Building Technological Innovation Capability in the High Tech SMEs: Technology Scanning Perspective

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Abstract. Small and Medium Enterprises (SMEs) are the main contributors to the international economy and commerce. SMEs contribute significantly to wealth creation in industrial economies and are a major driver of innovation and plays a significant role in global markets by employing around two-thirds of the world’s workforce. SMEs have limited resources and therefore their existence depends on how they overcome technology limitations and upgrade themselves with the latest technology. For whatever reasons, undertaking adequate technology surveillance and monitoring always poses challenges to SMEs.

This paper focuses on the manufacturing SMEs operating in high-tech. This paper aims to explore ability of high tech SMEs to undertake adequate technology surveillance through technology scanning perspective. The technology change is rapid and the environment is dynamic, and on the other hand there is an ever increasing amount of information available owing to advances in information technology in general. The paper reveals through literature review, Technology scanning as a process and explores past research, linking scanning and technology innovation performance.

This paper draws findings from doctoral study of the author of this paper. The paper attempts to add the new perspective of scanning in a highly turbulent environment, and discusses its contribution to high tech firms in enhancing their technological innovation abilities and competence.

Keywords High Tech SME; Technology intelligence; competence; scanning; innovation.

1 Introduction

Small and Medium Enterprises (SMEs) are the main contributors to the international economy and commerce. Furthermore, the SME sector is a major driver of innovation and plays a significant role in global markets employing around two-thirds of the world’s workforce. The impact of SMEs on the economy of both developed as well as developing nations is considerable. The definition of an SME varies across the world, market segment and from literature to literature. However, criteria that specify the level of total manpower, sales turnover and capital employed, for example, are some of the key factors defining an SME.

There is no standard accepted definition for high-tech SME, neither in the academic arena nor in the field of economics. However, the term ‘high-tech SME’ is often referred to by different terms with often similar meanings; for example, new technology based firms (NTBFs), innovative SMEs, knowledge-based firms, R&D intensive companies, the new economy and specific industry subgroups such as IT-enterprises or biotech firms. These high-tech firms operate in rapid growth sectors where technology may stabilise or may not yet have stabilised and there could be a lot of opportunities for the firms. Generally, high-tech firms are characterised by a wide-spread presence of high-tech skills and presence of entrepreneurship. These SMEs are often highly innovative or R&D intensive with complex production technologies.
NTBFs gain their innovative advantage and competence by exploring new areas on the technological landscape that may have been overlooked by large firms. Some high-tech sectors presently include Bio-technology, energy, Nano-technology, Opto-electronics, robotics, wireless technologies, solar cells and some more.

Owing to various reasons and constraints on resources, technology becomes critical for SMEs, especially for firms operating in high-tech areas. Those SMEs that have a good technological base, competitive advantage and flexibility to restructure themselves shall withstand the present challenges and will out-perform, and make their own contribution to the economy.

In order to develop and maintain a strong competitive position it is important for an organisation to have adequate knowledge available. The high tech firms are basically knowledge-based industry with its main focus on research and development. The core capabilities of organisations are based increasingly on knowledge seeking and creation.

The main question with regards to Technological innovation concerns the nature of technology itself. Technological innovation can be defined as technical change or the adoption of new processes and technology (Dewar and Dutton, 1986). Cohen and Levinthal (1990) noted that the most innovative firms appear to be those that are good at appreciating the importance of information on new technology and quick in importing, assimilating and applying it. For whatever reasons, undertaking adequate technology surveillance and monitoring always poses challenges to SMEs. The challenge for small firms is to remain innovative and competitive as they grow. They should be able to respond to the changing environment and be flexible and therefore information availability is a crucial factor. Forecasting emerging technologies is a challenging task due to little or no availability of historical data (Daim et al., 2006).

Technology up-gradation or change and continuous innovation are critical to being competitive and creating benchmarks. SMEs use their own networks, sometimes multiple networks, for their technological watches, depending upon requirements, strategic needs and changing circumstances. Sometimes it is also a multifunctional activity.

Scanning is dealt with both as an unspecific or a specific observation of the technological external environment. Technology scanning acts as an alarm system of potential changes, which means opportunities or threats. The information collected needs to be processed and analysed further to determine whether it is an opportunity or threat.

Therefore technology scanning in high-tech situations assumes more importance, which is discussed in this paper. This paper aims to focus on the technology scanning process and its contribution in building innovation capabilities in high tech SMEs.

All these indicate that high tech SMEs need external connectivity (information networks) to achieve radical innovation. Therefore Technology scanning becomes paramount important to high tech SME Sector. The literature review presented in subsequent section helps in exploring the technology scanning concept from different perspectives and provides understanding of various factors and determinants.

Review of literature showed two areas which needs to be addressed:

1. There is lack of understanding of Technology scanning (monitoring) process in high tech SMEs.
2. Information networks used by high tech SMEs considering internal resource constraints and volatile external environment.

So purpose of this paper is to explore, how technology scanning manifests in the high tech SMEs? This leads us to the first research question: How does the technology scanning process manifest in an uncertain environment of SMEs? And subsequent question: How do owner-managers of high-tech SMEs respond to this technological uncertainty? And importantly which information networks are used by high-tech SMEs and what is their effectiveness?

This paper is organised as follows. In Chapter 2 the relevant literature is reviewed. I have included sections to cover relevant areas that touch on technology scanning in this chapter.

In Chapter 3, the research findings and Theoretical rational is presented. It starts with the explanation of the research approach pursued in this paper. Also provided is a discussion and justification for choosing the qualitative approach, along with other research tools and methods.

In Chapter 4, Discussion and concluding notes are presented. It starts with various determinants and factors contributing to the manifestation of the technology scanning process in high-tech SMEs. The owner-managers’ perspectives and various constructs and relationships follow.

2 Literature Review

Technology scanning is a dynamic phenomenon grounded in the webs of various organisational processes and systems. Technology scanning is ahead of technology planning and is a key element of the technology intelligence program. Therefore, apart from discussion on technology scanning, it is equally important to understand different constructs of the technology intelligence process by taking a holistic view.

Technology scanning has always been considered to be part of environmental scanning in the past literature. The literature on environmental scanning dates back to 1967, when Aguilar (1967) first proposed the model for environmental scanning. Environmental scanning calls for analysis of the business environment to check on ‘Opportunities’ and ‘Threats’. The past literature on environmental scanning describes it as ‘PEST’ Analysis, which means analysis, observation and collection of information with respect to P: Political, E: Economical, S: Social, and T: Technological aspects of the business environment where the firm is operating. The technology-related search and collection of information is then refereed in subsequent literature as technology scanning.

It is prudent to state that technology scanning is a part of any technology intelligence or technology management program. It is interesting to study technology intelligence as a process by taking a holistic view even though past research has mostly focused on large and MNC organisations. In some early literature technology scanning is referred to as the technology intelligence method or management method. The figure 1, illustrates the technology intelligence process proposed by Kerr et al. (2006, p.85). As shown in the figure, the primary input into the technology intelligence model is the data on technologies from external and internal sources. However, in order to initiate the technology intelligence process another critical input is necessary: what information needs to be collected.
These various technology intelligence systems are necessarily more generic and applicable to large organisations and MNCs, whereas small firms may not have a formal R&D set-up or a dedicated team to undertake such activities. The person to handle this system single-handedly is the owner-manager of the SME or, in some cases, the technology manager. Therefore, in the SME set-up there may be one mode or duplication of more than one mode operating. Furthermore, the term ‘technology intelligence’ more appropriately fits with large corporation and MNCs, whereas the term ‘technology scanning’ fits with small firms.

Vanhaverbeke, Dysters and Beerkens (2001) state that the rate of the company’s innovation may vary to the extent that they explore new technologies (scanning). Their study concluded that there is a strong relationship between internal and external learning and their impact on the firm’s technological performance operating in a high-tech area. Therefore, the company that has limited access to an external network has to largely depend on internal resources. Laursen and Salter (2004) explore the relationship between the openness of a firm’s external search strategies and innovative performance. Today, innovation processes require firms to master highly specific knowledge about different markets, users and technologies. Laursen and Salter’s (2004) study introduced two new concepts on external search. The concepts of breadth and depth as two components of the openness of individual firms’ external search strategies. They link the breadth and depth of external search to innovative performance, exploring how differences in search strategies among firms influence their ability to achieve different levels of novelty in their innovative performance. Study found that firms who are more open – those who search widely and deeply – tend to be more innovative. This ‘openness’ refers to a firm’s ability to access the knowledge externally compared to internally. This external search ‘depth’ can be linked to radical innovation. Therefore different strategies can be planned in search and network management (scanning) to handle radical innovation, which is true for all high-tech firms.

Julien, Andriambeloson and Ramangalahy (2004) applied a theory of strong and weak tie networks to small firm’s external knowledge sourcing. Strong tie networks comprised of their own internal circle with which they deal regularly and feel comfortable. They are good useful tools to support the
innovation but not good sources for innovation ‘triggers’; whereas weak tie networks contribute more to innovation. They are not frequently used by small firms. It is found that firms which use weak tie networks are more innovative.

For small firms to develop innovation internally, they must have sufficient information about the external environment. The company’s technology strategy influences the use of scanning, and the degree of technology turbulence can play a role in assessing the criticality of good knowledge of the external environment. Sluismans, Hertog, Lommelen, Beck, and Kunst (2008) studied high-tech SMEs in the area of innovation management. Their study was aimed to improve upon the innovative management capabilities of the participating SMEs. Their study found that high-tech small firms differ significantly from other small firms with respect to their scanning ability.

Savioz (2003) provides an observation matrix, as presented in Figure 2. This matrix has a time and business horizon dimension. Depending on the strategy, the organisation puts the focus on a particular observation area. ‘Followers’ place their focus of interest on technologies in the present or the near future, and in existing or familiar businesses. ‘Leaders’, additionally, seem to follow observations beyond this limitation. As one can see radical innovation falls under ‘looking beyond’ segment of matrix, whereas incremental innovation falls under short term time zone. Therefore ‘leaders’ are always ahead of ‘followers’ in their innovation abilities.

Figure 2: Keeping abreast versus looking beyond

![Figure 2: Keeping abreast versus looking beyond](image-url)
3 Research Findings and the Theoretical Rationale

A qualitative approach was used to answer the main research question. Analysis of relevant research literature was carried out to understand various constructs and the relationship and theoretical perspectives underpinning the technology scanning process. The semi-structured interviews and focus group were used to capture the data. This ensured that data collection was rich in context based on owner-managers’ experiences, interpretation, insights and understanding of the situation. The qualitative approach was deemed appropriate to this research since I could take a holistic view of the process, and thorough analysis ensured rich interpretation. The qualitative approach with semi-structured interview allowed me to explore in-depth all the factors and determinants contributing to the manifestation of the technology scanning process in high-tech SMEs.

The relationship between the environment and organisations has its theoretical roots in the organisational theory literature. In knowledge-intensive settings like high-tech, organisational learning is of key importance. This paper makes an attempt at combining technology scanning and the organisational learning link by considering “Information based view of organisation”.

3.1 Information-based view of organisation

According to the theory of Information based View of organisation, the external environment is viewed as a source of information. Changes, events and trends in the environment continually send signals, which the organisation detects and uses to adapt to new conditions. Daft and Weick (1984) proposed a comparative model of organisations as interpretation systems. An interpretation is the process through which information is given meaning and actions are chosen. There are many interpretation images in the literature, including scanning, monitoring, and sense-making, interpretation, understanding and learning (Duncan & Weiss 1979). These concepts can be roughly organised into three stages that constitute the overall organisational process proposed by Daft and Weick (1984, p.286), as reflected in Figure 5.

Figure 3: Relationships among scanning, interpretation and learning


At the interpretation stage, the information collected during scanning is given meaning and becomes new knowledge. The previously stored knowledge helps in generating the meaning. Existing knowledge base owner-managers can use to describe and explain the new collected information. An organisation’s absorptive capacity represents the ‘lens’ through which new information is interpreted (McEwen 2008, p.1). During this stage, the owner-manager or gatekeeper disseminates the information throughout the organisation. SMEs may adopt different methods to store and retrieve the information. The rate of exchange of information will also depend on methods and tools adopted by SMEs. This sharing of information transforms into shared interpretation that can serve as a context for organisational action. More learning takes place when more and more varied interpretations have been
developed because this influences the range of the organisation’s potential behaviours and is consistent with the definition of learning (Huber 1991). It is the challenge for owner-managers to find the balance between interpreting the information according to existing beliefs (conservatism) and interpreting the data for the exploration of new alternatives (entrepreneurism), as proposed by Choo (1999).

According to Cyert and March (1963), organisational learning is the process by which organisations learn through interactions with their environment. Individuals are fundamental to the development of organisational learning and there is no organisational learning without individual learning. Thus scanning helps in improving technological innovation performance through organisational learning. Technology scanning also helps in building a priori knowledge (to improve absorptive capacity of the organisation).

Based on the doctoral study, this paper presents following information network sources used by high Tech SMEs are summarized in Table 1. These information networks are primary sources of improving technological innovation ability of high tech small firms.

Table 1: Information networks

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<tr>
<th>Publications</th>
<th>Friends</th>
<th>Social Network</th>
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<tbody>
<tr>
<td>Customer</td>
<td>Vendors</td>
<td>Distributors</td>
</tr>
<tr>
<td>Competitors</td>
<td>Collaborators</td>
<td>Exhibition</td>
</tr>
<tr>
<td>Seminar</td>
<td>Internet</td>
<td>Internal staff</td>
</tr>
<tr>
<td>Trade office</td>
<td>Library</td>
<td>University</td>
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Further, it was found that highly innovative firms use special information networks as depicted under in table 2, in addition to above mentioned sources.

Table 2: Additional information networks

<table>
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<tr>
<th>Consultants</th>
<th>Field Analysis</th>
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<tr>
<td>Global Research Centers</td>
<td>Patent Data Analysis</td>
</tr>
<tr>
<td>Engineering Standards</td>
<td>Professional Organisations</td>
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<tr>
<td>Special training to R&amp;D staff</td>
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During the research, attributes were mapped of high Tech SMEs who found to be high on the scale of technological innovation and competence.

As part of keeping abreast of the technology environment in which firm operates, technology scanning contributes to this competitive advantage. This external knowledge acquisition through scanning by extracting useful information from different sources helps product development, improvements, innovation, cost cutting etc. Technology ‘S’ curve scale was used to highlight importance of early absorption and up-gradation of technology. The ‘S’ curve is a useful tool to compare a firm’s performance with another in the same sector. The technology delay is the time gap between a firm and the leader firm to reach a fixed level of performance. Technology distance is the difference in the performance levels between firms that use a certain technology in a fixed instant of time. A good margin in technology distance and adequate technological advance indicate competitive advantage of the leader firm. In high-tech firms technological competence and advancement is the biggest competitive advantage.

For competitive reasons, there is a continuous challenge for a leader firm to stay ahead, since the follower firms will try to fill the gap. Therefore having a strategy to continuously innovate is imperative. This phenomenon was evident in the study sample. In this study, the ‘S’ curve was used as ‘adoption curve’. The technology ‘S’ curve is also known as a ‘diffusion’ curve. Using ‘S’ curve to define technology leadership level and on the basis of findings, the sample was mapped from different industry sectors and correspondingly their technology leadership level on the scale of low to high. It was evident from this presentation that firms having systematic scanning approach were ahead of their counterparts operating in the same industry sector in technology leadership position and innovation abilities. This means, they could handle technology uncertainty better, their technology road maps were clear, they could do better cost cutting and offer more innovative products and services.

4 Discussion and Concluding Notes

Technology innovation is said to be a matter of life and death for high tech firms. It is crucial for the value creation in high tech firms, but depends on many outside factors. The main benefits of information networks for innovation are the access to emerging areas of technology landscape, access to new technologies, and speeding products to market. The aim of this paper is to improve insight into the process of technology scanning by exploring dynamics of information networks and outside connectivity. On the one hand, small high tech firms are considered to be more flexible, thus better encouraged to adopting innovation than large firms. On the other hand, larger firms can easily innovate than smaller firms due to better internal resources and knowledge. For high tech SMEs it is perhaps more difficult to internalise external knowledge than for larger firms. Therefore, it is believed that SMEs might benefit more from innovation information networks than large firms. Therefore good technology scanning practises are strongly advocated for firms operating especially in high tech areas. Further it is suggested that it is not the density of networks but the diversity of networks, which might be important for innovation.

The management of SMEs is different from that of multinational and large organisations. SME structures are flat or pyramid depending on the size of the firm, but most SMEs are controlled by the owner-managers. The owner-manager, who is also referred to sometimes as CEO, director or managing director, is at the helm of the affair to plan, direct and organise actions. It is the personality that reflects in the organisation’s personality and culture. High-tech SMEs need to be more flexible and innovative and competitive as they grow. Therefore, the ability of SMEs to monitor their technology landscape is crucial.
The knowledge management integrates external information into internal knowledge. Knowledge management in small firms is not the focus of this paper. However, good knowledge management practices adopted by small firms is certainly key to scanning and innovation performance linkages. It is interesting to note that sizable respondents in this study, who have confirmed a strong positive relationship of scanning and performance, also reported to have ‘well structured’ knowledge management practices in place.

In fact, network needs are different for SME sectors. High-tech firms need special information networks that need to be more effective. Special information network used has been presented in Table 2. The general SMEs who are not operating in a rapid change technology environment may not face the need of a special system. Furthermore, the IT revolution has made many resources available online, such as social networking, online university, and professional groups and bodies. This has given a hedging effect to conventional weak signal networks such as universities and research laboratories. However, it does not mean that universities and laboratories play a less important role now.

SMEs rely heavily on owner-managers’ and top managers’ experience. The organisation’s attributes and management orientation are a key influencing factor on the scanning process. The findings were extended by using a theoretical rationale of ‘information based view of organisation’. The study identified that the scanning link helps to improve performance through organisational learning. Data (information) collected during scanning is given meaning at the interpretation stage. The learning (problem solving) takes place only after the interpretation stage. The previously stored knowledge (absorptive capacity) helps in generating interpretation. Therefore, technology scanning offers dual benefits: first of contribution to a firm’s absorptive capacity, and second, improving performance through organisational learning.

<table>
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<th>Key Concluding Learnings:</th>
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<tr>
<td>• Major contributing factors for influencing manifestation of technology scanning in high-tech SMEs are management orientation and organisation attributes.</td>
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<tr>
<td>• Technology scanning helps to improve performance such as technology innovation and technology competence so as to contribute to building competitive advantage of high-tech firms.</td>
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<tr>
<td>• Industry sector does not influence scanning approach in high-tech area</td>
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<td>• Age of the firm does not have causal effect on scanning practice in high-tech SMEs.</td>
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<tr>
<td>• Technology scanning has to be an integral part of strategic management of high-tech firms.</td>
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<tr>
<td>• Systematic scanning approach is an effective way of handling uncertainty.</td>
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<tr>
<td>• Some specialised information networks may help encounter uncertainty.</td>
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<td>• High-tech SMEs use special information networks apart from routine networks.</td>
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References


