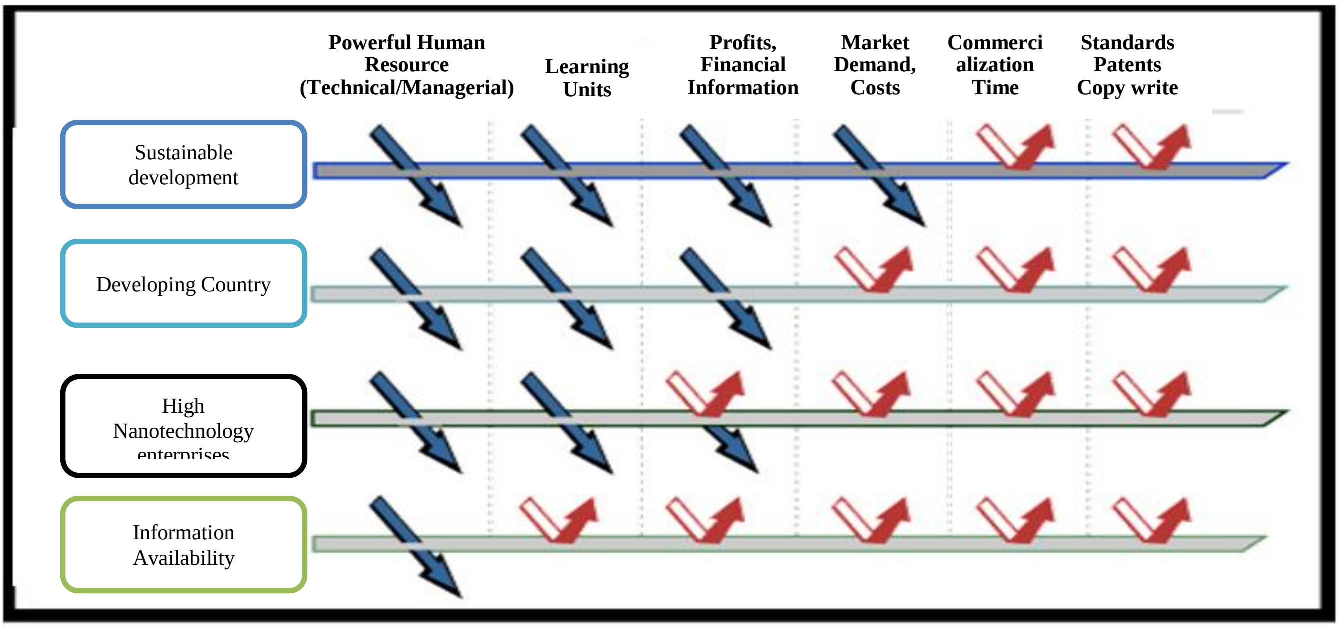

Figure 4. Filtration metaphor in technology strategy extraction

As shown in figure 4, some items are separated from each filtration stage (moderator). In fact, the selection process of omitted items is related to comparing interface parameters of indicators. For instance, the affected indicators of the first moderators – Iran as a developing country - conclude commercialization time, Capability/ Opportunity of Firm's technical knowledge base protection and Standard Setting. Iranian enterprises can't protect their technical and technological information result from the lack of strong rules in order to standard setting, patent protection and copy right protection. In addition, because of constant economic and political evolutions in a developing country, suitable estimation of commercialization time will be impossible. Thus, commercialization time and standard setting will be omitted from model's indicators and Capability/Opportunity of Firm's technical knowledge base protection will be changed, but the base of both is the lack of strong rules in order to standard setting, patent protection and copy right protection. Finally, the only key factor which remains is technical and managerial human resource. This factor can be used as a core competency for Iranian NBEs.

Results

Table 2 lists the selection dimension indicators of Chiesa's model with their proposed changes for some of the indicators using the methodology described above. In addition, it shows the degree of respondents' agreement in terms of Average percent and Standard Deviation of ideas which were determined using the questionnaire survey data. Of total nineteen factors related to the technology selection dimension, ten factors chosen for the proposed changes has been agreed. "The Capability/Opportunity of Firm's technical knowledge base protection" with an average of 89 percent has been agreed that due to its lower standard deviation, it has the highest percentage of approval. As Table 3 shows, timing dimension includes twelve indicators which are suggested according to literature on the changes of six of them. The proposed change for "Changes in Costumer's needs" is ranked as the most agreeable indicator that is followed by proposed changes of "Standard Setting". The significant point in this table is that the Standard setting factor influences both developing country and sustainable development moderators.

Table 2

The proposed changes for selection dimension

Standard Deviation	Average Percent	Proposed items	Moderator Title	Indicator
0.973	69.2 %	- Forecasting by market research centers (Chiesa, 2001). - More government investments (Lall, 1993).	High Nanotechnology	**Market Size**
Firm's Market Share				
0.981	76 %	- Continuous economic and political evolutions (Kim, 1998).	Developing Country	**Commercialization time**
The Number of Technology applications				
0.553	77.4 %	- The Type & Life of the wastes.	Sustainable Development	**Analysis of the key functional performance of the product**
1.001	69.8 %	- Role of the technology in wastes production.	Sustainable Development	**Technology Contributing to fulfil the required performance**
Level of technology progress				
				Difficulty of the objectives
0.762	82.3 %	- Resources availability for long time.	Sustainable Development	**Resource Adequacy**
Economic Return				
1.278	58.5 %	- Lack of documentation especially financial reports. - Lack of up-to-date information.	Information Availability	**Amount of Required investment**
Firm's Relative Strength to Competitors				
0.043	89 %	- Lack of copy right rules (Akubue, 2000). - Lack of patent rules and supporting organizations (Akubue, 2000).	Developing Country	**Capability/Opportunity of Firm's the technical knowledge base protection**
Creation of new technological trajectories				
0.648	61.9 %	- Inactive R&D departments. - Lack of technological documents.	Information Availability	**Acceleration of Technological Learning**
1.649	52.4 %	- Limited communications with international enterprises and organizations.	Information Availability	**Increase of Value External Sources**
1.12	79.3 %	- Environmental technologies development (Ghazinoory & Huisingh, 2006).	Sustainable Development	**Seed for Future Technological Development**

Table 3

Results of Questionnaire survey about proposed changes of Timing dimension

Standard Deviation	Average Percent	Proposed items	Moderator Title	Indicator
0.453	76.4 %	- More venture capital investments (Ghazinoory *et al.*, 2009). - Advanced computer systems (Naschie, 2006).	High Nanotechnology	**Pioneering Costs**
0.654	67.5 %	- High risk investments (Naschie, 2006). - Erratic demand (Scherer & McDonald, 1988).	High Nanotechnology	**Market Demand**
0.043	91.4 %	- High speed changes in costumer's needs (Vilkamo & Keil, 2003). - Flexibility (Berry & Taggart, 1998).	High Nanotechnology	**Changes in Costumer's needs**
				Specific Investments
				Technological Discontinuities
				Imitation Costs
				Possibility to postpone or accelerate the Introduction without Profit Loss
				Degree of Market Control
0.567	65.3 %	- Shorter life-cycle of Nano-composite products (Wilbon, 1999).	High Nanotechnology	**Cannibalization**
				Acceleration Trap
1.23	86 %	- Lack of national standard setting organizations (Akubue, 2000)	Developing Country	**Standard Setting**
0.821	84.4 %	- Advanced environmental laboratory (Staggers *et al.*, 2008). - Special instruments and tools (Staggers *et al.*, 2008).	Sustainable Development	
0.983	**76.6 %**	- **Social attitude to environmental performance of the company.**	**Sustainable Development**	**Availability of Complementary Assets**

Table 4

Results of Questionnaire survey about proposed changes of acquisition dimension

Standard Deviation	Average Percent	Proposed items	Moderator Title	Indicator
				Availability and Level of External Sources
				Spent Time
				Appropriability
0.583	78.5 %	- More costs of participation or purchase (Staggers *et al.*, 2008). - Limited resources (Barton, 1995).	High Nanotechnology	**Costs**
1.011	67.8 %	- Hazardous material risk (Ghazinoory & Kheirkhah, 2008).	Sustainable Development	**Technical Risk**
0.871	69.2 %	- Learning as a competitive factor (Hipkin, 2004). - Less technological sale or participate (Lux Research Report, 2005).	High Nanotechnology	**Learning Acceleration**
				Availability of Complementary Assets
				Commercial Risk
0.432	**85.4 %**	- **Lack of national standard setting organizations (Akubue, 2000).**	**Developing Country**	**Standard Setting**

According to Table 4, there is a nine indicators subset of technology acquisition dimension, and only three moderators affected these indicators. The proposed changes include four indicators with the highest 85.4 percent agreement on “Standard Setting” when considering the low standard deviation around the average consensus views are confirmed.

Considering the fact that the average two-thirds of respondents have agreed with the proposed changes of the model dimensions, we can design the final model according to the filtration metaphor.

Conclusions

Technology strategy extraction models receive limited coverage in the literature on key environmental conditions moderating these models. This research has identified important items in formulating NBEs’ technology strategies. These findings may be constructed as “local theory” (Patton, 1990) for Iran situation, and as a “working hypothesis, not a conclusion” (Salami & Reavill, 1997) for other developing countries. The challenge for managers lies in addressing the issues that cannot easily be controlled. Conditions will not remain static for final nano-filtration model. Therefore, the model should be verified in various conditions; nevertheless, a comparative model of technology strategy extraction for Iranian NBEs is offered. It assures the selection of an effective alternative in the process of technology strategy extraction, especially taking into consideration the final goal of a selected high-technology industry in a specific developing country about sustainable nanotechnology development.

The extraction of technology strategy as a key element of enterprises' competitive performance in developing countries has posed a fundamental challenge to research on the subject. New studies must focus on the distinctive aspects of technology strategy in those countries to define mechanisms and approaches that can be most effective in their context. This paper aimed at contributing to this debate by reviewing the literature on dynamic technology strategy models to build such a research agenda.

The proposed metaphor of this study compares four filtration stages – i.e. microfiltration, ultrafiltration, nanofiltration and reverse osmosis - to four moderating variables in TS extraction process. In addition to revising the Chiesa’s model, the metaphor provides a fruitful vision for technical people in better understanding of managerial issues. The results of this research can be completed by future research especially around applying the adjusted model for TS of nanotechnology-based enterprises. It seems that the application of Nano filtration metaphor will offer a suitable visual view for managers in these enterprises.

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Nanofiltracijos pavyzdžio panaudojimas parenkant technologijos strategiją ją taikančioms įmonėms

Santrauka

Dabartiniu metu poreikis plėtoti ir įdiegti tarptautinės apimties technologinę strategiją tampa vis svarbesniu verslo sėkmei. Technologijos strategija (TS) yra vienas iš svarbiausių bet kurios įmonės strateginio požiūrio aspektų, ypač tokioje dinamiškoje aplinkoje kaip nanotechnologijomis pagrįsta pramonė. Taigi TS panaudojimui reikalingas visapusiškas modelis, Šiame darbe, išanalizavus teorinę literatūrą ir įvertinus skirtingus dinaminius modelius, pasirinktas *Chiesa* TS modelis (*žr. 1 pav*.), kaip geriausias/tinkamiausias variantas besivystančioms šalims.

Pagrindinis šio darbo tikslas yra pateikti nanofiltracijos pavyzdį, kuris gali suteikti produktyvų požiūrį, kad inžinieriai suprastų TS. Pavyzdys būtų naudingas užpildant spragą tarp inžinierių ir vadybininkų. Darbe dėmesys taip pat sutelkiamas ir į svarbiausius aplinkos moderatorius, kurie daro įtaką pasirinktam baziniam modeliui tyrimo metu. Kad būtų galima kontroliuoti aplinkos moderatorių dinamiką, šiame darbe dėmesys sutelkiamas į sąlygas Irane per tą patį laiko momentą. Be to, siekiant minimizuoti stulbinantį aplinkos pokyčių daromą poveikį, šiame darbe nanotechnologijomis pagrįsta pramonė nagrinėjama kaip aukštųjų technologijų pramonė. Be to, taip pat yra pripažįstamos išskirtinės, nanotechnologijomis pagrįstų įmonių, kurios skiriasi nuo kitų aukštųjų technologinių įmonių, sąlygos. Taip pat, remiantis literatūros apžvalga, darbe nagrinėjami keturi svarbūs aplinkos moderatoriai, kurie parodyti 3 paveiksle. *Straipsnio problema:* Kaip padėti technikams, dirbantiems nanotechnologijų srityje, geriau suprasti tokius vadovavimo klausimus kaip technologijos strategija? *Problemos svarba:* Inžinieriams, kurie įkūrė nanotechnologijų įmones, trūksta tinkamo supratimo vadovavimo klausimais. *Straipsnio tikslas* yra užpildyti spragą tarp inžinierių ir vadybininkų, pateikiant nanofiltracijos proceso pavyzdį.

Analizės metodai: pirmiausia, norint atrinkti skirtingus TS modelius, buvo atlikta išsami literatūros apžvalga. Pasirinkus *Chiesa* modelį ir nustačius 4 moderuojančius kintamuosius, naudojami kokybinis ir kiekybinis metodai (interviu ir anketinė apklausa).

Šiam tyrimui sudaromas modelis, kuris parodo skirtingą aplinkos moderatorių įtaką ir todėl yra atliekama anketinė apklausa. Nagrinėjamas nanotechnologijomis pagrįstų įmonių atvejis. Kadangi daugumos šių kompanijų vadovų išsilavinimas yra susijęs su techninėmis sritimis, buvo nuspręsta panaudoti bendrą procesą, kad galėtume išaiškinti TS modelio moderavimo procesą. Vienas iš populiariausių procesų nanomoksle ir technologijose yra selektyvinio filtravimo membranos panaudojimas, kuris gali būti taikomas pašalinant arba apdorojant daleles. Konceptuali šio proceso struktūra yra taikoma norint pailiustruoti tokį šio tyrimo *Chiesa* modelio proceso moderavimą, kaip filtracijos pavyzdys. Duomenys buvo gauti iš dešimties nanomedžiagų įmonėse dirbančių darbuotojų, tam naudojant anketinę apklausą.

Iš 50-ies aukštųjų, nanotechnologijomis pagrįstų įmonių, atitinkančių tyrimo kriterijus, buvo pasirinktos *nanomedžiagų* įmonės, dėl jų stipraus pagrįstumo ir kiekio. Šiame tyrime, interviu ir anketinės apklausos derinys buvo naudojamas siekiant sumažinti stebėtojo šališkumą. Dėl šių reikalavimų metodika, kuri buvo panaudota, buvo tiriamoji ir standartizuota. Kaip minėta anksčiau, mes naudojome *selektyvinės filtracijos membranas* (SFM) kaip pavyzdį. Kaip parodyta 2 paveiksle, SFM sudaro keturi etapai. *Mikrofiltracija* (MF) yra žemo slėgio, skersinio srauto membranos procesas, atskiriantis koloidines ir plūduriuojančias daleles, kurių dydis 0.05-10 mikronų. Ultrafiltracija (UF) yra selektyvinis suskirstymo procesas, kuriame panaudojamas slėgis iki 145 *psi* (10 bar). Jis sukoncentruoja plūduriuojančias kietas ir ištirpusias medžiagas, kurių molekulinė masė yra didesnė nei 1,000. Atvirkštinis osmosas (RO) yra aukšto slėgio, energiją taupantis metodas vandens pašalinimo procesui, kuris koncentruoja mažos molekulinės masės medžiagas tirpale arba valo nuotekų vandenis. Nanofiltracija (NF) yra membranos skysčio atskyrimo metodas, kuris užima poziciją tarp atbulinio osmoso ir ultrafiltracijos. Pirmoje lentelėje, mes parodome kai kuriuos panašumus tarp TS, SFM ir nano-filtracijos modelio.

1 lentelė

TS atrankinės filtracijos modelio ir nanofiltracijos modelio panašumai

Panašumo rūšis	Selektyvinės filtracijos modelis	TS, Nanofiltracijos modelis
Pritaikymas	Filtruoti tirpalus tokios paskirties pritaikymui kaip vandens/nuotekų valymas.	Filtruoti *Chiesa* technologijos strategijos modelį nanotechnologijomis pagrįstoms įmonėms.
Tikslas	Aukštas efektyvumas ir lankstumas.	Aukštas efektyvumas ir lankstumas.
Etapų skaičius	4	4
Pirmas etapas	Mikrofiltracija	Pirmasis moderatorius: nuolatinis technologijos tobulinimas.
Antras etapas	Ultrafiltracija	Antrasis moderatorius: besivystanti šalis.
Trečias etapas	Nanofiltracija	Trečiasis moderatorius: nanotechnologijomis pagrįsta pramonė kaip aukštosios technologijos pramonė.
Ketvirtas etapas	Atbulinis kosmosas	Ketvirtasis moderatorius: galimybė gauti informaciją.
Mechanizmas	Pagrįstas dalelių dydžiu: nuo didelių iki mažų.	Pagrįstas moderatoriaus svarba: nuo bendro iki specifinio.
Procesas	Daugiaetapis	Daugiaetapis
Rezultatai	Gaunamas švarus vanduo tokiam specialiam pritaikymui kaip maisto pramonė.	Gaunamas pakoreguotas TS modelis tokioms specialioms pramonėms kaip nanotechnologijomis pagrįstos įmonės.

Šį moderavimo procesą mes pavadinome TS nanofiltracijos modeliu dėl dviejų priežasčių:

1) egzistuoja keli stiprūs panašumai tarp šio moderavimo proceso ir selektyvinės filtracijos modelio cheminio proceso metu;

2) šis *Chiesa* TS modelio moderavimo procesas yra skirtas nanotechnologijomis pagrįstoms įmonėms, todėl mes galime atskirti jį nuo kitų filtracijos etapų. (Galutinio moderavimo proceso scheminį vaizdą lyginant su selektyvinės filtracijos modeliu galima pamatyti straipsnio 4 paveiksle).

Kaip parodyta straipsnio 3 paveiksle, kai kurie punktai yra atskirti nuo kiekvieno filtracijos etapo (moderatoriaus). Iš tiesų, praleistų punktų atrinkimo procesas yra susijęs su rodiklių sąveikos parametrų palyginimu. Pavyzdžiui, pirmųjų moderatorių rodikliai, kuriems padaryta įtaka, – Iranas kaip besivystanti šalis – apima komercializacijos laiką, įmonės gebėjimus/galimybes apsaugoti techninių žinių bazę ir standartinius nustatymus. Irano įmonės negali apsaugoti savo techninės ir technologinės informacijos rezultatų dėl įstatymų stokos, kad galėtų standartizuoti nustatymus, patentų apsaugą ir nuosavybės teisių apsaugą. Be to, dėl nuolatinės ekonominės ir politinės plėtros besivystančioje šalyje, būtų neįmanoma tinkamai įvertinti komercializacijos laiką. Tokiu būdu, komercializacijos laikas ir standartiniai nustatymai bus neįtraukti į modelio rodiklius, o įmonės gebėjimai/galimybės apsaugoti techninių žinių bazę bus pakeisti. Galiausiai, lieka vienintelis svarbus veiksnys - techniniai ir vadovavimo žmogiškieji ištekliai. Šis veiksnys Irano nanotechnologijomis pagrįstoms įmonėms gali būti jų pagrindinis dalykas.

Apibendrinant galima teigti, kad šiame darbe pateikiamas pavyzdys lygina keturis filtracijos etapus – t. y. mikrofiltraciją, ultrafiltraciją, nanofiltraciją ir atbulinį osmosą – su keturiais moderuojančiais TS išgavimo proceso kintamaisiais. Papildydamas *Chiesa* modelį pateiktasis pavyzdys atskleidžia produktyvų požiūrį technikams, kad jie geriau suprastų vadovavimo klausimus.

Raktažodžiai: *technologijos strategija, Irano nanotechnologijomis pagrįstos įmonės, nanofiltracijos pavyzdys, besivystanti šalis*.

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