Technology, innovation and collaboration of firms

The case of light engineering clusters in Bangladesh

Nurul Quadir and Rasel Mahamud

The light engineering industry plays an important role in the economy of Bangladesh, as it provides useful products and services to agriculture, helps imports substitution, besides aiding industrial development. The light engineering industry clusters' development is due to the support it provides to other industries, such as the transport sector, the agricultural sector and the power sector. These clusters have the capacity to meet the market demand through knowledge-based internal collaborations. Although they do not function in an organized way to manage technology and innovation, they are capable in their own way to respond to the market when the opportunities arise.

Nurul Quadir
Deputy General Manager
E-mail: nquadir@gmail.com

Rasel Mahamud
Programme Manager
E-mail: ranaraselm@yahoo.com

Small and Medium Enterprise Foundation
4 Panthapath
Dhaka 1215, Bangladesh
Tel: +88 (2) 814 2983
Fax: +88 (2) 814 2467
Website: www.smef.org.bd

Introduction

The world is experiencing a phenomenal and unprecedented growth in technology over the last few decades. This growth has made it difficult to forecast the development scenario in the long term. The free market economy and follow-up of the Uruguay Round Agreement is one of the important factors for this change in technology (Azim, 1999).

Business and economic developments are hastening the pace of technological change, with innovations that further human capability. Economic opportunities play a significant role in technology upgrading and innovation, which require an organized application of knowledge, proper allocation of resources, and integration. Large companies, mostly multinational corporations (MNCs) from developed countries, have systems that respond to the market with technological innovations. Companies in the developing countries, with their poor endogenous technological capacities, face numerous challenges. Nevertheless, they are operating in a globally competitive market system, applying their own innovations and

technology management. This paper emphasizes on technology innovation, and the role of inter-firm collaboration to sustain and grow in a technology-intensive industry – light engineering industry (LE)[1] of a developing country like Bangladesh.

An innovation can be defined as a process that takes an idea or invention, links it to a market demand, and turns it into a product, a technique or a service that is bought and sold (Bas and others, 2008). Innovation also includes the improvement of an existing product or process and bringing it to the market. This study depicts the manner in which market-based innovation is driving technological development – in particular, technology upgrading and innovation – across different clusters in the local LE industry in Bangladesh.

This study conducted field as well as literature-based surveys to collect information. The primary information serves as the critical framework for analysis, while the secondary information provides important input for understanding the context and rationale. This combination provides a rich contextual explanation of the situation. Instead of structured data collection instrument, the study employs observations and investigations with projections. Secondary data came from available literature and relevant websites. The key informants include industry experts, government officials, functionaries from non-government organizations and the private sector, business membership organization leaders, academicians, researchers and policy-makers.

LE industry in Bangladesh

LE industry plays a pivotal role in the industrial landscape, both locally and globally. It offers many opportunities of value addition, thereby, contributing to Bangladesh's economic growth and poverty reduction. It is frequently referred to as a mother industry that supports all other industries by providing capital machinery, spare parts and maintenance support. There is no historical reference about LE industry in Bangladesh. However, the common saying is that the industry started by providing maintenance support to the large-scale industrial units commissioned in the 1950s in Bangladesh (then East Pakistan). Spare parts manufacturing for those industrial units came in the second stage, as an extended service to maintenance. The Dholaikhal area of Dhaka was at the centre of such activities. These activities developed all over the country, but mostly concentrated in the vicinity of the large-scale industries. In the 1980s, the Dholaikhal project and sub-contracting with state-owned enterprises were facilitated through the Bangladesh Small and Cottage Industries Corporation, a state-owned organization for the promotion of small and cottage industry in the country. This provided the initial boost to this sector, which was flourishing with thousands of workshops and foundries across the country. According to Akter (2009), the sector involves three kinds of work: making complete machinery, producing spare parts, and repairing old machines. As stated previously, it also carries out maintenance of different machinery.

Table 1: LE industry products

1. Agricultural machinery and spares
2. Automobiles, railway and marine transport spares
3. Blades, battery and carbon rods
4. Bread, biscuit and food processing machinery
5. Construction, building machinery and maintenance services
6. Gas distribution, LPG cylinder and fire extinguishers
7. General machinery and spares
8. Hardware, kitchen and bathroom fittings
9. Metal products and steel furniture
10. Moulds and dies, foundry and Casting
11. Paper, pulp, sugar, cement, plastics, rubber, and paint machinery and spares
12. Pharmaceutical machinery and spares
13. Printing and packaging machinery and spares
14. Textile and jute machinery and spares
Source: BEIOA website, 2009

Industry overview

According to the Bangladesh Engineering Industry Owners' Association, which is the country's largest industry association (BEIOA, 2009), the contribution of this sector has been 2.15 per cent of Bangladesh's Gross Domestic Product (GDP) in the last few decades. It is producing a wide range of products as listed in Table 1. A brief picture of the LE industry is as follows (The Daily Star, 2007):

Number of enterprises: Approximately 40,000;
Employment: 89,632 employees; and
Market size: Tk 51,510 million (US$ 748.7 million) for local manufacturers.

Akter (2009), quoting Ahmad, said that the sector in Bangladesh contributes 2.2 per cent to the GDP, which is more than the foreign aid received every year (The Daily Star, 2009).

Major LE clusters in Bangladesh

According to the International Finance Corporation's South Asia Enterprise Development Facility, of the 48 clusters in the country, 27 are in Dhaka and its suburbs (The Daily Star, 2007). Bogra, the commercial hub of the North-West part of the country, has three clusters while Chittagong and Jessore are two other districts with several clusters.

It is noted that the Dhaka clusters have concentrated on capital machinery, bicycles, construction equipment and spare parts for the automobile and various other industries, factories and mills, in addition to maintenance

[1] Light engineering industry represents small-scale engineering firms involved in production of metal-based spare parts and machines, and maintenance services.

work. The Bogra clusters have their focus on foundry, agro-machinery and spare parts for small agro processing industries, in addition to maintenance work.

Technology, innovation and inter-firm collaboration in LE

Technology use in LEs in Bangladesh

The production technology used by the industry is not standardized, and adoption of new technology changes is slow. Majority of the enterprises use traditional and outdated machines and tools with poor precision that results in poor quality. Obsolete plants from India and China, including machines used for ship-breaking, are the major sources of machines for the industry. The various international fairs organized in Bangladesh and interaction with machinery suppliers have served to increase the use of modern machines that use technologies such as computerized numerical control (CNC) and electrical discharge machining (EDM).

The capacity of human resources engaged in the production and operation is not standardized. Usually, workers get on-the-job skills training from their predecessors, who themselves have not had any formalized education and training in this trade, but have learned by working in the industry. Technology upgrading is particularly difficult when the workforce is not adequately trained to manage that technology.

The organizational effects are important because they exert a powerful influence on the ability of firms, industries and nations to adapt to new technologies (Florida and Kenney, 1991). Technology is organized in an informal way in the LE industry. The entrepreneurs are mostly managers who lack formal education, and have educated themselves through interaction with peers and the market. These contacts are the primary channel for flow of information for new technology, ideas and knowledge.

It is noted that mostly low precision, non-automated lathes are used in production by the industry. Drilling, grinding and boring machines are to be found in almost all the machine shops. Most of the units are facing problems with accuracy, precision, low intensity workforce and productivity. The foundries are using cupola and crucible furnaces for melting metal. Casting of brass and other alloys is done in crucibles. Sand mould and manual pouring system are used for iron casting, while both sand mould and metal dies are used for alloys casting. The entrepreneurs acknowledge that they are using outdated processes, which give no assurance of quality and the rate of wastage is high. Foundries often face problems in testing, metal property control, efficient patterning and die making.

Table 2: Category of production

Category	Process	Products
Relatively larger scale	Casting products. Other activities include drawing, forging, rolling, extrusion, sheet metal forming, and wire drawing	Agricultural machinery and parts, parts for automobile industy, etc.
Small scale	Different machining operations	Import substitute goods and products for agriculture, machines, automobile

Technology development and inter-firm linkages

In the beginning of 1980, studies on the role of innovation in economic development brought up the need to organize innovation activities within firms. Therefore, innovation management became a strategic business element (Zawislak and Marins, 2007). The LE units in Bangladesh, as a response to the market and underlying economics, innovate and update their technology in various processes or product development. The study reviewed many cases, but has described only two of them in this report. Case 1 focuses on the process and Case 2 on product development.

To get a better understanding of the LE industry, it may be classified into two major categories based on the production scale (Table 2). Production of agricultural machinery and parts by the local manufacturers is on relatively large scale, as the market demands a large volume of these products. The Bogra clusters are the main suppliers to this market. A case study (Case 1) presented here explains the manner in which this large-scale demand is being met through a technology upgrading, which has taken place recently due to inter-firm collaboration.

On the other hand, where goods and parts for the substitution of imports are concerned, the market is sensitive to the changing customer usage patterns. This is why these goods and parts are produced in a relatively smaller scale. The Dhaka clusters are responding to this market (Case 2). The Dholaikhal cluster, situated close to the Noabpur market, is the largest wholesale market in the country for machines and spare parts. It is familiar to innovation through reverse engineering. The study has identified how this market is utilizing reverse engineering to respond fast to the market demand and the way in which inter-firm linkages are working here for new product development.

Case 1: Foundries of Bogra collaborate to upgrade technology

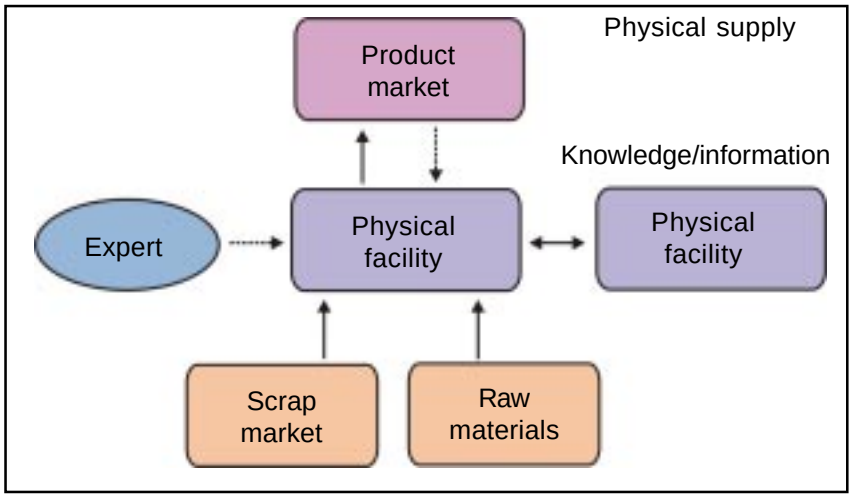
The foundries of Bogra are manufacturing agricultural machinery and parts on a mass scale. Most of the Bogra foundries use relatively large cupolas (with an inner diameter of 30 inches or more). The metallic charge usually consists entirely of scrap metal and foundry returns, and pig iron is rarely used. Pollution control does not seem to be an important issue. Most of the foundries produce small-sized castings used in machine tools as well

as agricultural implements. These foundries were incurring high production costs, mainly due to the high cost of energy. This was a result of using inefficient cupolas leading to a low rate of production while meeting the market demand.

A team of about 10 foundry entrepreneurs from of the Bogra cluster, who formed the Foundry Owners Association of Bangladesh (FOAB), visited India for a week in July 2007. The objective of FOAB was to provide an opportunity for firms to unite and collaborate. The team visited the foundry clusters of Howrah in West Bengal, Rajkot and Ahmedabad in Gujarat, and Agra in Uttar Pradesh. It identified low-cost, energy-efficient technologies suitable for foundries in Bangladesh. The team's field visits and interactions with foundry owners provided it with a good understanding of the technology used in India. It also realized the scope to save energy by upgrading the conventional cupolas in operation in Bangladesh's foundry units, as it observed that the foundry units in Howrah and Rajkot are using the divided blast cupola (DBC). The team found this type of furnace were suitable for Bangladesh because the reduced energy intake they offer is an attractive payback on investment.

The Bogra foundry entrepreneurs contacted the design provider for DBC. Two members of FOAB – Milton Metal Industries and Gunjon Metal Works – decided to install DBC, with capacity to produce 4 tonnes of melt iron per hour. The FOAB members, who studied the design, planned to install DBCs by garnering resources from the local market through a collaborative effort. Two DBCs were thus installed by joint efforts, with engineering assistance from two other foundry owners who had a relatively better understanding of foundry technology. Thus, knowledge was transferred in the installation as well as commissioning of the project. Later, the FOAB members installed and commissioned two more DBCs using the same design; one more in Milton Metal Industries and another in Haque Metal Industries, which helped install the first two DBCs.

Figure 1: Inter-firm linkages in the dholaikhal cluster



This example demonstrates horizontal linkages among the foundries in technology development through collaboration in the management of knowledge and expertise. The Bogra foundries are now capable of installation and commissioning of DBC for the mentioned capacity. These firms, using their own capabilities, could upgrade technology to meet the increasing market demands for their products. The FOAB members are currently studying the designs of various capacities of DBCs. This is being done in order to install DBCs according to requirement of the foundries, which need to produce products for the export market. For instance, an Indian buyer has placed an order for 20,000 pieces of centrifugal pumps to be supplied by December 2009. (The Daily Star, 2009).

Case 2: Reverse engineering in Dholaikhal, Dhaka

The Dholaikhal cluster is adjacent to Noabpur market, the largest wholesale market in the country for all types of machinery and parts. The market has roughly more than 5,000 such shops. Most of the machinery and parts are imported – mostly from other Asian countries such as China, India, Taiwan, Malaysia, Singapore, Republic of Korea and Japan – and only a small portion is locally manufactured. The changing market demand, imposition of import duties and technological changes are continuously making space for local manufacturers to produce import substitutes and ancillary products. As Zawislak and Marins (2007) pointed out, the dynamic capitalistic trends promote innovation, change, discontinuity, replacement, and creation, marked by value aggregation.

Because of their close interaction with the importers/wholesalers, the local manufacturers get information about niche market demands. In many ways, this is rewarding in terms of the price. The manufacturers in the clusters can spend time for researching products for reverse engineering.

Another important aspect observed in the Dholaikhal cluster is the provision of repair and maintenance service for a wide range of machines. At times, the repair jobs extend to replacement of parts that are not in the stock of the company, prompting it to reverse engineer the part. The capacity for reverse engineering has been developing over the years in this manner. The inter-firm linkages augment knowledge, input supply and physical capacity of the firms in reverse engineering a product (Figure 1).

The firm gets an original sample of a product to be reverse engineered from the adjacent market. The scrap market provides a good opportunity to change or reshape certain parts to make the product through supplying scrap of similar product or a product of same material properties. It also serves as a source of input for some products that are not available in the

regular markets. In some cases, the scrap market is quite adequate to supply the required volume of inputs for the product/spare to be reshaped or manufactured. The physical facilities are mostly shared because every firm has some degree of specialization for a specific job. As the volume for this production is relatively low, the firms with limited investment capacity are unable to diversify resources. Thus, the inter-firm linkages play a very important role to accomplish or manage a total production process required to produce a product.

The firms of Dholaikhal cluster generally focus on new product development that can maximize their profit. The reverse engineering they use is knowledge and expertise they gained in their ongoing business. For instance, the testing of material for a part is done by sight, sound, feel, etc. The mechanical properties are tested by using the part where it is meant to be used. This is due to lack of facilities or unaffordability of testing services. At times, it is also owing to a lack of knowledge about the relevant or important service. This learning by practice has produced numerous successes that are visible as new products coming in the market.

Conclusion

This study found that the knowledge and expertise gained through practice is developing innovations and thereby leading to the development or upgrading of technologies. A common observation from the two cases described is that the firms are not documenting their activities nor are they communicating the knowledge in an organized way. Hence, they are remaining in the same loop of development. There may be two options for their further development: one is finding a way for their immediate graduation and future growth; and the other is integrating knowledge gained from the formal sector. According to the Japanese Ministry of Trade and Industry, Japanese manufacturers devoted over one-fourth of their research and development investment to imported technology during 1960s and 1970s (Kodma, 1992). As a late adopter of technology, there is much opportunity in Bangladesh's LE industry to adopt a similar methodology and for its technology development agencies to emulate the experience of Japan to adapt technologies in an organized way.

Note: The views and observations expressed in this paper are solely those of the authors, and SME Foundation is not responsible or liable for them in any manner.

References

1. Akter, S. (2009). Light engineering seeks government funding. *The Daily Star,* 18 May 2009, Dhaka, Bangladesh.
2. Azim M.A. (1999). Paradigm shift in engineering profession and the flexible engineer. *Journal of Institution of Engineers,* Bangladesh. Vol. Mul-dis 23 & 24. No. 1 & 2.
3. Bas, Tomas Gabriel, Ernesto Amoros and Martin Kunc (2008). Innovation, entrepreneurship and clusters in Latin American natural resource – implication and future challenges. *Journal of Technology Management & Innovation,* Vol. 3, Issue 4, pp. 52-65.
4. BEIOA (Bangladesh Engineering Industry Owners' Association) (2009). Website: www.beioa.net.
4. Florida, R. and M. Kenney (1991). Organizational factors and technology intense industry: The US and Japan. *New Technology, Work and Employment.* Vol. 6., No. 1.
5. Kodma, Fumio (1992). Technology fusion and the new R&D. *Harvard Business Review,* Jul-Aug 1992.
6. The Daily Star (2007). IFC-SEDF presentation on LEs cluster study. 8 November 2007, Dhaka, Bangladesh.
7. The Daily Star (2009). Bogra seizes Indian market for irrigation equipment. 12 April 2009, Dhaka, Bangladesh.
9. Zawislak, Paulo Antônio and Luciana Manhães Marins (2007). Strengthening innovation in developing countries. *Journal of Technology Management & Innovation,* Vol. 2, Issue 4, pp. 44-53.❐