Advancing technological innovation

Strategies for small and medium enterprises in an IT economy

Koji Tanabe and Chihiro Watanabe

As industrial society gave way to an information society in the 1990s, Japan experienced its "lost decade". Its electrical machinery and automobile industries, however, remained highly competitive. Interestingly, this was due not only to its large enterprises but also to its small and medium enterprises (SMEs). SMEs undoubtedly have several disadvantages in comparison to large enterprises. But the dramatic advance of information technology helped to make the SME competitive position far stronger, mainly because of the latter's distinct edge in organizational flexibility and efficiency. This article argues that the excellent performances of quite a few SMEs can be attributed to their business strategies of utilizing external technology information to the maximum.

Mr. Koji Tanabe
Department of Research and Statistics, Ministry of Economy Trade and Industry
1-3-1 Kasumigaseki, Chiyoda-ku
Tokyo 100-8902, Japan

Dr. Professor Chihiro Watanabe
Department of Industrial Engineering & Management, Tokyo Institute of Technology
2-12-1 Ookayama, Meguro-ku
Tokyo 152-8552 Japan
Tel: (+81-3) 5734 2248
Fax: (+81-3) 5734 2252
E-mail: chihiro@me.titech.ac.jp

Introduction

During the paradigm shift in the 1990s from an industrial society to an information society, the Japanese economy experienced prolonged economic stagnation. Some manufacturing industries, however, notably electrical machinery and automobiles, continued to stay competitive. This was true of both large enterprises and small and medium enterprises (SMEs).

While SMEs generally suffer a disadvantage compared to large enterprises in funding, human resources and information, the dramatic advance of information technology (IT) has been shifting SMEs to more advantageous positions, thanks to their greater organizational flexibility and efficiency.[1] Quite a few SMEs have been demonstrating excellent business performance through efficient and effective technological innovation in mega-competition.[2] This excellent performance can be attributed to their strategies aiming at a maximum utilization of externally available technology information.[3]

A number of studies have identified the significance of technological innovation (T.I.) in improving SME productivity, thereby overcoming their comparative disadvantage vis-a-vis large enterprises. Quite a few have also suggested a potential comparative advantage in flexibility, reflecting institutional changes and explorations of niche markets. No study, however, has focused on outstanding SME techno-sales performance as a consequence of R&D with the unique contribution of IT in an information age.

This article attempts to do just this. First, on the basis of an empirical analysis of Japan's electrical machinery firms, it hopes to show that R&D is essential for SMEs as well as large enterprises to maintain excellent business performance, and that R&D activities in outstanding SMEs are often more efficient than in large enterprises. The article then identifies the sources that enable SMEs survive and achieve this better performance. Finally, based on real-life experiences of three Japanese SMEs that worked to develope T.I., the article suggests strategies for SMEs to link up with large enterprises, universities and government for technology monitoring and capability development.

The next section reviews some dynamic SME performances based on T.I. The third section highlights the comparative advantage of SMEs in an IT economy. The fourth section introduces case analyses demonstrating SME success in improving T.I. The final section summarizes new policy implications arguing for systematic T.I. in SMEs in an information society.

SMEs and T.I.

Electrical machinery sector

In order to analyze the current situation of SMEs in Japan, we will attempt an empirical analysis of the electrical machinery industry, which holds the highest share of sales in the Japanese manufacturing industry. In fact, this industry has been maintaining the strongest competitive position in the world, but large enterprises in the industry had been shifting their manufacturing operations overseas since the late 1980s. Thus SMEs in Japan's electrical machinery industry had been facing structural problems and were endeavouring to overcome such problems.

Our empirical analysis utilizes enterprise micro-data based on the Basic Survey of Japanese Business Structure and Activities[4,5], conducted annually by the Ministry of Economy, Trade and Industry (METI). The survey data relate to enterprises with 50 or more employees and a capital of ¥ 30 or more million, in manufacturing, commerce, restaurants and some services industries. 550 firms in the electrical machinery industry were chosen on the basis of micro-data for 1995 and 2000. These firms were in operation in 1995 and also in 2000, and conducted R&D activities in this period. The 550 firms are classified into three groups by scale in 1995: firms with less than 300 employees or capital less than ¥ 100 million (SMEs); firms with 300 or more employees or capital exceeding ¥ 100 or more million (large enterprises or LEs); and firms with ¥ 100 or more billion sales (super large enterprises or SLEs).

As summarized in Table 1, while SMEs numbered 268, or nearly half of the 550 firms, the proportions of SME sales and employees in 1995 were only 3.4 per cent and 6.6 per cent, respectively. The share of SMEs in R&D expenditure was extremely small, only 1.1 per cent. On the other hand, while the number of SLEs is 49, their shares in sales and employees were 80 per cent and 66 per cent of the total respectively; and in R&D expenditure more than 90 per cent. These figures demonstrate that SMEs are extremely small in sales, employees and R&D expenditure. What is noteworthy, however, is that the share of SMEs in sales and R&D expenditure has been maintained at the same levels as in 1995 and 2000. This means that SMEs have maintained the same growth rate in sales and in R&D as SLEs and LEs in this period.

The utilization of IT such as the internet and the cellular phone dramatically increased in Japan in the latter half of the 1990s. SLEs made consistent R&D investments in this period, increasing by 16.1 per cent between 1995 and 2000 to maintain their competitiveness. In the same period, SMEs sales increased over 15 per cent. Furthermore, their R&D expenditure also increased at the growth rate of over 13 per cent, higher than that of SLEs.

In the industrial economy of the 20th century, with its economies of scale, large enterprises enjoyed a competitive position, and SMEs were considered to have many disadvantages. In fact, their performances were far below those of large enterprises. However, in the latter half of the 1990s, a number of SMEs became important players in the economy.

SME performance and T.I.

Business performance

We now analyze the sales growth of Japan's electrical machinery enterprises from 1995 to 2000, utilizing the micro-data of 550 firms, by comparing SMEs, LEs and SLEs.

We can make some interesting observations about the distribution of enterprises in growth rates by size.

- First, although the growth rate of total sales in the electrical machinery industry from 1995 to 2000 is 15.5 per cent, the distribution of the growth rates is very wide, from "-70~80 per cent" to over 300 per cent. The highest distribution density range is demonstrated as "0~10 per cent" growth, followed by "-10~0 per cent" growth.
- Second, there are many Japanese enterprises that show excellent business performance even in the bad macro-economic situation of the late 1990s. In such circumstances, the performance of SMEs is not substantially different from that of larger groups (LEs and SLEs). More than half of the SMEs increased their sales from 1995 to 2000 to the same extent as LEs. The distribution of SME sales growth is almost the same as for LEs.
- Third, many SMEs enjoyed extraordinary sales growth. There are 38 SMEs among 79 firms with over 50 per cent sales increase, and 11 SMEs among 16 firms with over 150 per cent sales increase. Contrary to such SME performances, the growth rate of SLE sales is relatively small. Only 7 SLE firms achieved over 50 per cent sales increases.

These analyses demonstrate that Japan's SMEs have been acting as dynamically as large enterprises, and the competitiveness of Japanese electrical machinery industry can be attributed to such SME activities.

R&D

If we focus on SME R&D activities, we note that there is a sharp contrast between outstanding SMEs and SMEs with bad performance. As can be seen (Table 2), outstanding SMEs with sales growths of over 10 per cent had allocated about 3 per cent of their sales to R&D. On the contrary, SMEs with poor performances, where sales decreased by over 10 per cent, spent only around 2 per cent on R&D.

This indicates that R&D was crucial for SMEs to achieve excellent performance through technological innovation in the late 1990s. It is worth noting that, while the R&D intensity of SLEs is

Table 1: Share of small and medium enterprises in the electrical machinery industry

1995	Number of enterprises	Sales (billion yen)	Employees (thousand)	R&D expenditure (billion yen)	R&D intensity
Total	550 (100.0%)	38,652 (100.0%)	837 (100.0%)	2,641 (100.0%)	6.8
SMEs	268 (48.7)	1,308 (3.4)	55 (6.6)	29 (1.1)	2.2
LEs	233 (42.4)	6,677 (17.3)	218 (26.0)	218 (8.3)	3.3
SLEs	49 (8.9)	30,666 (79.3)	564 (67.4)	2,394 (90.6)	7.8

2000	Number of enterprises	Sales (billion yen)	Employees (thousand)	R&D expenditure (billion yen)	R&D intensity
Total	550 (100.0%)	44,656 (100.0%)	751 (100.0%)	2,938 (100.0%)	6.6
SMEs	268 (48.7)	1,507 (3.4)	53 (7.1)	33 (1.1)	2.2
LEs	233 (42.4)	7,535 (16.9)	202 (26.9)	275 (9.4)	3.6
SLEs	49 (8.9)	35,614 (79.8)	496 (66.0)	2,630 (89.5)	7.4*Source:*

Source: Basic survey of Japanese business structure and activities in 1995 and in 2000, Ministry of Economy, Trade and Industry (METI)
Note: R&D Intensity is a ratio of R&D expenditure to sales.

extremely high (Table 1), their business performance (sales growth) is not so impressive. This means that R&D productivity in SMEs is very high and that the R&D activities of outstanding SMEs are very efficient and effective.

Potential SME advantages

With the dramatic advance of IT in the 1990s, the speed of changes in market demand and technology accelerated considerably. Institutional circumstances changed substantially thanks to the IT revolution.[6] In this business environment, the ability to commercialize a product concept promptly and efficiently became crucially important, and as a technology strategy, using external resources became one of the most important strategies.

In an industrial economy, where mass production is common and economy of scale decisive, large enterprises enjoyed superiority and competitiveness. But SMEs began to gain competitiveness as the industrial economy gave way to a very different environment. We will now discuss the distinctive features of the new economy.

Information integration

Large firms integrate the division of labour within their organization, and have high productivity through efficient information gathering, creation and transfer among them. But, with the advance of IT, the cost of information processing and communication have become very low, and thus efficient information activity does not need a large organization. Thus IT has removed a traditional impediment indigenous to SMEs and has enabled SMEs to maximize their advantages of speedy communication and quick consensus among far fewer employees.

Table 2: SMEs sales growth and R&D intensity

Sales growth 2000/1995	Number of SMEs	Average of R&D intensity in 1995
over 50 %	38	2.8
30 ~ 50	27	3.0
10 ~ 30	42	2.8
0 ~ 10	38	2.3
-10 ~ 0	36	2.9
-20 ~ -10	36	1.9
-30 ~ -20	27	2.2
under -30	24	2.1

Source: Basic Survey of Japanese business structure and activities in 1995 and in 2000, Ministry of Economy, Trade and Industry (METI).

Market optimization

In the industrial society, SMEs were bound by a *keiretsu* group initiated by large manufacturing firms. Now, however, they can enjoy opportunities of doing business with customers using the Internet, and conducting joint activities with external technology resources in an information society. SMEs can play independently in a market, and many with successful T.I. can become important players under optimizing markets.

Organizational inertia

Rapid technological change requires prompt decision-making and flexible management, and without them firms will lose their competitiveness. Large enterprises are usually not good at changing the direction of their activities because of their organizational inertia.[7,8] This prevents them from moving toward new opportunities and new ventures. SMEs are less impeded by organizational inertia.

Table 3 summarizes a key direction of the shift in innovation activities from the 1980s to the 1990s, corresponding to the paradigm shift to an information society.

As demonstrated in the table, product life cycles are becoming shorter, and nimble reactions to customer requirements are essential to become and stay competitive. In addition, there is a dramatic increase in the uncertainty about the future. Thus prompt decision-making and flexible management are indispensable for business success. Even R&D activities are required to be more efficient and effective, which gives increasing significance to outsourcing and to joint activities with outside technology partners.

Clearly, lower organizational inertia plays a decisive role in competitiveness and has the potential to give a comparative advantage to SMEs.

SME strategies for T.I.

Case analyses

It is crucial for SMEs to monitor technological advances and to evaluate technologies for possible adoption as their core technologies in the future. There are many types of strategies for competitive position through technology. We will now look at three outstanding and pioneering SME challenges from Japan.

Case 1: Choshu Sangyo (CIC)

CIC was established in 1980 as a firm manufacturing housing equipment, such as boilers and solar systems. CIC endeavoured to develop new products in this field using advanced technology. A turning point came in 1985, when NEC constructed an IC factory at the adjacent town. In order to secure some IC-relevant business from NEC, CIC entered a business alliance with a large IC-manufacturing equipment producer and seconded six talented engineers out of 60 employees to this allied firm for training. CIC then started to provide a maintenance service to the NEC factory and gradually accumulated the know-how essential for manufacturing IC-relevant equipment. That has since grown into CIC's main business, with 420 employees.

Case 2: Nakashima Propeller

Nakashima Propeller was established in 1926 as a manufacturer of marine propellers. In the 1970s, it had technical agreements with prominent European manufacturers of controllable pitch propellers and rudders. These technical alliances enabled it to introduce the most advanced technologies and to develop its own technological potential. It grew into the world's technology leader in the fine fabrication field. With its high fabrication capabilities and CAD/CAM systems, Nakashima Propeller has the leading position in the world of propellers, with 330 employees. With its advanced technology capacity, and in cooperation with several medical university professors, since the 1980s, it has developed a competitive new field of artificial joints of titanium alloy for medical treatment.

Case 3: Kato Seisakusho (KSJ)

KSJ was founded as a toy-car manufacturer in 1946 and later took to manufacturing clock parts. It specialized primarily in die making, metal punching, stamping, plastic moulding and unit assemblies. While its business enjoyed success in the manufacture of oil-stove parts and gas equipment and parts, KSJ's President, Mr. Kato, realized the importance of participating in a new business field where the demand for parts could be sustained. Stimulated by the government's vision for durable consumer goods, he realized the enormous market potential of home equipment and cars. He decided to enter the automotive parts business and endeavoured to secure as customers automotive firms with identical manufacturing technologies. Automobile parts has since grown into one of KAJ's main businesses, leading to an excellent SME, with factories in the USA, Korea and Singapore.

Assimilating T.I.

The foregoing case analyses suggest the following three business strategies that SMEs can successfully apply in an information society:

Allying with large enterprises

SMEs can assimilate advanced technologies through technical alliances with large firms. CIC and Nakashima propeller pursued this strategy. However, it is generally not easy for SMEs to secure the confidence of, and aspire to joint activities with, large firms. CIC took advantage of the larger producer's heavy cost of directly providing maintenance services from a geographical distance. In general, SMEs should already possess a certain level of technology to be able to secure technical alliances. Thereafter, with the technical support of, and collaborative activities with, large firms, SMEs can develop their technology capability.

Tying up with universities

Generally, SMEs do not have enough technical staff and may not provide sufficient training opportunities for their engineers. Universities, therefore, are very important resources for SMEs. Technical advice is available from university faculty for new product development. SMEs can conduct joint research with universities as the latter need an SME's manufacturing capability for giving physical shape to their new ideas. This is what the Nakashima Propellers move into artificial joints demonstrates. It is most important to realize that universities can be the source of new technologies. New knowledge and technology can be created from challenging new basic research in universities. Linking up with academic research and with such challenging innovations can be more easily conducted by SMEs rather than by large firms.

Utilizing government information

Government often publishes future scenarios of the direction of the country's technology development in order to win public support for them. On the basis of these visions, it initiates new national-level R&D projects involving prominent companies. Such scenarios identify market trends of emerging new products or technologies as well as the techno-sales situation. As in the case of KSJ, SMEs can extrapolate future technology by making effective utilization of government-published scenarios and statistics. After all, government information is equally open to all, and it is essential for SMEs to interpret these for their own strategies for the future.

Table 3: Shift in innovation activities from the 1980s to the 1990s, corresponding to the paradigm change

	1980s	1990s
Economy	Industrial economy	IT economy
Degree of certainty	High	Low
Key technology	Manufacturing technology	Information technology (IT)
Objective	Quality, cost, delivery time	Originality, speedy action tocustomers
Type of R&D	Improvement seeking	Intellectual property seeking
R&D in industry	In-house	Outsourcing, partnership
Product life cycle	Long	Short

These strategies can be effective tools for making maximum use of external technology resources. As a general principle, further business development of SMEs will depend on how effectively they develop the technology capability they already have. SMEs should therefore always maintain a strong concern for technology development.

In an era of uncertainty, where no one person can confidently predict the future, SMEs need to have their own clear vision and a strong will to pursue and realize it. At the same time, they must maintain their inherent comparative advantage of being relatively free from organizational inertia and of possessing flexibility to handle the new information society.

Conclusion

As the industrial society gives way to an information society, we find a sharper differentiation between winners and losers. While SMEs have certain innate disadvantages compared to large enterprises, this article has attempted to identify where outstanding SMEs have discovered their strengths.

By focusing on SMEs in Japan's electrical machinery industry, empirically reviewing the dynamic performances of some of them, studying the comparative advantage that some SMEs could have, thanks to IT, and analyzing cases of successful SMEs firms, we could draw certain conclusions:

- SMEs played an important role in the Japanese economy in the latter part of the 1990s. Some SMEs certainly became more competitive thanks to the IT revolution. Through the Internet, they could easily collect information about markets, customers and technology. Also, because prompt decision-making and flexible management are essential for competitive business in an IT economy, SMEs have certain inherent potential advantages.
- In fact, quite a few Japanese SMEs have been performing more dynamically than large enterprises. On a macro base, SME indices of R&D investment and sales are comparable to those of large enterprises. Our analysis, based on micro-data, demonstrates that there are many SMEs with excellent performances. The evidence also shows that the competitiveness of Japanese manufacturing industry has been created by collaborative activities between large enterprises and SMEs.
- Outstanding Japanese SMEs have utilized their technology potential to develop new business aggressively through T.I. This they have done by utilizing technology information from external sources, particularly from large enterprises, universities and government.

Altogether, the findings suggest a new policy direction. Through T.I., SMEs should get maximum mileage out of their potential comparative advantage. In line with these findings, Japanese policies for SMEs changed in the late 1990s from supporting inferior firms to stimulating and challenging SMEs to get the best of their potential comparative advantage.

The Japanese government now strongly promotes SME R&D activities, as in the form of research consortia consisting of firms with different core technologies, and of joint R&D between SMEs and universities.

Thus stimulated, SMEs are expected to develop their own core technologies and to increase their competitiveness through T.I. by making full utilization of external resources.

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