A CRITICAL STUDY ON THE STRATEGY FOR CAPITAL MACHINERY MANUFACTURING SMEs IN BANGLADESH

by

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This thesis Presented to Dublin City University as the fulfilment of the requirement for the degree of;

Doctor of Philosophy

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2005

DECLARATION

I hereby certify that this material, which I have submitted for assessment on the programme of study leading to the award of Doctor of Philosophy, is entirely my own work and has not been taken from the work of others. Within the text of my work, some literatures have been incorporated to the present work with references and acknowledgements.

Signed: ----------------------

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Date: 20/12/05

DEDICATION

This thesis is dedicated to

My Mother, I lost at the end of my research,

My loving wife Dr. Shahoor Begum , a source of my inspirations,

and

My beloved kids for sacrificing their time.

M. Shahidul Islam

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I would like to express my sincere thanks and gratitude to Professor Mahuddin Ahmed and Professor M.S.J.Hashmi for their supervision, encouragement, valuable suggestions and friendly advice throughout the period of this study.

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Finally, I submit myself to Almighty, the creator and sustainers of the Universe who is perfect in wisdom and knowledge providing for my needs and enabling me to complete this study.

M.Shahidul Islam

A CRITICAL STUDY ON THE STRATEGY FOR CAPITAL MACHINERY MANUFACTURING SMEs IN BANGLADESH

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ABSTRACT

This study presents the results of a research programme carried out on small and medium sized enterprises (SME) of manufacturing industrial capital machinery in Bangladesh. The study is intended to establish the market potential of industrial capital machinery (ICM), barriers to growth and government policy support issues towards the development of ICM manufacturing SMEs.

This research involved the study of manufacturing industries, case studies on the manufacture of capital machinery and designing a postal survey questionnaire which was mailed to industries, government departments and raw material suppliers in Bangladesh. The questionnaire was designed with an aim to collect, information on opportunities, barriers to manufacturing, strategy of procurement and sales of ICM, use of locally available industrial indigenous resources, strength of AMT, size and performance of the SMEs and the impact of government policy on the growth of ICM manufacturing SMEs.

Based on the result of the study, a number of models have been developed for ICM in Bangladesh in terms of demand, market growth, factors affecting the manufacturing cost, government policies, contribution of the national engineering sector to the manufacturing industries and barriers to the growth.

The key findings of the study show that the locally available industrial resources based strategic plan for industrial development and government policies are the dominant factors for the growth of ICM manufacturing SMEs through which engineering industries could contribute to the economy of the developing countries in general and Bangladesh in particular. The work concludes with recommendations to overcome the barriers and constraints to the growth of ICM manufacturing SMEs.

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LIST OF ABBREVIATIONS

ICM-Industrial capital machinery

CAD-Computer aided design.

CAM-Computer aided manufacturing.

CNC-Computer and numerical control

SME-Small and Medium Sized Enterprise

P&ID-Installation drawing of the plant machinery

AMT-Advanced manufacturing technology

Tc-Total cost

Vc-Variable cost

TQM-Total quality management

BSC-Backward supply chain

FSC-Forward supply chain

ISC-In house supply chain

CIM-Computer Integrated manufacturing

HT-High tension

LT-low tension

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LIST OF ABBREVIATIONS

CAD-Computer aided design.

CAM-Computer aided manufacturing.

CNC-Computer and numerical control

SME-Small and Medium Sized Enterprise

P&ID-Installation drawing of the plant machinery

AMT-Advanced manufacturing technology

Tc-Total cost

Vc-Variable cost

TQM-Total quality management

BSC-Backward supply chain

FSC-Forward supply chain

ISC-In house supply chain

CIM-Computer Integrated manufacturing

HT-High tension

LT-low tension

CHAPTER 1
Introduction

1.1 IMPORTANCE OF CAPITAL MACHINERY

Manufacturing industries made significant contribution to the world economy and these industries heavily dependent on capital machinery and equipment. Industrial capital machinery (ICM) are like seeds because they produces the industrial products.

Machine tools are considered as the generator of industrial capital machinery. The history of machine tools in manufacturing industry is very old. It started since the early days of the Stone Age, when people learnt to make round holes in stones using their hands to rotate a wooden stick pressing the sand being worked upon. More over, the history of the bow driven turning lathe for making wooden goods has been traced as far back as 5000 B.C. In the late sixteenth century, the pedal type lathe was in use. In the eighteenth century people learnt to use water power and horse power for driving lathes for the production of highly complicated goods. In the late 1900's, skilled craftsmen were engaged to start to manufacture the modern machine tools.

It is generally acknowledged that the modern age of manufacturing began in England in the 18^{th} Century. In the 19^{th} century, the industrial revolution started in the United States of America with the introduction of powered machinery. This fact is now a part of the history of science and manufacturing technology. However, by this time, the manufacturing technology of capital machinery reached a considerable level.

After the industrial revolution, the requirements of industrial machinery increased. Technologists understood that machine tools were the generators needed to manufacture capital machinery. In addition, the increase of the demand led to the development the machining tools.

A classic study was undertaken by Seymour Mailman of Columbia University on the manufacturing of capital machinery [1]. He was studying the impact of automation on the rising rate of worker output. He showed that in the manufacturing industry over the period of 1900-1949, the increase rate of installed machine horsepower per production worker grew at a relatively constant rate. The study pointed out that the increase rate of installed horsepower of machinery and productivity of plant is parallel. The study established that there is a relationship between the level of automation of capital machinery and the productivity of industrial plant. This result indicates that automation in the manufacturing plants was started at the early stage of the last century.

It is generally accepted that muscle power has replaced by mechanical power and that brainpower has been replaced by the computer. The installation of the computer in the manufacturing system was the turning point of the manufacturing revolution. After the World War II, the numerical control system was introduced in the computer and that was in manufacturing systems in order to increase the productivity.

To meet the present market challenge and to remain competitive in the market places, manufacturing industries have started to install high-speed industrial machinery to increase productivity in order to reduce the cost of their products. Therefore, to gather the knowledge and to develop the manufacturing capability of high productivity machinery ICM manufacturers have started to invest in science and technology, and in R & D activities.

The design and manufacture of capital machinery involve considerable inputs of science and engineering. Naturally, countries with strong capabilities in science and engineering excel in the ICM manufacturing sectors. Literature shows that the expenditure on R & D and S & T in the industrially developed countries are higher than in developing countries [2]. It can also be noted that developed countries are spending huge amounts to develop the infrastructure facilities within the country to speed up the growth of their ICM manufacturing capabilities.

Developing countries are continuing to remain dependent on the industrially developed countries for their supply of capital machinery. It is a fact that the developing countries have to spend their hard earned foreign currencies to procure industrial capital machinery for the development of their manufacturing industries because they are weak in the manufacture of capital machinery.

The employment and economic growth of a nation largely depends on manufacturing industries and these industries are dependent on capital machinery, thus capital machinery becomes the heart a national economy. The importance of capital machinery is more significant to the developing countries because most of them are now passing the early or pre-industrial stage and they still have significant opportunities to develop their industries. Bangladesh is an example of such country.

Bangladesh is a developing country and in a typical year, spends about 7% of its total import budget on capital equipment and machinery [3]. It is evident from history that Bangladesh is dependent on foreign countries for industrial capital machinery. There could be many reasons why this country is continuing to depend on others for its capital machinery. This study aims to study the issues related to the manufacturing capability of capital machinery in Bangladesh.

1.2 AIMS OF THE STUDY

The current study will investigate the market potential of industrial capital machinery (ICM), barriers to growth and government policy support issues affecting the development of ICM manufacturing SMEs in Bangladesh in order to establish the scope of the contributions of engineering based manufacturing industries to the national economy.

The relevant information will be researched under this study programmes. The data will be analyzed using standard research methodology, in order to identify the require technical and policy measures for the development of capital machinery manufacturing industries in Bangladesh. The structure of the initial phase of this programme of study is outlined in the flow chart in Figure 1.1.

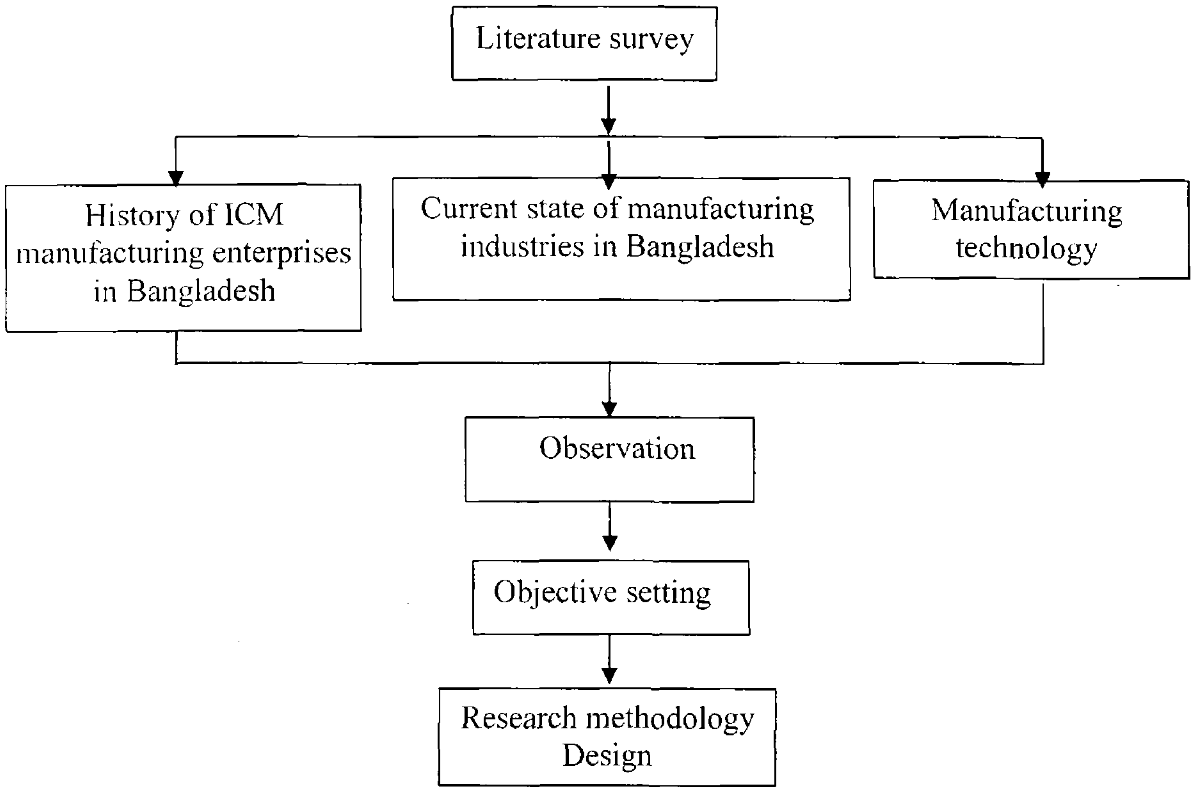

Figure 1.1 Initial phase of work programme

1.3 STRUCTURE OF THE THESIS

The thesis is divided into six sections, which are as follows:

Chapter 1

This chapter gives introduction of the study and initial objectives of the work.

Chapter 2

This chapter reviews a broad range of literature relating to manufacturing enterprises. The current information relating to the development of ICM manufacturing technology is presented. The history of capital machinery manufacturing enterprises and the current state of manufacturing industries of Bangladesh is produced.

The chapter ends with the principal findings of the literature survey and flow chart of the current research methodology.

Chapter 3

The chapter presents an insight of manufacturing industries and ICM manufacturing enterprise in Bangladesh. Information on various aspects of the industries is presented in forms of tabular form and as figures. The use of locally available industrial indigenous resources, the procedure of implementation of industrial projects, the barriers to procure the locally made ICM, the pattern of investment in capital machinery and industrial technology, and the growth patterns of manufacturing industries are outlined.

The nature of ICM manufacturing enterprises, the current strength of AMT, the present pattern of growth, the barriers to growth and impact of government polices on the development of ICM manufacturing SMEs are focused to bring the insights of this sector. The chapter ends with the result of the case studies on the manufacturing of capital machinery.

Chapter 4

The chapter gives the survey methodology of the current research. Sizing of population and sample, scaling methods and principles of questionnaire design are described. Conducting pilot survey, administering the main survey and response improvement methods is also described.

Chapter 5

The chapter presents the results of the research. The total market size of ICM and the growth pattern of demand for locally made machinery are shown in tabular and graphical forms. Current AMT status in ICM manufacturing SMEs, requirement of technology need to excel the ICM manufacturing SMEs, barriers to growth relating to government policies have focused. Present growth and the growth model at higher inputs of AMT and technology for the locally made ICM are demonstrated. The chapter ends with the discussion on the principal findings of the research.

Chapter 6

The chapter contains the conclusions of the research, recommendations for the future study on this issue and the statement of research contributions. At the end of the thesis, Appendices have been included to present necessary supporting data and background of the work.

CHAPTER 2

Literature survey

2.1 INTRODUCTION

Manufacturing enterprises are making significant contributions to the growth of industries, employment and import substitution of products [4]. The important contributions of manufacturing enterprises to the national economy are widely recognized in both developing and developed countries. In South East Asian countries, about 90% industrial establishments are within the structure of small and medium sized enterprises (SME). In countries like Singapore, Malaysia, Taiwan, Thailand and South Korea, contributions of SMEs to employment ranges from 35 to 61% and contribution of value added products ranges 22 to 40%. Though in the highly developed countries, the manufacturing industries are declining, but the manufacturing SMEs are still the key economy-generating sector in Japan, the United States, the UK, Canada and Germany and other many developed countries. In the case of China (newly entered into the market economy), the government has taken initiative to revise the policy support programmes for the development of the SMEs aiming to focus their economy on manufacturing SMEs. Numerous reports and other evidences are available in the literatures outlying the efforts made by governments of industrially developed and newly developed countries for the development of the manufacturing SMEs [5, 6, 7].

The current study intends to examine the present state of manufacturing industries in Bangladesh in order to determine the scope of contributions of ICM manufacturing enterprises to the development of manufacturing industries by supplying locally made capital machinery. In the course of this study, a literature survey programme was undertaken covering covered the following areas:

(a) Manufacturing technology,
(b) History of manufacturing enterprises of capital machinery in Bangladesh,
(c) Current status of capital machinery manufacturing enterprises in Bangladesh.

The results of this literature survey were used to design the preliminary questionnaire to carry out the initial study of manufacturing industries in Bangladesh and to formulate the research methodology in order to perform the entire study to meet the research objectives.

2.2 SMALL AND MEDIUM SIZE MANUFACTURING ENTERPRISES

Manufacturing enterprises are recognized as the engine for the growth of the economy. The contribution to the growth in employment is also significant. Small and medium sized enterprises (SMEs) are highly prized for their contribution to the growth of services industries, employment and economy. In fact, in both developing and developed countries about 70-95% of all manufacturing industries are SMEs. The industrially developed countries are introducing modern manufacturing tools and technologies in manufacturing SMEs in order to improve their performance and productivity.

The growth and performance of SMEs is largely dependent on social values, industrial resources and on the level of technical education of a country. Political commitment is also a key issue to utilize the local resources in industries. In deed, the utilization of the available resources in the manufacturing industries is highly dependent on human resource in firms, government policy supports, on-going business environment, communication facilities, and the degree of internal and external barriers existing in the country. In addition, the strength of science and technology in the country and or in the region is also a dominant factor.

2.2.1 Size of the employment in manufacturing enterprises

The size of the firm in terms of the number of employees and the age of the firm in terms of year of establishment are two key parameters in manufacturing enterprises. It has been suggest that size is an important determinant of performance and profit [8]. According to Porter and Porter [9, 10], there are some advantages available to large size firms due to their amount human resources, However, the medium size firms are frequently unable to avail of the use of modern manufacturing, administrative and technological advantages due to a shortage of skilled wise employment in the relevant fields. The author emphasized importance of employees and their skills to ensure better performance to make profit for the company forfitable. According to the European Commission [11], the SMEs sector is disaggregated into three components:

(a) Those having to 9 employees are called micro-enterprises,
(b) Those having 10 to 99 employees are called small enterprises,
(c) Those having the employees 100 to 499 employees is called medium enterprises.

Currently in Europe, 98% of all manufacturing companies have less than 250 employees [12].This highlights the importance of SMEs and it is also important to see how these firms are improving their survival capability in the present competitive market by keeping this number of employees in the enterprises [13].

In addition to the number of employees and size of the investment, the definition of SMEs of a nation is dependent on few other factors [14], which are:

(a) The technological capability in the country,
(b) The size of the economy.
(c) Business culture and environment for investment within the country.

In this respect, some examples can be cited to give a clearer focus on the definition of SMEs such as;

SMEs in Bangladesh

The SMEs sector is divided into three categories parts based on the number of employees;

(a) Micro-enterprises/cottage industries having the size of employment up to 9,
(b) Small enterprise having the size of employment in between 10 to 20 employees,
(c) Medium enterprise having the size of employment in between 21 to 50 employees [15].

The other parameter of SMEs is the size of investment. The limit of investment for the SMEs isa minimum of Tk 1.0 million and a maximum Tk 10.0 million [US$/Tk=1/60]

SMEs in South East Asia;

Firms with less than 50 staff in Singapore and Hong Kong and those with less that 100 employees in Malaysia are included in the SMEs groups.

2.2.2 The key factor of a SMEs performance

Numerous efforts have been made to study entrepreneurial characteristic (in terms of the size of employment and investment and ownership pattern) and in the performance of the manufacturing SMEs [16, 17, 18]. The evaluation of SMEs performances is based on three key parameters such as:

(a) Number of employees in the firm,
(b) The level of skills of the human resources working in the firm,
c) Experience of firm in the business.

These indicators are acknowledged by the industries as important determinants of performance for a manufacturing firm. In fact many researchers suggest that the employment size, productivity of the employees and experience of the manufacturing SMEs can play a vital role on the total performance and reported that these factors are the important determinants of a profitability of manufacturing firm [19]. For example, Porter [20, 10] suggests that the large sized firms are in a good position to make strategic alliances with the others to improve performance of the both by sharing their knowledge and other resources. He added that medium-and small sized firms are unable to do this due to their lack of human and other resources.

Researchers have also suggested [17, 18], that the overall performance of a small size firm is usually poor and in addition to that, the performance and size of the firm are usually grown together. However, the performance of bigger size firms is better. This can be attributed to the fact that larger ICM manufacturing enterprises have scope to engage some of their human resources for R & D activities and quality improvement programmes. Moreover, unlike small firms, bigger firms use some of their experts for the development of business programmes and costs cutting studies to remain competitive.

2.3 COMPETITIVENESS AND MANUFACTURING SMEs

In an increasingly open market, manufacturing enterprises face strong competition in both local and export markets. In addition to market competition, SMEs are suffering from a lack of skilled technicians who trend to move counties to join bigger size firms. Thus, the large firms get richer with skilled human resources and able to face open market challenges with skilled human resources. The movement of skilled manufacturing technicians is more prominent in developing countries due to their poor wage structure. However, it is evident that the flow of human resources from the developing counties to the developed countries is significantly high.

Large firms and SMEs are different from each other with regards to organizational structure, performance, resource capability and business strategy. Large firms and SMEs, in most cases, are working in the same business environment, but their competitive strategies are different from each other. According to Thomas [21], the managerial style is a very important way through which SMEs can compete with the larger firms. However, for the survival of SMEs, and to find out the ways to remain competitive at the market places SMEs are giving efforts. In fact, studies on the competitiveness of the SMEs have increased substantially in the recent years. A number of such studies were devoted to identifying the various factors of competitiveness. For example, according to Horne [22], the competitiveness of small firms is dependent on:

(a) The business environment,
(b) The degree of access to the capital resources,
(c) The inherent ability of the firm to act as a professional enterprise.

In general, the competitiveness of manufacturing firms is largely dependent on the following key factors:

(a) The internal firm factors,
(b) The external environment,
(c) The influence of entrepreneur on the business strategy.

These factors usually affect the total performance of a firms ability to gain competitiveness and an acceptable profit margin.

2.3.1 Internal firm factors

The internal factors are based on some entrepreneurial character. Among the factors, a few are known as tangible resources. These factors can speed up the growth and performance of a manufacturing firm. The factors are:

(a) Business capital,
(b) Skilled human resource,
(c) Management capability,
(d) Communication skills.

These factors represent the internal aspects of competitiveness of the SMEs. According to Horne [22], *internal resources are the key-facilitating elements.* O'Farell [23], O'Farell and Hitchens [24] have conducted a number of studies on the relationship between the source of competitiveness and firm factors. They added the following factors in their studies;

(a) Performance,
(b) Price,
(c) Quality of services,
(d) Design of the products,
(e) Marketing and management style.

Slevin and Covin [25], however, applied a 12-factor instrument to measure the ''total competitiveness'' of SMEs, including the firm's structure, culture, human resources, products, services etc. According to them, total competitiveness means high scoring on all these factors. Pratten's [26] study on small firms in several industries in the UK also highlighted the importance of product development, the quality of customer service, the efficiency of the production system, marketing expertise and low overhead cost as the sources of competitiveness.

List of internal firm factors have also been produced by Bamberger [27], Chaston and Mangles [28], Stoner [29], and Chawla [30]:

(a) Financial capabilities,

(b) Human and technological resources,

(c) Organizational structure and system,

(d) Productivity and innovative capabilities,

(e) Image and reputation,

(f) Internal culture,

(g) Product, service flexibility,

(h) Quality of the service,

(i) Marketing capability,

(j) Product quality,

(k) Organizational commitment.

2.3.2 External environment

The external environment is also an influential determinant for a SME's competitiveness. In the context of the external aspect of competitiveness, a framework has been proposed by Horne [29]. Framework indicates how a firm should react to the availability of the opportunity to generate long-term profitability in turbulent external business environment. Pratten [31] suggests that even, the industrial stage (like pre or post industrial stage) of a nation can be a source of competitiveness. Moreover, Barringer found [32] that rapid-growing manufacturing a enterprises get slow in external competitive environment. Other authors have taken a more proactive approach when they considered the impact of external factors on the growth of manufacturing SMEs. For example, Slevin and Covin [33] suggests that continuous repositioning in business is needed for a SMEs in order to adjust with external competitive environment. They added that SMEs should have the power to anticipate the action of the competitors and accordingly they should respond. Malecki and Tootle [34] also emphasized the same role. These studies suggest a strong interaction between the firms and the business environment. However, it can be summarised that small and medium firms should not always be the recipients of the effect of environmental changes, but they must also work to control the environment to make business more favourable.

2.3.3 Impact of effort of chief executive on the growth of SMEs

The chief executive is the key player in the manufacturing enterprise because the decision-making power is concentrated in the owner/manager in a SME. The competitiveness of a firm is strongly influenced by the key players. Stoner [35] stressed the experience, knowledge, and skill of the chief executive for the growth of the manufacturing SMEs. According to Chawla [29], the target and the experience of the owner is an important factor of an enterprise. Slevin and Covin [33] also suggested that an owner or a proprietor of SMEs can pay much more attention in operating the business in order to develop the enterprises.

2.4 ADVANCED MANUFACTURING TECHNOLOGY IN SMEs

In the current turbulent market and open economy business environment, small and medium sized manufacturing enterprises (SMEs) must meet higher standards and responsed more effectively at a competitive price. In such an intensely competitive environment, it is no longer possible for companies to achieve their strategic goal by using conventional technology and business tools. To meet this competitive challenge, manufacturing enterprises must develop their services facility by improving the quality of their working tools. Advanced manufacturing technology (AMT) is usually helpful in this respect. AMT can contribute to substantial benefits to a manufacturing enterprise by providing strategic tools.

2.4.1 Composition of Advanced Manufacturing Technology

The application of advanced manufacturing technology (AMT) has been defined, as the strategic tool needed to achieve competitive advantage. The adoption of technology in a firm depends mainly on three key factors: knowledge, skills of human resources, and hardware (machinery and equipments) used in the production process [36, 37]. In the current globalization pressure, AMT is considered one of the most potential determinants for gaining competitiveness for manufacturing SMEs and it is also an important tool which is needed to face the challenge of on going open market pressure. Machine tools, automating in the business process, skilled manufacturing staff and administrative employees (marketing, sales, accounting and finance) are the key elements in the manufacturing business. The AMT has four components, which are shown in Table 2.1.

Table 2.1 Parameters of AMT [38].

AMT parameters	Functions
Computer integrated functions	Installed a high level automation
Manufacturing equipment	Directly used on production line
Manufacturing employees	Technical people (engineers and technicians) in the manufacturing system
Management employees	Marketing, accounts and administrative people in the manufacturing business.

AMT can be an even more powerful tool with the integration of information technology. According to Mansfield, a flexible manufacturing system can easily be achieved by adopting information technology with the manufacturing process [39]. He added that Technology cannot be discarded from the manufacturing process. Based on the use of technology in the manufacturing sector, a few questions are raised with regard to technology penetration in the business process and the benefits of technology to the manufacturing business. In fact, some advantages and benefits are derived from the combined use of computer and information technology for manufacturing process. These advantages are dependent on the knowledge and skills of the organization [40, 41]. According to Bargeman and Rosen these advantages create cumulative effects on the development of SMEs [42].

2.4.2 Benefits of advanced manufacturing Technology to SMEs

Advanced manufacturing technology (AMT) can bring substantial benefits for manufacturing firms. It is evident with current globalization pressures; AMT is a more powerful business tool in both developed and developing economy. Especially in the context of developing countries, AMT should have more beneficial effect because these countries industries are in pre and early stages. However, industries of the developing countics have considerable scope to improve and expand by using AMT in the manufacturing process. And also they can gain huge benefits from AMT to improve their manufacturing capability and capacity. The benefits of AMT as put forwarded by Miller and Roth are present in Table 2.2.

Table 2.2 Benefits of use of AMT in manufacturing SMEs [43].

Direct benefits	Indirect benefits
Space reduction	Reduce capital investment.
Inventory level reduction	Reduce business capital and improve cash flow cycle.
Increase efficiency in machinery	Improve productivity
Increase the productivity of the plant	Increase volume of production, reduce unit product cost
Decrease the set-up time of the machinery	Reduce production time and improve production volume
Reduce rejection of finished product	Increase production performance
Increase production flexibility	Reduce the reset time of the machinery and increase production and performance
Reduce lead-time to market	Reduce the cost of business capital
Increase management controls	Reduced the size of investment
Working environment becomes favorable	Improve productivity, increase volume and reduce unit product cost
Improve firm's image in the market	Increase sales
Increase number of customized products	Increase business volume
Increase flexibility in products	Increase market size and business
Increase number of new products	Increase market size and business
Increase product life cycle	Increase market size and business
Increase reliability of the products	Increase market size and business
Decrease cost in after sales services	Increase profit and market size
Reduce cost in manufacturing	Increase profit and competitiveness
Increase contact efficiency with the client	Increase market size and business

To meet the market challenge, SMEs must produce higher standard products at a lower cost and in addition to that, after sales services and total quality management in the manufacturing business are necessary. Lower operating cost of an organization and shorter delivery time [44] are also required to meet customer demand. In order to gain such advantages, the firms must be, in many cases, relying on new computer-based technologies, which may be associated with both 'administrative and production applications' [45].

Advanced manufacturing technologies (AMT) have been shown as a tool to be used to improve the total performance in manufacturing firms [46]. Similarly, information technologies in the administrative field can also be used to improve the performance in business [47]. In the present competitive manufacturing environment, technologies cannot be disassociated from either administrative or production applications. To reach the manufacturing strategic goal, the integration of all applied technologies is essential for rapid growth, reduction of lead times to market and for a flexible manufacturing process. Technology integration is also important in order to support the internal and external activities of the firm for the coordination between customers and suppliers [48]. To exploit the growing market, the use of AMT in a manufacturing firm is an important issue for the managers/owners of the enterprises [49]. In order to capture a reasonable market share, the firm should introduce appropriate technology into the business process.

2.4.3 CIM in ICM manufacturing SMEs

Computer integrated manufacturing (CIM) has been defined as an umbrella that covers all computer aided functions in manufacturing businesses. Computer integrated manufacturing is concerned with computer assistance, control and high-level of integrated automation at all levels of manufacturing business process [50, 51]. The strength of CIM is refereed to the level of installations of computer facilities in the manufacturing system. Some major parameters of CIM which are commonly used have been identified from the literature. The identified parameters are shown in Table 2.3.

Table 2.3 CIM parameters in ICM manufacturing enterprises [52].

SL No	Computer aid integrated manufacturing (CIM)
1	Computer aided Engineering (CAE)
2	Computer aided planning (CAP)
3	Computer aided Quality control (CAQ)
4	Computer aided design (CAD)
5	Computer aided Production planning and control (CPPC)
6	Computer aided supply chain management (CSCM)
7	Production ordering planning (PO)
8	Production progress monitoring (MPM)

According to LeBlanc [53], CIM is considered as a dynamic part in the modern manufacturing process, which offers considerable advantages to SMEs. It can facilitate and speed up the growth of SMEs by improving productivity of the manufacturing system, but a question is raised as to whether SMEs can afford the required investment to install CIM in their manufacturing business. After all, the argument is whether the investment on CIM for SMEs is feasible and viable against the traditional production process or whether CIM can bring competitiveness for ICM manufacturing SMEs. It is evident that both large and some percentage of SMEs are using CIM in the manufacturing process, but large business organizations are enjoying and gaining better advantages from CIM [54].

2.4.4 Application of CNC machine in manufacturing SMEs

In the present highly automated manufacturing environment, CNC machines can dramatically increase manufacturing productivity. Installation of CNC machines in aSMEs is a budget intensive exercise, but it is essential to produce a quality product and to increase productivity. Open market pressure is a stimulating agent, which insists that manufacturing SMEs invest in CNC machines. Emphasis should be given to the economic and technical feasibility before investment is going to make in a CNC machine. According to Shingo [55], in addition to automation in the production system, the CNC machine is also able to detect and correct irregularities, can easily monitor and control the speed of a high production line.

2.4.5 Application of CAD in manufacturing SMEs

A computer aided design (CAD) is used to aid manufacturing process. CAD is a system which includes software and hardware and usually used on the workstations to speed up the production process. It allows the engineers/manufacturers to create the design a product on the computer; it provides a facility to print the drawings and enables the storage the works in computer memory for future use. CAD also facilitates the manufacturing process at the production stage by providing the dimensions of the product geometry. In a high speed manufacturing process, CAD is linked to data base of the product geometries and process to ensure product quality. According to Drucker [56], in the future, CAD will be found in the factories, apart from the present use and it rather would be integrated with process and product development activities.

2.4.6 Application of CAM in manufacturing SMEs

Computer aided manufacturing (CAM) is very popular in mass production lines and it is mostly used in the industrially developed countries. The investment in CAM is only justified if the enterprise has sufficient economic demand for the products. CAM can contribute to increased product quality and the productivity of the manufacturing process. In addition to that, CAM can add more flexibility to the manufacturing process. However, CAM is an expensive proposition and it is viable only for larger size SMEs who face high demand and have a strong financial background.

The CNC, CAD, CAM and CIM are cost incentive and capital investment issues. Manufacturing SMEs must justify whether these advanced manufacturing facilities are essential for them to meet market demand and if the investment is economically and technically feasible for them and they should estimate the pay-back time of this investment [57].

2.4.7 Manufacturing employment in ICM manufacturing SMEs

Manufacturing knowledge-based human resources and their skills are essential for the growth of manufacturing SMEs. Especially in ICM SMEs, manufacturing employees can play a vital role in the quality and product development functions.

The involvement of the number of skilled technical people in the production programme is one of the measures of strength of among the production capability. The manufacturing staff are those who are directly heavily involved in the manufacturing process. The category of manufacturing employees is shown in Table 2.4 [58].

Table 2.4 Manufacturing employments.

SL No	Technical employment
1	Skilled technician
2	Diploma engineer
3	Engineering graduate
4	Post graduate in science and engineering

2.4.8 Management employment in ICM manufacturing enterprises

Management employees are referred to as management staff, who are working to manage the business and in addition to that they are not directly involved with the production process and product development activities. The cost accountants, business executives, sales and marketing managers and personal managers should be management employees [58]. Management employees should be the important human resource for the ICM manufacturing enterprise. An efficient management team can play a vital role on the growth of ICM manufacturing SMEs by contributing their skills. Table 2.5 shows various types of management employee.

Table 2.5 Management employments.

Sl No	Types of management employees
1	Cost accountants
2	Business managers
3	Sales and Marketing personnel
4	Personal management

2.4.9 Development of manufacturing technology of capital machinery

It is generally acknowledged that the modern age of manufacturing began in England in the 18^{th} century and it evolved in the United States of America in the 19^{th} Century with the introduction of powered machinery in mechanical fabrication. These technologies are no more in use because, information technology has successfully revolution in the manufacturing process.

A classic study of the manufacturing of capital machinery was undertaken by Seymour Mailman of Columbia University [1]. He was studied the impact of automation on the rising rate of worker output. This study showed that over the period of 1900-1949, the level of installed horsepower of the machine per production worker has grown at a relatively constant rate. The study further showed that the rate of increase of installed horsepower of the machine and the productivity of the plant are developing proportionately. The study found that the level of automation of the capital machinery has a positive impact on the productivity of the industrial plant. The study justified that the cost of installation of powered machinery is cheaper than the wages of the employees. The results of such studies have made a significant impact on the growth of mechanization in the production of machinery and consequently, manually operated machinery has been largely removed.

The installation of the computers in the manufacturing system was also a turning point in the manufacturing revolution. IBM is recognized as the pioneering organization that took part in that novel job.

After World War II, the numerical control system was introduced and since then, the popularity of the computer has started to grow in business, in policy making and also in manufacturing industries. The computer has promoted automation in manufacturing process and ultimately, industries started to enjoy higher productivity.

2.4.10 MORDEN ICM MANUFACTURING PROCESS

Manufacturing operations using capital machinery are carried out in the different sequences either to make parts or complete machines. Each operation brings the materials closer to the desired and designed state. Manufacturing machinery is a specific process through which materials are transformed to a dedicated item having greater value. The key function of manufacturing is to add value with the materials by changing its shape or properties through the inputs of know-how, engineering knowledge and skills. The concept of the modern manufacturing process of ICM is shown in Figure 2.1. It can be visualized from Figure 2.1 that ICM manufacturing is a process that integrates the components of machinery. Usually the components are collected from the different suppliers and are then assembled together to produce a complete machine. It can also be seen that knowledge, labour, tooling and energy is added along with the components to get the final required output.

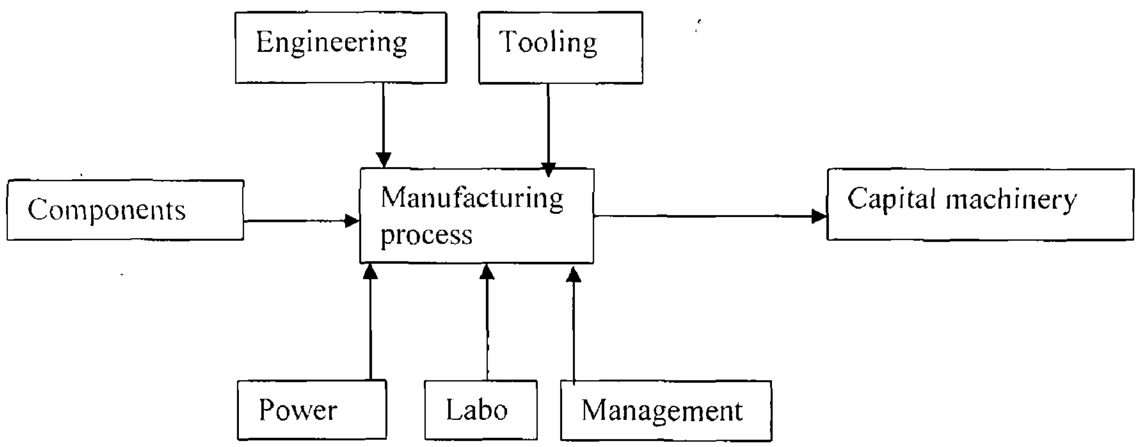

Figure 2.1 ICM manufacturing process.

The supply chain management and information technology bring structural changes to ICM manufacturing processes. At present the ICM manufacturing process is mainly based on the assembly system. However, out sourcing is an import issue for manufacturing the capital machinery. It is evident that the bigger companies, especially working in post industrially developed countries, are used to collect the components from reliable sources and finally they are assembled at their own factory [60, 61, 62].

2.5 TOTAL QUALITY MANAGEMENT IN THE MANUGFACTURING SMEs

Total quality management (TQM) is a tool that is systematically used to improve performance in business. By following the concept of TQM, internal and external training programmes are arranged by firms to improve the quality of their management [63]. Usually training programs are designed to have some pre identified and dedicated courses, which are essential to effectively operate the business to achieve the organizational strategic target. The design of training course depends on many factors and among them, the size of the enterprise and the skills of the employees are important issues. In addition to that, the training programmes are dependent on the structure of the organization, policy-making procedures and utilization capability of the resources. Lindmark [64] and Bryttling [65] suggested considering the organizational flexibility, assessment capability of the market, ownership pattern, business strategy, motivation power and the level of education of the employees prior to design the training course for TQM.

The frequency of execution of training depends on many factors. Atkinson and Storey [66] demonstrate that the frequency of training is increased with the size of the firm. The reason is to develop flexibility in the skills of the workforce. To gain competitive advantage, SMEs usually set up their training to develop diversified knowledge and skills in the organization [67].

2.5.1 Presence of TQM in manufacturing SMEs

The manufacturing SMEs face strong price competition in the market places. This competition is continuously growing in the market together with the development of information technology. The growing competitor has forced many small and medium sized enterprises to start focusing on quality improvement programmes, to develop flexibility in products and in the cost reduction process in order to continue the business. Indeed, currently the large manufacturing firms enjoy the benefits of Total Quality Management (TQM) but many SMEs are starting to realize that they could also enjoy competitive benefits by the implementation of TQM in their enterprise. This is the indication of growing interest in quality methods and which will make a gradual change in many companies. However, the use of TQM in SMEs is quite limited and the reasons may, the identified reasons are [67, 68, 69];

(a) The lack of network between SMEs and training provider,
(b) The lack of knowledge of TQM,
(c) Implementation policy of organization.

2.5.2 Implementation process of TQM in manufacturing SMEs

The implementation of Total Quality Management in manufacturing SMEs provides training for the staff through the external and internal learning process and uses the out put of the training to improve quality in services in all work stations of enterprises. In SMEs there are lots of constraints to implement TQM and among these the lack of adequate human resource and the capability of investment are the main. In addition to that, management capability to the implementation of TQM is also a considerable factor. Researchers reported [70, 71] that two effective methods for the implementation of TQM in the manufacturing SMEs which are:

1. Organizational learning or team learning,
2. Experimental learning.

1. Organizational learning or team learning

This is an internal training approach through which the members of the organization are trained to improve their quality to provide value added services. According to Henry [72], this can be achieved through quality practice in workstation. The motivation can change the behavior of the employees to provide quality services. According to Senge [73], a learning team needs practice in the field to develop skills and qualities in services. Dixon [74] proposed an organizational learning process, which can be viewed in Figure 2.2. This model is likely to be similar of Deming's model for continuous improvement. The insight of the model is the way to generate information within the organization. In general, the information is integrated within the enterprises and collectively interpret and demonstrate among the employees to generate knowledge.

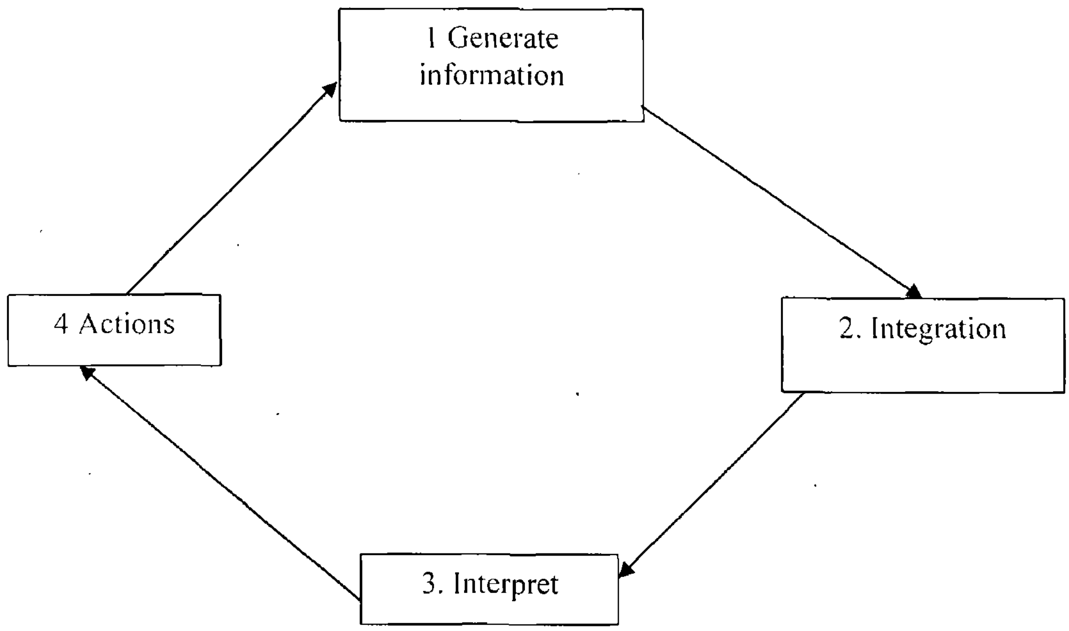

Figure 2.2 The organizational learning cycle.

Thereafter, necessary actions are taken to understand the needs of this knowledge. Finally the employees are convinced to use this knowledge to improve quality an they provide a better service.

According to Mayo and Lank [75], employees can create informal networks for the common interests and through this network; the knowledge of TQM can be disseminated to all employees. Furthermore, these processes include team learning, personal skills and knowledge.

2. Experimental learning

The experimental learning process is an effective tool that can be used to improve the quality of management. The task of implementation the experimental learning processes is costly and time consuming. The implementation of experimental learning process needs collaboration among the team members. This collaboration transforms the experiences of the team members into knowledge and action. It is a complete cycle of practice, learning, and increases knowledge among the participants. The cycle ends with an active experiment and successful implementation of the results obtained from the training. An experiential learning model proposed by Kolb [76] is shown in Figure 2.3.

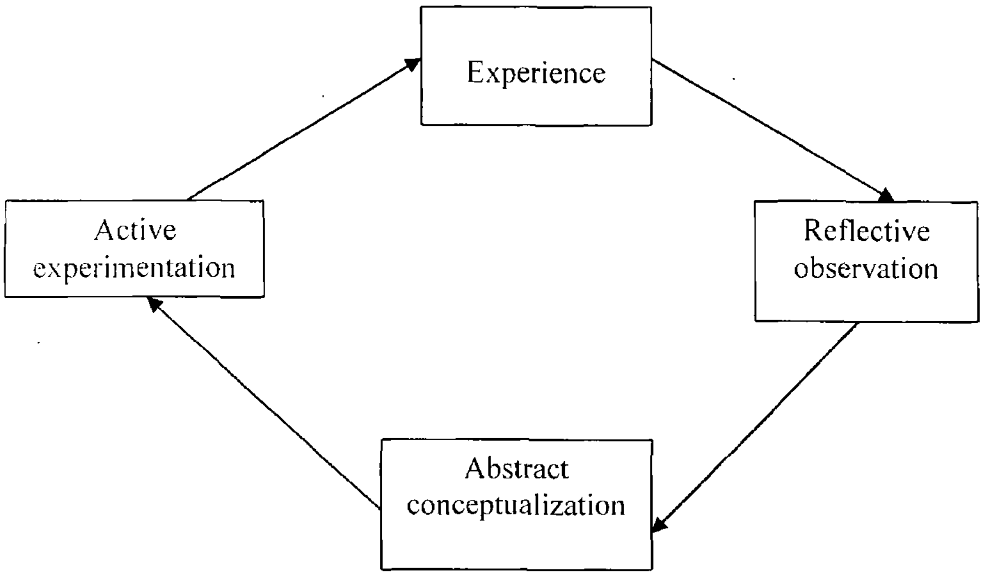

Figure 2.3 Experimental model.

According to Fiol and Lyles [77], the organizational learning process is different than individual learning process. In the organization learning process, emphasizes is usually given on physical evidences, which can be improved routinely as per the specifications, but the individual learning process is weak in this sense.

According to Garvare and Wiklund [78], for implementation of TQM, a local network is formed by the SMEs with local universities or colleges. These institutions should play an active role for the implementation of TQM.

TQM should include two goals [79, 80], controls and learning. In the context of TQC (total quality control), emphasis should be given to improve the quality of the existing management by strengthening management skills. In the case of TQL (total quality learning), emphasis should be improving the learning process by reducing the errors in the learning procedure.

2.6 ENTERPRISE RESOURCE PLANNING

Over the part few decades the world economy has been highly dominated by SMEs [81]. It is evident that the growth of SMEs is highly dependent on the efficient use of external and internal resources. For that reason, enterprise resource planning and management become essential tools for account growth in manufacturing SMEs.

2.6.1 Manufacturing resource

The resources have physical and conceptual dimensions, and are directly and indirectly involved with the manufacturing process [82]. These resources also can be external and internal. The following are among the major resources

a) Internal resources

The internal resources are those resources that are available within the enterprises. The internal resources have the following parts;

*. Business capital,

*. Human resources,

*. Production and service machinery and equipments,

*. Production floor and the other spaces,

*. Utilization of knowledge and experience,

*. Utilization of enterprise reputation.

b) External resources are

The external resources are those that are not within the enterprises but usually effect the business process. The external resources have the following parts;

*. Market potential,

*. Availability of low cost and competitive raw material sources,

*. Utilization of subcontracting and distribution networking,

*. Access to low cost fund,

*. R & D collaboration and technology partnering,

*. Tapping information of demand,

2.6.2 Resource based planning in manufacturing SMEs

Enterprise Resource Planning (ERP) is acknowledged as a management tool and it is helpful to manufacturing enterprises in managing their resources [83]. ERP offers many advantages for the enterprise, but it is not as yet used as an essential management tool in small and medium sized enterprises (SMEs).

Information technology, advance flexible manufacturing process and AMT have created a new business environment for manufacturing SMEs. To face this new business atmosphere, many companies have installed ERP systems in their enterprise to improve their business performance. It is evident that IT and ERP have a symbiotic relationship and to use ERP, SMEs need an IT system in their organization.

At the moment, the adoption of information technology in SMEs is very much limited. ERP is sufficiently flexible and can easily be used in general manufacturing enterprises. But two points are important for SMEs to consider prior to installing ERP. These important points are whether it is technically and financially feasible for the manufacturing enterprises.

It is evident that a tremendous amount of knowledge intensive activities are flowing within manufacturing enterprises [84] in order to improve their performance. Among the knowledge-based workflows, computer knowledge is expanding very fast. The growth in the use of manufacturing software has increased significantly. According to a Boston-based market analysis, the sale growth of ERP software was about 32% and the sales reached to US \$50 billion in 2002 [85]. ERP systems are usually installed in the traditional business management without making a major amendment in the existing business processes. In addition to that it can contribute to speed up the existing or old management system [86]. To utilize ERP as a management tool; skilled manpower should be developed within the manufacturing SMEs. The combination of ERP and the skills of the employees is a potential resource which can be used to make a profitable manufacturing enterprise. At present there are huge business opportunities for the manufacturing SMEs, it could be tapped by using ERP [87].

2.7 ENTERPRISE RESOURCES MANAGEMENT

The enterprise resources management (ERM) is defined as the proper and efficient use of the resources available within the enterprise. The enterprise has many tangible and intangible resources and for its growth, it is necessary to use those resources efficiently. Even the performance of the enterprise can be improved by good use of these resources. The enterprise resources management has the following main functions [87]:

a) Planning,
b) Execution,
c) Coordination Agent,
d) Communication and synchronization agents.

2.8 SUPPLY CHAIN MANAGEMENT IN MANUFACTURING SMEs

In the last few decades, SMEs have tried to adapt their manufacturing planning and business process to the increasing demand of customers. At the same time, these increasing demands have brought a change in price and in product quality [88]. These changes have also brought new methods for manufacturing process and planning. One new method, 'the supply chain management' has been introduced into manufacturing enterprises with the aim reducing cost of products, to achieve minimum delivery time, to minimize the inventory level and to increase flexibility in the products and to make after sale services faster.

2.8.1 Supply chain framework

Manufacturing SMEs are keen to adopt the supply chain in the manufacturing system to meet global business challenges. The global supply chain forum has defined the supply chain as a key component in a business process that integrates the end-users and suppliers through the products. The products may be services, hardware and information that add value for customers [88]. The basic parameters of the supply chain are the follows [88, 89];

(i) Vendor managed inventory,
(ii) Supply hubs,
(iii) Electronic marketing (Internet),
(iv) Advanced pilling system.

The supply chain is largely dependent on the internet. Some common use of the supply chain and internet are described in the following sections.

2.8.2 Strategic internet application in supply chain management (SCM)

The internet is evolving as a powerful force in the new competitive market that changes the information flow theory among the vendors, industries and the end users. It has been observed that internet technology has taken away the supply chain from its conventional position and set it into a novel position. Now SCM is a powerful tool, which is used to collect and distribute the information from supply sources to end-users.

According to Roberts and other researchers [90, 91, 92], the attachment of digital technologies with SCM, and the use of SCM is continuously increasing in the manufacturing field. It has been reported that by using the internet in SCM, about 8–35% materials handing and about 22–85% inventory cost have been reduced. It is also evident that about 12–42% efficiency in delivery system and about 17–68% business cycle time has been improved by the aid of internet in the business system.

Many applications of the internet in the supply chain have been identified and among them the following are the main:

(i) Networking both in home and abroad for raw materials sourcing and product sales,
(ii) Inventory management in production phase,
(iii) ERP and ERM,
(iv) Sourcing of manufacturing technology,
(v) Product distribution.

2.8.3 Use of internet in SCM for purchasing the goods

The use of the internet in supply chain has increased rapidly over the last few years. The application of these technologies is essential to speed up the purchase function. However, the internet has a wader application in industrial procurement, which includes [93, 94]:

a) Sourcing for vendors,
b) Sourcing for competitive price,
c) Technical specifications of the materials,
d) Delivery schedule of the materials.

It is generally acknowledged that, the internet is a potential tool for manufacturing industries in order to reduce the order cycle time.

2.8.4 Internet in inventory management

Inventory is one of the sensitive cost components in a manufacturing business. According to Mueller, inventory is a costly area in manufacturing SMEs and the internet can play a vital role to reduce the inventory cost. By installing the internet in enterprisers, about 30% of inventory cost could easily be reduced [95].

2.8.5 Internet in goods transportation system

In most manufacturing SMEs, the use of the internet has increased rapidly. The transportation of industrial goods is communication-intensive area. The efficiency in the transportation system can easily be increased by using the internet. In many cases the internet is used for rescheduling the transport of goods [96].

2.8.6 Internet in sales

The internet is getting preference also in the sales process. The Web is contributing significant benefits to the manufacturing industries to prepare quotation for clients. When this electronic device is used in sales, the cost of sale processing activities are reduced to a significantly [97].

2.8.7 Internet in after sales services

Repair and maintenance services, called after sales services, in time, are an important part of the ICM manufacturing business and the internet makes this activity easier. However, currently the internet is well used in almost all reputed manufacturing companies to provide after sale services [98].

2.8.8 Vendor relation and Internet

To maintain the effective flow of products and services, vendor relations are important and can be maintained by using the internet. The research shows that the application of the internet has increased significantly in the industries to monitor the stock level of raw materials at the vendor end. In addition to that, some buyers are keen to share their production schedule with the manufactures. The internet is creating these facilities by making a link between these two entities [99].

2.8.9 Firm size and the use of internet

It is evident that [100], larger firms are keen to use internet technology in their firms to speed up their business. It is evident that this tendency is low in the case of smaller sized firms. It is reported that in the most cases, the smaller firms are unable to use this technology in their business due to the lack of skilled employees and investment capability.

2.8.10 Applications of the internet in the management

The internet offers numerous benefits to logistic service providers by carrying and disseminating information. In the virtue of the internet, now customers could access the current information of tariffs and delivery schedules, cost of transportation and materials movement routes etc. Even a company can get quickly the information relating to their business by deploying the internet. The internet contributes many benefits to the business process and among them; the followings are the main [101]:

(i) Quickly adjust inventory level,

(ii) Add or reduce transport when needed,

(iii) Increase the speed in reacting to customer service,

(iv) More effectively manage communication irrespective of distance,

(v) Reduce the level of paperwork,

(vi) Purchase material throughout the business cycle when necessary,

(vii) Shipment more accurately,

(viii) Develop cost-effective purchasing strategies,

(ix) Improve quality in production schedule,

(x) Reduce operational redundancy.

2.9 BARRIER OF MANUFACTURING ENTERPRIESES

ICM manufacturing is a difficult undertaking; it is especially difficult for firms that have little experience or resources. Small firms in less developed countries have to face many barriers to manufacturing in addition to their limitation of size, infrastructure and tangible resources [102].

2.9.1 Dimension of barriers to manufacturing

According to Piatier [103], the measurement of the impact of barriers to the manufacturing is a difficult task. In general, manufacturing barriers have two main parts, which are [104]:

a) External barriers

b) Internal barriers

External barriers can be further subdivided into few parts;

Barriers in supply;

This barrier includes the difficulties in obtaining technological information, raw material and finance.

Barriers in demand;

Demand barriers include customer needs, domestic or foreign market limitations.

Barriers in policy;

Policy issues include government regulations and policy actions.

Internal barriers: Internal barriers can be further divided into resource related components.

The internal barriers can be further divided into the following groups [105];

(a) The lack of internal fund,

(b) Technical expertise,

(c) Management capabilities,

(d) Business culture and outdate accountancy systems,

(e) Human nature and the attitude of top manager to take risk in the business, or the resistance of employees to innovation.

Small and medium sized enterprises face internal and external barriers during manufacturing activities. These barriers occur in developed and developing countries. This is why, world wide more emphasis has been given by manufacturing SMEs in studying their barriers to the business process. SMEs need support to over come external barriers and in addition to that, they need technology and resource in order to develop themselves. However, research suggests that if SMEs get supports, they can become a more powerful organization in the manufacturing sector compared to large enterprises [106].

Studies on barriers to manufacturing in this context are relatively rare but there have been some studies on barriers to innovation undertaken by Levy [107] and Lall et al. [108]. The dimensions of the internal and external barriers to manufacturing come from the socioeconomic environments. According to Granovetter [109], the barriers consist of the enduring wave of relationships of customers, suppliers, bankers, trade associations etc. Although, the manufacturing firms are in the face of socioeconomic barriers, they always find a way out of it by employing their limited resources, management capabilities and appropriate manufacturing strategies. Inadequate financial capability is considered the major barrier to growth of the manufacturing SMEs. It is a common complaint from the SMEs that the commercial bank insists submitting collateral for new financing [110]. This attitude has an adverse effect on the growth of the manufacturing SMEs.

In a study in Ghana a developing country, some barriers have been identified by Lall et al. [108]. They were investigating the barriers to the development of technological capability of firms which has also some relevance with the innovation capability of the manufacturing. They were studying the barriers in relation to financial constraints, the lack of managerial skills, and short supply of skilled technicians, and the lack of local linkages with the information network. The result of this study suggests that there is a strong and negative correlation with the growth of technology and the barriers (i.e barriers have a strong tendency to reduce the growth of technology in the society).

2.9.2 External barriers

Some top ranking external barriers to the manufacturing enterprises have been identified and are shown in Table 2.6. It can be seen from the table that there are the origin of three barriers. The three barriers are as follows:

(a) S&T policy of the government,
(b) Import policy of the government,
(c) Industrial policy of the government.

It can also be seen from Table 2.6 that the forward and backward supply has some impact on the growth of the manufacturing enterprises.

Table 2.6 External barriers to the manufacturing SMEs [102,105].

Sl no	Internal barriers
1	High tax on raw materials
2	Quality (ISO) certificate
3	Lack of information of demand
4	Short supply of skilled technicians
5	Local payment terms
6	Lack of demand for locally made products
7	Bank finance
8	Access to information on manufacturing technologies
9	High VAT on sales
10	High Tax on sales
11	Low quality of raw materials
12	Lack of technical training facilities
13	Import policy
14	Limited access to research
15	Lack of co-operation with other firms
16	Lack of responsiveness to the new product development
17	Wages policy
18	Government bureaucracy
19	Subcontracting system
20	Government attitude towards the development of manufacturing SMEs
21	Lack of industrial engineering and technological capabilities

2.9.3 Internal barriers

The top ranking internal barriers to the manufacturing enterprises has been identified and shown in Table 2.7. It can be seen from the table that the origin of barriers are three. The three barriers are as follows:

(a) Government policy industries,

(b) In-house supply chain

(c) Lack of manufacturing infrastructure

Table 2.7 Internal barriers to manufacturing SMEs [102,105].

Sl no	External barriers
1	Lack of product promotion work
2	Lack of documentation capabilities
3	Lack of lab facilities
4	Lacks of manufacturing infrastructure
5	Lack of time (one man responsible for many job)
6	Lack of qualified management
7	Inadequate financial means
8	Inadequate R & D facilities
9	Lack of motivation for the work force
10	Lack of market survey facilities
11	Lack of local demand
12	Lack of human resources development policy
13	Lack of industrial engineering and technological capabilities

Both external and internal barriers could be overcome by manufacturing firms and the government agencies making joint efforts. Adequate training, implementation of development policy, co-ordination among the trade bodies and strategic planning are the tools that could help to overcome the manufacturing barriers.

2.10 EFFECTIVE MARKETING TOOLS FOR MANUFACTURING SMEs

The last few decades of 20^{th} century have witnessed a significant growth in sales and marketing techniques. The manufacturing companies of a few developed centuries are enjoying a unique manufacturing advantage and are continuing to remain as the leaders in the market place. The manufacturing of capital machinery is both a highly S & T (science and technology) and a capital intensive business. Maybe, this is one of the main reasons why the ICM manufacturing businesses all most remained exclusive within the developed countries. But, in recent years, a part of the ICM manufacturing activities have moved to the newly industrial developed countries (NICs). This development has created pressure on the firms working in the developed countries and these firms are facing more difficulties in the market. [111, 112]. In order to stay as important leaders in the market place, new marketing and promotion tools have been introduced by manufacturers. Among the potential tools, web based marketing is the top most one. Web-based marketing tools have become popular in the recent years. Manufacturers and buyers are becoming dependent on the web system. The web-based sales have been increasing faster in the world market. However, it is reported that in 2001, the web-based sales figure was about US$ 48.3 billion, at an annual growth rate of 45.9% [113].

2.10.1 Marketing tools in manufacturing SMEs

Some important and popular sales and marketing tools have been identified from the literature and is shown in Table 2.8 [114].

Table 2.8 Important Marketing tools.

Sl no	Marketing tools
1	Product image
2	Reputation of the company
3	Price of the products
4	Personal sales effort
5	Having a strong service organization
6	State of art technology
7	Advertising Media
8	Web based marketing

2.10.2 Product promotional tool for manufacturing SMEs

Product promotion activities are popular in the market. Some important product promotion tools which are commonly used by the manufacturers are shown in Table 2.9 [115].

Table 2.9 Product promotion tools.

Sl no	Product promotion tools
1	Sales and sales management
2	Use of yellow pages
3	Sales promotional materials
4	Advertisement in trade magazine
5	Web-based advertisement
6	Technical seminars
7	Advertisements in news paper
8	Use of television

Currently, the ICM manufacturing enterprises are facing the ongoing challenge of globalization. The business environment, marketing efforts and techniques are becoming more important in an open economy system in an attempt to capture the strategic share.

It can be seen from Table 2.9 that product image (reputation of the brand) is the top most ranking tool for products promotion. The web-based marketing and the brand image are also getting priority. The brand image and the reputation of the company are also important tools as well to the manufacturers. The Yellow Pages is very popular in both developed and developing countries.

2.11 R & D CAPABILITIES OF THE ICM MANUFACTURING SMEs

The manufacturing activities of the ICM manufacturing enterprises are largely dependent on the R & D and S & T capabilities. SMEs have limited resources to carry on in-house R & D, but these facilities are essential for them to maintain the quality of product and to improve manufacturing process.

The current open market system has changed the character of demand of the machinery. The end users want operating flexibilities in machinery and in machine tools. To have cheaper technology in the manufacturing system, SMEs are forming strategic alliances with other organizations in order to reduce expenditure on R & D activities.

It is evident, that over last two decades there has been a fundamental change in the way of innovatory activities. The richest organizations are keen to invest in R & D activities for the development of new products and improvement in quality. Manufacturing SMEs are overcoming these barriers by forming strategic alliances [116] with capable firms, universities and private research organizations.

2.11.1 Collaboration for R&D

Literature on innovative activities highlights the fact that the manufacturing enterprises bring a change in their business activities. The enterprises tend to avail of higher R & D facilitates by exploiting the knowledge that created by the larger firm [116, 117]. SMEs are enjoying the result of R & D through the collaboration process with the larger firms. This alliance has brought benefits for SMEs. However, the larger firms are also keen to form an external network as a core part of their development strategy and they also willing to form collaboration facilities with SMEs. By this process, both of them manage to increase their manufacturing flexibility [118, 119].

2.11.2 Expenditures on R & D and S & T

It is evident that the developing countries spend an insignificant amount on S & T and R & D for the development of their manufacturing capabilities. In developing countries, the R & D budget is substantially less compared to developed countries. Table 2.10 and Figure 2.4 present a report on the expenditure of R & D and S & T for the year 2003 of some developing and developed countries [120].

Table 2.10 Expenditure on R & D and S & T of GDP [121].

COUNTRIES	GDP US$	Industrial contribution on GDP	Expenditure on R&D and S&T VS GDP
USA	10.4 trillion	18%	2.5%
GERMANY	2.184trillion	31%	2.25%
UK	1.52 trillion	24.9%	2.0%
JAPAN	3.55 trillion	30.9%	3.0%
FRANCE	1.54 trillion	26%	2.1%
S. KORIA	931 billion	41.4	3.0%
CANADA	923 billion	26.5	1.5%
AUSTRILIA	528 billion	26.0	1.4%

Table 2.10 shows that, Japan has spent about 3% of their total national GDP on research and development, while 22 developing countries have spent about 0.22% on the R & D activities [122].

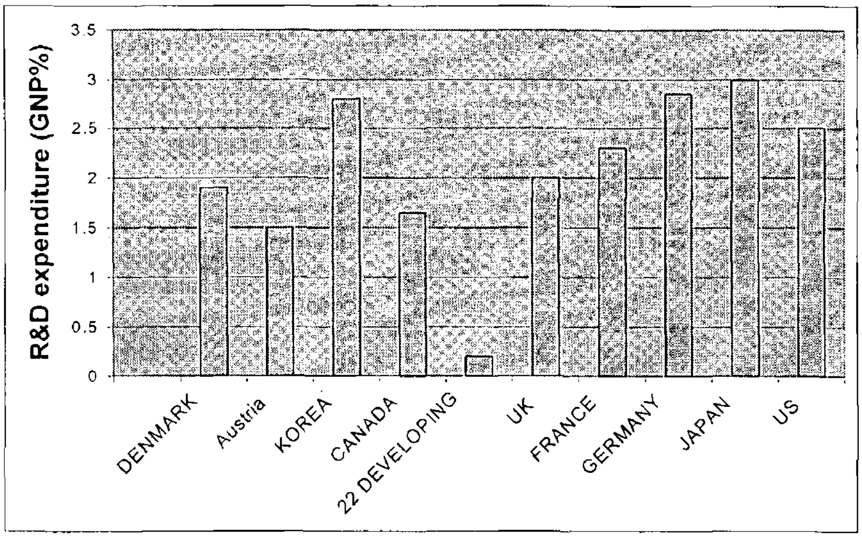

Figure 2.4 Investments on S & T and R & D [122]

It can be seen from Figure 2.4 that investment in S & T and R & D for the developing countries is low and it is generally acknowledged that the manufacturing capabilities of the developing countries are poor. On the other hand, the manufacturing capabilities of ICM in the developed countries are high [123]. Based on the data shown in the table and figure, and from the guide line obtained from the literature, it could be stated that the expenditure on S & T and R & D could speed up the growth of the ICM manufacturing capabilities.

2.12. INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN MANUFACTURING ENTERPRISES

Technology plays an increasingly important role in all aspects of business. Information and communication technology (ICT) has created the most important technological advantages in manufacturing SMEs. This technology has made a radical change in the manufacturing SMEs by introducing networking system among the suppliers, manufactures and end users [124]. Large manufacturing firms have adopted higher-level communication facilities in the manufacturing system. Smaller firms are reluctant to use this ICT management in their enterprise.

The benefits of this technology are important for the growth of manufacturing SMEs. Most of the manufacturing SMEs are now aided by ICT to collect information of manufacturing technology for the development of their products. Presently, new materials, design parameters and product development information are used to collect data through the internet. Data collection and transfer to a partner can easily be done through ICT. By using this technology, workload can be reduced significantly. However, today the ICT is an effective tool, which is used to increase the performance of manufacturing business [125, 126].

2.13 CONTRIBUTION OF MANUFACTURING SMEs TO EMPLOYMENT AND THE ECONOMY

The strategic importance of small and medium-sized enterprises (SMEs) is widely acknowledged in both developed and developing countries. The contribution of SMEs to employment and industry is ultimately turned the development of economy. In the context of south East Asian countries like Singapore, Taiwan, Thailand and South Korea, about 91-93% of the industrial establishments are within the SMEs group [127]. In those countries, the contribution of SMEs to employment ranges from 35-61% and the contribution to value added product ranges from 22-40% [128].

In case of Russia, it has been reported that in the year 2000, approximately 7 million people were employed by SMEs [129] and the average number of permanent employees per single SME were about eight [130]. In Bangladesh, the employment in SMEs is over 80% and the growth rate of employment in SMEs is about 11.56% [131]. The contributions to employment in the UK and the USA are about 90% and 88% respectively. In deed, irrespective of the countries, the contribution of SMEs to employment ranges from 75-95% and thus, SMEs become a generator for making opportunity for employment and economy [132].

2.14 GOVERNMENT SUPPORT FOR THE DEVELOPMENT OF MANUFACTURING ENTERPIRSES

In most developed and developing countries, the governments have initiated some policies for the development of their SMEs sector. It is evident that many countries embarked on the industrialization process based on the manufacturing SMEs [127]. In order to overcome growth barriers, the governments of those countries have established agencies to implement the development policies to speed up the growth of their manufacturing enterprises. The governments of the different countries have offered intensive facilities for the development of manufacturing enterprises and among them financial and credit assistance, technical support for the development of technological capability, extension and advisory services, sales and marketing research and support for infrastructure facilities are main [127].

2.14.1 Financial and credit assistance

World wide some specialized institutions are available to provide financial support and credit assistance to SMEs [132]. In the case of Malaysia, the government has established a number of institutions to provide financial assistance in order to achieve rapid growth in manufacturing enterprises. The Small and Cottage Bank, commercial banks and finance companies of Malaysia are giving soft loans at a lower interest rate [127,133]. In Bangladesh, Small and Cottage bank, Brack bank, Grameen Bank and Islami Bank are also giving soft loans to SMEs. In addition to that, the World Bank, small and medium scale Enterprises and the other International Agencies have taken programmes for the development of SMEs by providing funds at a lower cost [134, 135, 136].

2.14.2 Technical and training assistance

It has generally been acknowledged that the availability of adequately well-trained, skilled workers, engineers and managers are essential for the development of ICM manufacturing SMEs. Under Technical and Training Assistance Programmes, the governments of different countries have offered some technical support. This support can be grouped in to the following two categories [137]:

1. Entrepreneurial development and business management training,
2. Skill development training.

Training for entrepreneurial capacity building and business management are the major issues that are considered for the growth of manufacturing SMEs. The training programmes are usually funded by the government and eventually, they are also aided by the World Bank and the other International Development Agencies.

2.14.3 Extension and advisory services

The supports that are given by the governments for the extension and advisory services which are mainly cover the follow-up activities of business. The identified advisory supports are the followings:

(a) Management consultancy,

(b) Training for the improvement of business performance,

(c) Training for business planning,

(d) Accounting system, preparation for regular income statement, cash budget, cost analysis for production and investment,

(e) Banking, loan repayment policy and financial statement.

2.14.4 Marketing and market research

Problems in sales and marketing of the products are common in manufacturing SMEs. To overcome this problem, in both developed and developing countries, several government agencies have been established to provide marketing consultancy. Even in many counties, non-government organizations (NGOs) are working to provide marketing consultancy services to develop sales and marketing network in order to distribution the products. The NGOs are also providing support in set up shopping centres, office complexes and bazaars and in addition, supports are available for preparing sales brochures [137].

2.14.5 Infrastructure facilities

It is evident that in many developing countries, the government-funded agencies are working to provide infrastructure supports for the development of manufacturing SMEs. Namely, the free trade zones (FTZs), the light-industrial zones (LIZs), the licensed manufacturing warehouses (LMW) and the custom houses have been established and based on this organization, the infrastructure supports are provided.

In those areas, basic infrastructure facilities such as electricity, water, telecommunications and the other basic facilities have been installed and made available for SMEs at an affordable cost [135,136].

2.14.6 Manufacturing technology in South East Asian countries

In the developing countries, usually the ICM manufacturers have limited access to the local machinery market, but the newly-developed countries successfully manage to overcome this barrier. Some newel developed countries like Malaysia, Korea, Taiwan, Thailand and Singapore have embarked on ICM manufacturing industries by the virtue of their industrial management capabilities.

In the middle of the last century, the economy of many South East Asian countries was poor. The level of education, S & T capabilities and manufacturing industries were weak in these countries. In the early 1960s, their economies were labour driven and agriculture was the main economic sector. The natural resources were unused due to the lack of process industries [138].

In the last few decade of the previous century, these countries built up their S & T infrastructure, R & D facilities and industrial capacity. This enabled them to establish an industrial base and now, many of those NICs have set up their new target towards achieving the knowledge base economy [139].

Even in the last quarter of the 20th century the economic condition of some developing countries were still continuing to remain poor and Bangladesh was one among them. Bangladesh and other developing countries can take directions and lessons from the NICs to develop their industries and economy.

(i) Korean Experience in ICM manufacturing

At the beginning of the Korean economic development plan numbers of few sectors were chosen for the development of the national economy and among these were manufacturing industries, S & T, the light engineering. The Korean government started to build a technological infrastructure within the county by establishing technical institutes and research laboratories in order to supply technical knowledge to industry. Huge numbers of universities were also established to provide the necessary human resources to excel the industrial development activities [140].

In the beginning, the industrialization process was started by importing capital machinery and technologies on a turn-key basis from developed countries. Korean engineers and scientists started to learn industrial technology from the imported capital machinery. They performed full cycle reengineering on the imported industrial capital machinery starting from structure of the machine, producing the manufacturing drawings, rebuilding the old machines and finally, production of new machinery. In the whole cycle, the Korean government, entrepreneurs and S & T groups worked together to develop the manufacturing capabilities of capital machinery and industrial technology [141].

Soon after achieving the manufacturing capability of industrial capital machinery and acquires the knowledge of industrial technologies, they have taken the restructuring process of the nation industrial policy. The government, technology development groups and industrial entrepreneurs gave support to Korean ICM manufactures to create their market in the local industries. Under these facilities, huge numbers ICM manufacturing SMEs [142] were started up. Staying at this favorable environment, ICM manufacturing enterprises have started to supply capital machinery to the manufacturing industries. Based on the locally made machinery and indigenous industrial technologies, the Korean manufacturing industries speeded up and finally they achieved their present status.

(ii) Malaysian experience in ICM manufacturing

Right at the beginning of the execution of first five-year economic development plan (1965-70) [143], Malaysia started to set up conventional industries to meet the local need for commodity products. Government has taken expansion programmes for light engineering enterprises in order to provide peripheral and low-tech machinery to these industries.

The government of Malaysia has established numerous technical institutes and research centers in order to build S & T capabilities. Experienced engineers and scientists were engaged for industrial research. The research programmes were aided by government funding. Under full government support, Malaysian S & T and industrial technology reached a sustainable level. [143]. In the period of the 2^{nd} five-year plan (1970-75) and up to the end of the 3^{rd} five-year plan (1975-80), the Malaysian labour driven economy started to change towards the industrial economy and the change in economic structure was speed up at the time of 4^{th} five-year master plan (1985-90) [143].

During those periods, direct foreign investments were highly encouraged. Foreign and local entrepreneurs started to invest in industries under the full support of the government. Huge industrial plants were setup based on the imported capital machinery and technologies. The imported capital machinery and technologies have also played an important role on the development of technological capability in this country. Local scientists and engineers started to learn from the imported machinery and technologies and slowly this knowledge and experience was transferred to the ICM manufacturing industries.

After aching manufacturing capability of ICM and industrial technology, government has taken the restructuring process of industrial policy. Under the revised industrial growth policy, the industrial technology group got chances to develop technical documentation for the implementation of industrial projects; entrepreneurs were encouraged to buy locally made capital machinery and available industrial technologies. Malaysian entrepreneurs enjoyed locally available industrial technologies and capital machinery and in this favorable environment; the manufacturing industries started to grow [144].

Thailand, Taiwan, China, Malaysia, Korea and other NICs had similar economic development plan but their execution policies and strategies were different. Many local and regional factors and political issues influenced their national economic development plan. Among these factors were social and cultural values, investment climate, political commitment, quality of education, level of S & T, communication infrastructure, financial support from the friendly countries and commitment of the international funding agencies were the main [145].

In general, the level of S & T, applied research capability and technological infrastructure has created an investment climate for ICM manufacturing business. Industrially developed counties always pay full attention to secure local ICM manufacturing industries against the threat of imported machinery and at the same time, they open the home market for locally made machinery. The developing countries can learn from the developed counties and the NICs in order to develop their ICM manufacturing sector.

2.15 MANUFACTURING ENTERPIRISE OF CAPITAL MACHINERY IN BANGLADESH

2.15.1 The history of light engineering enterprises in Bangladesh

The ICM manufacturing enterprises of Bangladesh achieved organizational shape in 1940s [146]. At the beginning, this sector started to provide services to agriculture [147]. In the period 1947-1960, this engineering based enterprises started to grow. The investment growth rate in the ICM manufacturing sector increased rapidly during the late 1960s and in the late 1960s, some ICM manufacturing SMEs had established in private and public sectors.

The private SMEs had been setup to provide support to the jute textile, tea and other agricultural industries. At that time, the main products of this sector were spare parts, peripheral and some generic machinery. Since then, the reverse engineering methodology had been adopted in the manufacturing process in order to increase the products. In the early 1960s, a few numbers of larger scales public manufacturing enterprises were to set up and by the end of 1970s, these projects had been completed.

By the mid 1980s [148, 149], some ICM manufacturing SMEs had been established in a number of cities. In the 1967, government realized that manufacturing enterprise of industrial capital machinery is an essential sector [150, 151]. Based on this realization, the Bangladesh Small and Cottage Industries Corporation (BSCIC) was established. The target of this organization was to provide support to ICM manufacturing SMEs [152]. At the beginning, BSCIC took some programmes in order to provide some basic supports to private entrepreneurs to build ICM manufacturing enterprises.

Since early 1980s, both private and public manufacturing enterprises started to grow. Starting from the late 1980s [153], the private sector started to grow faster than the public sector and consequently, the private sector stated to dominate manufacturing-sector of capital machinery.

2.15.2 The nature of ICM manufacturing enterprises in Bangladesh

The ownership pattern, size in terms of number of employees, capital investment and the average age of firms were not found in well documented form. But some partially and incomplete information relating to this sector were obtained from some sources. The available information was described in the next sections under the following captions:

* Contribution of manufacturing enterprises to the GDP in Bangladesh,
* Sourcing options of capital machinery for manufacturing industries,
* Impact of government policy on the growth of ICM manufacturing SMEs,
* Government policy supports for the development of manufacturing enterprises.

2.15.3 Contribution of manufacturing enterprises to the GDP in Bangladesh

It is estimated that 250,000 manufacturing companies are in operation in Bangladesh. It is reported that directly and indirectly about 5.0 million people are engaged in this industrial sector [153]. Census on manufacturing industries shows that about 88% of manufacturing industries belong to the SMEs group [154]. The contribution of manufacturing industries to GDP is obtained from the distribution of national GDP. Table 2.11 presents the distribution of GDP for the period 1998-2003.

Table 2.11Contribution to GDP [155].

Sectors	1998-99	1999-2000	2000-01	2001-02	20002-03
Agriculture (%)	25.28	25.58	25.43	23.78	23.47
Manufacturing industries (%)	27.70	25.71	25.84	26.75	27.17
Service industries (%)	47.02	48.71	48.73	49.27	49.36
Total	100	100	100	100	100

It can be seen from Table 2.11 that the contribution of manufacturing industries to GDP is about 26%. It is reported that, the contribution of SMEs to the GDP is about 80% [156]. The manufacturing SMEs contribute about 33% of value added products to the GDP [157]. The distribution of manufacturing SMEs was shown in Figure 2.5 [158].

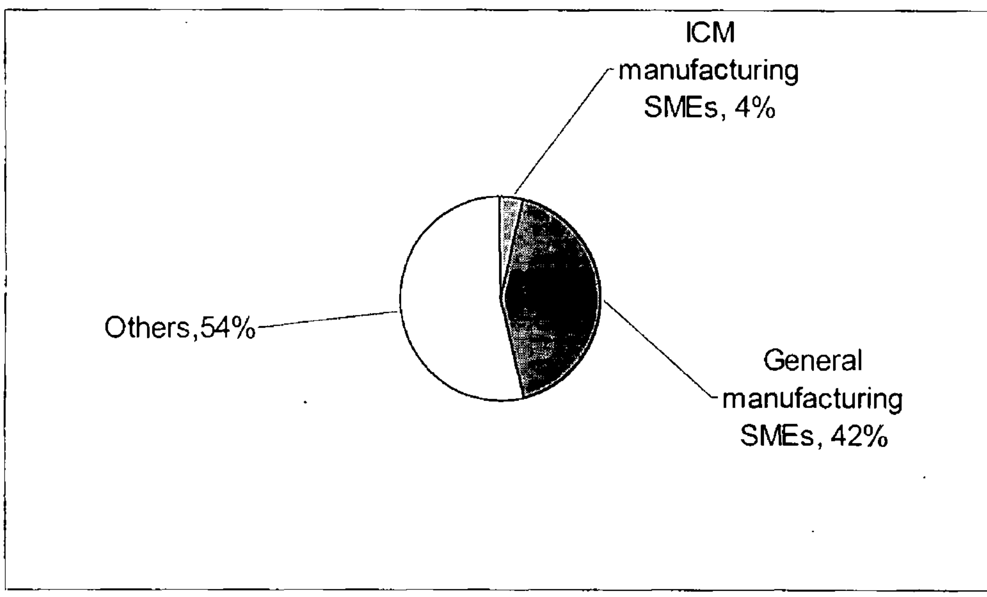

Figure 2.5 Distribution of SME

It can be seen from Figure 2.5 that the percentage of ICM manufacturing enterprises is very small and the share is about 4% of the entire SME. In the last few decades, the growth of ICM manufacturing SMEs is not significant and its contribution to the manufacturing SMEs is also very limited. The growth of general manufacturing SMEs is better than ICM manufacturing enterprises and its contribution to the national economy is significant. The growth of small and cottage industries and its contribution to employment is shown in Table 2.12 [153,159].

Table 2.12 Distribution of employment in SMEs.

Year	Number of unit		Employment (per thousand)	
	In small enterprises	In cottage enterprises	In small enterprises	In cottage enterprises
1961	16331	234,934	143.800	53.100
1978	24005	280,000	322.100	NA
1981	24590	321,000	NA	655.200
1990	38104	403,237	NA	1,331.000
1991	38294	NA	323.000	NA
2001 (June)	55280	511,621	808.900	1,664.700

It is evident from Table 2.12 that the growth rate of employment in small and cottage industries is insignificant compare to the size of 140 million citizens in the country.

2.15.4 Sourcing option of capital machinery for manufacturing industries

Bangladesh is a developing country; its industrial development is highly dependent on foreign equipment and machinery sources [160]. It is reported that Bangladesh is spending a huge amount of money to import capital machinery for the development of its manufacturing industries. In a typical year, Bangladesh spends about 7% of its total import budget on foreign capital machinery. This situation is continuing since early stage of its industrialization. Currently, Bangladesh is used to import capital machinery from 20 friendly countries. The major ICM suppliers are shown in Table 2.13.

Table 2.13 indicates that Japan is enjoying the highest share of the machinery market in Bangladesh. Singapore a small country is enjoying the second highest share and china is in third position. The highly industrially developed countries like the USA, the UK and Germany are enjoying less market share compared to Japan, China and India. The data shown in Table 2.13 indicates that, Bangladesh has a tendency to import capital machinery from the low industrially developed countries. From the data it is clear that, manufacturing industries in Bangladesh are more inclined to Asian countries for its capital machinery.

Table 2.13 Major sources import of capital machinery [161].

Countries	Import in 1999-2000 US$ in million	Share in percentage
Japan	191.2	16.2
China	148.7	12.6
UK	70.7	6.0
Germany	55.5	4.7
India	107.7	9.1
Singapore	172.3	14.6
USA	79.1	6.7
South Korea	48.4	4.1
Russia	21.2	1.8
Hong Kong	15.3	1.3
Italy	24.8	2.1
France	51.8	4.4
Taiwan	22.4	1.9
Switzerland	9.4	0.8
Denmark	10.4	0.9
Malaysia	9.4	0.8
UAE	11.8	1.0
Other countries	130.0	11.0

The size of total investment on capital machinery for the period 1998-2003 is shown in Table 2.14. In 1997 the investment on ICM in Bangladesh was 152.3 million [162]

Table 2.14 Distribution of investment on capital machinery

Period	Investment on ICM US$ Million	Investment growth (%)
1998	204.22	33.0
1999	286.77	40.42
2000	342.17	19.31
2001	461.84	34.97
2002	582.70	26.16
2003	727.0	24.76

2.15.5 Government policy support for the development of ICM manufacturing enterprises

A few organizations have been established by the government of Bangladesh to provide trainings and support services for the development of ICM manufacturing SMEs. Among those, a training institute for small and cottage industries (SCITI) has been set up under the governance of the Small and Cottage Industries Corporation of Bangladesh. The

SCITI designed its training program under the co-operation of Bangladesh University of Engineering and Technology, University of Dhaka and other professional bodies. This co-operation enriches the quality of training programme and has brought about some effective results for SMEs [163]. Fundamental training programme is offered by the SCITI for SMEs in order to develop entrepreneurial skills. A Few other non-government organizations (NGO) are also offering comprehensive programmes for this sector to improve its productivity. Among those the NGOs, BRAC, GRAMEEN BANK and PROSHIKA are the main organizations.

These organizations have offered training for the development of entrepreneurial, managerial, marketing and communication skills. The Small and Cottage Industries Corporation of Bangladesh has offered a comprehensive package, which includes financial assistance, infrastructure support for manufacturing, sales network through sub-contracting system, land and other logistics. In addition to that, a bank has been set up under the governance of BSCIC to provide financial assistance to the enterprises. Industrial estates (park) have also been established in almost all districts by the BSCIC in order to provide electricity, gas, water, land and other manufacturing facilities [164].

2.15.6 Impact of Government Policy on the growth of ICM manufacturing SMEs

Dual tax policy has been observed in the structure of import duty. It has been observed that the import duty and VAT on the raw materials ranges from 37-60%. In contrast, the import duty on the industrial capital machinery ranges from 3.5-7.5%. This is a serious anomaly in the government policy that has an adverse effect on the growth of ICM manufacturing enterprises.

16 PRINCIPAL FINDINGS FROM LITERATURE SURVEY

Literature suggests that the major contribution to the world economy is coming from the manufacturing industries and it is also evident that capital machinery are the engines for the industries. The experts believe that to speed up the growth of the national economy, it is essential to give effort to improve S & T facility through which engineering based manufacturing enterprises can grow in order to supply capital machinery to the manufacturing industries.

Bangladesh is one of the least developed nations in the world and manufacturing industries are dependent on foreign supply sources for its capital machinery. In deed, this situation has continued in the last few decades but there was no documented evidence of efforts in the literature produced by researchers or government bodies, towards getting out of this unfavourable situation.

The results of this literature survey suggest that there is scope of work on the manufacturing enterprises of capital machinery in Bangladesh. Based on these findings the objectives of this study have been identified and research methodology has been designed.

17 THE PRINCIPAL OBJECTIVES OF THE RESEARCH

The current study will investigate the market potential of industrial capital machinery (ICM), barriers to growth and government policy support issues towards the development of ICM manufacturing SMEs in Bangladesh in order to establish the scope of contributions of engineering based manufacturing sector to the national economy. The following areas were included in study programs to establish the aims:

1. Focus on the insight of manufacturing industries in Bangladesh.
2. Identify the barriers to the use of locally develop industrial resources in manufacturing industries.
3 Develop a mathematical model for manufacturing cost of industrial capital machinery
4 Undertake modeling of the growth in market size for industrial capital machinery in Bangladesh.
5. Undertake modeling of the demand for locally made ICM in Bangladesh.
6. Identify the barriers to growth of ICM manufacturing enterprises in Bangladesh.
7. Scope of contribution of the ICM manufacturing enterprises to develop the manufacturing enterprises.

18 RESEARCH METHODOLOGIES

A survey manufacturing industries and case studies on the manufacturing of capital machinery were the principal methods for this current research. The work programmes for this study are outlined in the flow chart shown in Figure 2.6.

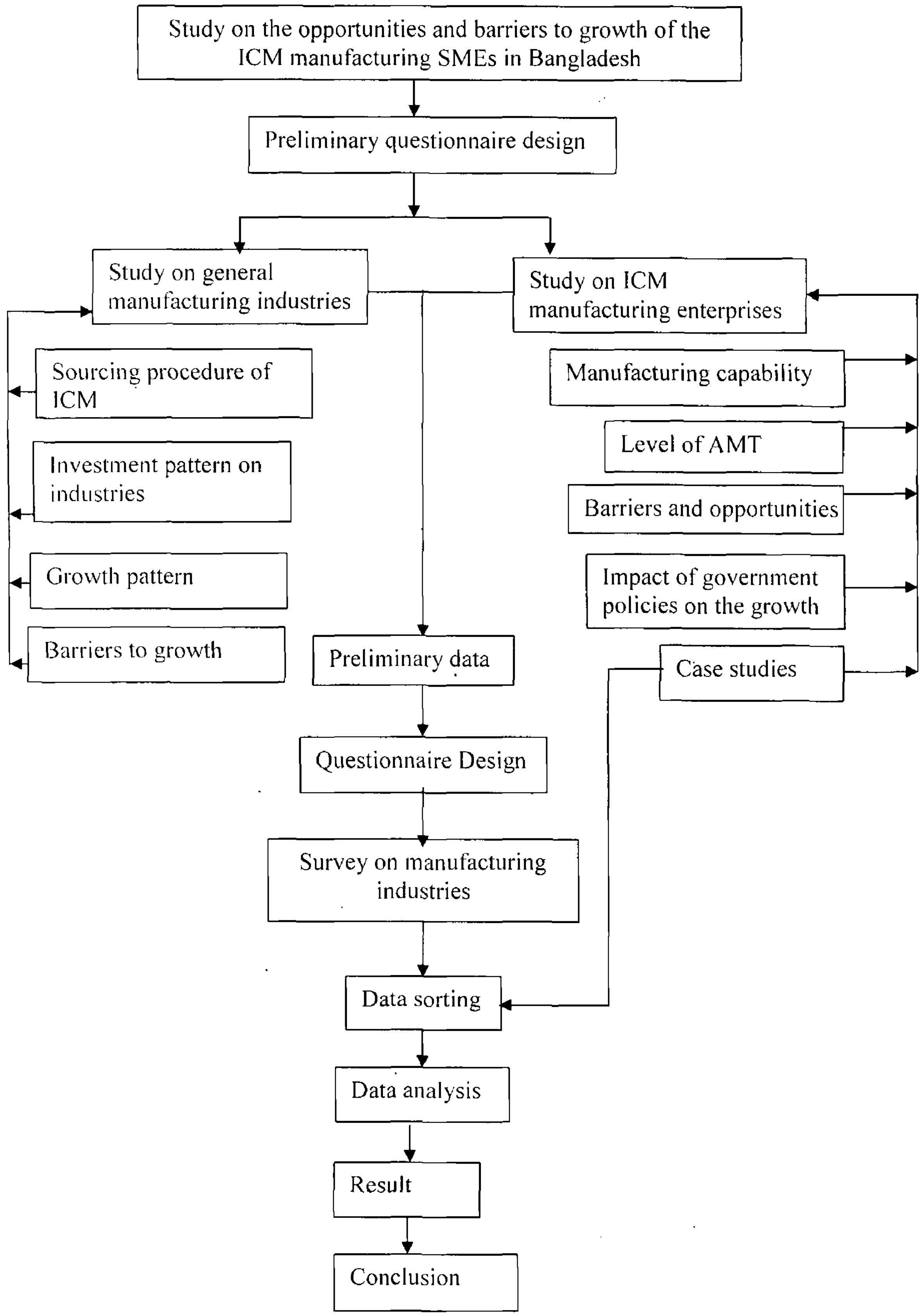

Figure 2.6 Research methodology

CHAPTER 3

Initial study on the current state of Manufacturing Industries in Bangladesh

3.1 INTRODUCTION

This initial study programme was designed to obtain information on the current state of manufacturing industries in Bangladesh in order to a design survey questionnaire to execute the research. As the documented evidence of the present state of manufacturing industries was not available, by following the research methodology [165], a preliminary questionnaire was designed to implement the visit programmes so as to generate basic information on the industries.

Sixty-five general manufacturing industries and one hundred and sixty manufacturing enterprises of ICM were selected from the 'Yellow Pages' and printed documents of the relevant trade bodies. To select the enterprises from both sectors, some general criteria was formulated and used, such as the nature of products, size, age and reputation of the companies.

General manufacturing industries were visited in order to gather data relating to the strategy for the implementation of industrial projects and the procurement of capital machinery, the adoption of industrial technology, and investment pattern and barriers to the use of locally available industrial resources.

The manufacturing enterprises for capital machinery were also visited to obtain information and documents on the relevant issues. During this study, concentration was given on the size of the enterprises in terms of the number of employees, experience in terms of the age, sale strategy, and range of the products, wage structure, manufacturing capability, barriers to manufacturing and the impact of government policies on this sector.

In addition, three case studies were carried out on the manufacturing of industrial capital machinery in Bangladesh in order to study the impact of import policy on the price of the locally made machinery. This initial data was analysed by using standard research techniques and the results were presented in tabular and graphical forms. The data processing method is presented by the flowchart.

Data processing -method

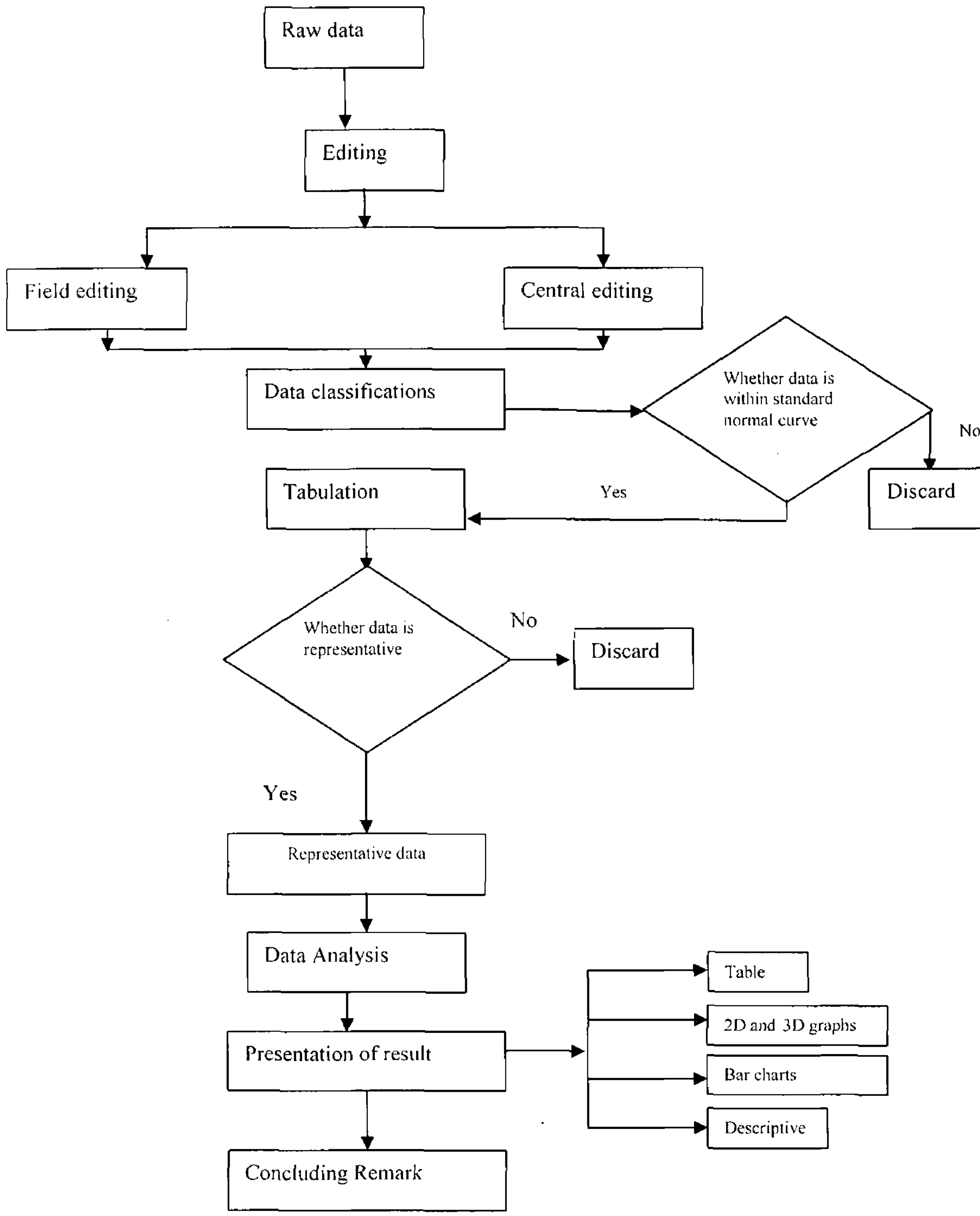

Figure 3.0. Data processing methods

Quality improvement procedure of Data

Reliability test of data:

Data were accepted and used if these were under the normal distribution curve and the normal distribution curve was drawn by following frequency distribution and histogram theory.

Representative data:

Any data which were out side the 3 (σ- standard deviation) range were discarded.

3.2 STUDY ON GENERAL MANUFACTURING INDUSTRIES IN BANGLEDSH

Sixty-five manufacturing industries were identified for visiting from the pre selected thirteen industrial sub-sectors. The distribution of the selected industries is shown in Table 3.1.

Table 3.1 List of the industrial sub sectors [166].

Sl NO	Industrial sub sectors	Number of industries
1.	Pharmaceutical industries	7.0
2.	Fruit juice manufacturing industries	4.0
3.	Carbonated drink manufacturing industries	5.0
4.	Fish processing industries	6.0
5.	Textile industries	7.0
6.	Garments industries	6.0
7.	Vegetable oil processing industries	4.0
8.	Tea processing industries	5.0
9.	Leather processing industries	6.0
10.	Sugar cane processing industry	3.0
11.	Drinking water bottling industries	4.0
12.	Dairy processing industries	4.0
13.	Fertilizer and chemical industries	4.0
	Total	65.0

3.2.1 Visit programmes in the general manufacturing industries

The visit programmes were designed to gather data and information on the following industrial operations:

i. Implementation of industrial projects,
ii. Distribution of investment on the implementation of industrial projects,
iii. The use of locally available indigenous resources in the industries,
iv. The use of sourcing tools for the procurement of capital machinery,
v. The strategy for the procurement of all industrial plant machinery,
vi. Barriers to procurement of locally made industrial capital machinery,
vii. Pattern of investment for all capital machinery.

3.2.2 Implementation of industrial projects

To identify the major functions of implementation of the industrial project, the procedure of information flow in every step was thoroughly observed [167] and which are shown in Figure. 3.1.

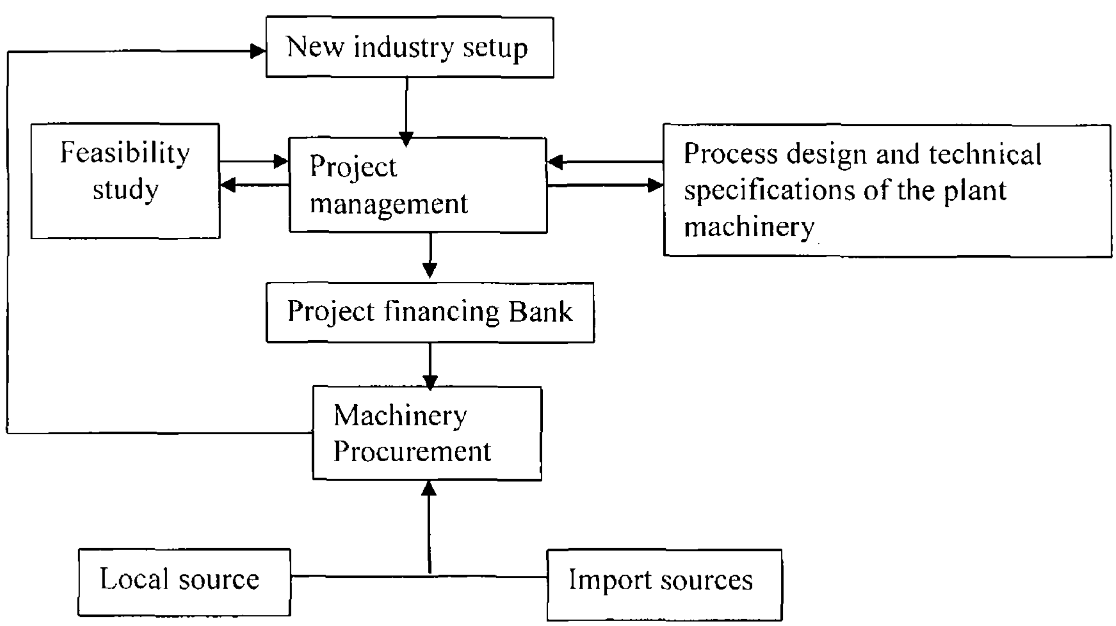

Figure 3.1 Flow chart for industrial project implementation

In the industrial project implementation process, many private and government agencies are involved. To perform the entire job, inputs from multi-professionals are also needed. At the initial stage, one process design engineering company is usually employed to prepare the technical specifications for the proposed industrial plant machinery. The engineering company initially does the design for the product processing techniques and based on this design, they prepare the technical specifications and the bill of quantities for the plant machinery.

When the basic design and technical specifications are ready, the entrepreneurs start to search for the suppliers of the machinery through the local sales agents of the machinery manufacturers. At least three sets of price quotations from different manufacturers/suppliers are collected to determine a preliminary budget.

Alternately, the entrepreneurs collect a few quotations from different companies for turn-key offer (design, product process techniques and machinery from one single supplier) to implement the project. In that case, the entrepreneurs discard the local engineering firm and only keep a professional group to perform the economic and technical feasibility study.

The preliminary budget of the project machinery is sent to another group of professional to study the economic feasibility of the proposed industrial project. The economic feasibility report is prepared very carefully and precisely with detailed information on the cost of water, electricity, gas, land, building and management. Based on this feasibility report, the budget for the industrial project is finalized and submitted to the bank for approval. Usually, the bank will undertake further a study on the project report prior to approval and after any necessary amendment; action is taken by the bank for the procurement of plant machinery.

A single bank usually provides finance to small and medium sized industries. In that case, the entrepreneur has some freedom to choose the origin of plant machinery. In the case of a bigger sized industrial project, such as a chemical or power plant, bridging financing is used in practice [168], which is exercised between the local and foreign investors (foreign private or government or financing agencies). The foreign partners usually dictate the procurement process for plant machinery and technologies.

It has been observed that to avoid risk, the Bank and entrepreneur usually prefer a turnkey system to implement the industrial project. Study shows that around 90-95% of industrial projects are usually implemented under the turnkey package system from foreign sources and in that case, almost 100% of plant machinery is imported and 5-10% is followed to purchase the plant machinery from the different sources other than turnkey system. In the second process, entrepreneurs have the option to procure some locally made machinery. The foreign machinery is imported through the bank by an opening letter of credit in the favour of the suppliers and if any procurement is made from local manufacturers, the payment is made in the form of cash in local currency.

It is evident from the implementation process, that if the plant machinery is purchased in a turnkey system, the involvement of the local engineering company is reduced. In the case of a turnkey project, the scope of supply for the locally made machinery is almost nothing. The process also demonstrates that the scope for the supply of the locally made machinery is dependent on the sourcing options of procurement used which is related to national industrial policy. The result tends to state that the national industrial policy is not favourable for the growth of local ICM manufacturing enterprises.

3.2.3 Distribution of investment for implementation of industrial projects

Information on investment from sixty-five manufacturing industries was collected for the period 1998-2003 to determine the distribution of the amount of investment industries used to implement a project. The total amount of investment was divided into three parts, as shown in Table 3.2.

Table 3.2 Distribution of investment on manufacturing industries.

Major parameters of investment	Total (%)
Land	15.0
Building	25.0
Capital machinery and technology	60.0
Total	100

Table 3.2 lists the main components of investment, which indicates that the entrepreneurs spend the major percentage of their investment on capital machinery.

3.2.4 Distribution of installed machinery in terms of their origin of manufacturing

The data on the installed capital machinery was collected from the manufacturing industries for the period 1998-2003 in order to establish the origin of the supplied machinery. It was evident from the data that the range of imported machinery was 90-95% with 5-10% sourced from local manufacturers.

3.2.5 Distribution of categorized ICM

The installation drawings of the plant machinery (P & ID) were collected and analyzed to establish the level of automation of the industrial machinery. Based on the available drawings, technical specifications and the definitions described in the Appendix C, the installed machinery have been divided into four groups. The groups are as followings:

1. Low-tech
2. High-tech
3. Peripheral
4. Generic

The distribution *[Source: Survey of manufacturing industry, Appendix C]* of investment of the installed plant machinery is shown in Table 3.3.

Table 3.3 Distribution of installed capital machinery.

Types of machinery	Installed capital machinery		Total share (%)
	Local (%)	Imported (%)	
Low-tech	1.50	20.50	22
High-tech	0.44	56.56	57
Peripheral	2.50	07.50	10
Generic	1.30	09.70	11
Total	5.74	94.26	100

3.2.6 Use of locally available indigenous resources in industry

The uses of locally available indigenous industrial resources in the manufacturing industries were as examined to determine the sourcing pattern resources. Here, the industrial indigenous resources were measured with suggest capital machinery, spare parts, engineering services and product process techniques.

It is generally acknowledged that locally available industrial resources are cheaper and could save the lead-time in supply to industries. The use of industrial indigenous resources for the period 1998-2003 was obtained from the manufacturing industries. Table 3.4 indicates the percentage of use from local source of the total requirement.

Table 3.4 Use locally available indigenous resources in the industry.

Industrial resources	2003	2002	2001	2000	1999	1998
Spare parts (%)	13.0	12.0	10.0	9.0	8.0	6.0
Troubles shooting (%)	11.0	10.0	9.5	9.0	7.0	6.0
Industrial technology for Plant expansion (%)	6.5	6.25	6.0	5.20	6.0	5.5
Industrial technology for Plant implementation (%)	12.0	11.5	11.0	11.0	10	9.5
Capital machinery for plant expansion(%)	7.5	7.5	7.0	6.5	6.0	6.0

Table 3.4 shows that the use of locally available industrial resources is increasing at a marginal rate. The table also indicates that the manufacturing industries are dependent on the foreign resources.

3.2.7 Use of procurement tools

The uses of ICM procurement tools were examined in order to determine the sourcing procedure. The most common tools were searched and the available tools were ranked as per the merit of the entrepreneur's choice. The procumbent tools are shown in Table 3.5.

Table 3.5 Rank of procurement tools.

SL No	Sourcing tools	Merit of choice
a	Use procurement management	1
b	Use yellow pages	2
c	Choose suppliers through promotion materials	3
d	Choose ice suppliers by using advertisement available in the trade magazine	4
e	Web-based sourcing	5
f	Technical seminar	6
g	Choose supplier through advertisement in newspaper	7
h	Choose suppliers by using advertisement available on television.	8

It is evident from Table 3.5 that industries rely on the traditional methods for the procumbent of ICM. The result suggests that the Web-based sourcing is not as yet popular in manufacturing industries in Bangladesh.

3.2.8 Strategy for procurement of industrial plant machinery

The Strategy for the procurement of industrial plant machinery was examined in order to determine the business scope for locally made ICM supplying manufacturing industries. The procurement strategy of the surveyed industries for the period 1998-2003 is presented as a bar chat in Figure 3.2

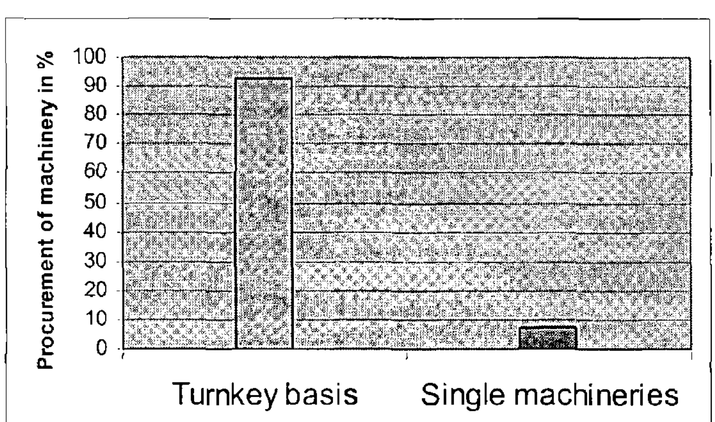

Figure 3.2 Strategy for procurement of industrial plant machinery.

It can be seen from Figure 3.2 that currently about 90% of industries are interested in implementing their industrial project on a turn-key basis it means that the scope of supply for the locally made ICM is poor *[ref:3.2.2]*.

The trend of future planning for the procurement of plant machinery was also examined. Figure 3.3 represent the future tendency of procurement.

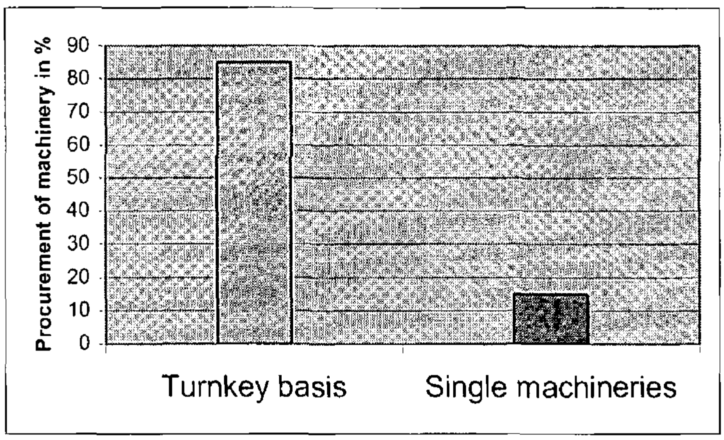

Figure 3.3 Strategy for procurement of industrial plant machinery.

It is evident from the bar chat plotted in Figure 3.3 and 3.2 that the industrial entrepreneurs are willing to procure the single machinery at a higher percentage from the local sources in the future. The results tend to describe that the scope of supply for locally made ICM in future would be increased.

3.2.9 Barriers to procurement of locally made ICM

The barriers to the procurement of locally made ICM examined. The result was applied to measure the magnitude of constrains existing in the industries for locally made machinery. To measure the existing constrains (barriers) a scale of 5 points was formulated and used as shown in Table 3.6.

Table 3.6 Scale of the barrier

Components of barriers	Scale of barriers	Rank
No barrier	Can easily be over come	1
Of little barrier	Can easily be over come there is some production loss	2
Moderate barrier	Operation of machinery gets a little difficult.	3
Strong barrier	Operation of machinery gets difficult.	4
Very strong barrier	Operation of machinery gets very difficult.	5

The rank barriers to procure the locally made industrial capital machinery are shown in Table 3.7.

Table 3.7 Barriers to the procurement of locally made ICM.

Parameters of barriers	Rank of barriers	Remark on source of barriers
Low quality machine	5	Lack of automation in the manufacturing plant.
High lead time	4	Inadequate manufacturing facilities
Short supply of after sales services from the local manufactures	4	Lack of skilled technicians and size of the companies is small
Bank financing is poor for locally made ICM	4	Industrial policy is not favourable
Short supply of industrial technology	4	Weak S & T policy of the government
Short supply of technical documentation	3	Engineering knowledge level is poor (lack of engineering staff)
lack of communication facilities in ICM manufacturers	2	Infrastructures is poor
Lack of testing facilities to measure the quality of the machinery.	3	S & T policy is weak
lack of experience	4	The company are young
The lack of skilled technicians in the manufacturing enterprises	5	Short supply of skilled technical in the labour market

Table 3.7 suggests that the industries are facing barriers to procure the locally made ICM mainly from three sources:

(i) From ICM manufacturing enterprises,

(ii) From Financing Bank, this is generically a barrier of industrial policy,

(iii) S & T policy of the government.

From this result it can be stated that procurement barriers are likely to reduce the scope for the supply of locally made ICM to manufacturing industries.

3.2.10 Investment growth on Capital machinery

The investment growth in capital machinery among the surveyed manufacturing industries was examined. The available data was used to measure the scope for the supply of locally made ICM to industries. The average investment growth in ICM for the period 1998-2003 is plotted in Figure 3.4.

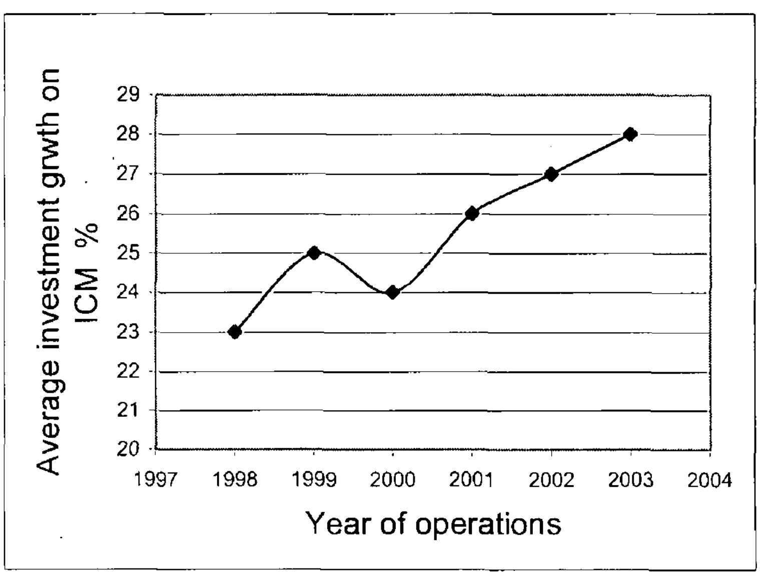

Figure 3.4 Average investment growths on capital machinery.

It is evident from Figure 3.4 that the demand for ICM in manufacturing industries significantly increased over the last six years. This means that, the scope of business in capital machinery in Bangladesh is increasing.

3.3.11 Distribution of investment on machinery and technology

The distribution of investment on machinery and industrial technology is shown in 3.4a

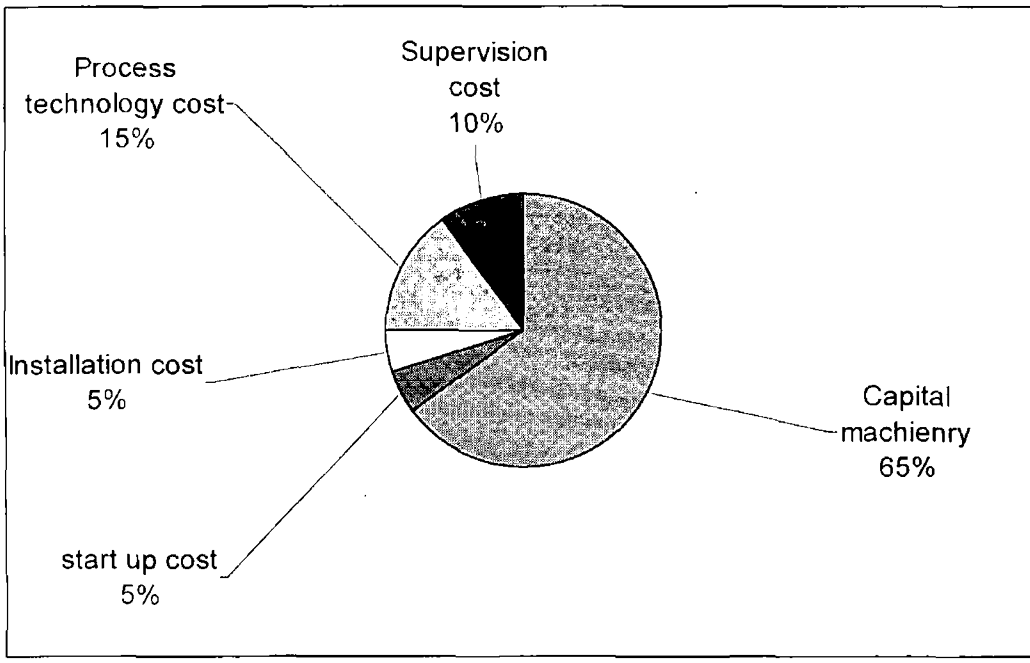

Figure 3.4a Distribution of investment on ICM and technology.

It can be viewed from Figure 3.4a that about 35% of total investment is spending on industrial technology which is a huge amount.

3.2.11 Summary of the preliminary study on the general manufacturing industries

The results of the preliminary study on the general manufacturing industries can be summarized as follows;

Most industrial projects are implemented under a turn-key system and this existing process is likely to account for the poor scope for the supply of locally made ICM to general manufacturing industries.

The major percentages (about 90%) of industrial resources are imported and the contribution of locally made ICM and industrial technology to the development of local manufacturing industries is insignificant.

The procurement strategies for the industrial plant machinery are shifting very slowly from turnkey to single machinery due to the existing barriers of industrial and S&T polices. The opportunity for the supply of locally made ICM is growing very slowly, although the rate of annual investment growth in ICM is about 25%.

The primary results conclude that the national industrial and S&T policies are not favourable for the growth of manufacturing industries in Bangladesh.

3.3 STUDY ON MANUFACTURING ENTERPRIESES OF INDUSTRIAL CAPITAL MACHIMNERY

A hundred and sixty ICM manufacturing enterprises were visited to determine their current performances and growth patterns. The result of these visit were used to design the questionnaire for this research project*[ref: Section 3.1]*. To obtain the basic information of these enterprises the visit programme was designed to examine the following:

i. Nature of ICM manufacturing enterprisers,
ii. Current status of the use of AMT,
iii. Manufacturing capability,
iv. Range of products produce,
v. Sales and marketing strategy,
vi. Manufacturing infrastructure,
vii. Growth pattern,
viii. Barriers to growth.

3.3.1 Nature of manufacturing enterprise

In order to establish the nature of ICM manufacturing enterprises the following parameters were examined:

a) Ownership pattern
b) Average experience in terms of age
c) Size in terms of the number of employees
d) Investment size

e) Skill composition of technicians

f) Wage structure

(a) Ownership pattern of ICM manufacturing enterprises

The ownership patterns of the ICM manufacturing enterprises are examined in order to establish the management style of this sector. The available data on the ownership pattern is shown in Table 3.8.

Table 3.8 Ownership pattern ICM manufactures enterprises

Type of the Enterprises	Ownership pattern			
	Family	Partnership	Private	Total
Cottage	90	7.0	3.0	100
Small	59	31	10	100
Medium	20	38	42	100
Large	10.	10	80	100

Table 3.8 shows that the family-owned enterprises dominate the ICM manufacturing sector. This means that their growth and operating style are dependant on the targets and the management capability of the chief executive of those enterprise.

(b) Age of the ICM manufacturing enterprises

The age structure of the current ICM manufacturing enterprise was examined to evaluate the manufacturing capability and experience of this sector. The age structure of 160 ICM manufacturing enterprises is shown in Table 3.9.

Table 3.9 Age structure of ICM manufacturing enterprises

Types of the industries	3-5 years of age (Number)	6-8 years of age (Number)	9-11 years of age (Number)	Age 12+	Total Number
Cottage	8.0	19	8.0	7.0	42
Small	17.0	24	12.0	10.0	63
Medium	23.0	10	11.0	110	55
Total	48.0	53.0	31.0	28.0	160

It can be seen from Table 3.9, that the ICM manufacturing enterprises of Bangladesh are young in age. This means that this sector is operating with a lack of manufacturing experience. This lack of experience could be a barrier to future growth.

(c) Size of ICM manufacturing enterprises

The size in terms of the number of manufacturing employee was examined to measure the performance of the targeted enterprises. The distribution of available employees is listed in Table 3.10.

Table 3.10 Size of ICM manufacturing enterprises.

Size of the firm	No of units Observed	Sample unit in (%)	Average number of employees
Cottage and Small	105	65.62	15
Medium	45	28.430	35
Large +	10	6.25	75
Total	160	100	

It is evident from Table 3.10 that the major percentage of ICM manufacturing enterprises is small in size. The result could be a useful predictive tool in measuring the performance of those manufacturing enterprises.

(d) Advanced manufacturing technology in ICM manufacturing enterprises

The strength of advanced manufacturing technology (AMT) was examined in order to measure the automation level, skill in manufacturing and management capability of ICM manufacturing enterprises. To evaluate the current strength of AMT, the following parameters were used.

Table 3.11 Parameters of AMT.

	Parameters of AMT	Functions
i	Computer aided manufacturing (CIM)	Level of automation
ii	Machine tools	Directly used for production

(i) Strength of computer aided manufacturing capability

According to Ranky [169], the computer integrated manufacturing (CIM) is concerned with computer assistance, control and high-level automation at all stages of the manufacturing process. The CIM has the capability to provide manufacturing flexibilities, to improve product quality and could also contribute to speed up of the production process [170,171].

CIM strength of the ICM manufacturing enterprises was studied in order to examine the automaton level and the use of computers in manufacturing businesses. The strength of CIM was measured using the parameters shown in Table 3.12.

Table 3.12 Parameters of CIM.

Parameters	Identification label
Computer aided manufacturing (use of NC, CNC machine)	a
Computer aided Engineering (Computer based design analysis)	b
Computer aided production planning (Use of software based planning)	c
Computer aided Quality control (Use of computer for quality analysis)	d
Computer aided design (Use AutoCAD or other graphics software)	e
Computer aided supply chain management (use spread sheet or custom software)	f
Production order planning management (use spread sheet or custom software	g
Production progress monitoring (MPM) management (use spread sheet or custom software	h

The current strength of CIM and the planning for future use is plotted in Figure 3.5.

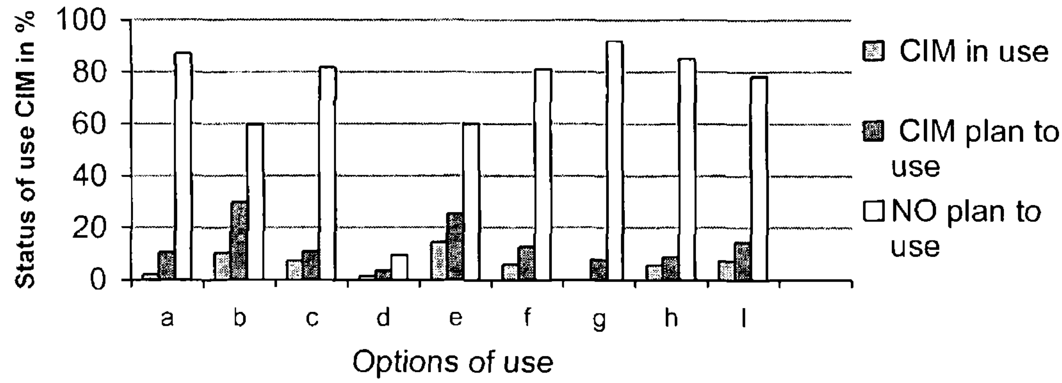

Figure 3.5 Strength of CIM in manufacturing enterprises.

Figure 3.5 demonstrates that the current strength of CIM in the manufacturing enterprises is poor and planning for future use is also insignificant. From this result, it can be assumed that the productivity and quality of the products of those manufacturing enterprises will remain the same unless the situation is improved.

(ii) Strength of machine tools

The automation level in the production line was examined to identify the productivity and manufacturing capability of ICM manufacturing enterprises. The data on the machine tools is shown in Table 3.13.

Table 3.13 Strength of machine tools.

Categorical machine tools	Manual operated (%)	Semi automatic (%)	Automatic (%)
a. Lathe machine	87.6	10.9	1.5
b. Drilling machine	96.12	3.88	0.0
c. Surface grinding machine	97.69	2.31	0.0
d. Shaper machine	96.03	3.97	0.0
e. Milling machine	96.63	3.17	0.0
f. Boring machine	96.82	3.18	0.0
g. Welding machine	100	0.0	0.0
h. Metal forming machine	94.48	3.52	2.0
i. Surface coding	95.30	2.20	2.0
j. Metal cutting machine	100	0.0	0.0

It can be read from Table 3.13 that a major percentage (about 90%) of manufacturing enterprises is dependent on manually operated machine tools. It is evidence of low productivity and poor production capability of the enterprises.

(e) Investment size in ICM manufacturing enterprises

The size of the investment on machine tools, laboratory equipments for testing facilities, telephone, fax and other moveable equipment was examined in order to measure the infrastructure facilities of the ICM manufacturing enterprises. Table 3.14 presents the current investment on the ICM manufacturing enterprises.

Table 3.14 Investment size on manufacturing industries (US$).

Type of the firm	No of units (%)	Sample unit (%)	Average investment
Cottage and Small	105	56.25	10,000
Medium	45	28.3	35,000.0
Large	10	06.25	75,000.0 +
Total	160	100	

The data shown in Table 3.14 indicate that the average size of investment on the manufacturing plant is poor and the manufacturing capability obviously should be marginally low.

(f) Skill of employees in manufacturing enterprises

The skills of manufacturing employees have been divided in to three parts which are;

(i) Skills of manufacturing technicians,
(ii) Skills of manufacturing staff,
(iii) Skills of management employees.

(i) Skilled compositions of manufacturing technicians

The skill of manufacturing technicians was examined to determine the manufacturing and after sales services capability of the enterprises. The skill compassion is shown in Table 3.15.

Table 3.15 Distribution of skilled composition of manufacturing technicians.

Type of the firms	Unskilled (%)	Semi skilled (%)	Skilled (%)	Total
Cottage	33	42	25	100
Small	30	35	35	100
Medium	25	27	48	100

Table 3.17 shows that in the cottage industries, the ratio of skilled labour to total labour is 25, but in small industries the ratio is 35 and in the medium size-enterprises the ratio is 48. The result indicates that the level of skill and service capability in medium sized industries is higher than the small industries.

(ii) Manufacturing employment in ICM manufacturing enterprises

The strength of manufacturing employment was examined to determine the level of knowledge-based human resources and the skills in the enterprises. The manufacturing employees could play a vital role in production productivity and could contribute to improve in the quality of the products. Table 3.16 shows the current strength of manufacturing employment of the ICM manufacturing enterprises.

Table 3.16 Manufacturing employees in the enterprises.

Manufacturing employees t	Number of employees				
	0	1-2	3-5	6-8	8+
Skilled technician (%)	30.8	36.76	18.36	8.88	5.14
Diploma engineer (%)	32.8	38	22.38	6.71	0
Engineering graduate (%)	77.44	15	7.5	0	0
Post graduate in science and engineering (%)	87.57	8.75	3.68	0	0

It is evident from the Table 3.16 that the number of manufacturing employees on the production floor is poor. The lack of manufacturing staff could have negative effect on the quality of products and on the productivity in the manufacturing business and account for the growth of this sector.

(iii) Management employment

The management employment is referred to managerial staffs (i.e., cost accountant, business executive, sales and marketing manager, and personnel manager). The strength of the company management of employee was examined in order to establish the capability of ICM manufacturing business. The strength of management employee is shown in Table 3.17.

Table 3.17 Strength of management employee.

Category wise management employee	Number of employees				
	0	1-2	3-5	6-8	8+
Cost Accountant (%)	57.8	37.14	5.0	0	0
Business Management (%)	57.5	36.66	5.7	0	0
Sales and Marketing (%)	54.74	37.4	7.2	0	0
Personnel Management (%)	88.0	10.5	1.4	0	0

It can be seen from Table 3.17 that management employees in manufacturing enterprises are poor. The result indicates that the management capability in business is weak which could reduce the scope of business and competitiveness.

(g) Wage structure in the manufacturing enterprises

The current wage structure of ICM manufacturing enterprises was studied in order to establish the living standard of the manufacturing technicians. The structure of their monthly salary is converted to American dollar and presented in Table 3.18.

Table 3.18 Distribution of wages (US$ per month).

Type of the firms	Unskilled	Semi skilled	Skilled
Cottage and Small	25-30	30-50	50-100
Medium	40-50	60-80	80-125

Table 3.18 shows that the monthly wage for the employees is generally low. Based on this result, it can be assumed that the low wage structure could be making people unhappy and it could turn out to be a barrier to the growth of ICM manufacturing enterprises.

3.3.2 Manufacturing capability of the categorized ICM

The manufacturing capability of the enterprises was examined in respect of the level of technology of their products. The entire locally made capital machinery was divided into four groups [*ref: key note*]. The distribution of the current manufacturing capability is shown in Figure 3.6.

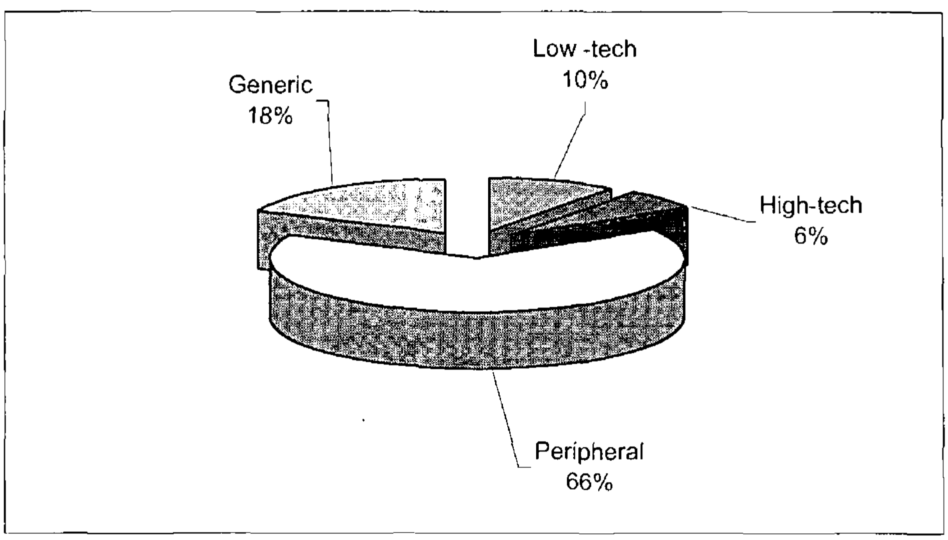

Figure 3.6 Manufacturing capability of ICM.

Figure 3.6 indicates that the manufacturers have concentrated their business on the peripheral and generic machinery.

3.3.3 Range of products of ICM manufacturing enterprises

The range of products of locally made ICM was identified from the list supplied by the manufactures and relevant trade bodies. Table 5.19 presents a list of the main products.

Table 3.19 List of locally made industrial capital machinery.

1.Centrifugal pump	18.Liquid level sensor and controller
2.Vacuum pump	19.Temperature sensor and controller
3.Shut of Valves	20.Power transmission gear
4.Shell and tube heat exchanger	21.Power transmission pulley
5.Water and Liquid transfer pump	22.Transformers
6.Air compressor	23.High tension an Low tensions witch gear and Inverter
7.Low pressure Boiler	24.Power factor improvement device
8.Single and jacketed tank	25.Cable
9.Conveyors	26.Meaneature circuit breaker
10.Evaporator	27.Motor start/stop switch
11.Bottle filling machine	28.Signal transmission Relay
12.Capping and sealing machine	29.Speed control
13.Liquid filling machine	30.Agitator
14.Gear box	31.Nut bolt
15.Gear	32.Power transmission belt and shaft
16.Motor	33.Bush
17.Electrical panel	34.Shaft (dia 20mm-100mm)

3.3.4 Sales and marketing strategy of the ICM manufacturing enterprises

The manufacturing business of capital machinery takes its bearing from high-level inputs of S & T, engineering capability and finance, but the current open market pressure has added another requirement for this business. A newly added component is the sales and marketing strategy. The sales and marketing strategy has now become an essential tool in the face of current market challenge. The business of ICM manufacturing was very much exclusive to the developed countries and recently part of this business shifted to some newly industrial developed countries and the developed countries are now introducing a new sale and marketing strategy to stay as competitive leaders in the market place.

The current sales and marketing strategies taken in Bangladesh to promote its locally made ICM were examined. The key tools are described as:

(i) Marketing tools

The data that is normally used in sales and marketing of ICM was gathered in order to justify the current sales capability of manufactures. The common marketing tools are shown in Table 3.20

Table 3.20 Sales and marketing tools

SL No.	Marketing tools	Order of preferences
a.	Product image	1
b.	Reputation of the company	2
c.	Price	3
d.	Personal sales effort	4
e.	Having strong after sales service	5
f.	State-of-art technology	6
g.	Advertising Media	7
h.	Web base marketing	8

Table 3.20 indicates that ICM manufacturing enterprises are concentrated on the image of their products and the reputation of the company to sell their products. This strategy is almost inline with the strategy in many developed countries. But web-based marketing has dropped to a less important position, undertaken with the current practice developed countries. The data suggests that the current policy and practice used in sales and marketing is still based on the traditional method and that could reduce the possibility of capturing of greater market size.

(ii) Sales strategy of ICM

The current sales and marketing strategies were examined. The current strategies and the future planning are shown in Figure 3.7

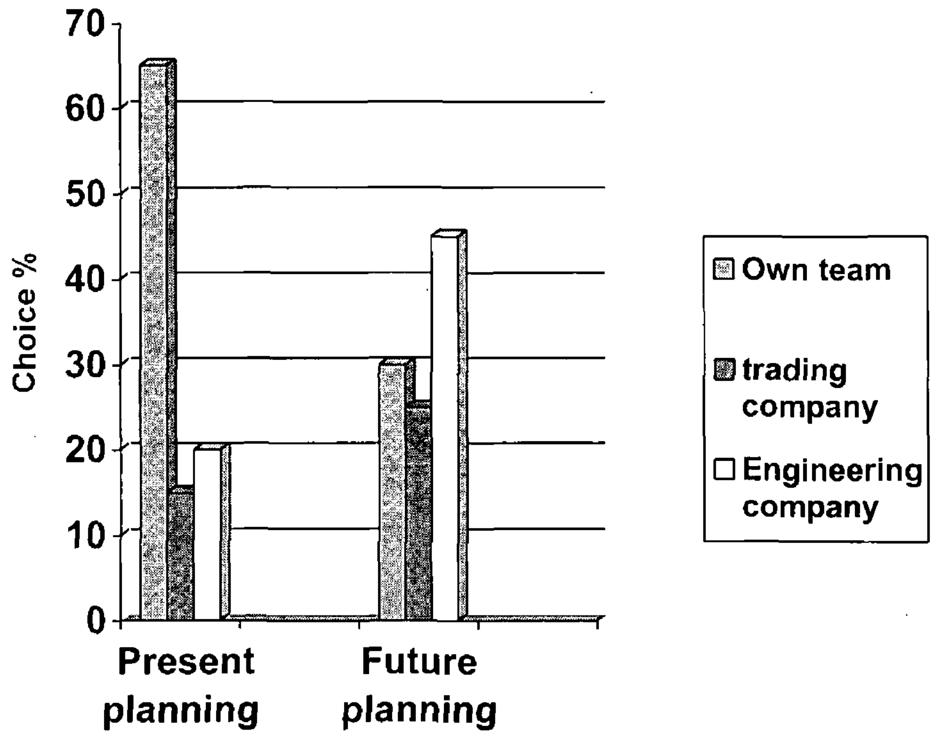

Figure 3.7 Sales and marketing strategies of ICM.

Figure 3.7 shows that the enterprises have the tendency to reduce their own sales team and put their product in a sales net work to speed up the sales at a minimum cost and efforts. The strategy demonstrates that the enterprises are aware of the current competitive market and accordingly, they want to reduce the price and lead time to market.

3.4 Barriers to growth of the ICM manufacturing enterprises

ICM manufacturing is a difficult task, especially for firms with little experience and limited resources. Small manufacturing firms in the least developed countries, additionally, have to face the liability of their size, limitations of the inadequate infrastructure and resources. In this part of the study, the barriers to the growth of ICM manufacturing enterprises were examined. To measure the impact of barriers a scale of 5 points was formulated and used as shown in Table 3.21.

Table 3.21 Scale of Barriers

Strength of barrier	Types of barriers	Rank
Not barrier	Can easily be over come	1
Of little barrier	Can easily be over come, but profit is reduced	2
Moderate barrier	Reduce profit and operation of business gets little difficult.	3
Strong barrier	Reduce profit and operation of business gets more difficult.	4
Very strong barrier	Reduce profit and operation of business gets very difficult.	5

The barriers to growth of ICM manufacturing SMEs were divided into three parts;

(i) External Barriers,

(ii) Internal Barriers,

(iii) Lack of infrastructure

3.4.1 External Barriers

These barriers are perceived by the managers/owners from out side of the firm during the manufacturing process. External barriers can be further divided into supply, demand and environment, in relation to the manufacturing activities. Table 3.22 presents current external barriers to growth of the ICM manufacturing enterprises.

Table 3.22 External ICM manufacturing barriers.

Parameters of barriers n	Rank	Remark on source of barriers
Low quality raw material	3	BS* is poor and Industrial policy is not favourable.
Lack of infrastructure	3	BSC and FSC is poor and Industrial policy is not favourable
High tax on raw materials	4	Import policy is not favourable
High tax on sales	4	Import policy and Industrial policy is not favourable
High VAT on sales	4	Import policy and Industrial policy is not favourable
Bank finance	3	Industrial policy is not favourable
Not enough demand	2	Lack of market survey activities
Update information of manufacturing technology	3	S & T policy is weak
Information of demand	5	Lack of information system and S&T capability
Trained technician	4	S&T policy is weak and lack of policy implementation agencies
Local payment terms	4	Weak business culture
Testing facilities	5	Industrial policy is not favourable
Quality (ISO) certificate	5	S & T policy is weak
Promotional work	3	Business policy issue and lack of policy implementation agencies
Technical documentation	3	S&T policy is weak and lack of policy implementation agencies
Government attitude toward the development of ICM manufacturing SMEs	3	Industrial policy is not favourable
Sub contracting net work	4	Industrial policy is not favourable and lack of policy implementation agencies
Import duty of the Capital machinery	5	Import policy and Industrial policy is not favourable
Wage policy	3	Industrial policy is not favourable and lack of policy implementation agencies
Lack of responsiveness to the new product	3	Business culture
Industrial engineering capability	5	S & T policy is weak
Short supply of skilled manufacturing staffs (70%)	5	S & T policy is weak

* Back ward supply chain–BSC,* Forward supply chain-FSC

It is evident from the list shown in Table 3.22 that the major sources of external barriers are related to S & T, import and industrial polices of the government.

3.4.2 Internal Barriers

These barriers are related to internal affairs of the manufacturing firms, which are perceived by the managers/owners from the inside during the manufacturing process. The owners and managers have identified twelve internal barriers, which are shown in Table 3.23.

Table 3.23 Internal barrier to manufacturing enterprises.

SLNo	Internal barriers	Rank	Remark on Barriers
a	Promotion work	4	ISC* and Industrial policy is poor
b	Technical documentation	3	S & T policy is poor
c	Lab facilities	4	ISC is poor
d	Manufacturing infrastructure	5	ISC and Industrial policy is poor
e	Lack of time	4	ISC is poor
f	Qualified management	4	ISC is poor
g	Inadequate financial means	5	ISC and Industrial policy is poor
h	Inadequate R&D facilities	4	ISC is poor
i	Capability of Motivation	3	ISC is poor
j	Market survey facilities	5	ISC is poor
k	Clean business strategy	4	ISC is poor
l	Human resources development policy	3	ISC poor
m	Industrial engineering capability	4	ISC and S & T policies are poor

* In-house supply chain-ISC

Table 3.23 indicates that lack of time is the top ranking internal barrier to growth, which is the character of small firm.

The barriers shown in Tables 3.22 and 3.23 are the significant information for ICM manufacturing enterprises. It is evident from the tables that the majority of barriers are concentrated on the industrial, S & T and import policies of the government. From the results, it can be stated that the current government polices are not favourable and appear as barriers to the growth of ICM manufacturing enterprises in Bangladesh.

3.4.3 Lack of infrastructure in ICM manufacturing enterprise

Infrastructure is an important input is a important factor for manufacturing business because the lead-time to supply is largely dependent on it. The strength of the infrastructure in ICM manufacturing enterprises was examined in order to measure the business capability of this sector. To measure the strength of infrastructure a four points scale was used which is shown in Table 3.24.

Table 3.24 Scale of infrastructure.

Order	Parameters	Quality level
1	If totally absent in the manufacturing plant	1
2	Have partial facility in the enterprise	2
3	Fully installed to meet the requirement	3
4	Fully installed to meet the requirement and have some standby facilities to cover the risk	4

The current strength of infrastructure of the ICM manufacturing enterprises is shown in Table 3.25.

Table 3.25 Infrastructure in manufacturing SMEs.

Infrastructure parameters	Quality level
Laboratory	2
Transportation	1
Computer	1
Fax	1
Telephone	2
Banking	1
Internet	1
Storage facilities	2
Raw materials supply	1
Sales sub contracting net work	2
Technical and advisory services	1
Market information	1

Table 3.25 shows that the facilities for transport, computer, fax, banking and the internet are poor while the other parameters are acceptable, but not good or very good. The table indicates that laboratories, finance from bank, communication facilities (fax, internet and transport, telephone) are poor. From the data shown in Table 3.25, it can be stated that the weak infrastructure might affect the growth of the ICM manufacturing enterprises.

3.4.4 Summary of study on ICM manufacturing enterprises

The ICM manufacturing enterprises in Bangladesh are small in size and this sector is operating with 11-20 employees and the average age of these enterprises ranges 11-15 years. The wage structure is very poor. The result showed that the strength of advanced manufacturing technology in the enterprises was insignificant. About 80%-90% of are enterprises operating their manufacturing business without the aid of computer, inadequate skilled manufacturing employees and professional management staff. The sales and marketing strategies are inline with international level and competent. The major percentages of enterprises do not have automatic and semi automatic machine tools in the production line and they are concentrated on peripheral and generic machinery business. The enterprises list the manufacturing barriers that are mainly generated from the government police.

3.5 CASE STUDIES ON MANUFACTURING OF CAPITAL MACHINERY IN BANGLADESH

Three case studies were carried out on the manufacturing of capital machinery in Bangladesh to establish the following:

i. The impact of current import duty on the price of locally made capital machinery.
ii. To develop a model for manufacturing cost.

3.5.1 Methodology of the case studies

The methodology of the case studies has been designed with an aim to obtain the research result. The steps of the case studies included a visit to manufacturing sites, a study of manufacturing drawings and process, a study of impact of the import policy of the government, data collection, analyses, data tabulation, modeling and a discussion of the results.

Data collection on manufacturing process

During the studies, sources of raw materials, manufacturing types and sources of design were collected from plants. In addition to that the following manufacturing information was gathered in order to perform the study.

The following documents were collected to obtain the required information;

*. Manufacturing drawings from local plants,
*. Price of the components for the machinery from international sources,
* Price for the imported complete machines from the foreign sources,
* The service charges for import of the machinery from local plants,
*. Manufacturing steps of the machinery from local plants.

3.5.2 Study on the water softenering machine

The study of a industrial water softener was carried out in two steps, to compare the price when manufacturing was done at a local plant and the price when imported from international sources.

(i) Manufacturing at local plant in Bangladesh

Capacity of the unit : 3000 ltr/hr of water and 540 of kgrain water hardness.
Manufacturing Plant : Modern Erection Ltd., Dhaka, Bangladesh.
Duration of the study : September-December 2003

The cost of manufacturing of water softener machine is shown in Table 3.26. *[Source: Case studies-1, Appendix A.].*

Table 3.26 Manufacturing data for water softener machine.

SL No	Cost components	Type of cost	Unit cost US$	Total cost US$
1	Cost of the raw materials	Fixed cost (FC1)	950.0	950.0
2	Import duty, VAT, AIT and DSC on raw materials, at the rate of 55% on the cost of the raw materials [171].	Variable Cost (VC)	950 x 0.55	522.5
3	Design, labour, documentation, R & D and depreciation at the rate of 20% of the raw materials cost.	Fixed cost (FC2)	0950 x.20	190.0
4	The cost of office rent, inventory, salary of the staff, at the rate of 15% of the raw materials cost.	Fixed cost (FC3)	950.x.0.15	142.0
	Total			1805.5.0

Table 3.26 shows that the cost of manufacturing for the water softener machine is US$ 1805.0 The sales price of the machine was obtained from the manufactures, which is US$ 2100.0.

(ii) The imported price of water softener machine in Bangladesh

The price of the imported water softener machine of the same capacity is shown in Table 3.27.

Table 3.27 Imported cost of water softener.

SL No	Cost components	Type of cost	Unit cost US$	Total cost US$
1	Imported water softener machine	Fixed cost (FC4)	1800.0	1800
2	Import duty at the rate of 7.5% on the cost of water softener [171].	Variable Cost (VC1)	1800 x 0.075	135.0
3	Bank, insurance and port charge at the rate of 3% of the cost of water softener.	Fixed cost (FC5)	1800 x 0.03	54.0
	Total			1989.0

It can be seen from Tables 3.26 and 3.27 that the price of the locally made machine is greater than the price of the imported water softener machine. Furthermore, the quality of the imported machine would be better than that of the locally made machine because the average level of AMT in the local manufacturing plant is low and due to this obvious reason the buyers will choose the imported machine and the local manufacturers would lose the market share.

(iii) The model for manufacturing cost of water softener machine Bangladesh

It is evident from Tables 3.26 and 3.27 that the variable costs are the determinant factor for the manufacturing cost of the machine.

FC1 is the value of the raw material, which is a cost driving factor for the manufacturing of this machine. The amount of import duty is dependent on the cost of the raw materials and for this study the value of the raw material (a) can be assumed as the coefficient of the import duty.

VC is the variable cost for the manufacturing of water softener machine, which is dependent on the cost of the raw materials and on the value of its import duty.

The variable cost (VC) can be presented by Equation 3.1;

$$
\begin{aligned}
VC &= \text{Cost of the raw materials X import duty in percentage} \\
&= (a\,.x)/100 \\
&= kx \qquad\qquad (3.1)
\end{aligned}
$$

where

a - cost of the raw materials

x - Import duty on raw materials in percentage

k= a/100

The cost components FC2, FC3 have some effects on the cost of the manufacturing of the machine. The values of FC2 and FC3 are dependent variables and the nature of variables is as follows;

FC2 - Cost of manufacturing activities which depends on the level of AMT of the manufacturing enterprises.

FC3 - Cost of manufacturing activities which depends on the size of the manufacturing organization.

The sum of FC2 and FC3 can be mentioned as the operating cost for the manufacturing enterprise. The values of FC2 and FC3 are fixed for this particular manufacturing case. The operating cost can be expressed by the following relation.

$$
\begin{aligned}
OC &= f\,(F2, FC3) \\
&= C \qquad\qquad (3.2)
\end{aligned}
$$

In this particular case, Table 3.26 shows that the values of the FC2 and FC3 are dependent on the amount of investment made on the raw materials (a). Based on this consideration, FC2 and FC3 can be presented by the following equation.

Operating cost =Total fixed operating cost (FC)

= FC2+FC3

= 0.2 a + 0.15a (Value of FC2 and FC3 from Table 3.26)

FC= 0.35a (3.3)

Using data from Table 3.26, the total cost of manufacturing for water softener machine can be expressed by the relation.

TC=Cost of the raw materials + Variable cost+ Fixed operating cost

=FC1 + VC1 + FC2+FC3 (3.4)

=a + kx+ 0.35a

= kx + 1.35a (3.5)

where, a - cost of the raw materials

x - value of import duty in percentage

TC - total cost of manufacturing

k - a/100.

(iv) The impact of current import duty on the manufacturing cost of locally made water softener machine

The manufacturing cost was estimated under the following conditions (a) and (b):

(a)

* at fixed operating cost,

* at fixed raw materials cost ,

* at different values of import duty,

(b)

* at fixed operating cost,

* at different cost of raw materials,

* at different values of import duty.

The manufacturing cost of water softener machine at condition (a):

By using Equation 3.5 at the different values of import duty, the manufacturing cost of the water softener machine was potted which is shown in Figure 3.8.

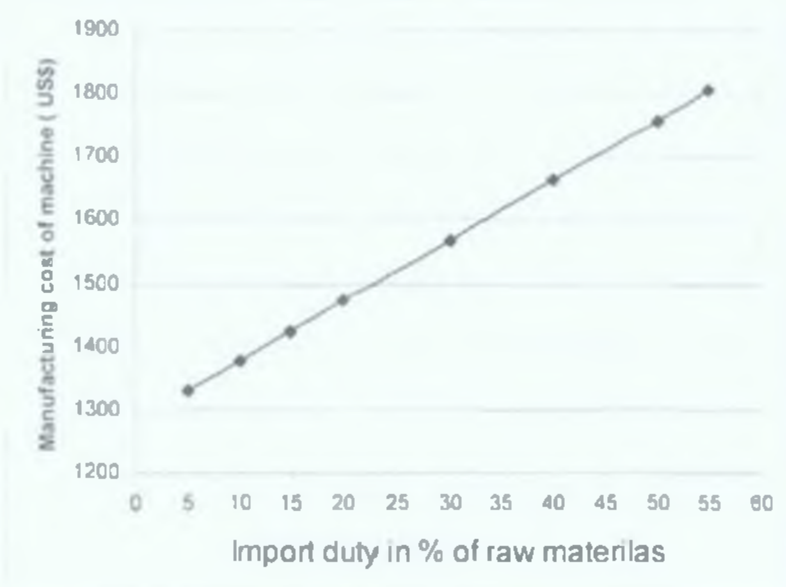

Figure 3.8 Impact of import duty on manufacturing cost of water softener

Figure 3.8 shows that the water softener could be produced at low cost by reducing the value import duty on the raw materials. The trend of the curve of cost shows that if it is possible to fix the value of import at 7.5% at the current level of imported duty of the complete machine, the cost of manufacturing tends to reduce by about 25%.

The manufacturing cost of water softener machine at condition (b):

By using Equation 3.5, the manufacturing cost of the same capacity water softener machine was estimated at different values of raw materials. It was seen during the price collection that for the same standard raw materials, the variation of price in different vendor was about 10%. By using sigma plot, the manufacturing cost of the machine was estimated under the following conditions.

* at fixed operating cost , at raw materials cost US$ 800.00-1000.00 per unit machine and at import duty range 5-70%.

The impact of the raw material on the manufacturing cost and import duty on the price can be seen in Figure 3.9.

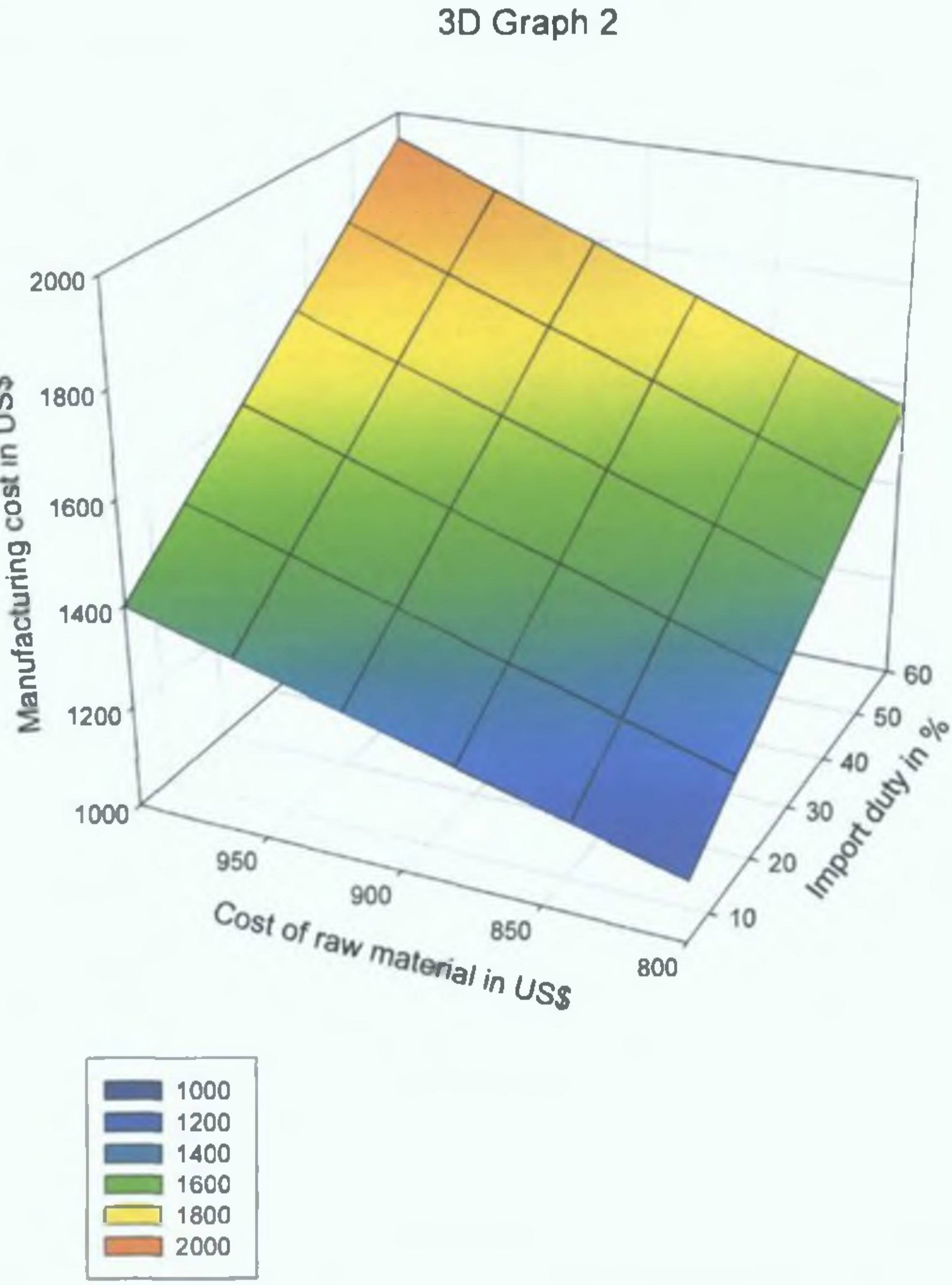

Figure 3.9, 3-D surface graph for the manufacturing cost of water softener machine at different price of raw materials and import duty.

It can be visualized from the graph shown in Figure 3.9 that the manufacturing cost of the machine is dependent on the value of the raw material and its import duty.

3.5.3 Study on pressure vessel

The study of an industrial pressure vessel was carried out in two steps, the price when manufacturing was done at a local plant and the price when it was imported from international sources.

(i) Manufacturing at local plant in Bangladesh

Capacity	: 7500 ltr in volume
Working pressure	: 60 psi
Location of the study	: Mark industries, Dhaka, Bangladesh
Duration of the study	: January–February 2003

The cost of manufacturing for the pressure vessel is shown in Table 3.28. *[Source: Case study-2, Appendix A.]*.

Table 3.28 Manufacturing data for pressure vessel.

SL No	Cost components	Type of cost	Unit cost US$	Total cost US$
1	Cost of raw materials	Fixed cost (FC1)	5500.0	5500.0
2	Import duty, VAT, AIT, and DSC on raw materials, at the rate of 55% on the cost of the raw materials [171].	Variable Cost (VC1)	5500 x0.55	3025.0
3	Cost of consumables, design, labour for manufacturing, documentation, R & D, depreciation, at rate of 40% of the cost of raw materials.	Fixed cost (FC2)	5500 x 0.4	2200.0
4	Cost of office rent, inventory, salary of the staff, at the rate of 20% of the cost of the raw materials.	Fixed cost (FC3)	5500 x 0.20	1100.0
	Total			11,825.0

Table 3.28 shows that the cost of manufacturing for the pressure vessel is US$ 11,825.0. The sales price of the machine was obtained from the manufactures, which is US$ 13,250.0.

ii) The cost of imported pressure vessel in Bangladesh

The cost of imported pressure vessel of the same capacity is estimated and shown in Table 3.29.

Table 3.29 Imported cost of pressure vessel.

SL No	Cost components	Type of cost	Unit cost US$	Total cost US$
1	Imported pressure vessel.	Fixed cost (FC4)	11.500	11,500.0
2	Import duty at the rate of 7.5% on the cost pressure vessel [171].	Variable Cost (VC2)	11500x0.075	862.50
3	Bank, insurance and port charge at the rate of 3% of the cost of pressure vessel.	Fixed cost (FC5)	11500X.03x	345.0
	Total			12,707.50

Tables 3.28 and 3.29 show that the price of locally made and the price of imported pressure vessel were very close. As the AMT level in the manufacturing plant in Bangladesh is low, the quality of locally made machines would be poorer than that of an imported one and in consideration of the price; the industrial entrepreneurs would choose the imported machine.

(iii) The model for the manufacturing cost of pressure vessel in Bangladesh

It is evident from Tables 3.28 and 3.29, that the variable costs are the determinant for manufacturing cost of the machine.

Based on the consideration taken in Section 3.5.2 for the variable cost and fixed cost, the operating cost of the Pressure vessel can be presented by the following equation.

$$FC2+FC3 = 0.40a + 0.20a$$

$$= 0.60a \tag{3.7}$$

Using data from Table 3.28, the total cost of manufacturing for pressure vessel can be presented by the following relation.

$$TC = FC1 + VC1 + FC2 + FC3$$

$$= a + ax + 0.60a \text{ [replacing the value of FC2+FC3 from Equation 3.6]}$$

$$= ax/100 + 1.60a$$

$$= kx + 1.6a \qquad (3.7)$$

where, a - cost of the raw materials

x - value of import duty in percentage

TC - total cost of manufacturing

k - a/100.

(iv) The impact of current import duty on the manufacturing cost of locally made pressure vessel

The manufacturing cost was estimated in following conditions (a) and (b):

(a)

* at fixed operating cost
* at fixed raw materials cost
* at different values of import duty

(b)

* at fixed operating cost
* at different cost of raw materials
* at different values of import duty

The manufacturing cost of pressure vessel at condition (a):

By using Equation 3.7 at the different values of import duty, the manufacturing cost of the pressure vessel was estimated, which is shown in Figure 3.10.

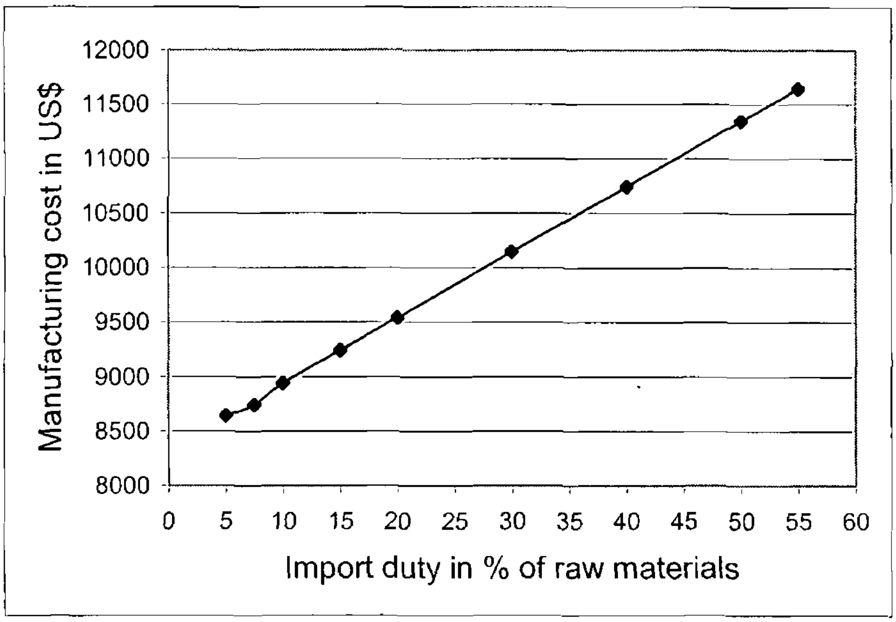

Figure 3.10 Impact of import duty on the manufacturing cost of pressure vessel.

Figure 3.10 shows that the manufacturing cost of the pressure vessel could be reduced by rescheduling the import duty on the raw materials at the level of import duty (7.5%) of the complete machine. The trend of cost curve shows that at 7.5% import duty on the raw materials, the cost of manufacturing tends to reduce by about 25%.

The manufacturing cost of pressure vessel machine at condition (b):

By using Equation 3.7 the manufacturing cost of the same capacity pressure vessel machine was estimated at different values of raw materials and at different import duties. It was observed that the price of the same standard raw materials was fixed and the variation of price of different vendors was about 10%. By using sigma plot, the manufacturing cost of the machine was estimated under the following conditions

* at fixed operating cost
* at raw materials cost US$ 5000.00-6000.00 per unit machine
* at import duty range 5-70%

The different cost of manufacturing can be seen in 3-D plot in Figure 3.11.

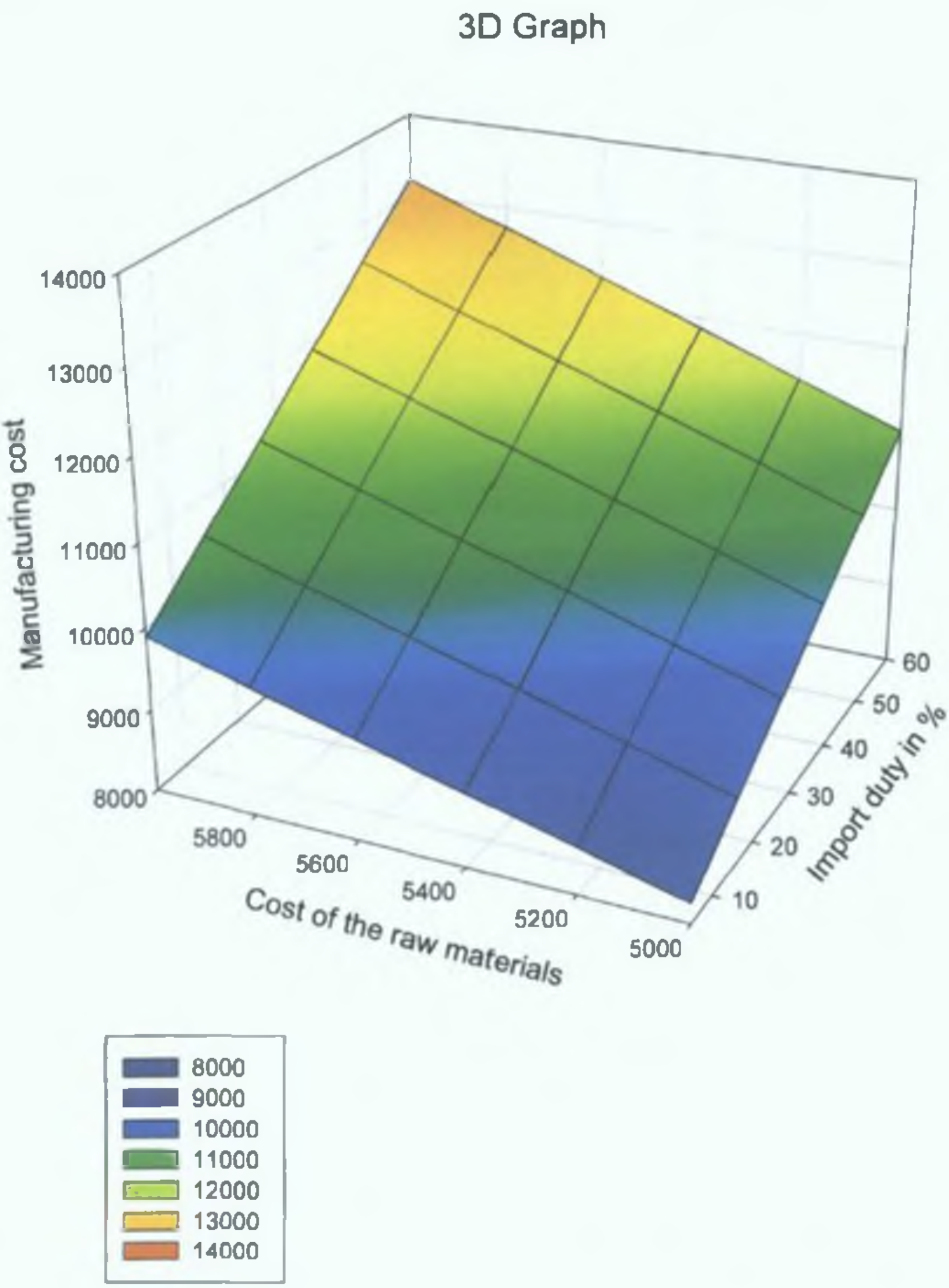

Figure 3.11, 3-D surface graph for the manufacturing cost of pressure vessel machine at different price of raw materials and import duty.

It can be seen from the graph that manufacturing cost of the machine is dependant on value of import duty and the price of the raw materials.

3.5.4 Study on reverse osmosis machine

(i) Manufacturing at local plant in Bangladesh

A study on industrial reverse osmosis machine was performed in two steps, the cost when manufacturing was done at local plant and the price when imported from international sources.

Capacity	:2000 ltr /hr
Working pressure	:150 psi
Location of the study	:Techno-Food, Dhaka, Bangladesh
Duration of the study	:March-April 2003

The cost of manufacturing for the reverse osmosis is shown in Table 3.30. *[Source: Case study-3, Appendix A.]*.

Table 3.30 Manufacturing data for reverse osmosis machine.

SL No	Cost components	Type of cost	Unit cost US$	Total cost US$
1	Cost of raw materials	Fixed cost (FC1)	4000.0	4000.0
2	Import duty, VAT, AIT and DSC on raw materials at the rate of 55% on the cost of raw materials [171].	Variable Cost (VC1)	4000 x 0.55	2200.0
3	Cost of consumables, design, labour, documentation, R & D and depreciation, at the rate of 65% of the cost of raw materials.	Fixed cost (FC2)	4000 x 0.65	2600.0
4	Cost of office rent, inventory, and salary of the staff at the rate of 45% of the cost of raw materials.	Fixed cost (FC3)	4000x0.45	1800.0
	Total			10600.0

Table 3.30 shows that the manufacturing cost of the reverse osmosis machine is US$ 10,600 0. The documented sales price of the machine was US$ 11,200.0.

(ii) The cost of the imported reverse osmosis machine in Bangladesh

The cost of the imported reverse osmosis of same capacity was estimated, which is shown in Table 3.31.

Table 3.31 Imported prices of reverse osmosis.

SL No	Cost components	Type of cost	Unit cost US$	Total cost US$
1	Imported reverse osmosis.	Fixed cost (FC4).	9250.0	9250.0
2	Import duty at the rate of 7.5% on the machine [171].	Variable Cost (VC2).	9250.0x0.075	693.50
3	Bank, insurance and port charge at the rate of 3%.	Fixed cost (FC5).	9250x0.03	277.50
	Total			10,221.0

Tables 3.30 and 3.31 show that the price of locally made and the price of the imported machine was not much different. It can be mentioned that the quality of the imported machine would be better than the locally made one and the price would lead the entrepreneurs to choose for the imported machine.

(iii) The model for manufacturing cost of reverse osmosis machine in Bangladesh

Based on the consideration taken in Section 3.5.3 for the cost of fixed items, the operating cost can be expressed by the following relation;

$$
\begin{aligned}
FC2+FC3 &= 0.65a + 0.45 \\
&= 1.1a \qquad (3.8)
\end{aligned}
$$

Using data from Table 3.30, the total cost of manufacturing for reverse osmosis machine is presented by Equation 3.9.

$$TC = FC1 + VC1 + FC2 + FC3$$

$= a + ax + 1.1a$ *[replacing the value of FC2+FC3 from Equation 3.8]*

$= ax/100 + 2.1a$

$$= kx + 2.1a \qquad (3.9)$$

where, a - cost of the raw materials

x - value of import duty in percentage

TC - total cost of manufacturing

k - a/100

(iv) The impact of current import duty on the manufacturing cost of locally made reverse osmosis machine

The manufacturing cost was estimated under the following conditions (a) and (b):

(a)

* at fixed operating cost
* at fixed raw materials cost
* at different values of import duty

(b)

* at fixed operating cost
* at different cost of raw materials
* at different values of import duty

By using Equation 3.9, at the different values of import duty the manufacturing cost of reverse osmosis machine was estimated which is shown in Figure 3.12.

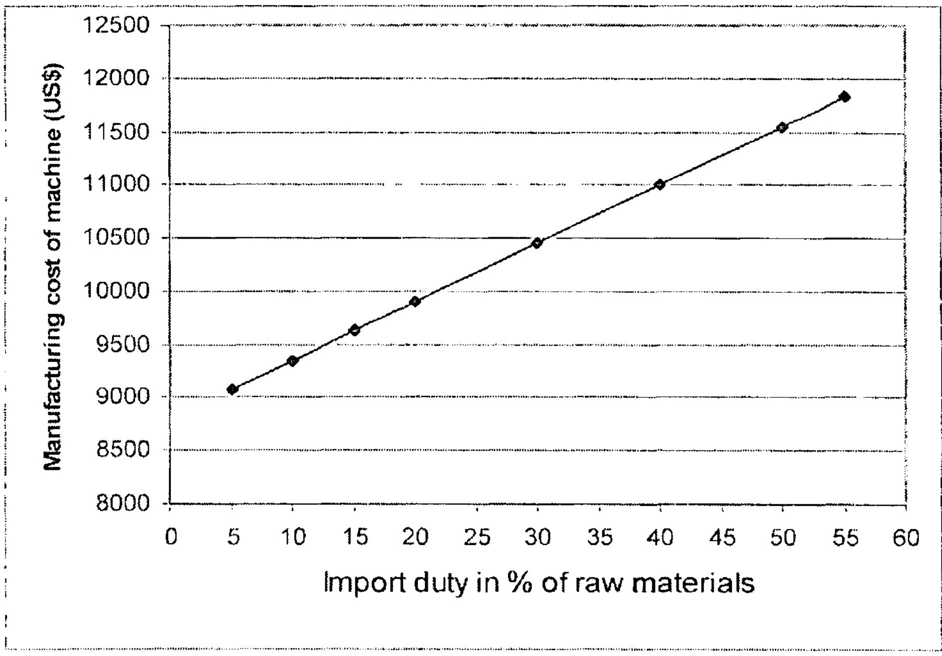

Figure 3.12 Impact of import duty on the manufacturing cost of reverse osmosis.

It can be seen from Figure 3.12 that the manufacturing cost of the reverse osmosis machine could be reduced by revising the import duty on the raw materials at the level of imported duty (7.5%) of the completed machine. The trend of cost curve shows that if the import duty is fixed at 7.5%, the cost of manufacturing tends to reduce by about 30%.

The manufacturing cost of reverse osmosis machine at condition (b):

By using Equation 3.9 the manufacturing cost of the same capacity reverse osmosis machine was estimated at different values of raw materials. There was a variation in price of the raw materials was found in different vendors. The limit of the price variation was about 10%. By using sigma plot, the manufacturing cost of the machine was estimated under the following conditions.

* at fixed operating cost
* at raw materials cost US$ 4000-5000 per unit machine
* at import duty range 5-70%

The different cost of manufacturing can be seen from 3-D plot in Figure 3.13.

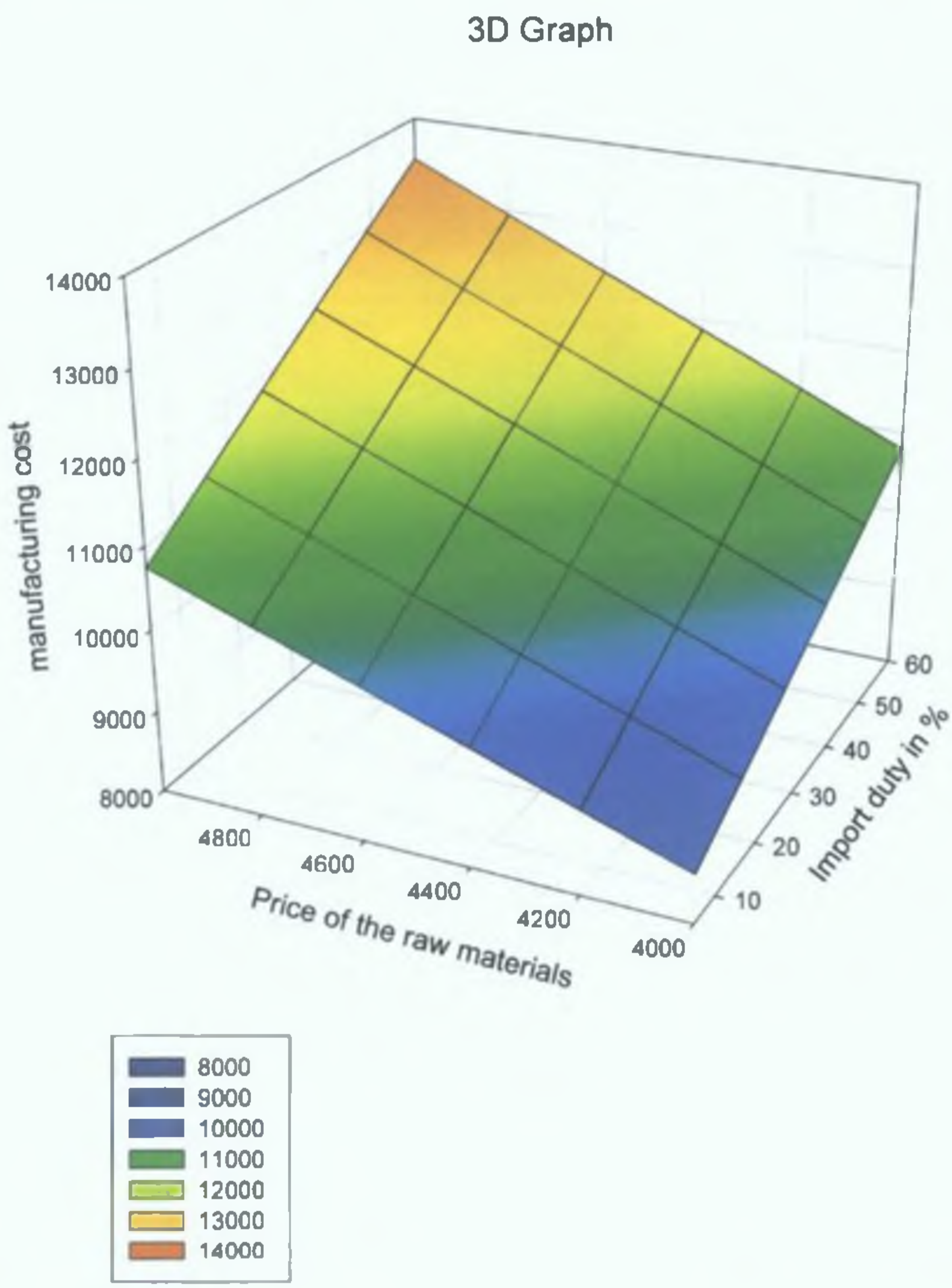

Figure 3.13, 3-D surface graph for the manufacturing cost of reverse osmosis machine at different price of raw materials and import duty.

It can be seen from the graph shown in Figure 3.13 that manufacturing cost of the machine is dependent on the price of the raw materials and its import duty.

3.6 Summary of study on the manufacturing industries in Bangladesh

The manufacturing sector in Bangladesh is dependent on the foreign sources for industrial resources. It has been established that for the period 1998-2003, the range of imported ICM was about 90-95% and the industrial technology was about 80-90%.

The manufacturing industries were facing strong barriers to procure locally made ICM and among the barriers the short supply of after sales services, poor quality machinery and long delivery time are the main. It was evident that for the period 1998-2003, the annual investment growth rate on ICM and industrial technology was about 25%.

The ICM manufacturing SMEs in Bangladesh is small in size and this sector is operating with 11-20 employees and the average age of these enterprises ranges from 11-15 years. The results showed that the strength of advanced manufacturing technology in these enterprises was insignificant. About 80%-90% of the enterprises were operating their manufacturing business without the aid of computer, with inadequate skilled manufacturing employees, and with the lack of professional management staff. A major percentage of the enterprises do not have automatic or semi automatic machine tools in their production line and they are concentrated on peripheral and generic machinery business.

A number of models for ICM manufacturing cost have been developed. It has been established that the price for locally made machinery are higher than that of the imported machinery due to the dual duty policy for the same groups of imported good. It is evident from the model that the price for locally made machinery could be reduced by about 25% through rescheduling the values of import duty at the current rate of complete imported machinery.

3-D surface graphs have been developed and relations among three manufacturing variables have also been established. From the model, it can be visualized in what manner the price of the machinery is dependent on the import duty, operating cost of the manufacturing enterprises and the raw materials.

CHAPTER 4

Designing the Survey

4.1 INTRODUCTION

The methodology used is designing the questionnaire would be described in this chapter. Survey procedure was been planned to establish the market potential for industrial capital machinery, the barriers to growth of the manufacturing enterprises of ICM, and the scope of contribution of ICM manufacturing enterprises to the industries in Bangladesh.

Based on the results obtained from the initial study on the manufacturing industries, the survey questionnaire was designed and formatted *[ref: Section 3.1]* for the main survey. The identification of population and sample, limitation in designing the questionnaire, pilot survey and the main survey are described in this chapter.

The data collection methods and the postal survey schedule are described. The analysis of the response rate and the methods for the improvement are also described and presented in tabular form. The chapter is ended with the presentation of theme of the individual question.

4.2 COVERAGE OF THE SURVEY

To perform the study on the manufacturing enterprises of industrial capital machinery, the following four stakeholders were selected:

(i) General manufacturing industries marked as 'Group A,'
(ii) ICM manufacturing SMEs, marked as 'Group B,'
(iii) Raw material suppliers, marked as ' Group C',
(iv) Government policy makers, marked as ' Group D.'

4.3 DATA COLLECTION METHODS

A postal survey was the main strategic tool used for the current study. Some other methods were integrated with the postal survey to enrich of the quality of the data in order to obtain a clear picture for the research object. Based on the guideline obtained from the research methodology, the preliminary data was collected from manufacturing industries *[ref: Section 3.1]*. The preliminary results formed the base on which the main questionnaire was built. The main questionnaire was designed accurately to the guideline of Kalton [172] and Kotheri [173]. The following five methods were used to carryout the survey:

i. Postal survey questionnaire: A postal survey was the main tool employed in this study. A questionnaire was designed and dispatched to all targeted stakeholders by post with a returnable prepaid envelope.

ii. Observation method: The industries were visited in order to justify the surveyed data.

iii. Interviewing method: An interview method was incorporated in survey programmes in order to clarify some answers.

iv. Documentations: Well-documented data in relation to ICM manufacturing SMEs, procurement of plant machinery, available indigenous industrial resources and government polices was collected and used to perform this research.

v. Combined methods: In some cases, (i), (ii), (iii) and (iv) methods were combined and used to collect the relevant information to carry out the research.

4.3.1 Principal steps of postal survey

The following steps were taken to perform the postal survey:

(i) Identifications of the target population,
(ii) Sample sizing,
(iii) Designing the questionnaire,
(iv) Pre test and pilot survey,
(v) Questionnaire posting,
(vi) Response quality,
(vii) Response improvement method,
(viii) Response analysis.

(i) Identifications of Population

One set of survey questionnaire was designed and used to obtain information from the relevant stakeholders *[ref: Section 4.1]*.

Well-documented and well-known populations were selected to provide authentic data and information. Yellow pages and documentations from the relevant trade bodies were used to identify the populations.

(ii) Population and Sampling criteria

The following criteria was formulated and used for population and sample sizing;

a. Easy access to the enterprises for data collection,
b. Accessibility of interview,
c. Reliable and authentic data can be obtained,
d. Personally well-known enterprises were selected for easy access into the business information,
e. The enterprises have face value in the market.

The strategy for sampling is highly biased by the size of the population, technological capability and productivity of the enterprises and their contributions to the growth of ICM manufacturing industries.

Here the sample is referred to the number of enterprises within the finite industrial population. The size of sample is the key issue for this study and efforts were to optimize the size so as to minimize the cost for the current research. Based on the guidelines of Kothari [173], the following criteria were considered for sample sizing:

(a) Sample size was representative for the research target,
(b) The minimum errors were in the sample,
(c) The size of sample was viable for the research fund,
(d) Systematic biases to highlight the aims were under control.

(a) The sampling criteria for Group-A

The following criteria was formulated and used to identify the general manufacturing industries;

(a) The industries usually purchased some locally made machinery,
(b) The size of the employees was within SMEs and large enterprise,
(c) The age of the companies was minimum 3 years and maximum 20 years,
(d) The companies have a practice of the documentation of management and technical activities, planning and development,
(e) Communication facilities like telephone, fax, and E-mail were available,
(f) They were well reputed, had good face value in the market and were easy to access.

The population and sample from general manufacturing industries was selected from thirteen industrial sub sectors *[ref: Section 3.2]*. Yellow Pages and documents of trade bodies were used to select the industrial population, which is shown in Table 4.1.

Table 4.1 Sample and population of general manufacturing industries Group-A [166]

Industrial sub sectors	Sample	Identified population
1. Pharmaceuticals industries	15	26
2. Fruit juice industries	15	28
3. Carbonated drink industries	13	29
4. Fish processing industries	15	27
5.Textile industries	14	29
6. Garment industries	15	28
7. Vegetable oil industries	15	27
8. Tea processing industries	15	26
9. Leather processing industries	15	27
10. Sugar cane process industries	13	25
11. Drinking water processing industries	13	27
12. Dairy processing industries	14	28
13. Fertilizer and chemical industries	13	25
Total	181	352

(b) Sampling criteria for Group B

The following criteria were used to identify the ICM manufacturing enterprises from Bangladesh:

(a) All companies had adopted at least one aspect of AMT for the manufacturing business,

(b) The size of employee was within 10-50,

(c) The age limit of the companies was minimum 3 and a maximum 18 years,

(d). Production capacity was greater than US$ 0.25 million per year,

(e) The companies had practice of documentation in management and technical activities, planning and development,

(f) Communication facilities like telephone, fax, and E-mail were available,

(g) The well known enterprises were selected.

The population and sample of ICM manufacturing enterprises are shown in Table 4.2 *[ref: Section 3.2]*.

Table 4.2 Population and sample of ICM manufacturing enterprises.

ICM Manufacturing enterprises	Sample size	Identified population
1. High tech machinery	125	300
2. Peripheral machinery	225	350
3. Generic machinery	200	350
4. Low tech machinery	150	300
Total	700	1300

(c) Sampling criteria of Group-C

The following criteria were formulated and used to identify the raw material suppliers.

(a) All had, at least the facilities for raw material import,

(b) All had, at least a VAT license,

(c) The age limit of the companies was a minimum 3 and a maximum 15 years,

(d) They had facilities to supply the raw materials for the ICM manufacturing enterprises,

(e) They have practice of documentation of sales, marketing, import and business planning,

(f) Communication facilities like telephone, fax, and e-mail were available.

The population and sample of raw material suppliers were selected from Bangladesh. Yellow pages and document of trade bodies were used to identify the target group, which is shown in Table 4.3.

Table 4.3 Population and sample size of Group-C [174].

Group-C	Sample	Population
Raw material suppliers.	46	80

(d) Sampling criteria of Group-D

The populations for public policy makers had been selected from the different government offices. The following criteria were adopted for the selection:

(a) Had university graduate,

(b). Age was in between 45-70 years,

(c) Working capacity was minimum chief executive level,

(d) Have experience in the relevant field.

The population and sample from policy maker were selected from the executives list published by government of Bangladesh. The size of population and sample are shown in Table 4.4.

Table 4. 4 Population and sample size of Group-D [175]

Group-D	Sample	Population
Policy makers	47	83

(e) Sample sizing criteria

The statistical method was used to size the sample. The sample sizes were checked and justified by the following rules:

(a) Confidence level was 95%,

(b) Standard error within 1σ-3σ

(c) Finite population theory and relevant equation was used,

(d) The value of 'Z' was used from the printed table of normal distribution curve.

(iii) Design of questionnaire

The questionnaire was the main tool used to carry out the current study. Result of literature surveyed in relation to manufacturing enterprises of Bangladesh and the result obtained from industrial visit and the guideline from Sudman [176], Fink[177] and Kothari [1173] were used to design the questionnaire: The principal guideline used for designing the questionnaire were as follows:

(i) Wording of the questions,

(ii) Ordering of the questions,

(iii) Formatting the questionnaire.

The parameters of the questionnaire were highly influenced by the current economy and the status of industrial technology of the country. The economy and the status of the technology were reflected in the questionnaire [178]. In addition to this the formulation of individual questions was highly influenced by the following factors:

(a) The growth of the economy of Bangladesh,
(b) Quality of education,
(c) The skill in communication of the respondents,
(d) Contribution of industries to the growth of economy,
(e) Technological capacity and capabilities of the country,
(f) Survey performance in Bangladesh.

The following steps were considered to finalize the questionnaire [173,176,177]:

(i) Draft questions were prepared,
(ii) Some questions were examined from similar surveys,
(iii) Questions had been set in order of sequence,
(iv) All questions were formatted in a specific sequence,
(v) Draft questions were given to supervisors,
(vi) Pilot survey was conducted.

(a) Design of questions

The questionnaire was divided into four separate parts [ref: Section 4.2]. The first part of the questionnaire was used to gather information from the end users of ICM. The second part of the questionnaire was used to collect data from the ICM manufacturing enterprises. The third part of the questionnaire was developed to bring insights of barriers relating to raw materials business of ICM. The last part of the questionnaire was designed to gather dedicated information from the policy makers relating the development of ICM manufacturing enterprises in Bangladesh.

Questions for Group-A

Questions were dedicated to gather information on the use of locally made ICM and available indigenous industrial resources for the development of manufacturing industries. The barriers to procure the locally made machinery were also focused in the questions.

Questions for Group-B

In this section, the questions were designed to gather information on the ICM manufacturing SMEs in order to a get insight into the manufacturing business. The principal aims of the designing of the questions was to collect data on technological capacity, capability, sales and marketing strategy, barriers to growth, lack of infrastructure and the impact of government policy. In addition to that the status of AMT, sizes of the firms, experience and sales were also focused.

Questions for Group–C

Questions were designed to capture information on the barriers to supply the raw materials for the ICM manufacturing SMEs. The questions were based on the import duty, VAT, business volume and the barriers to growth of the raw materials business.

Questions for Group-D

The questions were designed at aiming to capture the information from the government of Bangladesh on the existing policies and future strategies relating to the development of ICM manufacturing SMEs.

Scaling techniques

The following measuring scales (methods) were used in the current study.

Nominal scale:

Nominal scale is a numerical symbol usually used in the questionnaire to identify a question. Such number has no qualitative value. The numbers are used as a label to identify the sample or question. For example, the number 21 was used for question no 21. The label 21 does not carry any qualitative value of the question, it was just identification label for question no 21.

Ordinal scale:

Ordinal scale was used to rank a sample or questions. The ordinal scale is a quality label, which is usually used to recognize the merit of samples. An ordinal scale is the qualitative phenomena, which may be set up as per the inherent quality of a question or the samples.

For example, question no 29, this question was employed to establish the type of machine tools used in the manufacturing line. The automatic, Semi automatic and manually operated machine tools are the quality label of the question.

Interval scale:

The intervals are adjusted in terms of some rules that have been established as a basis for making the units equal. An interval scale has one arbitrary zero or reference point from where the measurement is started. Interval scale provides a more powerful measurement than an ordinal scale. For example, question no 19 is used to investigate how many ICM manufacturing SMEs are established within a 2 years interval of time. In that case "2 years" represents the interval.

Ratio scale:

Ratio scale has an absolute reference point from where measurement is started. Ratio scale can be employed to make a statement based on one reference point. For example, question no.24 is employed to find out the sales growth of ICM for a period of 5 years time. In that case, year 1998 is considered an absolute reference from whch the future growth was measured.

(iv) Pre test and pilot survey

In this research, sample questionnaire was given to academic staff and consultants in order to obtain comments on it would an aim of improving the quality. Based on their recommendations and advice received, the questionnaires were reviewed. One pilot survey programme has been carried out in order to establish the followings:

(a) Pre test

(1) To test the adequacy of the database and address of the samples taken for this study,
(2) To make a judgment on the questions if necessary,
(3) To calculate the probability of non-response rate,
(4) To test the suitability of the methodology adapted for the current survey.

(b) Pilot survey

One single pilot survey was carried out in over sixty companies of the group-A and group-B in order to examine the response rate, suitability of survey procedure and the quality of the questions. Sixty companies were selected from the targeted groups. The pilot survey was conducted from 2nd to 27th October 2003, giving the total time of 30 days to the respondents. Eighteen questionnaires were returned, one was undelivered and another one was rejected as the manufacturing firm had only four manufacturing employees. The first returned response was received on 20th October 2003. The initial response rate of the pilot survey was estimated and shown in Table 4.5.

Table 4.5 Response rate analysis of pilot survey.

Survey parameters	Data
No of questionnaire	60
No of return questionnaire	1
Actual send out	59
No of ineligible response	1
No of eligible response	18-1=17
No of respondents ineligible + eligible	17+1=18
Percent of eligible respondents	(17/18) x100=94.47%
Total no of none respondents	60-18=42
Initial respondents rate without reminder	17//59x100 =30.50%

The returned questionnaires were analyzed, revalued and redesigned to make it more convenient for understanding of meaning of the questions. The modified questions were resent to the non-respondents together with a reminder letter to inspire them. The first and second reminder letters were sent on 1st and 7th February 2003 respectively. A total of six questionnaires were returned during the first and second reminder. And the total response rate was 42.88%.

(v) Questionnaire posting

Based on the results obtained from the pilot survey, several questions were modified, dropped or merged. The final questionnaire was prepared by 2nd January 2004 for the main survey. The main survey was conducted between 10th January, 2004 and 3rd June 2004. Considering the large number of samples, the reminder letters were sent without a copy of the questionnaire. The survey secured a total 21.56% response rate. This is about an average response rate, which is found in the literature.

(vi) Response quality

Response rate and error are the two important parameters of the response quality for the current study. Response rate is heavily dependent on the quality of the text of questions and the communication skill of the respondents. In order to minimize the response errors; in the period of designing the questions, the following factors were considered which were as suggested by Sudman [176]:

(i) Memory:

Materials may be forgotten or may not be remembered clearly by the respondents.

(ii) Motivation:

Respondents may want to present the highlight of their companies.

(iii) Communication:

Lack of knowledge to reply on the question.

(iv) Knowledge:

Respondents may not know the answer.

Apart from the above, various types of non-response errors were considered such as:

(i) Sample might be out of selected population,

(ii) Companies refused to co-operate,

(iii) Change of address or wrong address of the firms.

(vi) Response rate improving methods

In order to improve the response rate, the following steps were been taken; One letter was issued *[ref: Appendix D]* together with the questionnaire for the respondents to stimulate the response rate. This letter was issued with a aim to give them an idea that the ongoing survey programme is an academic exercise. Another two letters were been sent to remind them speed up the reply *[ref: Appendix-D]*. In addition to that, repeated phone calls ware made to speed the reply.

(vii) Response rate

The analysis of the reply from the respondents is shown in Table 4.6.

Table 4.6 Response rate.

Sample groups	Sample size	Reponses				Response rate (%)
		First return	Return after first reminder	Return after 2^{nd} reminder	Total	
The users of ICM	181	28	7	5	40	22.09
ICM manufacturers	700	101	30	19	150	21.42
Raw material suppliers	46	7	2	1	10	21.73
Public policy makers	47	6	3	1	10	22.27
Total	974	142	42	26	210	21.56

It is evident from Table 4.6 that the average response rate is about 21.56%, which is matching with the other survey and hence the response rate is within the acceptable limit. Table 4.6 reveals that the reminder in any form is the stimulating tool which can be used to improve the response rate.

4.4 QUESTIONNAIRE ANALYSIS

In developing questionnaire, some guidelines were taken from the work of the survey of Roche [179] and Zini [180]. A total of thirty-nine group of questions were designed for four stakeholders for the current study. The basic themes of the questions are as follows:

Question 1

This question asks respondents to reply on their preference of the origin of ICM. The question intends to gather information on the demand for the locally made industrial capital machinery in Bangladesh. The question is designed to examine the market potential for the locally made machinery.

Question 2

The respondents were requested to respond on the machinery which has been bought from local manufacturers. This question was designed to examine and establish the demand for locally made categorized ICM.

Question 3

This question seeks information of preferences for purchasing the locally available technologies and machinery. The question intends to examine the pattern of use of locally made machinery and industrial technologies in the manufacturing industries in Bangladesh.

Question 4

Respondents are requested to respond on the sources from which they have bought high-tech or core process machinery. Survey findings were used to focus on the scope of supply for locally made high-tech or core process machinery.

Question 5

This question was designed to identify the barriers perceived by the manufacturing industries to procure the locally made machinery. Respondents were requested to select the barriers from the list attached with the question.

Question 6

This study seeks information on the procurement procedure of the ICM used by the industries. The reply was used to identify the selection procedure of the industrial capital machinery and its impact on the local ICM manufacturing enterprises.

Question 7

Why the industrial entrepreneurs are interested to procure the locally made machinery? The current question was designed to identify the reply of that interest. In addition, the study wants to apply the reply of this question to examine the impact of use of locally made machinery in the industries on the growth of ICM manufacturing SMEs.

Question 8

The study wants to identify, why the entrepreneurs are not interested to procure the locally made ICM.

Question 9

This question seeks information on the capabilities of local ICM manufactures of proving after sales service for repair and maintenances of the machinery. Survey results were used to analysis the impact of after sale service capability on the growth of ICM manufacturing SMEs.

Question 10

The question intends to identify the limitations of ICM manufacturing enterprises. The result was used to examine the impact of manufacturing barriers on the demand of locally made the ICM.

Question 11

Question seeks information of the investment on the locally made ICM. It was designed to examine the pattern of investment on the locally made categorized ICM usually followed by the industrial entrepreneurs

Question 12

Respondents are requested to respond on the reasons if they reduced the budget for locally made ICM.

Question 13

Here by industries are requested to respond on the reasons if they increased the budget for the locally made ICM.

Question 14

This question seeks information on the sourcing tools and techniques that are usually used by the industries for the procurement of the industrial capital machinery. The replies were used to rank the existing sourcing tools mostly used by the industries.

Question 15

Respondents are requested to rank the performances of local manufacturing firms from where they usually buy ICM and after sales services. This question was designed to examine the degree of performances of ICM manufacturing enterprises.

Question 16

It was a key question of this study. This question seeks information on the use of locally developed and available indigenous industrial technologies in the manufacturing industries.

Question 17

This question seeks information on the use of the locally made ICM. The survey finding was used to characterize the use of the locally made industrial machinery in the manufacturing industries.

Question 18

The question seeks information on the age of the ICM manufacturing enterprises. The answer was used to establish the relationship between the age and performances of manufacturing SMEs.

Question 19

The question was used to ensure, whether the surveyed firm was in the ICM manufacturing business.

Question 20

Question seeks information on the manufacturing capability of the surveyed enterprises, especially it stressed on the manufacturing capability of the categorized machinery.

Question 21

This question seeks information of growth on sales of locally made ICM for the period of last five business years.

Question 22

The question was designed to find the tools used by the manufacturers for the sales and marketing for the locally made ICM.

Question 23

This question seeks information on the sales amount of the locally made ICM from the different age groups of manufactures.

Question 24

The information of growth in sales of locally made capital machinery was gathered by using this question. The question has set its target to gather information on sales growth of ICM over last five years. The surveyed results were used to establish the demand behavior of the locally made ICM.

Question 25

The impact of price on demand was judged by the reply of this question. It intends to examine whether there is any impact of price on the demand for the locally made ICM.

Question 26

Respondents are requested to reply on the operating cost per unit of their products (machinery).

Question 27

The size of the employees of the enterprises was determined by using this question.

Question 28

The impact of size of employees on the sales was established by using the reply of this question.

Question 29

The question intends to gather information on strength of machine tools used in the manufacturing line by the enterprises.

Question 30

The strength of CIM in the manufacturing enterprises was established by using the reply of this question.

Question 31

The management capability of the ICM manufacturing enterprises was determine by this question

Question 32

This question seeks information on the deployment policy of employees in the job.

Question 33

This question was designed to establish the relationship between the strength of AMT and sales of the ICM manufacturing enterprises.

Question 34

The current import duty and VAT on the raw materials was established by this question. The survey result was used to measure the impact of import policy on the growth of the ICM manufacturing SMEs.

Question 35

This question is designed to examine the impact of government policy on the cost of raw materials and on the product.

Question 36

This question seeks information on the policy which government has taken for the growth of ICM manufacturing SMEs. Survey result was used to measure the impact of government policy on the growth of ICM manufacturing SMEs.

Question 37

Respondents are requested to reply on the development policy for the ICM manufacturing SMEs.

Question 38

This question seeks information on the programme that might be implemented by the government for the improvement of infrastructure requested by the ICM manufacturing SMEs.

Question 39

This question is designed to trace the strategy which has been taken by the government to be implemented in the future for the development of ICM manufacturing enterprises in Bangladesh.

4.5 CHAPTER SUMMARY

This chapter outlined the design of the survey presented the population and sample sizing methods, principals of questionnaire design, survey fundamental, limitations of question selection, schedule of pilot and main survey. Pilot survey, administering the main survey and response improvement methods were also described in detail. Response rate was calculated and presented in tabular form. The chapter ended with a description of the themes behind the design of the individual questions.

CHAPTER 5

Results and discussions

5.1 INTRODUCTION

The postal surveyed data was analysed in order to establish the market potential for ICM, barriers to growth of the manufacturing enterprises of capital machinery and the scope for the contribution of locally made industrial capital machinery to develop manufacturing industries in Bangladesh.

A questionnaire for general manufacturing industries, manufacturing enterprises for capital machinery, raw materials suppliers and policy maker was used to analyse the issues. The questionnaire is presented in Appendix E in tabular form together with the surveyed data, partial analysis and presentation of some results.

Standard techniques were used for the analysis, which includes a statistical package, Least Squire method, linear regression to correlate the joint variation of two variables, multiple correlation regressions to establish the relationship between variables, 2-D graphs to represent the relation between two variables and 3-D sigma plots for three variables.

Models for manufacturing cost of ICM have been developed and presented by mathematical equations and 3-D surface plots. Models for total market growth and demand for categorized locally made ICM have also been developed. The barriers to growth of the ICM manufacturing enterprises were analyzed and the results have been presented by 2-D graphs. The impact on demand at higher inputs of AMT and industrial technology were established and correlation was made with the current S & T and industrial policies of Bangladesh.

The model for demand at lower values of import duty on raw materials has been developed and correlation was made with current import policy and presented by mathematical equations and 3-D surface graphs. The scope for the contribution to manufacturing industries by supplying locally made ICM has also been established. The chapter ends with the summary of discussion on results.

Data processing -method

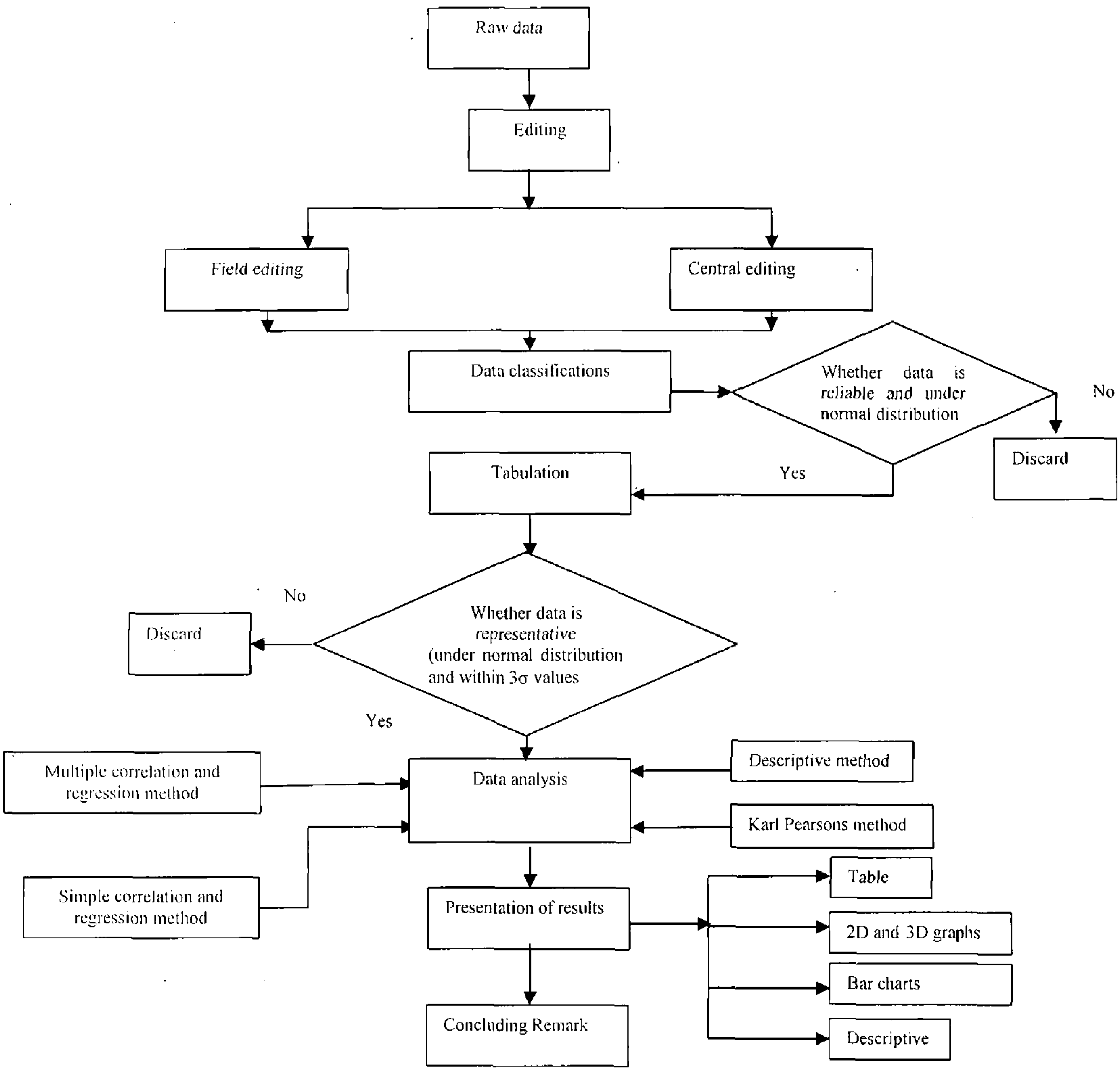

Figure 5.0 Data processing and analysing methodology and technique (Data quality was improved as per the procedure mentioned chapter 3, page 3.1)

5.2 THE MARKET POTENTIAL FOR INDUSTRIAL CAPITAL MACHINERY IN BANGLADESH

In this part of the study, the market potential for the industrial capital machinery was examined in order to identify the opportunity for the procedure of the locally made ICM. The market potential was studied by examining the following parameters of the machinery market for the period 1998-2003.

(a) The growth pattern of total market size of ICM,
(b) The market size of imported and locally made ICM,
(c) The market size of categorised locally made ICM.

The growth patterns of the ICM market were studied with at aiming to establish the growth models of demand for the both of total market and locally made categorized ICM.

5.2.1 Growth pattern of total market size of ICM

In order to examine the total market size of ICM, the relevant data on investment in capital machinery for the period 1998-2003 was collected from the Board of Investment of Bangladesh [181]. The growth pattern of the market is shown in Figure 5.1.

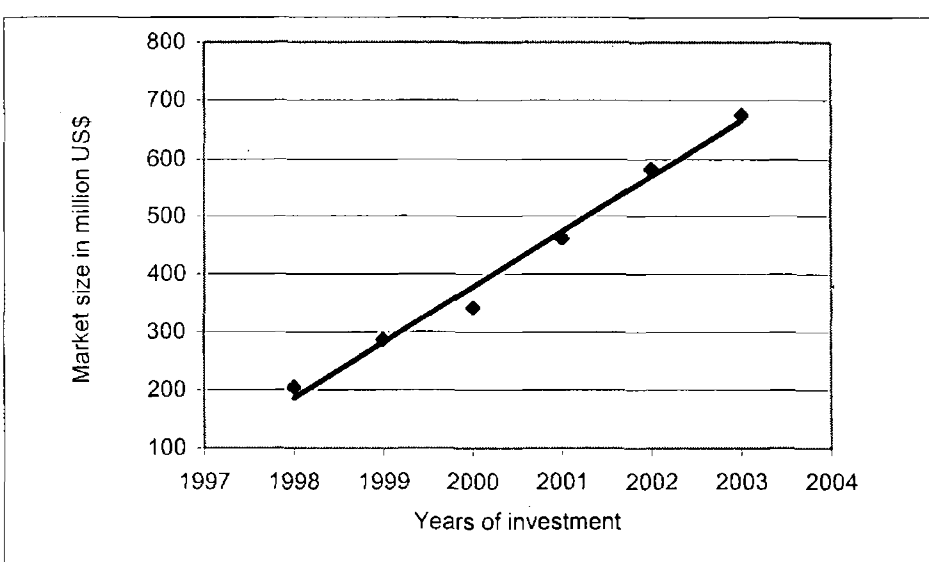

Figure 5.1 Growth pattern of size of ICM market.

Figure 5.1shows a growth curve of ICM market which indicates that trend of annual growth in Bangladesh is about 30%. The value of correlation coefficient (r) of growth of the market was estimated from the survey data shown in the figure by using the linier regression method. The estimated value of correlation coefficient (r) is 0.9876, which is statistically significant. The value of correlation indicates that growth of the market size has a strong and positive correlation with the year of operation of this business.

Mathematical model for market growth OF ICM

The growth mode of ICM for total market size has been established from the data shown in Figure 5.1. The model is presented by Equation 5.1;

$$y = 96.033\,x + 89.341 \tag{5.1}$$

where, 'x' is the year of operation,

'y' is the size of the total market.

The future market size for ICM can be predicted by using Equation 5.1. The future market size for the period 2004-2009 was estimated assuming that there will be no significant change in other factors. Table 5.1 presents the predicted market size.

Table 5.1 Predicted market size for the period 2004-2009.

Parameters of the market	2004	2005	2006	20070	2008	2009
Market size in US$(million)	762	858	954	1050	1146	1242

Table 5.1 suggests that the market size of ICM will be growing and there will be a huge potential market for industrial capital machinery in Bangladesh.

5.2.2 Market size for imported and locally made ICM

The market size for imported and locally made ICM was examined to establish their market share in Bangladesh. In order to obtain the market size of each group, the relevant data on investment was used from reference [181], which is shown in Table 5.2.

Table 5.2 Market share of imported and locally made ICM for the period 1999-2003.

Sources of ICM	1998	1999	2000	2001	2002	2003
Imported (%)	92.64	92.32	92	91.44	90.70	90.5
Locally made (%)	7.36	7.68	8.0	8.56	9.3	9.5
Total(%)	100	100	100	100	100	100

It can be seen from Table 5.2 that the market share for imported machinery is in excess of 90 percent and the locally made machinery has captured only 10% market share. Based on this result, it can be stated that the supply for locally made machinery is currently very small and if the conditions remain unchanged the manufacturing industries of Bangladesh will continue to dependent on imported machinery.

5.2.3 Market share for categorised ICM

The market share of categorized ICM was examined in order to establish the level of automation of the plant machinery used in Bangladesh. The installation drawings (P & ID) of the machinery from 65 manufacturing industries have been collected and the machinery were divided into four categories, i. High-tech, ii. Low-tech, iii. Peripheral, and iv. Generic machinery. *(Sources: Appendix C].* The current market sizes for the categorized machinery are shown in Figure 5.2.

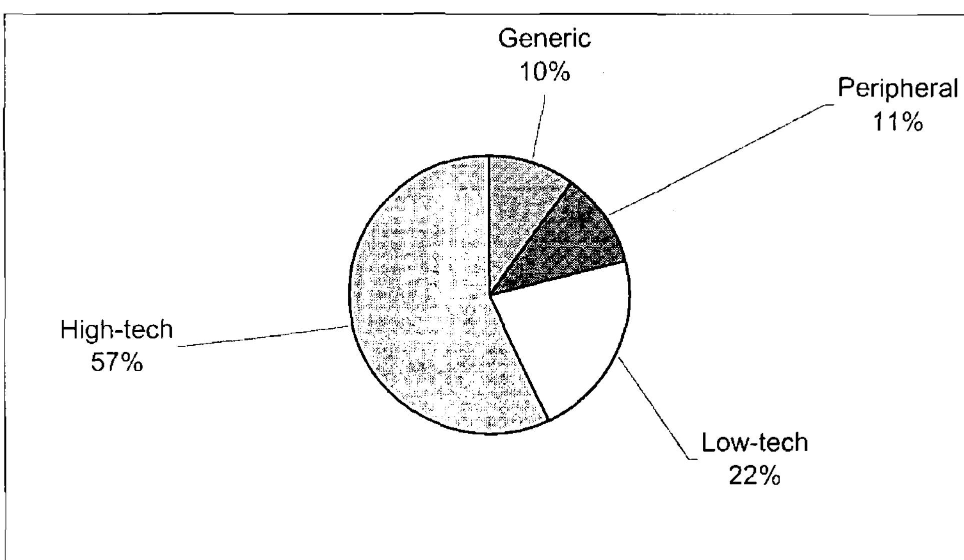

Figure 5.2 Total market share of categorised ICM.

Figure 5.2 shows that a major percentage industrial capital machinery is high-tech in nature.

5.2.4 Opportunity for scope of supply for locally made ICM

The opportunity for the supply of locally made ICM was determined by examining the following parameters. *[Source: Question No 01, Appendix E]*.

a. The preferences of industrial entrepreneurs for ICM (import or locally made).
b. The scope of supply for locally made ICM.

(a) Preferences of industrial entrepreneurs for ICM

The preferences of industrial entrepreneurs for ICM were examined to obtain their strategy for the procurement of plant machinery. The preferences were examined by using data from postal survey. *[Source: Question No 01, Appendix E]*, which is plotted and shown in Figure 5.3.

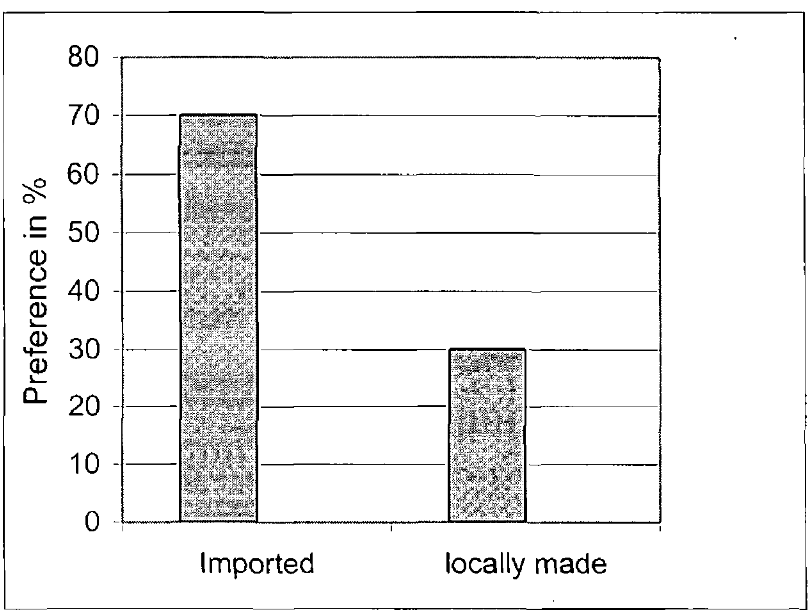

Figure 5.3 Distribution of preferences for locally made ICM.

It is evident from Figure 5.3 that a major percentage (about 70%) of entrepreneurs is not interested in purchasing industrial capital machinery from local manufacturers. Surveyed data showed that 30% of entrepreneurs have expressed on interest in purchasing some peripheral and generic machinery from the local manufactures.

[Source: Question No 02, Appendix E]. Results indicate that industries prefer to source high-tech and core process machinery from imported sources *[Source: Question No 03, Appendix E]*. The survey suggests that the preference for locally made ICM is low and it can be stated that the manufacturing industries of Bangladesh are heavily dependent on the imported sources for the required machinery.

(b) Scope of supply for locally made ICM

The growth trend of the market for locally made ICM was examined to predict the market size for the future. The current trend of growth was established by using data from Table 5.2 and shown in Figure 5.4.

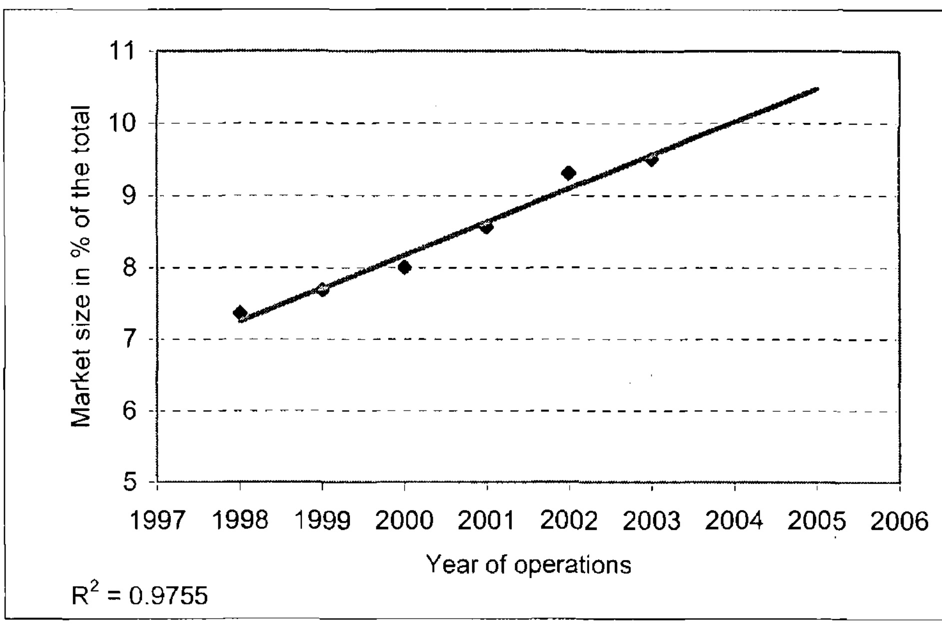

Figure 5.4 Trend of growth for locally made ICM.

The current trend of growth suggests that the market is increasing even by a small percent. The value of "r" for growth of market was estimated from data plotted Figure 5.4. The estimated value is 0.9857, which is statistically significant. The value of "r" indicates that demand for locally made machinery has strong correlation with growth of the total market size of the machinery within specified or limited time.

Mathematical model for market growth of locally made ICM

The growth model of the market for locally made ICM has been established from data shown in Figure 5.4.The model is presented by Equation 5.2

$$y = 0.426\,x + 6.854 \qquad (5.2.)$$

where, 'x' is year of operation

'y' is the size of market for locally made machinery.

The size of the market for that category for the future can be predicted by using Equation 5.2. The future market for the period 2004-2008 was estimated assuming that the other factors will remain unchanged. Table 5.3 presents the predicated market size.

Table 5.3 Market for the period 2004-2008.

Parameters of the market	2004	2005	2006	2007	2008
Demand size in %	9.41	9.836	10.262	10.688	11.114

Table 5.3 suggests that the market size will be growing very marginally and there will be limited scope of supply for locally made industrial capital machinery to the local market in Bangladesh.

5.2.5 Scope of supply for locally made categorised ICM

The current market size for categorized ICM was examined in order to determine the specific scope for the supply of locally made capital machinery to the industries. Examination was carried by using data obtained the postal survey *(Source: Question No 11, Appendix C]* for the business period 1998-2003. The categorized market size for locally made ICM was studied with a aim to develop the growth model for the followings:

(i) Scope of supply for locally made high-tech machinery,

(ii) Scope of supply for locally made low-tech machinery,

(iii) Scope of supply for locally made peripheral machinery,

(iv) Scope of supply for locally made generic machinery.

(i). Scope of supply for locally made high-tech machinery

Study examined the scope of supply for locally made high-tech machinery in order to establish the scope of supply for this category. By using the surveyed data, the current supply of high-tech machinery was estimated *[Sources: Question No 11b, Appendix E*] and shown in Figure 5.5.

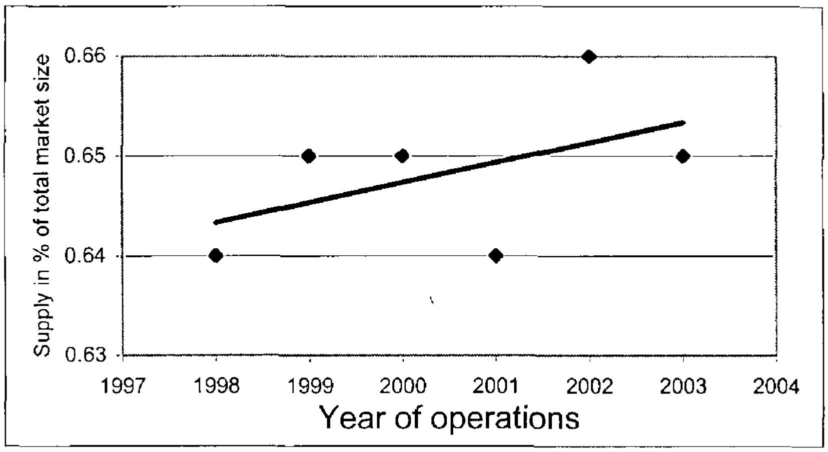

Figure 5.5 Supply of locally made high-tech machinery.

Figure 5.5 shows that the current supply of high-tech machinery is small and the estimated amount is about 0.65% of the total market size. The value of correlation coefficient of supply in respect to the year of operation is "r" is 0.497, which is statistically insignificant. This means that the supply of this category machinery is not strongly correlated with the age of the manufacturing industries.

Based on this result it can be stated that the industries are not expressing their confidence in locally made high-tech machinery and the market size of this category will remain low in the future in till situation improve.

(ii). Scope of supply for locally made low-tech machinery

The supply of locally made low-tech machinery was estimated in order to establish its future potential. Surveyed data *[Sources: Question No 11a, Appendix E]* was used to examine the current supply, which can be seen from the graph plotted in Figure 5.6.

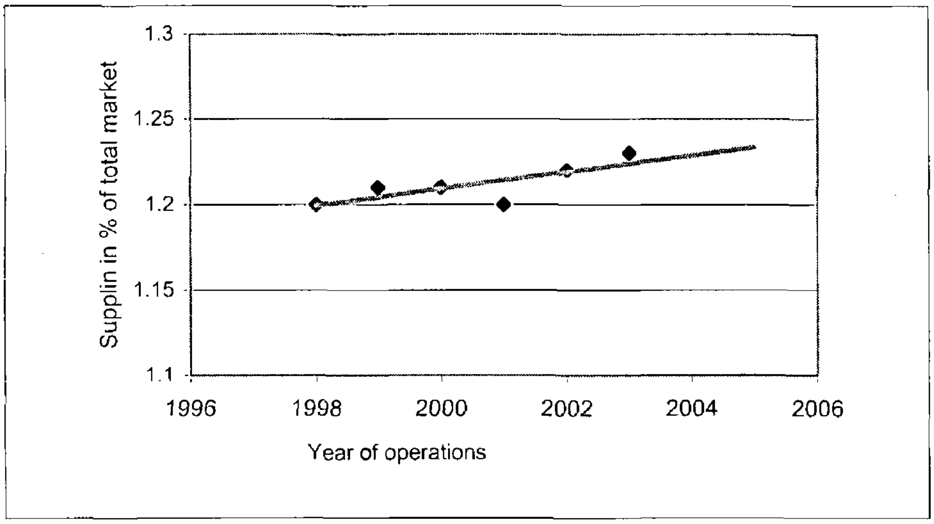

Figure 5.6 The supply for locally made low-tech ICM.

Figure 5.6 shows that the current supply is small and at about 1.2%. The coefficient of correlation ® for this data was estimated to be 0.5691 which indicates that there is a statistical relationship between independent variables (year) and the dependant variable (supply).The result suggests that though the local ICM manufactures are gaining experience, the end users of machinery are not showing on interest in purchasing low-tech machinery from them. The survey demonstrates that the market size for locally made low-tech machinery is small.

(iii). Scope of supply for locally made peripheral machinery

The current scope of supply for locally made peripheral machinery was examined to establish the trend of growth of this category. To examine the scope for supply, data from a postal survey for the period 1998-2003 was used. *[Sources: Question No 11c, Appendix E]*, which can be visualised from Figure 5.7.

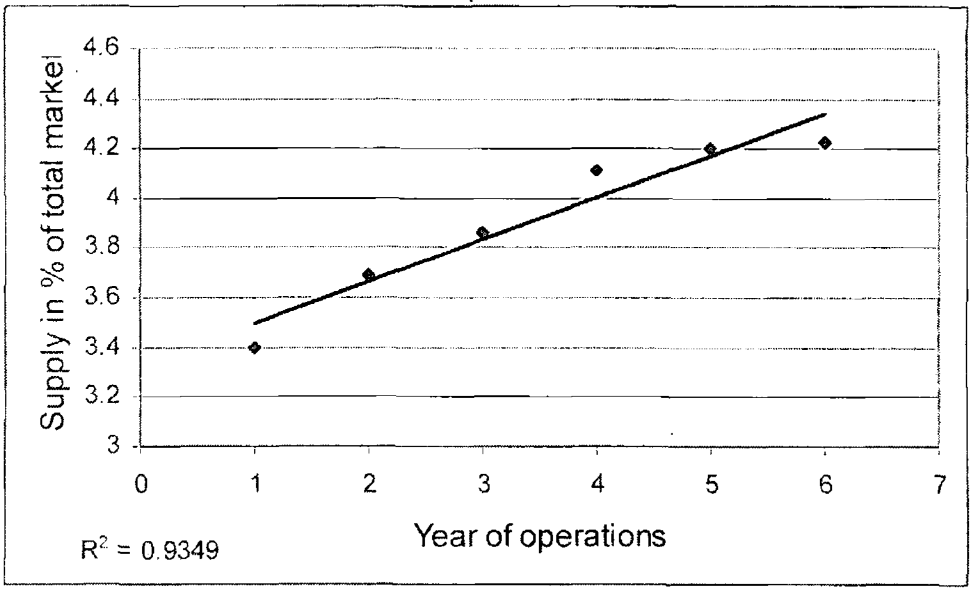

Figure 5.7 Supply of locally made peripheral machinery for the period 1998-2003.

It is evident from the graph plotted in Figure 5.7, that the trend for supply is currently increasing, but the average size is only about 4% over this period. The value of "r" (0.9349) of growth indicates that the supply of locally made peripheral machinery is statistically significant. Based on the result it can be stated that the buyers are showing some interest in purchasing the type of machinery from local manufacturers and there is some market potential for this category of machinery in Bangladesh.

Mathematical model for supply of locally made peripheral ICM

The supply model is derived from trend of growth shown in Figure 5.7 and expressed by Equation 5.5.

$$y = 0.1694x + 3.322 \tag{5.5}$$

where 'x' is the year of operation

'y' is the size of supply fro locally made peripheral machinery.

By using Equation 5.5 the supply for the future can be predicted. The scope of supply for period 2006-2010 was calculated and the results are shown in Table 5.4 (assuming that the other factors remain unchanged).

Table 5.4 Predicted market for peripheral machinery for the period 2004-2008.

Parameters of the market	2004	2005	2006	2007	2008
Demand in %	4.458	4.66	4.862	5.064	5.266

Table 5.4 suggests that the scope of supply for locally made peripheral ICM will be growing and will be about 5% for the foreseeable future.

(iv). Scope of supply for locally made generic ICM

The scope of supply for locally made generic machinery was examined in order to establish the growth model for future opportunities. The mathematical model was established by using postal surveyed data for the period 1998-2003. *[Sources: Question No 11d, Appendix E]*. The surveyed result on generic machinery was plotted and shown in Figure 5.8.

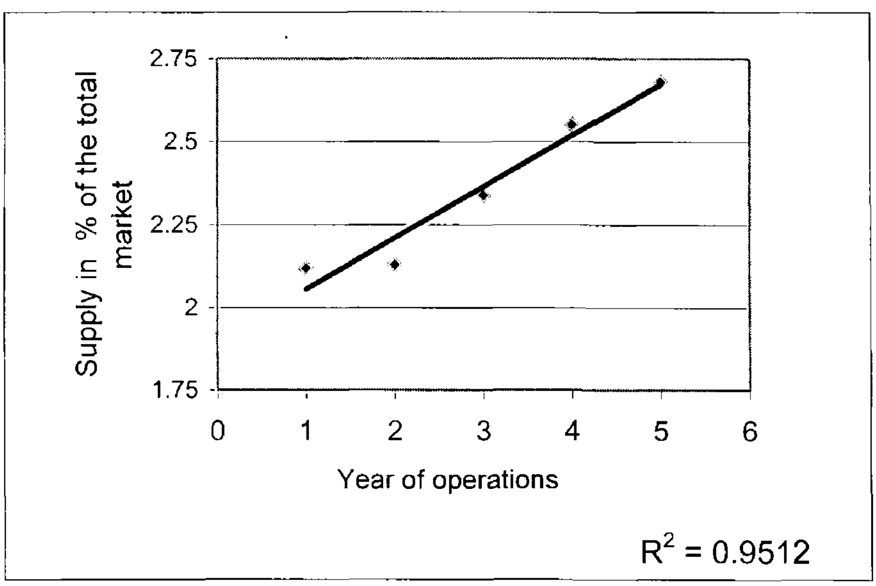

Figure 5.8 Supply of locally made generic machinery for the period 1998-2003.

Figure 5.8 shows that the market size of this category of machinery is currently small and the average is about 2.5%. The value of "r" was estimated from the data shown in Figure 5.8 and the estimated value is 0.9512, which is statistically significant. The value of "r" indicates that the industries are giving their preference on the locally made generic machinery. The result demonstrates that the market has some potential for this category of machinery in Bangladesh but over al its size is amll.

Mathematical model for supply of locally made generic ICM

The model for pattern of supply for generic machinery was derived from the trend of growth shown in Figure 5.8. The mathematic equation for supply is presented by Equation 5.6.

$$y = 0.154x+1.902 \tag{5.6}$$

where, 'x' is the year of operation

'y' is the supply of locally made generic machinery.

The result suggests that the supply of generic machinery is about 2.5% over this period and it can be argued that the scope of supply for this category continue to increase.

5.2.6 Summary of study on market potential for ICM in Bangladesh

Model for total market growth has been developed and it is evident that the annual growth rate of market is about 30%. It has been establish that to meet the requirement for industrial development, 92% ICM was imported for the period 1998-2003.

It has been established that the market share for peripheral and generic, low-tech and high-tech ICM is about 11% and 10% , 22% and 57% respectably. The result showed a good percentage (about 30%) of industrial entrepreneurs expressed preference to procure some locally made peripheral and generic machinery.

The growth model for supply of locally made categorized machinery has been developed and it was observed that the market for locally made peripheral and generic machinery is growing faster than the other categories.

The study tends to conclude that there is huge market potential for the ICM in Bangladesh. The scope of supply for locally made peripheral and generic ICM is significantly higher than the locally made high-tech and low-tech industrial capital machinery.

5.3 BARRIERS TO GROWTH OF THE ICM MANUFACTURING SMES IN BANGLADESH

In this part of the work, the barrier to growth of ICM manufacturing enterprises in Bangladesh was established by examining the following parameters:

(a) The lack of experience (age) of ICM manufacturing enterprise,
(b) The number of manufacturing employees,
(c) Lack of AMT capability,
(d) Short supply of industrial technology from local sources,
(e) Current S & T, industrial and import policies of the government.

The impact of barriers to growth was established in the following sections by using survey data shown in Appendix-E.

5.4 IMPACT OF EXPERIENCE ON THE GROWTH IN SALES OF ICM MANUFACTURING ENTERPRISE

Surveyed data on ICM manufacturing enterprises was analysed to establish the relation between sales and experience. The result of this study was used to examine whether the lack of experience is a barrier to growth of ICM manufacturing enterprises in Bangladesh.

5.4.1 Experience of ICM manufacturing enterprises

The age of ICM manufacturing SME was studied to identify the average experience of the enterprises. The study on experience was made by using data from the postal survey of ICM manufacturing enterprises in Bangladesh *[Sources: Question No 18, Appendix E.]*. Based on the experience, the surveyed enterprises were divided into five groups, which are shown in Table 5.5 and Figure 5.9.

Table 5.5 Distribution of enterprises by age.

Group -1	3-5 years
Group-2	6-8 years
Group-3	9-11 years
Group-4	12-14 years
Group-5	15-18 years

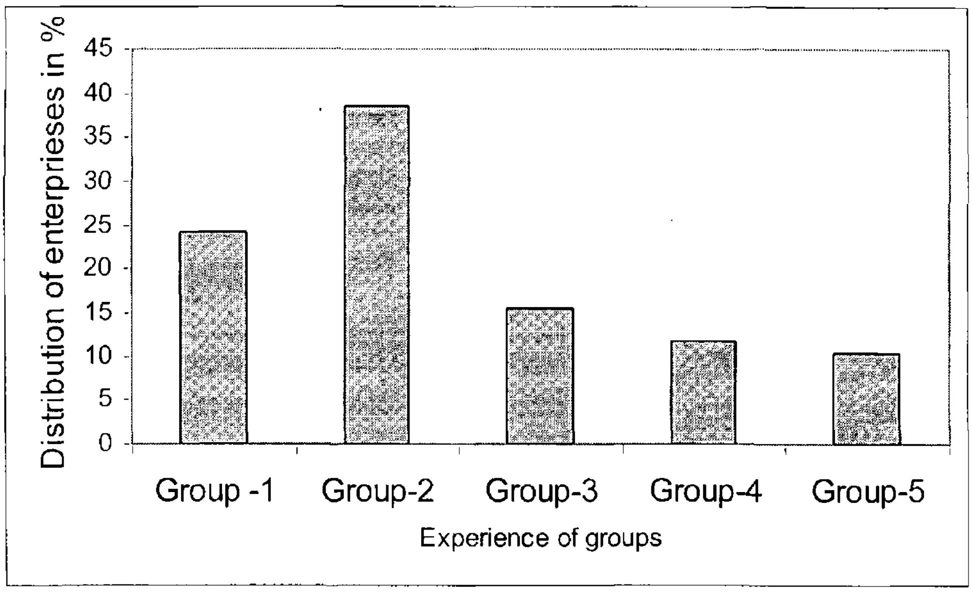

Figure 5.9 Experience of ICM manufacturing SME.

It is evident from Figure 5.9 that major percentages (about 40%) of ICM manufacturing enterprises are within the 6-8 years age group. The result indicates that the ICM manufacturing enterprises in Bangladesh are relatively young in manufacturing business.

5.4.2 Impact of manufacturing experience on sales

The influence of experience in the manufacturing business and the relevant sales of the age group was examined in this part of the study. To determine the impact of experience, the data from postal survey on sales for the year 2002 was used. *[Source: Question No 23, Appendix E.]*. The average sale of each experienced group was used to measure the impact on sales which is shown in Figure 5.10.

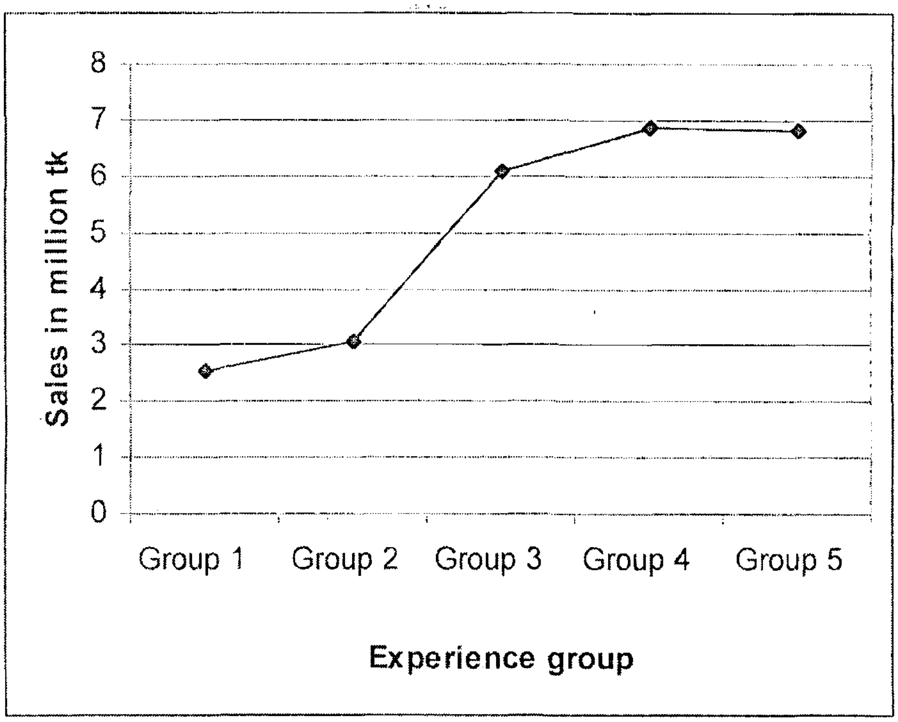

Figure 5.10 Impact of manufacturing experience on sales for the year 2002.

Based on the age group shown in Table 5.5, the sales of the relevant groups have been plotted in Figure 5.10. The graph shows that the sales are higher for the experienced groups. The value of "r" of growth of sales for the year 2002 was estimated from the data shown in Figure 5.10 and the estimated value is 0.8353, which is statistically significant. The value "r" demonstrates that sales has strong and positive correlation with the manufacturing experiences of the enterprises this means that there is a positive impact of experience on sale of ICM.

Based on the result, it can be argued that the buyer has a tendency to purchase ICM from the experienced companies and the sale is dependent on the experience of manufacturing business. The study tends to conclude that the manufacturing experience is a determinant factor in the sale of the machinery.

5.4.3 Discussion on experience and sale of ICM manufacturing SMEs

The experience (age) plays a vital role on the performance of an organization. Recent studies on industrial contributions to the economy have suggested that the age and size of the manufacturing firms are the two most important determinants of growth for the enterprises [182,183].

It has been established that the untested experience of the greatest number of ICM manufacturing enterprises is about 6-8 years. Results show that there is a relationship between experience and sales (the value of correlation coefficient is 0.8353) and the buyers are motivated to purchase ICM from experienced companies. It was evident that the market size for locally made ICM was about 8% over the period 1998-2003 *[ref: Section 5.2.2]* and the buyers had a tendency to procure plant and machinery from experienced manufacturing enterprises *[Ref: Figure 5.10]*. It has also been established that the local manufacturing enterprises are not capable of providing the required after sale services to industries because they are young and have insufficient experience. The survey showed that their lack of experience is one of the main barriers preventing the procurement of locally made ICM *[Source: Question No 05, Appendix E]*. The study demonstrates that the supply of ICM is only about 8% *[ref: Section 5.2.2]* and therefore manufacturing industries are dependent on foreign sources for the industrial resources, apparently92%. From this finding, it can be concluded that the lack of experience in the manufacturing business is a barrier to the growth of this sector.

5.5 Impact of size of employee on sales of ICM manufacturing enterprises

In this part of the study, the impact of the number of employees in an ICM manufacturing enterprise on its sales was established. This examination was carried in order to develop a relationship between the size of the enterprises and its sales.

To perform this test, a conceptual theory was adopted from the literature. The literature suggests that the company size, in terms of the number of employees is one of the key factors which could influence performance and can play a vital role in the achievement of strategic goals. Experts in SMEs believe that the number of employee size can dominate the growth of enterprises by enhancing its performance [184].

5.5.1 Size of manufacturing employee

The assessment on the current size of the ICM manufacturing enterprises was made by using the postal survey data. *[Sources: Question No 27, Appendix E]*. The surveyed enterprises were divided into five groups in respect of their number of employees, which are shown in Figure 5.11.

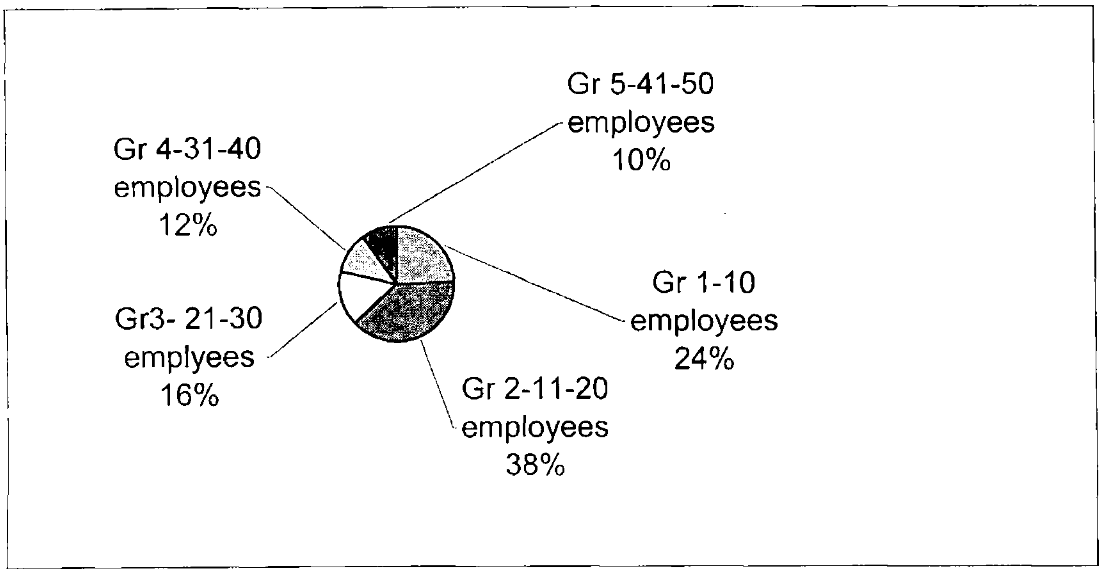

Figure 5.11. Size of manufacturing enterprises.

Figure 5.11 and Table 5.5a indicates that a major percentage (about 38%) of ICM manufacturing enterprises have 11-20 employees with a small percentage of management staffs. There is lot of evidence that the other groups have a significant number of employees with higher percentage management staff.

Table 5.5a Distribution of manufacturing and management staff*

Parameter of employees	SMEs Group				
	1	2	3	4	5
Total Employees	10	11-20	21-30	31-40	41-50
Manufacturing employees in percentage of the total	95	95	70	65	70
Non-manufacturing staff in present of the total	5	5	30	35	30

*The information in this table is based on data received from approximately 30% of the respondents. The remaining 70% of respondents failed to provide information that would add to this analysis

5.5.2 Impact of size on sale of locally made industrial capital machinery

The impact of capacity size on sales was examined for the period of 1998-2002. To establish the impact on sales the data from postal survey was used *[Source: Question No 28, Appendix E.]*. The surveyed data on sales of the enterprises were divided into five groups. *[ref: Section 5.4.1 and Figure 5.11]*. The average sale of each group was used to measure the impact of sales. Figure 5.12 presents impact of age on sales.

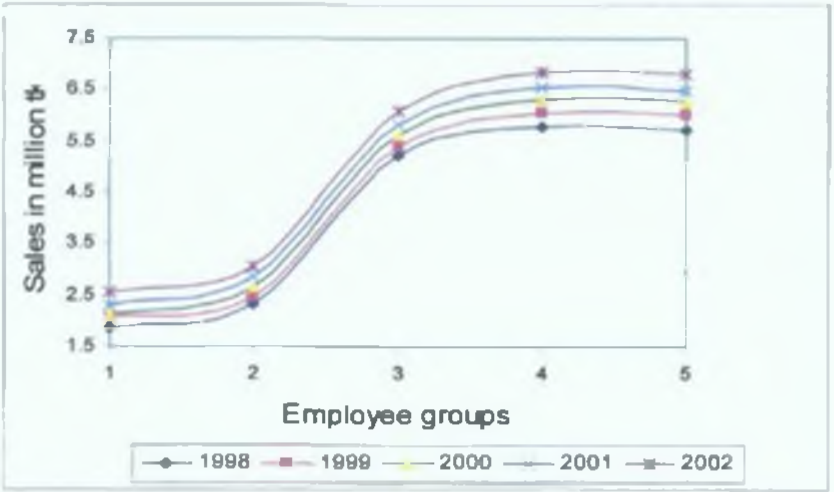

Figure 5.12 Impact of size on sales for 1998-2002.

It can be seen from the curve plotted in Figure 5.12 that the volume of sales of the bigger companies is higher. The value of correlation coefficient of sales and size of the company "r" was estimated from the data plotted in this figure. The estimated value for the year 2002 is 0.990, which is statistically significant. The value of correlation coefficient suggests that there is a strong and positive relation between the sales and size of the enterprises this means that there a impact on size of the companies on its sales.

Figure 5.12 and Table 5.6 indicates that SMEs in groups 1 and 2 have a small number of employees. It is also evident that their sale revenue is marginally small because manufacturing industries are not interested in purchasing ICM from these enterprises due to limited supply of after sales services and sales promotion. But those organizations that are within group 3 have sufficient human resources to prove after sales services which contribute to increase their sales and services. The SMEs in groups 4 and 5 have almost the same amount of sales despite the fact that SMEs in group 5 have a larger number of manufacturing employees. In many cases, it was found that SMEs in group 5 have enough manufacturing staff but they are operating without an adequate number of sales and management staff and due to these reasons they are operating inefficiently. Further analysis is required to determine the impact of the size of the sales and management teams in SMEs on sales revenue.

Based on this result, it can be argued that buyers are motivated to procure ICM from bigger manufacturing enterprises. Eventually, it can also be stated that the number of manufacturing employees, sales and management staff are the key determinants for the growth of ICM manufacturing SMEs in Bangladesh.

5.5.3 Result and discussion on size and sales of ICM manufacturing SMEs

It has been established that the numbers of employees of a large percentage of manufacturing enterprises is 11-20 and there is a positive impact of the current size on its sales (the value of correlation coefficient is 0.9807) and the buyers are motivated to purchase ICM from the bigger size companies. In addition, the result has shown that the market size for locally made ICM is about 8% over the period 1998-2002 *[ref: Section 5.2.2]*. Surveyed results also demonstrate that there is a seriously short supply of skilled technicians *[Sources: Question No 10, Appendix E]* and manufacturing staff in the labour market *[ref: Section 3.3.5]*, which is contributing to the size of the employees. The current survey suggests that the local ICM manufacturing enterprises are small in size and they have insufficient skilled staff to provide required services to industries and this is one of the identified barriers to procure locally made ICM *[Sources: Question No 19, Appendix E]*.

The survey results showed that in a small firm one employee is engaged in many different jobs and as result the overall performance of individual employee tends to be reduced *[Sources: Question No 32, Appendix E]*.]. The other research suggests that the small size of employee is a barrier which usually contributes to reduce performance [185].

From these findings, it can be concluded that the current size of manufacturing enterprise is the barrier for its growth. The short supply of technicians and manufacturing staff are the cause of the small size of the enterprises.

5.6 Impact of Advanced manufacturing technology on growth of sales of locally made ICM

The current strength of advanced manufacturing technology (AMT) in ICM manufacturing enterprises was examined to evaluate whether the present low level of AMT is a barrier to growth of ICM manufacturing enterprises in Bangladesh. The level of AMT was measured using two parameters shown in Table 5.6.

Table 5.6 Parameters of AMT.

Parameters of AMT	Functions
Computer aided manufacturing (CIM)	Level of automation
Machine tools	Directly used for production

In the present study, the growth in the use of AMT was measured on the basis of fresh investment made towards the development of AMT in ICM manufacturing enterprises in Bangladesh. The result of this study was used to establish the trend of the growth of ICM manufacturing business.

5.6.1 Level of automation in ICM manufacturing enterprises

The level of automaton (CIM) was examined to establish the current use of the computers in the manufacturing business. The study on CIM was carried out by using data from the postal survey for the period 1998-2003. *[Sources: Question No 30, Appendix E.]*. The current CIM status in CIM manufacturing SMEs is shown in Figure 5.13.

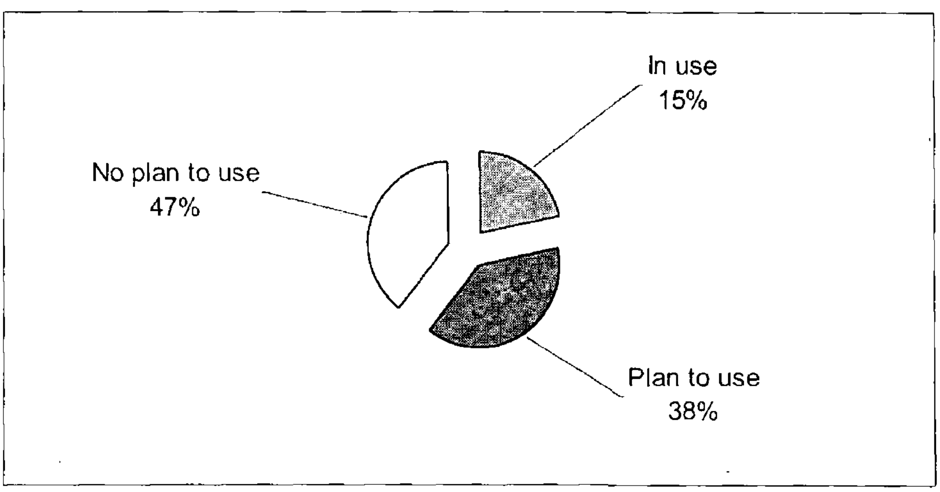

Figure 5.13 Use of CIM in ICM manufacturing enterprises in Bangladesh.

Figure 5.13 shows that the use of CIM in manufacturing business is insignificant. Based on this data, it can be stated that the manufacturing business in Bangladesh is dependent mainly on manual system instead of computer. The result indicates that the lack of automation in the manufacturing business is contributed to reduce productivity in this sector.

5.6.2 Use of machine tools and skilled manufacturing staff

The level of automaton in machine tools was examined to establish the productivity and quality of the products. The current status of automation in machine tools was established using the postal survey data for the period 1998-2003*[Sources: Question No 29, Appendix E]*. Figure 5.14 presents the current status of machine tools.

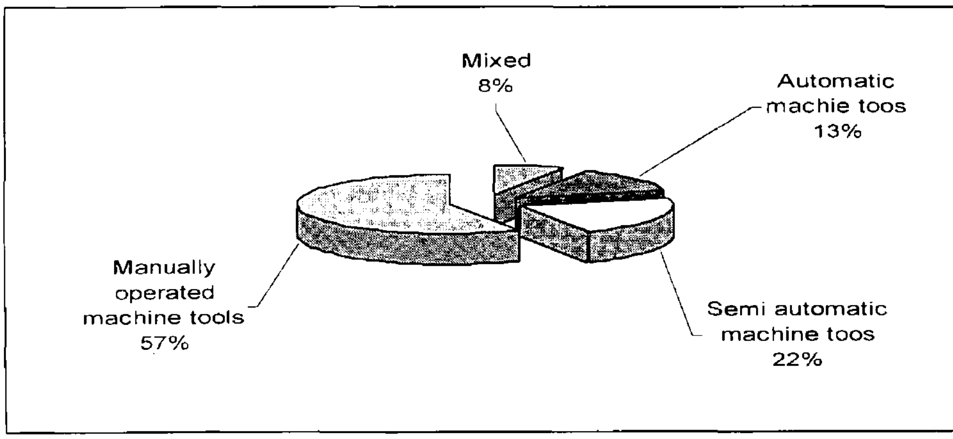

Figure 5.14 Automation levels of machine tools.

Table 5.6a Distribution of manufacturing staff*

Parameter of employees	AMT group		
	Group 1	Group2	Group 3
Skilled manufacturing staff percentage of the total	8	15	15
Unskilled Manufacturing staff percentage of the total	92	85	85

*The information in this table is based on data received from approximately 25% of the respondents. The remaining 70% of respondents failed to provide information that would add to this analysis

It is evident from the chart shown in Figure 5.14 that the majority enterprises are dependent on manually operated machine tools. In addition, Table 5.7 lists the ration of skilled and unskilled manufacturing technicians. This means that the production process of ICM manufacturing SMes is dependant on manually operated machine tools and unskilled technicians.

5.6.3 Growth of AMT in manufacturing enterprises

The growth of AMT in the ICM manufacturing enterprises was measured in respect of two parameters shown in Table 5.6. To establish the current growth of AMT, the data of average investment on ICM manufacturing enterprises for the expansion of manufacturing capabilities and productivities for the period 1998-2003 was used *[Sources: Question No 31, Appendix E]*, which is shown in Figure 5.15.

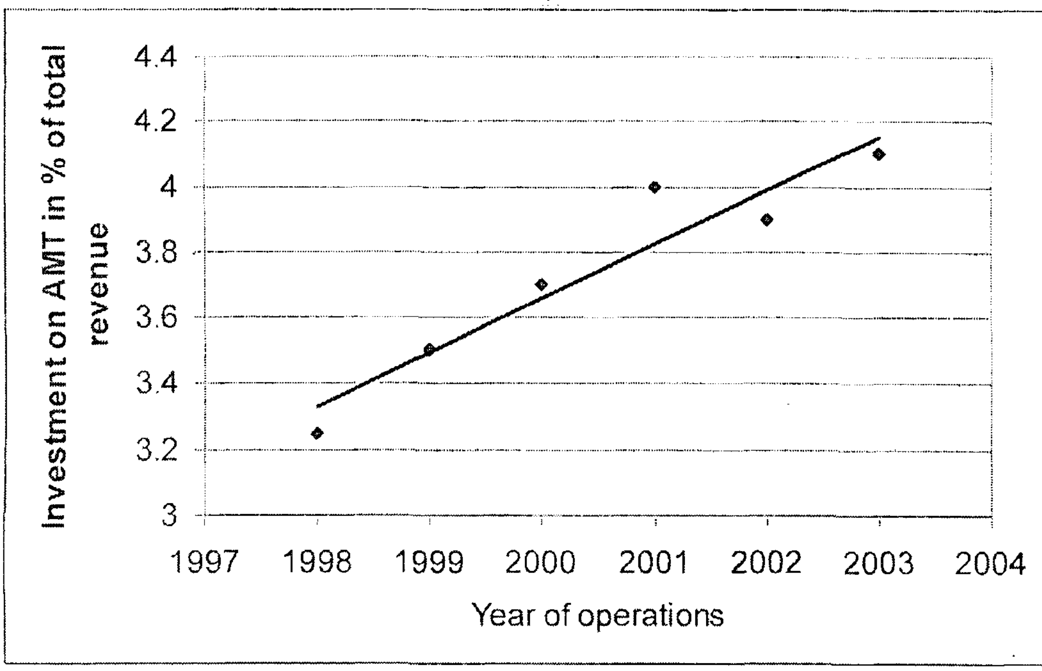

Figure 5.15 Growth of AMT.

Figure 5.15 shows that the average investment on AMT is less than 4% of the total revenue generate by the enterprises. The curve of trend of growth indicates that the enterprises are slowly but continuously making some investment in AMT to improve their production capacity and over all productivity.

Mathematical model for growth of AMT

Based on the up to date data of investment on AMT, the growth model of AMT in ICM manufacturing enterprises was established. The equation of the best fit curve of the relevant data shown in Figure 5.15 is presented by Equation 5.7;

$$Y(AMT)=0.4745Ln(x)+3.2214 \tag{5.7}$$

where, Y is investment growth on AMT

x the year of operations.

The model is based on the following conditions;

(i) Total demand for locally made ICM is 8%,

(ii) Technology supply from local sources is 9%,

(iii) Import duty on raw materials is 60%.

5.6.4 Impact of AMT on the growth of sales

The impact of AMT on sales was examined for the period 1998-2003 by using the data from postal survey *[Sources: Question No 33, Appendix E]*. The average data on sales of 45 manufacturing companies was divided into three groups to measure the impact of growth of AMT on sales. The impact of AMT on sales is shown in Figure 5.16.

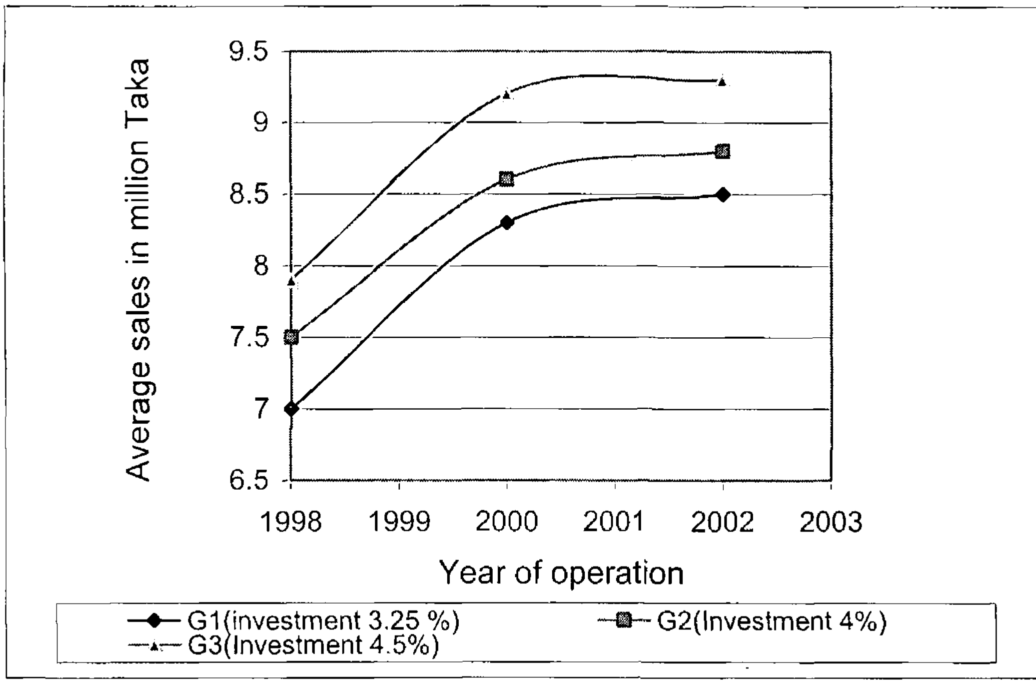

Figure 5.16 Impact of AMT on sales.

The curves of trend of growth show that the sale of the ICM is increased with higher AMT element. The values of correlation the coefficient of AMT and sales were estimated by using data shown in Figure 5.16, which are as follows:

r-(G1)-0.9285

r-(G2)-0.8962

r(G3)-0.9208

The above values of "r" are statistically significant. The value indicates that there is positive and strong correlation with the growth of sales and the investment of AMT in the manufacturing enterprises. It means that there is a positive effect of growth of AMT on sales and the buyers have comfortably shown their confidence in those manufacturing enterprises which had a higher level of AMT in their business. It is evident from the growth trend of sales for the years 2000-2002, that the growth of sales in the respect of growth of AMT is almost static because others factors relating to the sales have been offset by the growth of AMT.

Figure 5.16 indicates that even with higher AMT capability, after a certain level, the sale was not increased. It was evident that due to the lack of skilled technicians [Ref: Table 5.8], the quality of products was not improved and manufacturing industries were reluctant to procure higher percentage of machinery from those SMEs. It was found that the capability of AMT was offset by the lack of skilled manufacturing staff and the SMEs were operating inefficiently.

Based on this result, it can be argued that the buyers are motivated to procure ICM from those SMEs who have higher AMT capability and adequate number of skilled manufacturing staff. Eventually, it can also be stated that AMT and the number of skilled manufacturing employees are most important determinants for the growth of ICM manufacturing SMEs in Bangladesh.

5.6.5 Result and discussion on AMT and sales of ICM manufacturing enterprises

It has been established that the current use of CIM (15%) and automatic machine tools (13%) in the manufacturing business is poor. Results show that the average growth rate of AMT for the period of 1998-2003 was about (4%) and also it was evident that there is a positive impact of AMT on sales (the value of r is more than 0.8) and buyers are motivated to purchase ICM from the enterprises who have a higher level of AMT in the manufacturing business.

The surveyed data showed that the industrial entrepreneurs are inclined to import 92% of plant machinery from the foreign manufacturing companies because generally the quality of the locally made ICM is poor *[Sources: Question No 5, Appendix E]*. It was also evident from the survey results that the supplies of poor quality machinery and services have reduced the interest of the entrepreneurs to increase their budget for locally made ICM *[Sources: Question No 12, Appendix E]*. Results also show that machinery manufactures are not able to use CIM due to the lack of training facilities in the country and they do not to use automatic machine tools in their production process, as because the cost of such machine tools is high *[ref: Section 3.3.5]*.

The literature suggests that AMT [186] is a strategic tool which could be used to improve the performance in business and service. In view of current globalisation pressure; AMT is one of the potential determinants of the competitive advantage.

Based on these results, it can be clearly stated that the existing poor level of AMT utilization in the manufacturing business is a barrier to the growth of enterprises and this is due to the lack of training facilities and the high cost of the machine tools. It is also evident that these are under the control of S & T and industrial policies of the government. From these findings, it can be concluded that weak national S & T and industrial policies are contributing to the barriers of growth to the ICM manufacturing enterprises.

5.7 Impact of technology adoption from local source

The use of technology in industries from local sources was examined to evaluate its impact on the growth of the ICM manufacturing enterprises. The results of this study were used to measure the current support of S & T and industrial policies of the government for the growth of ICM manufacturing enterprises..

Here industrial technology is referred to as product processing techniques, engineering services for plant design, installation and start up work for the implementation of industrial projects.

5.7.1 Pattern of technology adoption in manufacturing industries

Adoption of industrial technology was examined in thirteen industrial sub sectors *[ref: Section 3.1]*. The technology input to the manufacturing industries was mainly from two sources, local and imported. The range of technology uptake from local sources was 7-25% and the average was about 12% *[Sources: Question No 16, Appendix E]*. The pattern of technology adoption for the period 1998-2003 is shown in Figure 5.17.

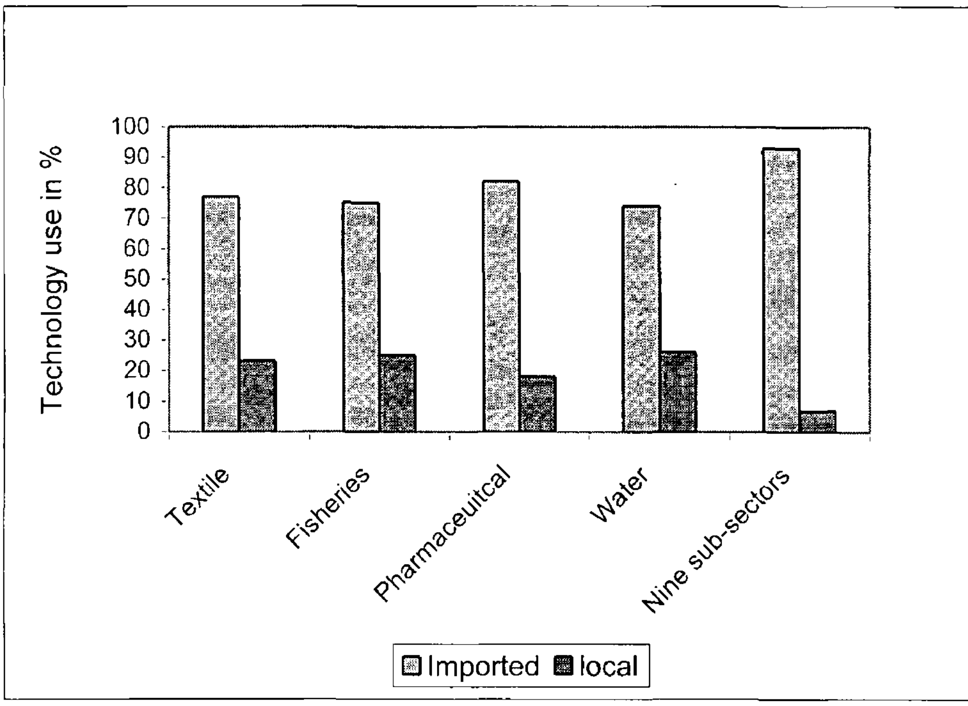

Figure 5.17 Pattern of technology adoption in industries.

It can be seen from the chart drawn in Figure 5.17 that the major percentage of industrial sub-sectors is dependent on the imported sources for their required industrial technology. The supply of local indigenous industrial technology to the industry is average about 9%. This result indicates that the technological capability in this country is poor and is further evidence of a fragile national S & T policy.

5.7.2 Impact of technology use from local sources

In this section, the utilization of indigenous technology from local sources for manufacturing industries and its impact on the growth of demand for locally made ICM was examined. The surveyed data *[Sources: Question No 17, Appendix E]* on adoption of technology and purchase of corresponding of ICM from the local sources was used to establish the correlations between these two variables (technology use from local sources and the growth of sales). The impact of technology sourcing from local sources on demand for locally made ICM for the period 1998-2003 is shown in Figure 5.18.

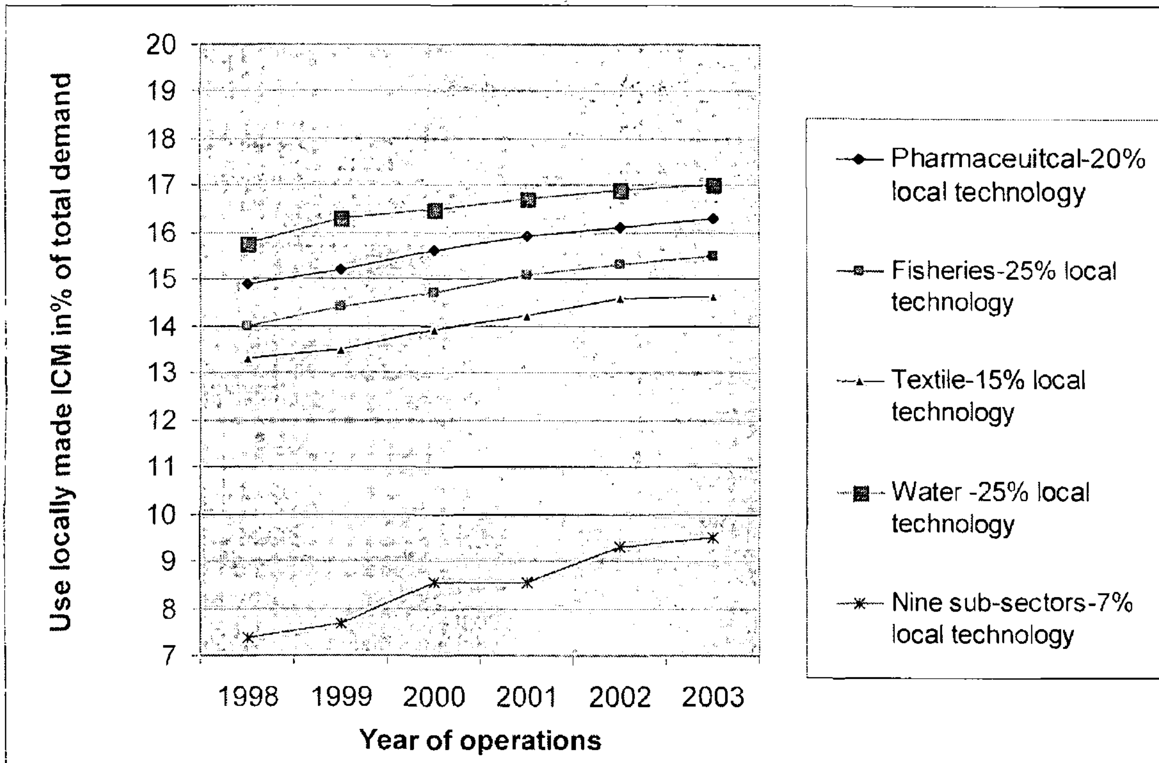

Figure 5.18 Impact of technology adoption from local sources for the period of 1998-2003.

Figure 5.18 shows that there is an impact of technology use from local source on the demand for ICM. The values of correlation coefficient of these two variables were estimated under the following conditions:

Technology sourcing limit:	25% maximum
Equipment sourcing limit:	18% maximum

The values of correlation coefficient of technology adoptions and the growth of demand are:

r- (pharmaceutical)	:0.9914
r- (Fisheries)	:0.9913
r (Textile)	:0.9697
r (Water)	:0.9628

The values of "r" suggest that there is a positive and strong correlation between the technology adoption and demand for locally made ICM at the period of 1998-2003.

The values indicate that there should be an impact of technology adoption from local source to manufacturing industries on the growth of demand for the locally made ICM. The growth curves demonstrate that at the utmost limit the rate of technology adoption and ICM utilizations are not the same and the rate of equipment demand are almost static. This phenomenon implies that there are some limitations for supply of ICM from local manufacturing sources.

The results tend to conclude that the use of industrial technology is the route through which locally made machinery can get access to the machinery market that could enhance the growth of ICM manufacturing enterprise. Industrial entrepreneurs have the a tendency to procure more machinery from local sources if the supply of industrial technology is available in the manufacturing company.

5.7.3 Demand model for locally made ICM at higher level of technology inputs from local sources

Demand models for the uptake of locally made ICM were established by using a best fit curve of current trends in technology utilization and these are presented by the following equations:

For pharmaceutical industries, $y_{(Ph)}=0.2857x+14.667$ (5.8)

For industries of fisheries, $y_{(f)}=0.3029x+13.78$ (5.9)

For Textile industries, $y_{(TX)}=0.274x+13.04$ (5.10)

For water industries $y_{(W)}=.0.2357x+15.7$ (5.11)

where,

y is the demand of locally made ICM in percent of the total requirement

x is the locally developed industrial technology in the percent of the total requirement

By using these equations, the demand of ICM in different sector can be estimated. These models can be useful for the ICM manufacturing enterprises for their business plan.

5.7.4 Result and discussion on technology adoption and growth of demand

The result demonstrates that the demand for locally made ICM was increased with the acquisition of higher percentage indigenous industrial technology. Results show that the range of the demand for locally made machinery is 13-18% of the higher percentage of technology supply from the local sources and this value is much higher than the current national average *[the average market size for locally made ICM is 8%, ref: Section 5.2.2]*. It has been established that the average sourcing rate of technology adoption from local sources was about 9% and this means that there is a severe shortage in the supply of industrial technology in the local market. Surveyed data on manufacturing industries *[Sources: Question No 3, Appendix E]* indicates that industrial entrepreneurs showed an interest in purchasing technology from local market, but the overall supply was not insufficient.

The demand models of machinery at higher technology supply have indicated that the demand for locally made ICM is largely dependent on the indigenous industrial technological capability. From this data and results, it can be stated that the industrial technology is the supporting base from which ICM manufacturing enterprises can get its bearing for growth [187].

From the results, the study concludes that the short supply of industrial technology from the local sources is a barrier to growth for ICM manufacturing enterprises. As technology get its bearing for growth from national S & T and industrial policies, therefore, this barrier can be overcome by adopting growth policies in the S & T and industrial policies.

5.8 Impact of price on demand for locally made ICM

The influence of price on demand for locally made ICM was studied in this part of the work. The results of the case studies on manufacturing of ICM *[Section 3.5]* have shown that the import duty on the raw materials is a important determinant for the price of the locally made capital machinery. The result of this study was used to evaluate the effect of import duty on the demand for locally made machinery. Here, the demand was measured on the size of the sales volume of machinery.

To ascertain the impact on demand, the surveyed data on sales of ICM was used for the period 1998-2003 *[Sources: Question No 25, Appendix E]*, which is graphically presented in Figure 5.19.

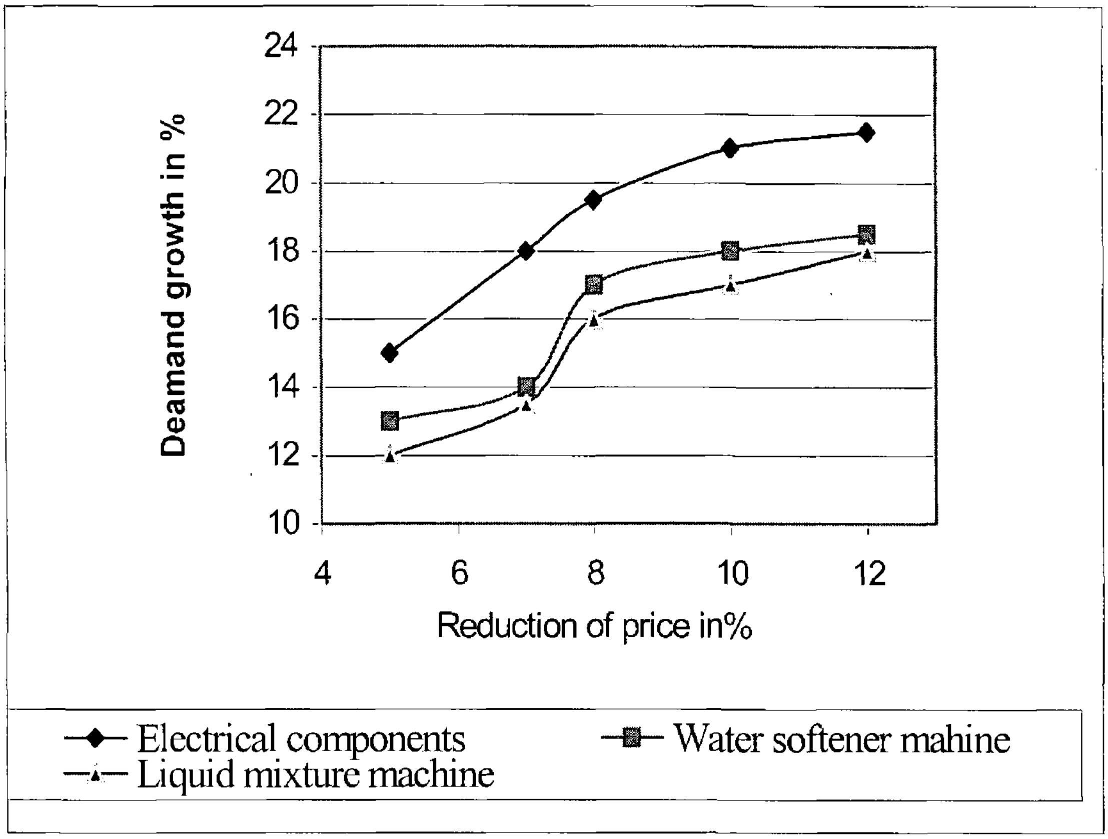

Figure 5.19 Impact of price reduction on demand for locally made ICM.

It can be seen from the curves plotted in Figure 5.19 that the demand of the electrical components, water softener and liquid mixture machines have increased with the reduction of its price level.

The Graphs in Figure 5.19 indicate that the growth in demand of ICM at price reduction ranges 4%-8% is marginally small. It is because the benefit of these price reductions is offset by higher manufacturing cost of machinery. It was found that the manufacturing cost of locally made ICM was increased due to higher import duty on raw materials and low productivity of ICM manufacturing SMEs.

The results demonstrate that low import duty of raw materials and higher productivity of manufacturing business are also two vital determinants for the growth of ICM manufacturing SMEs in Bangladesh.

The case studies have shown *[ref: Section 3.5]* that is some impact of the values of import duty and the operating cost of the manufacturing enterprises on the price of ICM. It can be visualized from Figure 3.5 that at 7.5% import duty, the manufacturing cost of the machine is reduced by about 25%. Based on the practice, it can be assumed that at 25% of lower manufacturing cost, the manufacturers would tend to reschedule the sales price to the lower value in order to increase the demand for their products.

Based on this result, it can be stated that by rescheduling the import duty at lower values, the manufacturing cost of the machinery could be reduced to a significant level, which would enhance the demand for locally made ICM.

5.9 Mathematical model for the manufacturing cost of ICM at different operating cost and import duty

In this part of the study, the manufacturing cost of ICM at different operating conditions was established in order to examine the impact of price on demand for the locally made machinery. To establish the mathematical model, the case studies *[ref: Section 3.1]* and the data book *[ref: Appendix F]* were used which was prepared during the visit to manufacturing industries.

One mathematical equation was established from the data obtained from the case studies to estimate the manufacturing cost for ICM and is presented by Equation 3.4. The equation is represented by the follow *[Ref: Section 3.5]:*

TC=FC1 + VC1 + FC2 + FC3

where FC1 - cost of the raw materials.(a)

VC1 - Variable cost dependent on import duty of the raw materials

FC2 - Cost of manufacturing activities and depends on the level of AMT.

FC3 - Cost of manufacturing activities and depends on the size of manufacturing organization.

TC - Total cost of manufacturing.

It can be visualized from Tables 3.26 and 3.28 that FC2 and FC3 have some impact on the manufacturing cost of the machinery this means that the values of FC2 and FC3 are the dependant variables.

The case studies have shown that the values of FC2 and FC3 are dependent on the operating cost of the enterprises, which can be called the cost factors. The main components of the cost factors were obtained from the ICM manufacturing enterprises which are:

(i) Level of AMT used in the manufacturing plant,
(ii) Sales volume per year,
(iii) Quality of communication facilities,
(iv) Level of forward and backward supply chain of the organization.

The surveyed data and the case studies have shown that the average minimum operating cost of the enterprises was US$500.0 and the maximum was US$ 1,250.0 for manufacturing activities for per unit machine (sum of values FC2 and FC3). Based on this data, the cost factors for the manufacturing enterprises were estimated and it was found that the range of the value is 1.0 - 2.50. *[Sources: Question No 26, Appendix E and data book, Appendix F]*.

The operating cost can be expressed by the following equation;

$$OC=cy \qquad (5.13)$$

where

OC – Operating cost
y – cost factor
c – minimum fixed cost (c=FC2 + FC3).

Substituting the values of FC1, VC1 and OC in Equation 3.4, the relation among the cost components and the total manufacturing cost can be expressed by the following equation:

$$\begin{aligned} TC &= a + ax/100 + cy \\ &= a + kx + cy \qquad (5.14) \end{aligned}$$

where

a - Cost of the raw materials

x - Import duty on the raw materials in percentage

k= a/100.

y – cost factor

c – operating cost.

5.9.1 Manufacturing cost for the industrial capital machinery at different values of import duty and operating cost

It can be seen from the graphs shown in Figures 3.8, 3.10 and 3.12 that the manufacturing cost of the machinery are dependant on the values of the import duty and the manufacturing cost should also be able to be calculated from Equations 3.5, 3.7 and 3.9. But these graphs and equations were established based on some particular cases mentioned in Section 3.5.

To estimate the cost of manufacturing at different combinations of import duty and operating cost, a mathematical model was established and presented by Equation 5.14. By using Equation 5.14, three graphical representations are given in Figures 5.20, 5.21 and 5.22 at different cost factors. The import duty, cost factor and manufacturing cost are presented by x, y, and z axes respectively.

It can be seen from Figure 5.20, that the value of manufacturing cost of a water softener machine for any combination of cost factors should be obtained within the given value range. It is evident from the data obtained from the case studies,that only three values of cost factors were available for the three enterprises. To estimate the manufacturing cost of the machinery at other unknown values, the graphs shown in Figures 5.20, 5.21 and 5.22 could be used.

The equation 5.14 and the 3-D graphs, therefore, provide the user with very useful predictive tools for estimating the manufacturing cost of machinery. Using this equation, manufacturing enterprises should be able to select the operating cost factors for their manufacturing programmes and government bodies might also be able to select the values of import duty to enhance the growth of ICM manufacturing sectors.

5.9.2 Manufacturing cost of machinery at different cost factors

Based on the equation 5.14, the manufacturing cost of a few machinery was estimated, as follows:

(a) Manufacturing cost of the water softener machine at 10% import duty, cost of raw materials at US$ 950.0 and cost factors at 1.2.

It is evident from the graph shown in Figure 5.20, which with the conditions mentioned above, the manufacturing cost of the water softener machine is US$ 1645.0. Similarly, the manufacturing cost for the other combinations should be obtainable.

(b) Manufacturing cost of the pressure vessel machine at 20% import duty, raw materials cost at US$ 6000.0 and at the value of cost factor 2.1.

Figure 5.21 shows that at the above-mentioned conditions, the manufacturing cost of the pressure vessel machine is US$ 8250.0. The manufacturing cost of the pressure vessel for the other combinations could be obtained from this graph.

(c) Manufacturing cost of the reverse osmosis machine at 5% import duty, the cost of raw materials at US$ 9250.0 and the value of cost factor at 1.6.

At the conditions mentioned above, by using Figure 5.22, the manufacturing cost for the reverse osmosis machine was estimated. The estimated value is US$ 10,575.0.

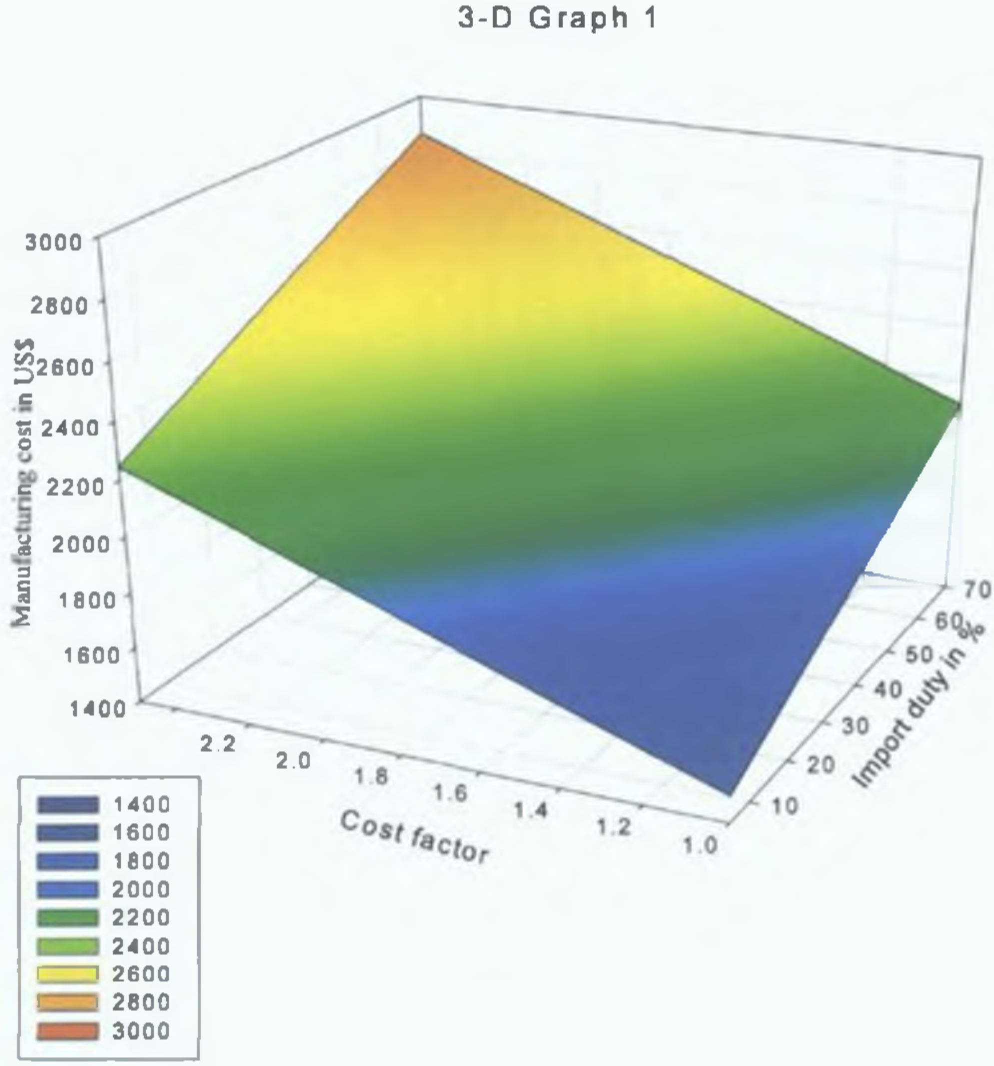

Figure 5.20. 3-D surface graph of manufacturing cost for water softener machine at different values of import duty and cost factors.

3-D Graph 2

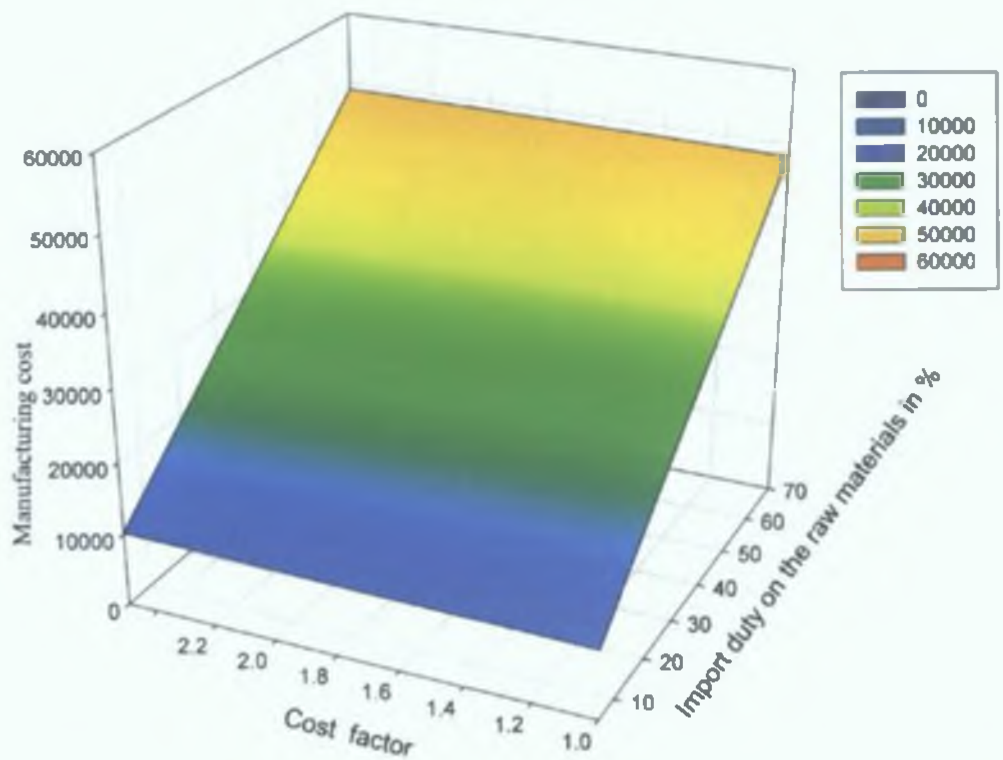

Figure 5.21. 3-D surface graph of manufacturing cost of pressure vessel machine at different values of import duty and cost factors.

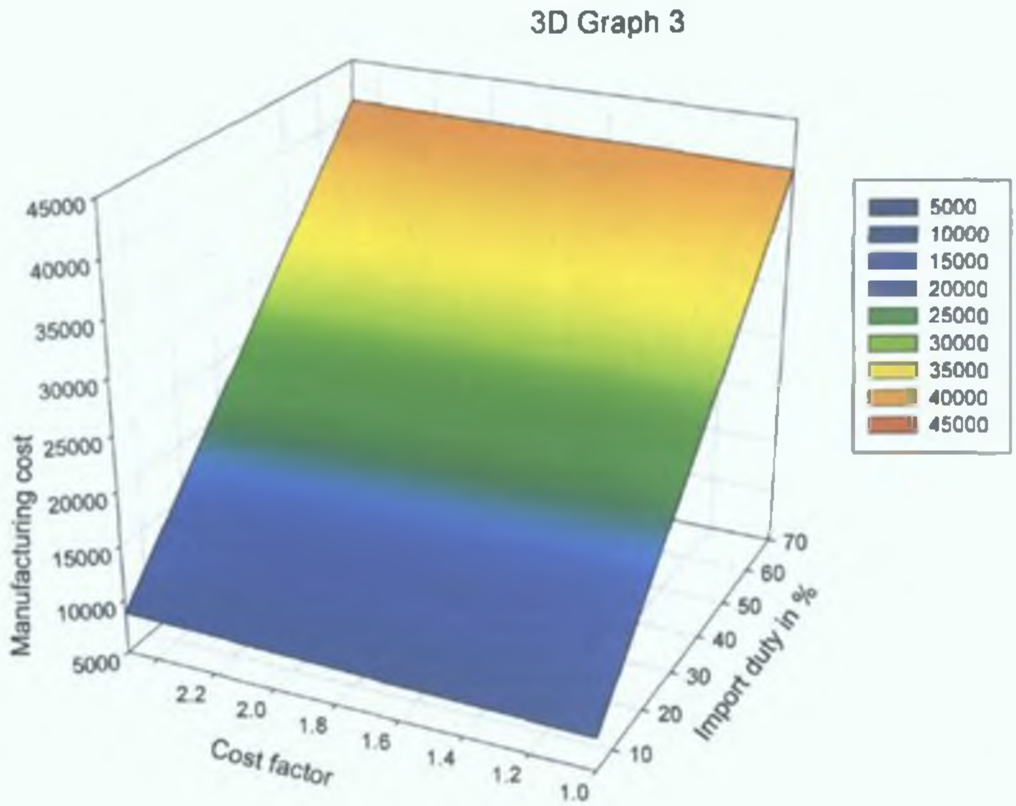

Figure 5.22, 3-D surface graph of manufacturing cost of reveres osmosis machine at different values of import duty and cost factors.

5.9.3 Impact of import duty and operating cost on the demand for locally made ICM

It is evident from Figure 5.19 that the demand for the locally made ICM as increased at the lower offered prices. It can be visualized from the 3-D surface graphs shown in 5.20, 5.21 and 5.22 that at lower operating values and the manufacturing cost of machinery are reduced. For example, the manufacturing cost of the reverse osmosis machine is US$ 4900.0 at:

Cost factor	=1.0
Import duty	= 10%
Value of the raw materials	= US$ 4,000.0

It is evident from the case studies that the manufacturing cost of the reverse osmosis machine at 2.1 cost factor is 10,600, which is much higher than US$ 4900.0 *[ref: Section 3.5.4]*.

Based on these results, it can be argued that to create the demand for the locally made ICM at a higher percentage, the government should reschedule the value of the import duty to a comfortable level. There is necessary to adopt some measures in S & T and industrial policies in order to reduce operating cost of the enterprises in order to speed up the growth of ICM manufacturing enterprises. However, argument is that to ensure that the potential engineering based manufacturing sector will be able to contribute to the industries for the development of economy.

5.10 SCOPE OF CONTRIBUTION OF ICM MANUFACTURING ENTERPRISES TO DEVELOP MANUFACTURING INDSUTRIES

The growth in ICM market in Bangladesh is about 30% over the period 1998-2003. And about 92% of machinery is imported to meet the requirement for industrial development. Consequently current supply of locally made machinery is only about 8%. The current study has established that internal barriers are the main reasons for why manufacturing enterprises are not growing. The study has also identified the main barriers with an aim of suggesting a way to remove those barriers from the manufacturing environment. The objective of this part of the study is to determine the potential contribution of the ICM manufacturing enterprises to the development of manufacturing industries under the supply of locally made capital machinery.

It can be a argue that by controlling as at least reducing the major barriers and by keeping this within a affordable limit, the ICM manufacturing environment can be made favourable and congenial. In this suitable business atmosphere, the enterprises will grow and produce a higher percentage of quality machinery for manufacturing industries. The study is now going to analyse the present growth of ICM manufacturing enterprises and the existing barriers with an aim to establish thing the patented contribution of locally made ICM to the manufacturing industries.

10.1 Growth of ICM manufacturing enterprises

The current growth in sales of ICM was examined to evaluate the growth trend of manufacturing enterprises of capital machinery in order to establish the scope of contribution of this sector to the manufacturing industries.

The average growth in sales for locally made ICM was obtained from the surveyed data on manufacturing enterprises for the period 1998-2002 *[Source: Question No 21, Appendix E]*.

The average growth on sales for locally made ICM per year for the period 1998-2003 is shown in Figure 5.23.

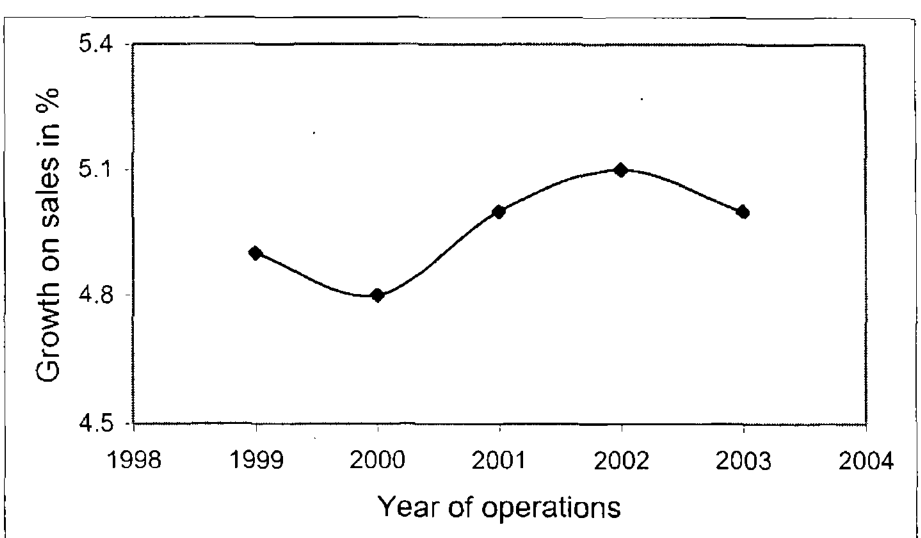

Figure 5.23 The growth on sales of locally made ICM.

It is evident from the graph shown in Figure 5.23 that the average growth on sales for locally made ICM is about 5%. The estimated value of co-relation coefficient "r" of growth on sales over this period is 0.4808, which is statistically insignificant. This means that the growth on sales is not satisfactory. Using data from the graph shown in Figure 5.23, the trend of growth on sales is plotted in Figure 5.24.

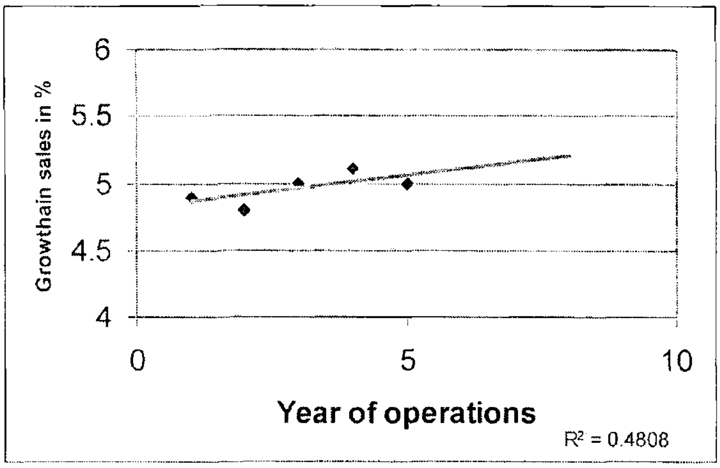

Figure 5.24 The trend of growth on sales.

It can be seen from the best fit curve and trend, that the rate of growth on sales (equivalent to demand) of locally made ICM is within 5%. Results show that the growth in the total market for ICM is about 30% *[ref: Section 5.2]*. From these results it can be seen that the growth in sales of locally made ICM is poor compared to the total growth of the market, which means that the sales of locally made ICM is not satisfactory.

It has already been established from the analysis of barrier, that the present low level AMT, the lack of industrial technology and the higher value of import duty on the raw materials are the main barriers to growth of ICM manufacturing enterprises *[ref: Sections 5.6 and 5.7]*.

The barrier of import duty was analyzed in Section 3.5 and it was evident from the result that *[ref: 3-D surface graph, which is shown in Figures 3.9, 3.11 and 3.13]* the price for locally made ICM could be reduced by rescheduling the lower values of import duty on the raw materials, which could contribute to increase the demand for locally made ICM.

It is evident from Figure 5.18 that at the higher input of industrial technology from the local sources, the demand for locally made ICM is increased and it can also be seen from Figure 5.16 that at higher AMT capability of the manufacturing enterprises, the demand for locally made ICM was also increased.

The above results suggest that present growth of ICM manufacturing enterprises, existing AMT level and current use of indigenous industrial technology from local sources are not sufficient for the growth of ICM manufacturing enterprise so as to increase their contribution to manufacturing industries.

5.10.2 Mathematical model of demand at higher level of AMT and industrial technology

The impact on demand of higher level of AMT to the ICM manufacturing enterprises and a higher percentage of industrial technology to manufacturing industries from the local sources was examined by formulating a mathematic model. This empirical examination was made in order to determine the potential contributions of ICM manufacturing enterprise to the manufacturing industries with the good technological conditions.

To determine the demand for locally made ICM at different AMT and industrial technology, a mathematical model was established by using a multiple correlation and regression method. The standard equation for linear multiple correlation and regression is;

$$Z=a + bx + cy \qquad (5.16)$$

where, x - level of AMT, independent variable

y - Industrial technology, independent variable

a - Constant related to the independent variables.

b – Constant and coefficient of AMT

c – Constant and coefficient of industrial technology.

Z - Demand for locally made ICM.

A number of sets data relating to AMT, industrial technology and demand for locally made ICM were obtained from the survey *[Source: Data book, Appendix F]*. The surveyed data was used to form few equations. These equations were used to determine the values of a, b and c.

By substituting the values of a, b and c in equation 5.16 *[Source: Appendix H.]*, the following equation is obtained;

$$Z = 1.52 + 0.25x + 0.51y \qquad (5.17)$$

By using Equation 5.17, a 3-D graph is pottered, which presents the different values of AMT, industrial technology and corresponding demand of locally made ICM. The AMT, industrial technology and demand of ICM are presented by x, y, and z axes respectively. It can be seen from Figure 5.25 that the values of demand for locally made ICM for any combination of AMT and industrial technology should be obtainable within the value range shown in the plot. It is evident from the data obtained from the industries *[ref: data book, Appendix F]* that only few values of demand for ICM were available at limited AMT growth and technology supply. The unknown values of demand at different combinations of AMT and industrial technology can easily be visualized from the graph shown in Figure 5.25. The Equation 5.17, therefore, provides the user with a very useful predictive tool for estimating AMT and industrial technology to enhance the manufacturing of ICM.

Using Equation 5.17, the manufacturing enterprises should be able to select the values of AMT and industrial technology needed to achieve their strategic market share and to meet the demand for local industries. Thus, Equation 5.17 and the 3-D surface plot should also be useful tools for the government body to use in the decision-making purpose for industrial and S & T policies.

Hence, it can be concluded that equation 5.17 and 3-D graph shown in Figure 5.25 are important tools for both ICM manufacturing enterprises and government bodies as well.

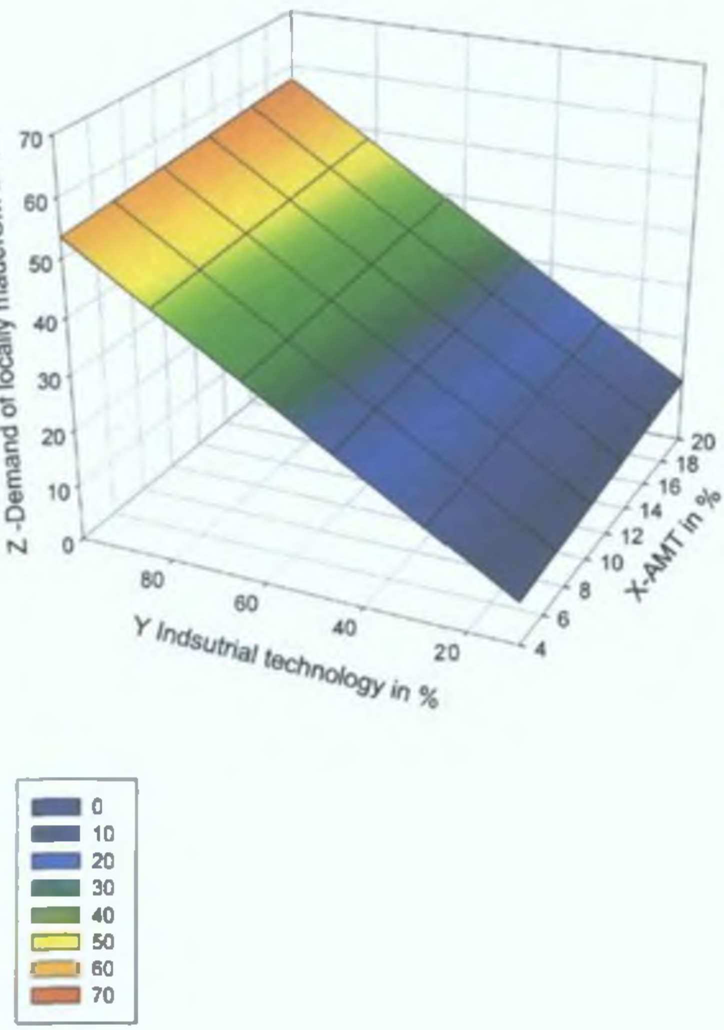

Figure 5.25, 3-D surface graph of demand for different values of AMT and industrial technology at different levels of AMT and industrial technology.

Here, AMT level, minimum- 4%

maximum 20%

Industrial technology input minimum 10%

maximum 100%

5.10.3 The size of AMT and industrial technology to meet the current demand for locally made peripheral and generic machinery.

The impact on demand of locally made peripheral and generic machinery of a higher level of AMT in the ICM manufacturing enterprises and higher percentage inputs of industrial technology to manufacturing industries from the local was examined by using the mathematic model presented in equation 5.17. This empirical examination was made in order to determine the scope of contributions of ICM manufacturing enterprise to the manufacturing industries at different technological levels.

The result on the demand analysis for ICM has shown that the industrial entrepreneurs are giving their confidence on locally made generic and peripheral machinery. The current market size for generic and peripheral machinery is about 21% of the total market size. To meet the market demand for 21%, the values of AMT and industrial technology can be estimated from the graph shown in Figure 5.26 and Equation 5.17.

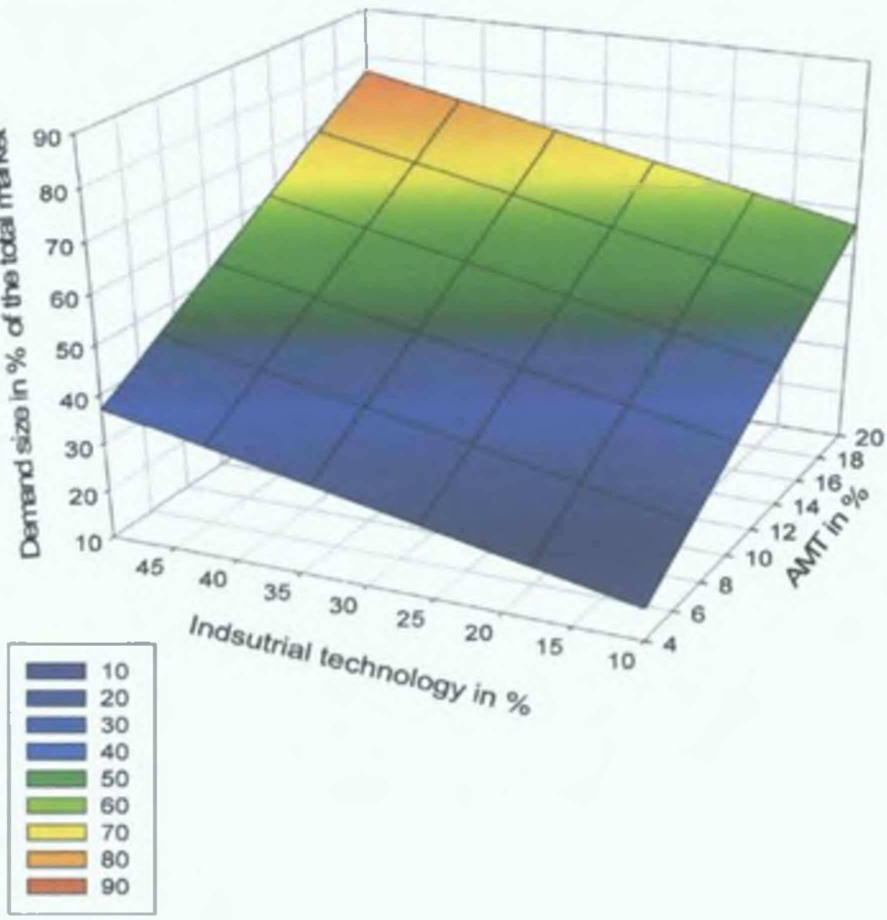

Figure 5.26. 3-D surface graph for AMT and industrial technology to meet the current demand for locally made ICM.

Here , AMT level minimum- 4% and maximum 20%.
Industrial technology input minimum 10% and maximum 50%

It can be seen from Figures 5.25 and 5.26 that the demand for locally made ICM increases at higher values of AMT and industrial technology. This means that at a higher technological environment the scope of supply of locally made ICM could be increased and this would give an ultimate result of higher contributions of the ICM manufacturing enterprises to the manufacturing industries.

As AMT and industrial technology is dependent on industrial and S & T polices of the government, so it can be said that the government policies are the determinant factors for the growth of demand for locally made ICM. Thus, the result concludes that the government should revise the S & T and industrial policies to increase the level of AMT in ICM manufacturing enterprises. Emphasize should also be given on industrial technology to improve it in the local market.

5.11. Government policy supports for the development of ICM manufacturing SMEs in Bangladesh

The strategies of the government for the development of ICM manufacturing enterprises were examined in order to determine the effect of the existing policy on the manufacturing capability of the enterprises. The result of the study was used to determine the scope of contribution of the locally made ICM to the manufacturing industries.

Current and future programmes of the government were studied to find the trend of the development strategies. The examination was made by using the survey data *[Source: Question No 36 and 37, Appendix E.]*. A scale of three points was formulated and employed to perform this study. The scales are described as follows:

(a) Implementation of the strengthening activities in future (1),
(b) Implementation of the strengthening activities in the near future (2),
(c) Immediate implementation of the strengthening activities immediately (3).

Surveyed results on the strategy for the development of ICM manufacturing enterprises are shown in Table 5.7.

Table 5.7 Strategy for the development of ICM manufacturing SMEs.

Government policy support programmes	Option for implementation		
	1	2	3
Strengthening training for capacity building for the manufacturing technicians and development of industrial technology.	70	20	10
Adapting a policy to reduce import duty and VAT on the raw materials	20	70	10
Extending supports to access the low cost fund	80	10	10
Extending support to get into the manufacturing infrastructure	60	20	20
Extending advisory services for business expansion	10	20	70

Table 5.7 indicates that the barrier to access the low cost funding and to develop manufacturing infrastructure will continue because government has no immediate plan to provide these facilities to the manufactures. It was also evident from the surveyed data that the government has no immediate plan to set up the agencies needed to speed up the implementation of the existing polices *[Sources: Question No 37 and 38, Appendix E]*. This means that the industrial policy of the government is going to be unchanged within the foreseeable future.

It is evident from Table 5.7 that the lack of skilled manufacturing employees and short supply of industrial technology are likely to continue because the government will take care of these issues in the near future. This suggests that the government is not going to make amendment on the S & T policy immediately.

It can be seen from Table 5.7 that government is not going to reduce the level of import duty on the raw materials immediately. The data suggests that the current values of import duty and import polices will continue and the barriers related to these issues will also continue *[Sources: Question No 34 and 35, Appendix E]*. The survey suggests that in the present condition, the price of the raw materials can not facilitate ICM manufacturing enterprises contributing to manufacturing industries.

The results conclude that both current industrial and import policies and S & T programmes of the government are not favourable for the manufacturing business of capital machinery in Bangladesh and these policies are the barriers to growth for the

ICM manufacturing enterprises. The scope of supply for locally made ICM will remain limited until the government initiates the adoption of growth polices.

5.12 Scope of contribution of locally made ICM to develop the manufacturing industries

The growth in ICM market in Bangladesh is about 30% and about 92% of machinery are imported to meet the requirement for industrial development. The current supply of locally made machinery is about 8%. The reason for the poor supply has been established and it was found that the manufacturing enterprises are facing strong barriers for growth from different agencies of the manufacturing environment and the government polices. The surveyed results have shown that government has the strategy to develop the manufacturing enterprises in Bangladesh *[Sources: Question No 39, Appendix E]*, but the documented evidence of removing the following barriers is not available;

* Low level AMT in the manufacturing plant,
* Short supply of industrial technology,
*. High import duty on raw materials,
*. Weak industrial and S & T policies of the government.

It has been established that at higher level of AMT and industrial technology, the demand for locally made ICM is increased *[ref: Section 5.6 and 5.7]*. It was also observed that at lower values of import duty, the manufacturing cost for machinery was reduced *[ref: Section 3.5]* and at the lower price, the demands for locally made ICM are also increase *[ref: Section 5.8]* significantly.

Based on this result it can be stated that by removing the barriers from the ICM manufacturing environment and by providing a significant level of AMT and industrial technology, the manufacturing capabilities of the enterprises could be built up. The improved manufacturing capability would speed up the growth of ICM manufacturing enterprises and would enable the supply of high quality and higher percentage locally made ICM for the development of manufacturing industries in Bangladesh.

Thus, the study concludes that at favourable S & T, industrial and import policies, engineering based ICM manufacturing sector could supply higher percentage industrial technology and capital machinery to the manufacturing industries in order to develop national economy.

5.13 The principal findings and summary

The growth model for the ICM market has been developed. The model has revealed that the current growth of the total market is about 30% and the market size for locally made machinery is about 8% for the period 1998-2003. It has been established that there is huge market potential for plant machinery in Bangladesh and to meet the requirement for industrial development, 92% ICM was imported for the operating years mentioned above. A percentage of industrial entrepreneurs expressed preference to procure some locally made peripheral and generic machinery and the market share for those was about 11% and 10% respectably. The trends of manufacturing activities show that major percentage (approximately 80%) enterprises are concentrated on peripheral and generic machinery business.

The barriers to growth of manufacturing enterprises were identified. It is evident that the annual rate of growth in this sector is about 5%. The enterprises are operating with between 11-20 employees and the average age of these enterprises ranges from 11-15 years. The performance of this manufacturing sector in Bangladesh is poor because the business is highly affected by internal and external barriers such as:

(i) Low level AMT in the manufacturing plant, (ii) Short supply of industrial technology, (iii) High import duty on raw materials and (iv) Weak industrial and S & T policies of the government.

Two types of demand models for locally made ICM have been established. The demand models for two variables (AMT vs demand, industrial technology vs demand) have been developed to measure the impacts at higher inputs of AMT and industrial technology on demand, which have been presented by equations and 2-D graphs. The results show that at higher inputs of AMT and industrial technology from the local sources, the demand for machinery was increased significantly.

The demand model for three variables (AMT, industrial technology vs demand) has been established to measure the impact of collective higher inputs of AMT and industrial technology on the demand for locally made ICM. The model is presented by an equation and 3-D sigma plot. The equation and 3-D plots show that at higher-level inputs of both AMT and industrial technology, the demand was increased.

The manufacturing model of three variables (Import duty, operating expenditure vs manufacturing cost) has been developed to determine the impact of import duties and the operating cost of the enterprises on the price of the locally made machinery. The model is illustrated by equation and 3-D sigma plots, which reveal that at lower values of import duty and operating expenditure, the cost of manufacturing is reduced which enhanced demand.

It is evident that the concern authority of Bangladesh is not fully aware of the current barriers prevailing in the ICM manufacturing business and due that reason ICM manufacturing SMEs in not growing. The study concludes that under the favourable S & T, industrial and import policies; the engineering based ICM manufacturing enterprises could supply a higher percentage and better quality industrial capital machinery to the manufacturing industries in order to develop the national economy.

CHAPTER 6

Conclusions and Recommendations

6.1 GENERAL CONCLUSIONS

The following general conclusions can be drawn from the study reported in this thesis on ICM manufacturing enterprises in Bangladesh.

The manufacturing industries of Bangladesh are dependent on foreign supply sources for its capital machineries. The industrial entrepreneurs are facing strong barriers to the procurement of locally made ICM, and among the main barriers are the short supplies of after sale services, low quality machineries and long delivery times.

This study shows that the ICM manufacturing enterprises in Bangladesh are small in size and young in age. The use of advanced manufacturing technology in the enterprises is insignificant. About 80-90% of enterprises are operating their manufacturing business without the aid of automation and an adequately skilled manufacturing and management staff. They mainly use manually operated machine tools in their production lines.

The model developed in this study for the manufacturing cost for ICM shows that the price of a locally made ICM is marginally higher than that of the imported price due to the high level of import duty on the raw materials. These models also show that the price for the locally made machineries could be reduced by 25% through reducing import duty at the current rate for the complete imported machineries. The 3-D surface manufacturing cost model shows that the price of locally made ICM is mainly dependent on the import duty on raw materials, operating cost of manufacturing enterprises and the cost of the raw materials.

A growth model established for the market for ICM in this study shows that there is huge market potential for ICM in Bangladesh and the annual growth rate of the market is about 30% .To meet the requirement for industrial development, 92% ICM was imported for the period 1998-2003. About 30% of the industrial entrepreneurs expressed preference to procure some locally made peripheral and generic machineries and the market share for these categories are about 11% and 10% respectably. The analysis for manufacturing capability has shown that the major percentage (about 80%) of enterprises is concentrated on peripheral and generic machineries business.

A model for the growth of ICM manufacturing enterprises has been developed and the manufacturing barriers were identified. Growth analysis shows that the annual rate of growth is about 5% and this sector is operating with 11-20 employees and the average age of the company is ranges between 11-15 years. The performances of ICM manufacturing industries in Bangladesh are poor and this sector is facing a number of barriers to ICM manufacturing business. This study identifies many barriers the serious ones are as follows;

* Low level AMT in the manufacturing plant,* Short supply of industrial technology,
* High import duty on raw materials,* Non supportive industrial and S & T policies of the government.

The demand model for locally made ICM has been established and it indicated that at a higher level of AMT and industrial technology, the demand for locally made ICM increases. It is evident that at a lower level of import duty the price for the locally made machineries reduces which contributes to increase the demand.

The scope of supply for the locally made ICM has been studied and the analysis show that by removing manufacturing barriers and lowering the cost of raw materials, the price for machineries gets reduced which increases the demand for locally made ICM.

It can, therefore, be concluded that for favourable S & T, industrial and import policies, the contribution of engineering based ICM manufacturing sector could be significantly increased in terms of the supply of higher percentage capital machineries to the manufacturing industries.

6.2 THESIS CONTRIBUTION

The results of the study should contribute greatly to the understanding of the need for strategic approach for the implementation and operation of ICM manufacturing enterprises in Bangladesh. In particular for those industries intending to improve their competitiveness to meet the global challenges, this study could be a guideline to follow. It would be also of great benefit to engineering, technical professionals and individuals involved in economic and industrial planning. The thesis could be the basis of a guideline for the people who are involved in the ICM manufacturing business. In particular, this thesis is making the following contributions:

1. A number of models have been developed for ICM in Bangladesh in terms of demand, market growth, effect of manufacturing cost, government polices, contribution to the national engineering sector and barriers to growth.

2. The thesis thus could provide sources of significant information for the engineering business executives, professional survey organizations and commercial banks on ICM manufacturing enterprises in Bangladesh. Such inputs could be used by these professionals in their respective domains of activities.

6.3 RECOMMENDATIONS FOR FUTURE STUDY

* The ICM manufacturing businesses in Bangladesh are mostly operated manually. It could be upgraded with sustainable manufacturing technology in order to improve its productivity. A study programme could be undertaken to establish the productivity model.

* It has been shown in the present study that for lower values of import duty, higher inputs of AMT and industrial technology and the demand for locally made ICM is increased. The incentive policy for the manufacturers could enhance the growth. This test can be performed by developing incentive modelling.

* It has been established in this study that the lack of opportunity of supply chain is a barrier to the growth of ICM manufacturing enterprises. The modelling for forward, backward and in-house supply chain could be developed to measure the impact on growth of manufacturing capability.

* The current lead-time to delivery of ICM is high in Bangladesh. It could be reduced by resource management modelling. A study can be undertaken to establish the resource management model for ICM manufacturing enterprises in order measure the impact of efficient use of internal and external resources on the lead-time.

6.4 RECOMMENDATIONS FOR RELEVANT STAKEHOLDERS

Based on principal findings of the research, the following recommendations have been made with aiming to speed up the growth of ICM manufacturing SMEs in order to develop national economy.

6.4.1 Government must review their policy on import duty of raw materials

Table 6.1 presents the cost components of ICM. Results of this study demonstrate that substantial amount of revenue is coming from the import duty of ICM (US$ 52.58 million) and only a small amount of revenue is derived from import duty of raw materials (US$12.79 million) at a rate of 55%. Moreover, due to this higher import duty, the market share for locally made machinery is only 8%. It is also evident from the results that due to higher import duty, the price for locally made ICM is higher which contributes to reduce its demand. For this obvious reason, it can be suggested this duty must be reduced to the same level as that of the imported complete machinery.

Table 6.1 Cost components of ICM for 2004 at 55% import duty on raw materials.

Origin of machinery	Cost components(US$ million)			
	Cost of machinery	Amount in manufacturing and profit (39%)	Amount in raw materials (40%)	Amount in import duty
Locally made 8%	60.95	23.77	24.38	12.79 (at 21%of the total cost or 55% of the raw materials)
Imported 92%	701.0	-	-	52.58 (at 7.5% on imported machinery)
Total	762			65.37

The impact of import duty reduction on demand of ICM and others is shown in Table 6.2. The data indicate that due to the adjustment of duty on raw materials, the market size for locally made machinery can be increased from US$ 60.95million to US$ 152.4 million and eventually, the import cost of machinery could be reduced from US$ 701million to US$ 609 million. In addition the manufacturing capability of ICM in the country will improve and the accumulated profit could contribute to increase AMT capability and its infrastructure facility. Finally, all these would have a positive impact on the national economy.

and the accumulated profit could contribute to increase AMT capability and its infrastructure facility. Finally, all these would have a positive impact on the national economy.

Table 6.2 Cost components of ICM for 2004 at 7.5% import duty on raw materials.

Origin of machine	Cost components(US$ million)			
	Cost of machine	Amount in manufacturing and profit (39%)	Amount in raw materials (40%)	Amount import duty
Locally made 20%	152.4	80.0	61.0	11.4 (at 7.5 % import duty on raw materials)
Imported 80%	609.6	-	-	45.67(at 7.5% on imported machinery)
Total	762			67.08

6.4.2 SMEs must improve performance in ICM manufacturing in order to reduce operating cost.

This study shows that the performances of ICM manufacturing SMEs are poor due to the lack of skilled technicians, AMT and manufacturing infrastructure. ICM Manufacturing SMEs must make investments in training programmes to improve staff skills in manufacturing. In addition, they should increase and upgrade the level of AMT and manufacturing infrastructure in order to improve productivity. These measures will reduce the price of their products and subsequently the market share of locally made ICM will be increased. For example, if the operating cost of manufacturing is reduced by 20%, the manufacturing costs will be reduced by about 5%. Indeed, this low manufacturing cost would result in approximately a 5% increase in demand for locally made ICM which could contribute about US$40 million to the national GDP.

6.4.3 Government must provide supports to improve S & T infrastructure in the country

To increase productivity and performance, government will need to make investment on S & T infrastructure to supply skilled manpower and industrial knowledge to industry. In particular, the government must invest:

* in science and engineering education through updating and expansion in order to produce highly skilled graduates and postgraduate engineers and managers for industry.

* to meet the demands of ICM manufacturing enterprises and general manufacturing industries by reforming the technical and vocational institutes to produce skilled technicians and diploma engineers.

*in research centres to increase R & D capacity in order to develop industrial technology. Moreover, national laboratories will need to be set up in order to provide facilities for testing of performance of locally made machinery.

* If government and industry address the above issues they will be investing in the future requirements of the industry for a highly skilled and educated workforce, which includes technicians, engineers, sales & marketing personnel and managers. In order to address the immediate needs of the industry to develop and improve the skills of existing management and manufacturing staff of ICM manufacturing SMEs, government and industry must collaborate to:

(a) provide technical training and up-skilling courses for existing technical and manufacturing operations personnel in AMT
(b) provide management skills and training courses for existing SME management teams

All these investments will create on ICM manufacturing environment in the country which will contribute to grow the national economy. As an example, if level AMT is increase to 10% in ICM manufacturing SMEs and if industrial technology supply increased to 30%, then demand for locally made ICM will be increased from 8% to 20%. Eventually, this measure will contribute about US$160 million to the national GDP.

6.4.4 Manufacturing industries will need to make investment for the development of industrial technology in order to reduce investment on industrial project.

This study on manufacturing industries demonstrates that about 88 % of industrial technology was imported together with capital machinery in order to set up and operate these manufacturing companies. It has also been shown that about 35% of the cost of an industrial project is spent in importing industrial technology. It is obvious that the country must try to become high tech as soon as possible. However, it is generally accepted that locally available technology is about 50% cheaper than that of the imported one. Based on these data, it can be recommended that manufacturing industries must invest on S & T and R & D in order to reduce cost on industrial project.

6.4.5 Industrial park for ICM manufacturing SMEs must be set up.

In order to increase up the growth of ICM manufacturing SMEs, government in partnership with private organizations must collaborate to forward to set up industrial parks for this sector. In industrial parks, all manufacturing infrastructure such as testing laboratories, a bank for low cost funding, communication facilities, common sales and advertisement centers, business advisory services must be made available at an affordable price.

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APPENDIX-A

CASE STUDIES ON ICM MANUFACTURING IN BANGLADESH

Three case studies on ICM manufacturing have been carried out in the following machineries:

1. Water softener
2. Pressure vessel
3. Reverse osmosis

The relevant data have obtained from the manufactures. The manufacturing drawings were not available because it was their exclusive property. Based on the available data, the flow sheet drawings for the machineries have been made and attached in this appendix.

Water softener

Capacity : 3000 liter /hr of water and 540 krain of water hardness

Manufacturer: Modern Erection

: Bangladesh.

Table A-1 Technical specifications for water softener machine.

SL. No.	Parameters	Data
1.0	Construction materials	Low carbon steel Thickness of the sheet-5.0 mm
2.0	Type of welding	Arc
3.0	Dimensions of the tank	Dia- 400m.m Height- 1500 m.m
4.0	Resin volume	150 litters
5.0	Controller	Automatic controller, Origin, USA
6.0	Hardness in feed water	98 ppm
7.0	Hardness in treated water	5 ppm
8.0	Regeneration cycle	16 hours
9.0	Working Pressure	30 psi
10.	Text Pressure	90 psi

The components of the machine are shown in flow sheet drawing Figure A-1.

Pressure Vessel

Capacity : 7500 liter of volume

Manufacturer : Mark industries Lltd, Dhaka

: Bangladesh

Table A 2 Technical specifications for pressure vessel machine.

SL. No.	Parameters	Data
1.0	Construction Material	Stainless steel AISI 304
2.0	Thickness of the sheet metal	6.0 mm
3.0	Type of welding	Argon
4.0	Internal surface finishing	2B, As per sanitary code
5.0	Connection for fluid at the inlet and outlet portd	50 mm
6.0	Configuration of the legs	No = 04 Dia = 100 mm Length = 450m.m
7.0	Pressure gauge	Range 0-10 bar
8.0	Working Pressure of the tank	4 bar
9.0	Test Pressure of the tank	10 bar
10.	Dimensions of the tank	Height = 2.4m Dia= 2m

Components of the machine can be sheen from the flow sheet drawing Figure A-2.

Reveres osmosis machine

Capacity : 2000 Ltr /hr of water flow

Manufacturer : Techno-Food engineering ltd, Dhaka

: Bangladesh

Table A-3 Technical specifications for reverse osmosis machine.

SL.No	Parameters	Data
1	Total dissolve solid in feed water	190 ppm
2.	Expect total dissolve solid in treated water	20 ppm
3.	No of pressure vessel fro membrane	4.0
4.	Construction materials for pressure vessel	Stainless steel, AISI 304
5.	No of membrane	4.0
6.	Dimensions of the membrane	L=40 inch Dia =4.0 inch
7.	Working pressure	10 bar
8.	Type of pump	Multi stage centrifugal Power 5.5 kw,440 Volt,50HZ
9.	Instrumentation	Pressure cut out switch TDS* meter Pressure sensor Pressure gauge Electrical control panel
10.	Supporting structure	Carbon steel

* Total dissolved solid of water

Components of the machine are presented by flow sheet drawing shown in Figure A-3.

10 FEED WATER PORT , GENERIC EQUIPMENT

2.0 SALT DISSOLVING TANK, GENERIC AND PERIPHERAL EQUIPMENT

1.0

3.0 PRESSURE VESSEL, LOW TECH MACHINE

4.0 OUT LET PORT, GENERIC AND PERIPHERAL - EQUIPMENT

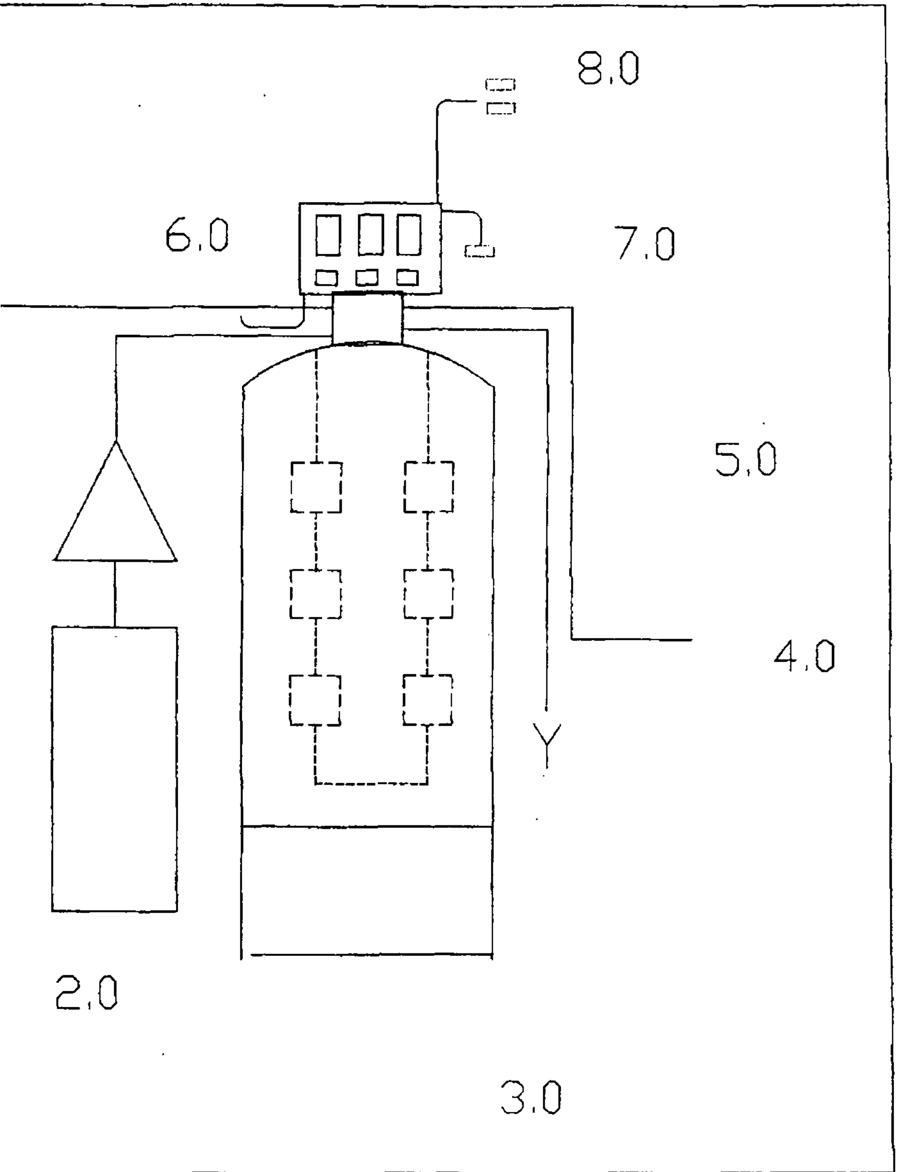
5.0 WATER DISTRIBUTION NOZZLE, GENERIC EQUIPMENT

6.0 CONTROLLER, HIGH -TECH EQUIPMENT

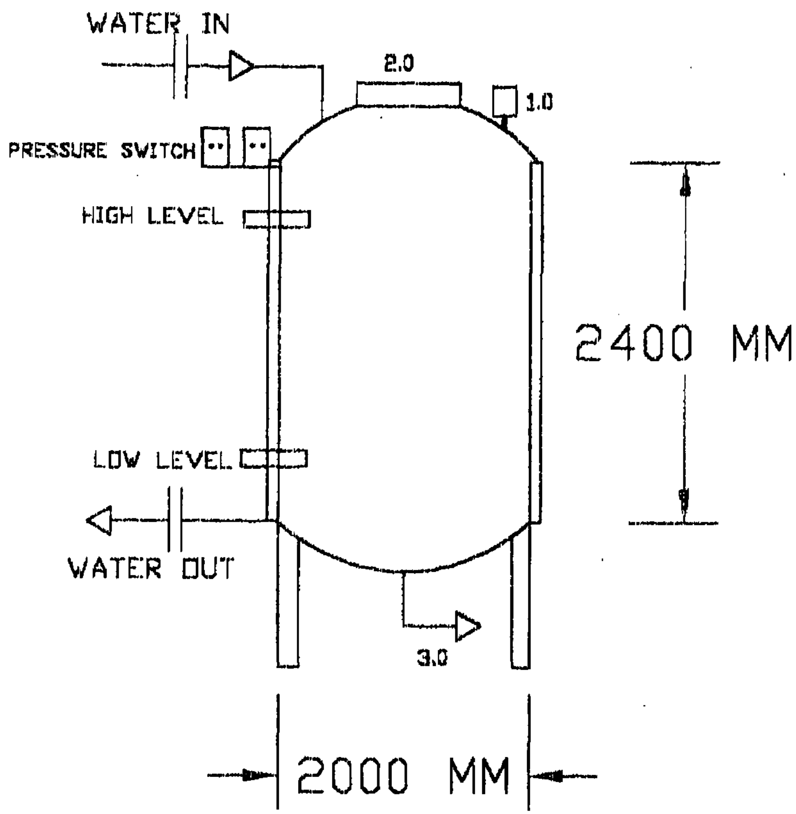
7.0 HARDNESS SENSOR,HIGH -TECH EQUIPMENT

8.0 ELECTRICAL CONNECTION , GENERIC EQUIPMENT

Figure A-1 Water softener machine



A.5



MAIN SHEET AISI-304

THICKNESS 8.5 MM

FINISH-2-B

INSULATION COVER AISI 304

THICKNESS 1.5 MM

INSULATION 50 MM

GLASS WOOL

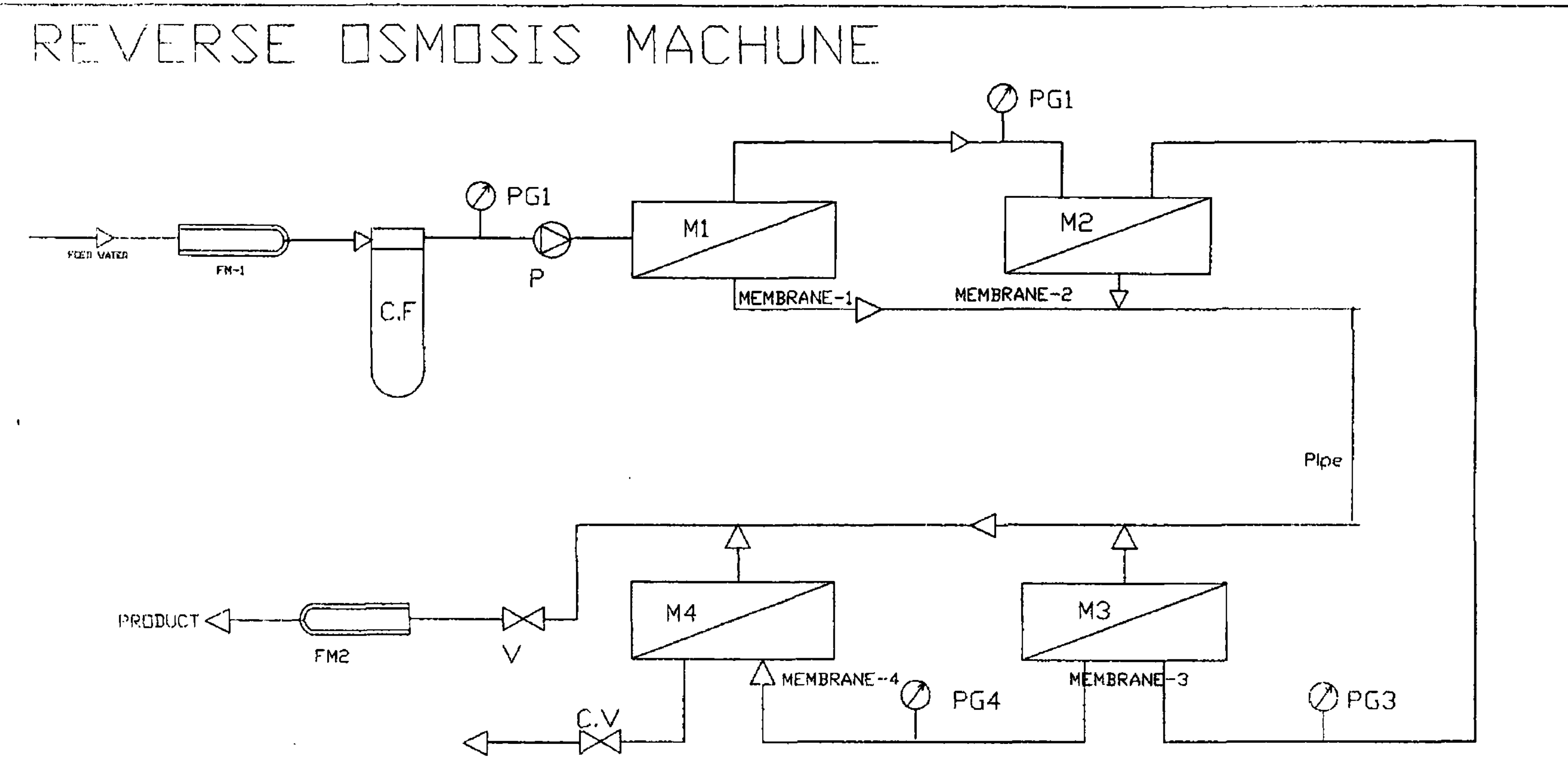
INLET OUTLET CONNECTION 40 MM

1.0 AIR VENT

2.0 MANHOLE COVER

3.0 DRAIN LINE

Figure A-2 Pressure vessel machine



C.F = CARTRIDGE FILTER= Peripheral rqiupment
C.V = CONCENTRADE VALVE= Generic equipment
V = PRODUCT VALVE= Generic equipment
P= HIGH PRESSURE PUMP= High-tech eqiupment
FM -FLOW METER- Pheripheral equipment

PG- PRessure gauge -peripheral equipemt
Pipe = Peripheral eqiupment
M- Membrane - High-tech equipment

Figure A-3 Reverse osmosis machine

Appendix B

Key note

The abbreviations used in this work are presented below as key note:

ICM-Industrial capital machineries

Machinery end user-General manufacturing industries

Policy marker-Government body

Industrial indigenous resources-The machineries, services and raw materials need to operate the manufacturing industries

Survey-Data collection from the manufacturing industries

CAD-Computer aided design. The use of softer to prepare the 2-D and 3-D manufacturing drawings

CAM- Computer aided manufacturing. Use CNC machine

SME-Small and Medium Sized Enterprises

P&ID-Installation drawing of the plant machineries
AMT-Advanced manufacturing technology
TC-Total cost
VC-variable cost
TQM-Total quality management
BSC-Backward supply chain
FSC-Forward supply chain
ISC-In house supply chain
CIM-Computer aided manufacturing

Technology

It is the knowledge, tools, techniques and actions to transform organizational inputs into outputs. It is an organizational transformation process which includes machinery, employee, education, skill and work procedures.

Industrial Technology

It is the engineering services with installation and start up work of plant machineries, product process technique, P&ID, technical specifications of the machineries.

Quality

The totality of features and characteristics of a product of service that bear on its ability to satisfy stated or implied needs. *

Quality Assurance

All those planned and systematic actions necessary to provide adequate confidence for the product or service that will satisfy the requirements for quality.

Quality Control

The activities undertaken that are used to fulfil the requirements for quality.
Operating cost –The expenditure on the manufacturing activities for the machineries.

Performance

Performance refers to the company's business results in key business areas like product, quality of products and service, productivity of the employees, profit generation, effective communication.

Practice

Practice refers to the established processes installed in a company to conduct its activity. It can include from supplier to manufacturing system to customer. It can cover from incoming inspection to reward system to tools and techniques, training and education, ISO etc.

Competitiveness

Competition is an activity involving two or more firms, in which ties to get people to buy its goods in preference to the other goods of other firm.

Low-tech machineries

It is a simple level of technology, which contains moderate surface finishing, standard materials and analogue controls for operation of machinery. Centrifugal feed pump, storage tank with agitators etc, are examples of low-tech machine.

High tech machineries

It is that machineries which are used for main process activities in the industry. The high-tech machineries require precision surface finishing, high quality materials and precision control. In a water treatment plant, for example, the water softener and the reverse osmosis is the example of high-tech machine.

Peripheral machineries

It is that machineries which are used to provide support for the core activities of a production process. It is an integral part of the machinery system. For example, in carbonated soda drink production plant, filter, valve, piping system, motor panel are the examples of the periphery machineries.

Generic machineries

It is a single unit machine that can be used as a part to many different process operations. A pump, for example may be used as feed pump, dosing pump, circulating pump etc.

APPENDIX – C

Thirteen industrial sub-sectors were studied in order to determine the market share of categorized ICM, which is shown as follows:

1. Pharmaceuticals
2. Fruit Juice industry
3. Carbonated drink industry
4. Fish processing industry
5. Textile industry
6. Garment industry
7. Vegetable oil industry
8. Tea processing
9. Leather processing
10. Sugars cane process industry
11. Drinking water
12 .Dairy processing
13 .Chemical industry

Definitions of categorized machineries.

The definitions are based on the level of automation and precisions of the machineries.

a). Low-tech machineries

It is a simple level of technology, which contains moderate surface finishing, standard materials and analogue controls for operation. Centrifugal feed pump assemble, storage tank with agitators etc, are example of low-tech machine.

b). High tech machineries

It is that machineries which are used for main process activities in the industries. The high-tech machineries require precision surface finishing, high quality materials and precision control. In a water treatment plant, for example, the water softener and the reverse osmosis is high-tech machine.

c) Peripheral machineries

It is that machineries which are used to provide support for the core activities of a production process. It is an integral part of the plant machineries. For example, in carbonated soda drink production plant, filter, valves, piping system, motor panel are the example of the periphery machineries.

d) Generic machineries

It is a single unit machine that can be used as a part of different process operations. A pump, for example may be used as feed pump, dosing pump, circulating pump etc.

Market share of categorized machineries

The installation drawings and the technical specifications of the machineries from the manufacturing industries have collected and analyzed. Based on the operation and level of automation of the machineries, 13 sets list for machineries were prepared in respect of the industrial sub sectors. Each set of machineries was again divided into four groups as per the definition of low-tech, high-tech, peripheral and generic machineries.

The lists were sent to different suppliers to obtain price of that machineries. A significant number of suppliers have replied. Price of the machineries has also collected through e-mail.

Based on the information of price, the market share for each category was determined which is shown in Table C.1.

Table C.1.Market of categorized machinēries

Industrial sub sector	a	b	c	d
1. Pharmaceuticals industries	18.0	59.16	11.0	13.0
2. Fruit Juice industries	19.0	53.0	13.0	15.0
3. Carbonated drink Industries	17.0	59.0	10.0	14.0
4. Fish processing industries	26.0	45.0	14.1	14.0
5. Textile industries	20.0	56.0	11.0	13.0
6. Garment industries	32.0	42.0	7.0	19.0
7. Vegetable oil industries	29.0	45.0	12.0	14.0
8. Tea processing	35.0	37.0	13.0	15.0
9. Leather processing	32.0	42.0	12.0	14.0
10. Sugar cane industries	19.0	58.0	11.0	12.0
11. Drinking water	21.9	52.0	13.0	13.0
12. Dairy processing	19.0	57.0	11.0	11.0
13.Fertilizer and chemical.	18.0	61.0	10.0	11.93
Average	22.0	57.0	11.0	10.0

The flow sheet drawings of installed capital machineries of few sub sectors have been presented in the flowing figures.

FISH PROCESS INDUSTRIES [SHRIMP PROCESSING]

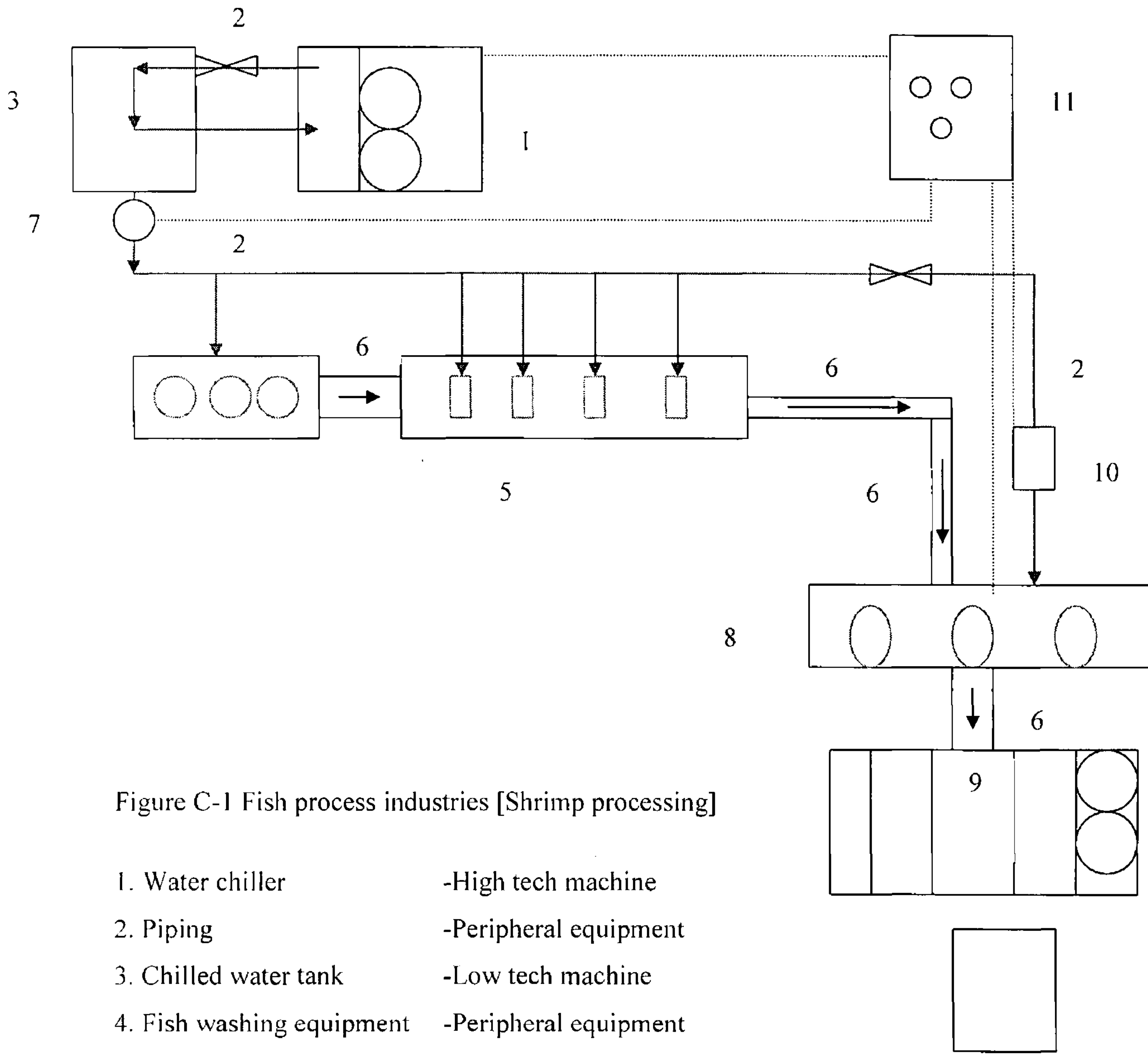


Figure C-1 Fish process industries [Shrimp processing]

1. Water chiller	-High tech machine
2. Piping	-Peripheral equipment
3. Chilled water tank	-Low tech machine
4. Fish washing equipment	-Peripheral equipment
5. Shrimp de heading equipment	-Peripheral equipment
6. Conveyor-	Low-tech machine
7.Water feed pump	-Generic machine
8 Shrimp packing	-Low tech machine
9. Plate frizzier	-High machine
10. UV sterilizer	-Low machine
11.Electrical control panel	-Low-tech machine

SUGAR INDUSTRY

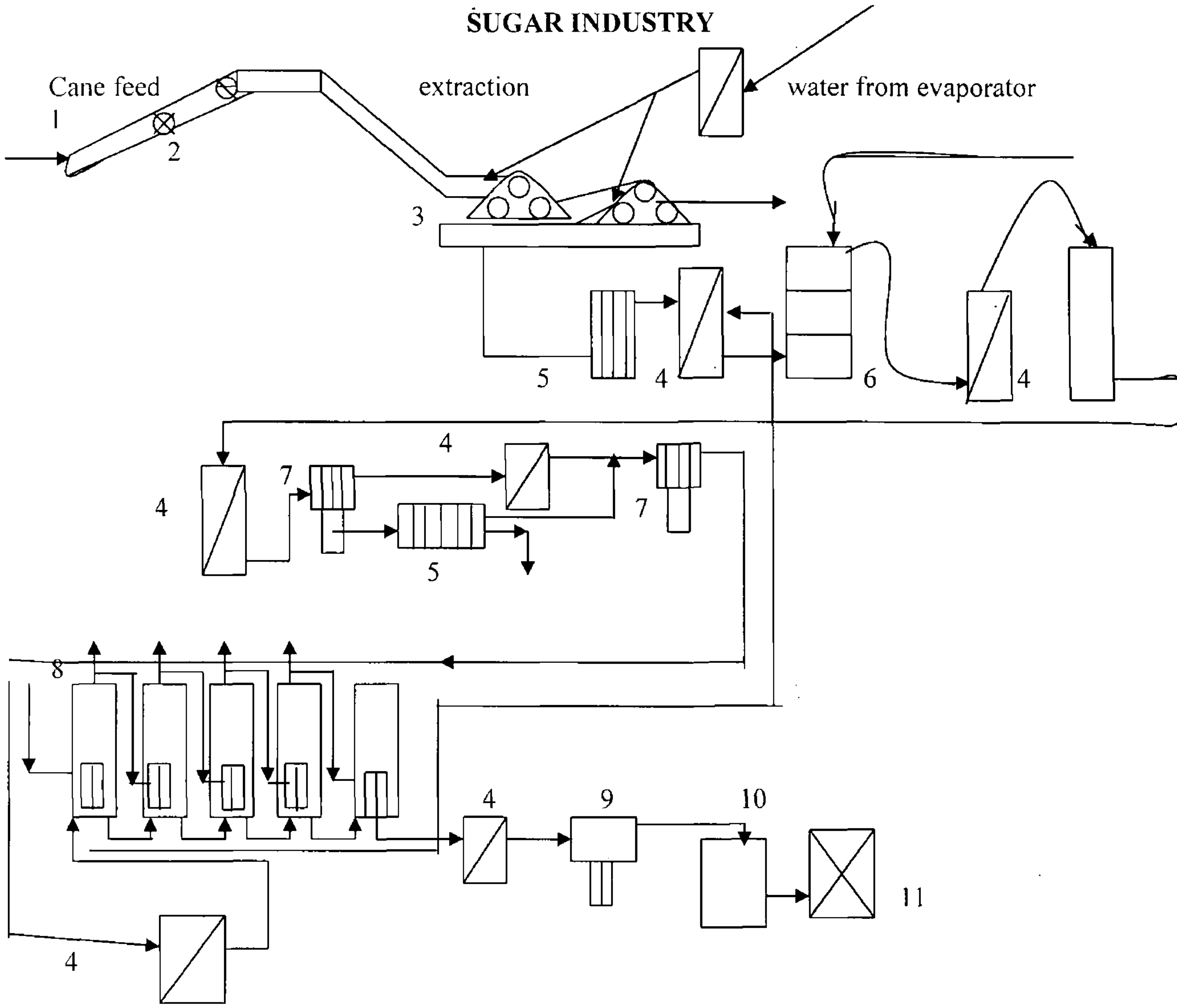


Figure C-2 Cane sugar processing plant

1. Cane Conveyor –Low tech machine

Equipment-speed variable, motor, gearbox, conveyor chain, steel frame
Construction materials - Carbon steel, stainless steel.

2. Cane slice-low machine
Equipment-rotary knife, motor, gearbox, steel frame
Construction materials - Carbon steel, stainless steel.

3.Cane Juice extraction-low tech machine

Equipment- Roller type Multi mill, conveyor, juice collector, motor, gear box, steel Frame, speed controller.

Construction materials - Carbon steel, stainless steel.

4. Heat Exchanger-high machine.

Equipment-Plate heat exchanger, temperature controller, water flow modulating valve
Construction materials -Carbon steel, stainless steel.

5.Juice–Filter, Low-tech machine.

Equipment-Pressure pump (positive displacement pump), mesh filter, valve, pressure switch, flow switch, steel frame.

Construction materials-Carbon steel, stainless steel

6.0 Juice clarifier-low tech machine.

Equipment - Tank, Variable speed agitator, motor, gearbox, steel frame, speed controller.
Construction materials - Carbon steel, stainless steel.

7. Juice heater-Low-machine.

Equipment-Plate heat exchanger, temperature controller, water flow modulating valve.
Construction materials -Carbon steel, stainless steel.

8.0 Juice Evaporator, High machine.

Equipment-Stainless steel tower, Vacuum pump, temperature controller, water flow modulating valve. Brick meter, product flow switch.

Construction materials-Carbon steel, stainless steel.

9.0 Juice Centrifuge equipment-High-machine

Equipment- High-speed rotary tank, solid separator, Speed controller
Construction materials - Carbon steel, stainless steel.

10.Concentrate Juice filtration-Low tech machine.

Equipment- Pressure pump (positive displacement pump), mesh filter, valve, pressure switch, flow switch, steel frame-

Construction materials - Carbon steel, stainless steel.

10.Sugar dryer

Equipment- Pressure pump (positive displacement pump), mesh filter, valve, pressure switch, flow switch, steel frame, Stainless steel tower, Vacuum pump, temperature controller, product flow switch, sugar cooler.

Construction materials - Carbon steel, stainless steel.

11.Sugar packing –Low machine

Equipment- Scale, bagging machine sewing, conveyor
Construction materials - Carbon steel, stainless steel.

LEATHER INDUSTRY

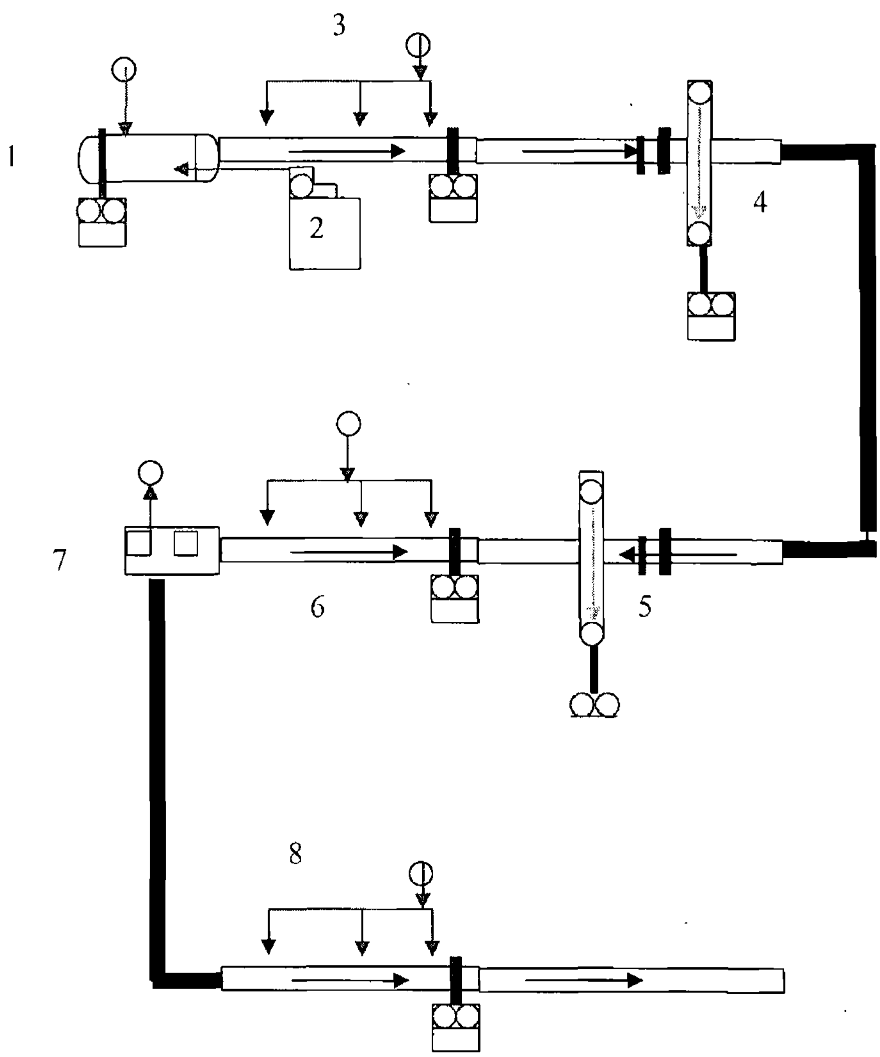


Figure C-3 Leather process

LIST OF THE MAIN EQUIPMENT

Wait blue line

1. HIDE WASHING

Equipment-Rotary type drum, Low-tech machine.
Water pump-generic machine
Gearbox -Generic machine
Motor-Generic machine
Steel frame-Peripheral

2.CHEMICAL MIXING AND DOSING SYSTEM

Equipments
Plastic tank Peripheral
Pipe Peripheral
Dosing Pump: Generic machine

3. TANNING
Equipment
Water pump-Generic machine
Gearbox -Generic machine
Motor -Generic machine

4. FLASHING MACHINE
Is a process of fat removal, skin surface make smooth uniform shape
Equipment
Rotary knife, Peripheral equipment, low tech
Feed roller, Peripheral equipment, low tech
Pressure roller- Peripheral equipment, and low tech
Motor - Generic machine
Speed controller- Gearbox - Low-tech machine

5.SPLITING MACHINE
Equipment
Rotary sharp knife-peripheral equipment
Feed roller –low-tech equipment
Conveyor pressure roller –Low-tech machine
Motor –Generic machine
Speed controller- gearbox -Low-tech machine

6.COATING MACHINE
Water pump-Generic machine
Gearbox -Generic machine
Motor -Generic machine

7.DRYING AND DYHIDRATION
Vacuum pump: Generic machine
Steel hooker -Peripheral

8. LEATHER SOFTENING MACHINE.
Feed roller –Low machine
Conveyor pressure roller-Low machine
Motor -Generic
Speed controller - Gearbox -Low-tech machine
Water nozzle -Low tech machine

COTTON TEXTILE WEAVING

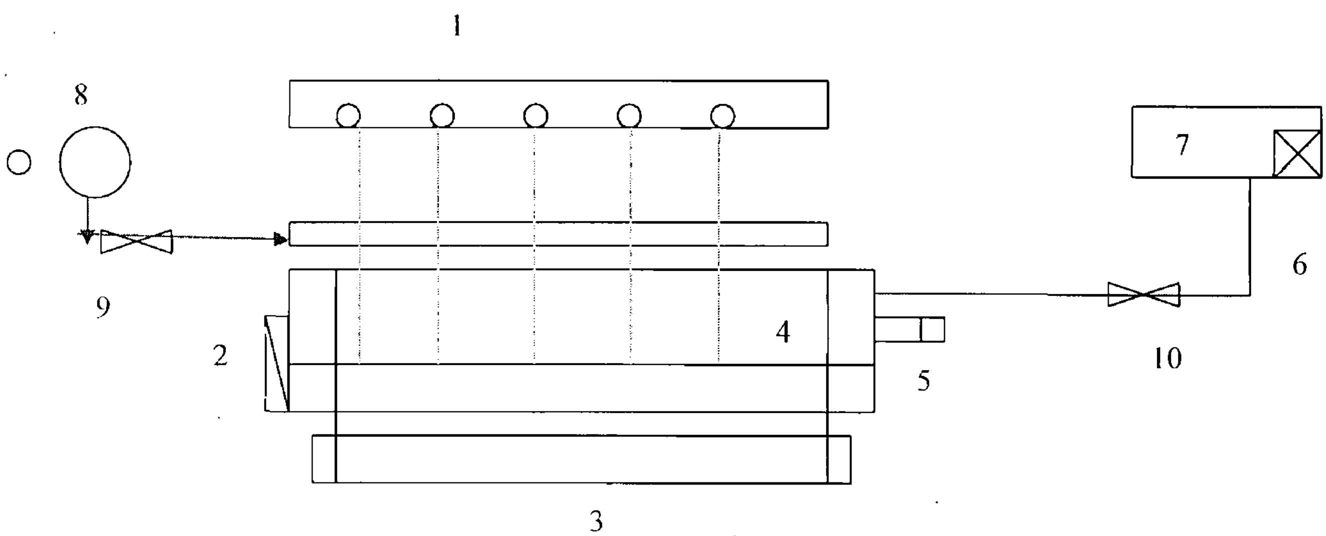


Figure C-4 Textile process

1. Threads holder -Low-tech machine
2. Control panel -low-tech machine
3. Cloths drum -Low-tech equipment
4. textile weaving machine -High tech machine
5. Driving motor -Generic machine
6. Piping -Peripheral equipment
7. Air compressors -Low-tech machine
8. Vacuum pump -Low tech machine
9. Service valve –Generic machine

TEA PROCESS INDUSTRY

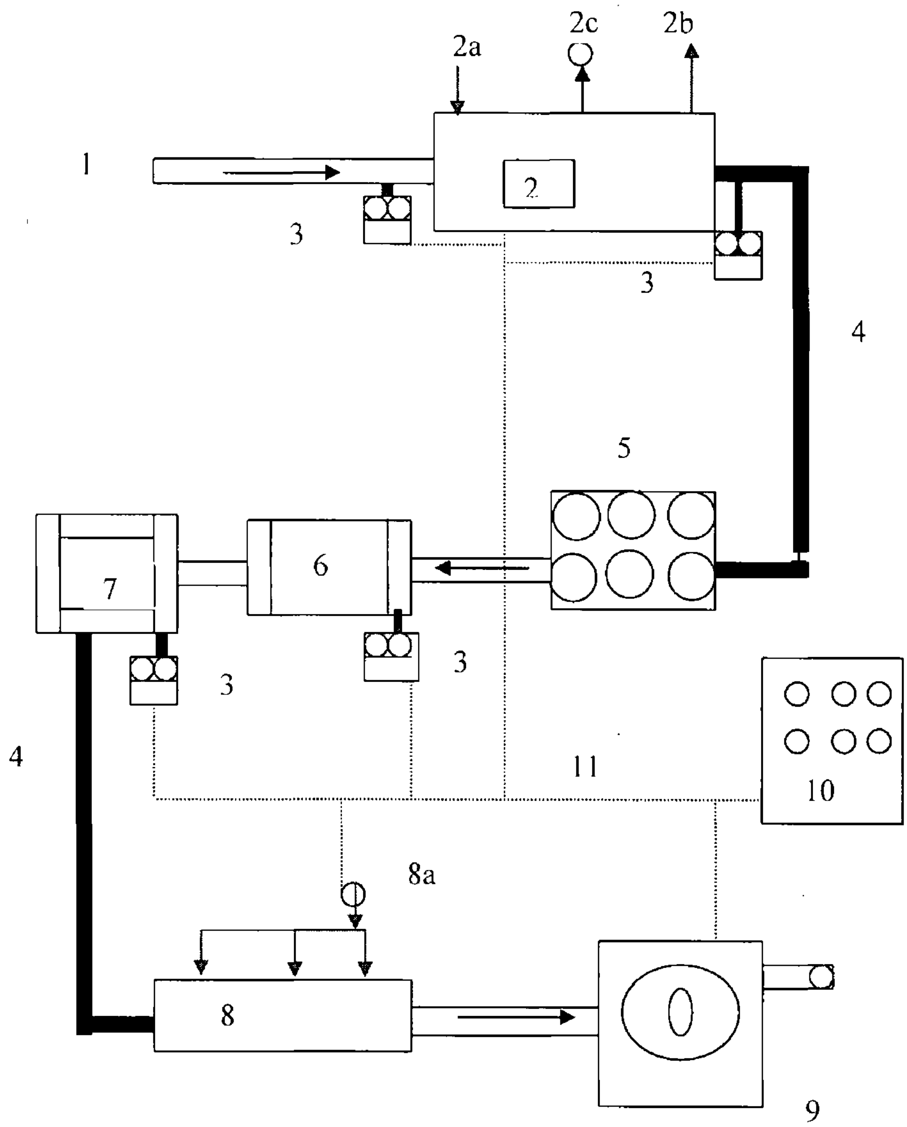


Figure C-5 Tea processing

LIST OF THE MAIN EQUIPMENT

1. Leaf loader –Low-tech machineries

2. De-Watering system Low-tech machinery

2a, 2b.Steam line-Peripheral equipment

2c. Vacuum machine-Low tech machine

3 Power transmissions system-Low-machinery
.Gearbox -generic machine
4. Leaf transfer table-peripheral equipment

5.Leaf chopper-Low tech machine

6.Dust separator-Low tech machine

7.Tea grading machine-Low-tech machine

8.Fermentation processing machine –Low-tech machine

8.a Water pump-Generic machine

9.Fluid bed dryer-High-tech machine

10.Electrical panel-Low-tech machine

11.Cable-Peripheral equipment

VEGETABLEOIL REFINERY INDUSTRY

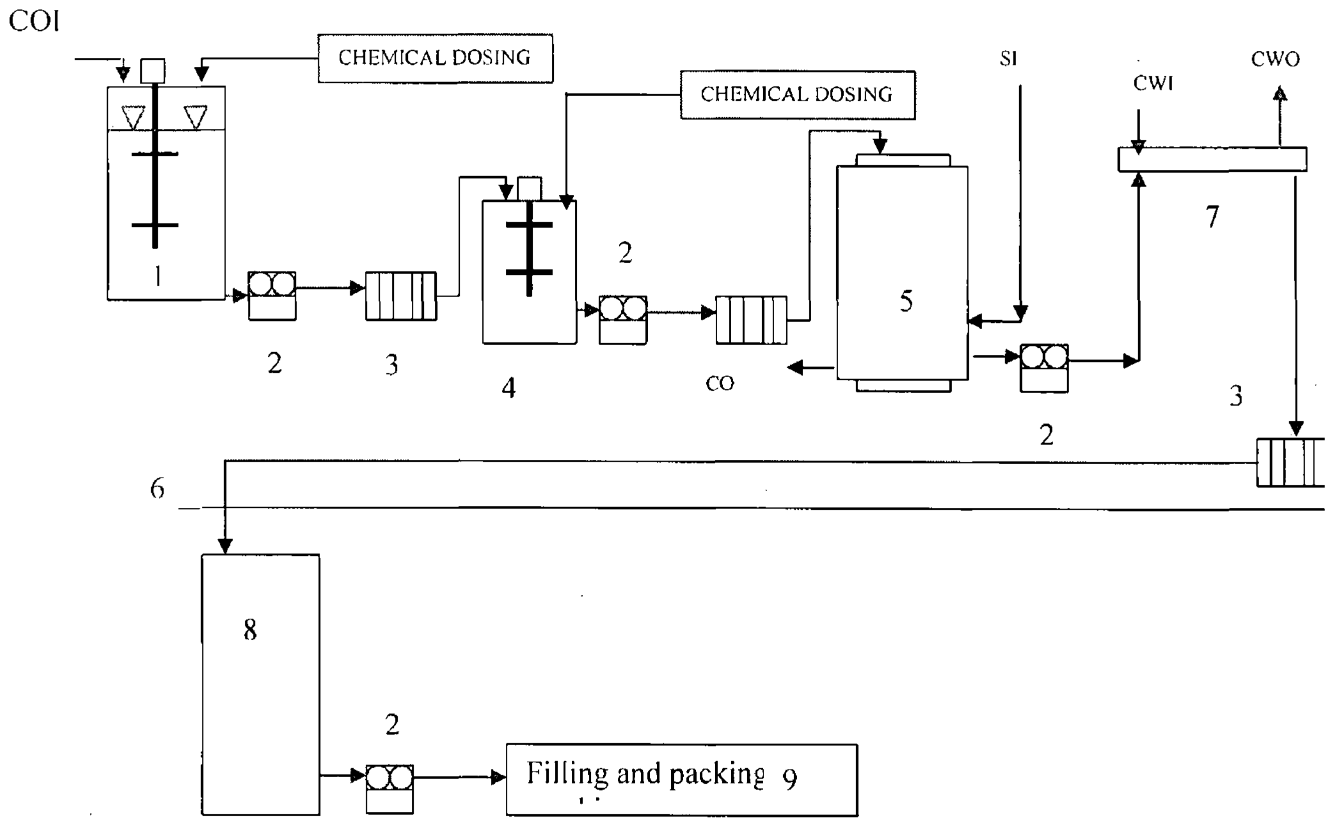


Figure C-6 Vegetable oil processing

1. Chemical mixing tank- low-tech machine
2. Oil transfer pump- generic machine
3.Plate filter-Low-tech machine
4. Chemical mixing tank- low-tech machine
5. Oil heating tank- low-tech machine
6. Piping-peripheral equipment
7. Shell and tube heat exchanger- low-tech machine
8.Oil Storage tank- low-tech machine
9.Filling machine, High -tech machine

Garments industry

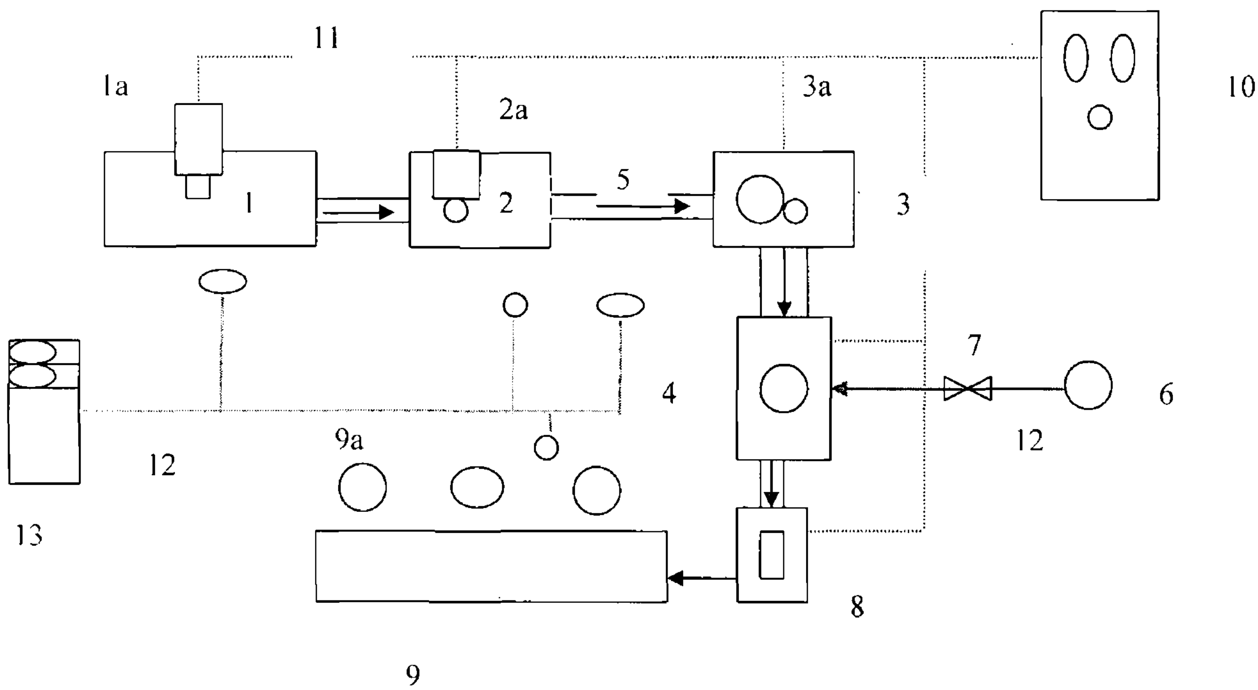


Figure C-7 Garments process

1.Cutting table	-Peripheral equipment
1a. Cutting machine	-Low-tech machine
2. Sewing table	-Peripheral equipment
2a. Sewing machine	- Low-tech machine
3. Jeepers table	-Peripheral equipment
3a. Jeepers machine	-Low -tech machine
4.Washing machine	-Low-tech machine
5.Convey system	-Low-tech machine
6.Water pump	-Generic machine
7.Valve	-Peripheral equipment
8.Calendering	-Peripheral machine
9. Packing table	- Peripheral equipment
10.Electrical control panel	-Low-tech machine
11.Electraicl wiring	-Peripheral components
12. Piping	-Peripheral equipment
13. Air compressor	-Low-tech machine

APPENDIX D
(DOCUMENT1)

SURVEY ON INDUSTRIAL CAPITAL MACHINERY MANUFACTURING SMEs IN BANGLADESH

Dear Sir/Madam,

A study on the industrial capital machinery manufacturing SMEs has been undertaken by the School of the Mechanical and Manufacturing Engineering of Dublin city university (DCU), Ireland.

DCU has set an aim to investigate the manufacturing barriers, manufacturing capabilities and the government strategic policy related to the ICM manufacturing SMEs.

It has been an accepted fact that ICM manufacturing capability holds the key to the success of the industrial business irrespective of size of the company.

I would like to emphasize, this is a very important project DCU has undertaken and its success will depend on getting a good response.

Please complete the enclosed questionnaire and kindly return it before **27th March 2004**

Yours sincerely,

M. Shahidul Islam 10 January 2004-
Research Student
DCU

APPENDIX D (DOCUMENT-2.
(1-First reminder)

SURVEY ON INDUSTRIAL CAPITAL MACHINERY MANUFACTURING SMEs IN BANGLADESH

Dear Sir/Madam,

We would like to remind you that a survey questionnaire has been sent to you on the 10th. January 2004. If you have already completed the questionnaire and returned it to us we would like to thank you and please ignore this letter.

But if you have not returned yet, I request you to kindly complete the questionnaire and return it by 30**th . April 2004**

I would like to emphasize, this a very important project DCU have undertaken and its success will depend on getting a good response from the firms we have identified in the manufacturing industry.

We realize that we have nothing to offer you in return for your co-operation other than our thanks.

If you have faced some problems in completing the questionnaire please do not hesitate to call us.

Your time and co-operation is highly appreciated.

Yours sincerely,

M.Shahidul Islam
Research Student
DCU

1 st April 2004

APPENDIX D (DOCUMENT-3)
(Second reminder)

SURVEY ON INDUSTRIAL CAPITAL MACHINERY MANUFACTURING SMEs IN BANGLADESH

Dear Sir/Madam,

We would like to remind you that a survey questionnaire has been sent to you on the 1st April 2004. If you have already completed the questionnaire and returned it to us we would like to thank you and please ignore this letter.

But if you have not returned yet, I request you to kindly complete the questionnaire and return it by 3**th . June 2004**

I would like to emphasize, this a very important project DCU have undertaken and its success will depend on getting a good response from the firms we have identified in the manufacturing industry.

We realize that we have nothing to offer you in return for your co-operation other than our thanks.

If you have faced some problems in completing the questionnaire please do not hesitate to call us.

Your time and co-operation is highly appreciated.

Yours sincerely,

M.Shahidul Islam
Research Student

15th **May 2004**

APPENDIX-E

Questionnaire analysis

Group A

Survey on general manufacturing industries

Q1. Please give your preference on sources of machineries [Please fill up the both options]

a Import sources in %

b Local sources in %

Analysis of surveyed data

Value label	Frequency of response	Total	Response rate (%)
a	28	28	70
b	12	12	30
Total	40	40	100

Sample -181, Response- 40, Response rate 22%, Missing case-0, valid case-40,

Mode=70, Standard deviation (σ) = 3.93,

Median=70, Acceptable data limit=+3σ -3σ = 58.07-81.79.

Q2. What are the types (shown below) you are willing to purchase from local manufactures? [Please tick ALL that apply]

a. Low-tech machineries

b. High tech machineries

e. Peripheral machineries

f. Generic machineries

Value label	Frequency of response	Missing cases of response	Total	Response rate (%)
a	5.0	34.0	39.0	12.82
b	2.0	37.0	39.0	5.12
d	24.0	25.0	39.0	61.53
e	8.0	31.0	39.0	20.51
Total	39.0			100.00

Sample 181, Response-40, response rate 22%.

Missing case 1, valid case 39.

Sample calculation. Ref 2a.

Frequency of response = 5.

Response rate 5/39 = 12.82.

Q3. In which forms are you willing to buy the industrial capital machineries? [Please tick all that apply]

a. Only single equipment

b. Only technology

c. In both form

Analysis of surveyed data

Value label	Frequency of response	Total	Response rate (%)
a.	26	38	68.42
b.	25	38	65.8
c.	30	38	79.0

Sample -181, Response- 40, Response rate 22%.

Missing case-2, valid case 38.

Sample calculation =Ref 3a.

Reponses on option number is 26.

Response rate-26/38 x100 = 68.42%.

Q4. From which sources are you purchasing the core process or high tech machinery? [Please tick one]

a. From local manufacturers

b. From International qualified manufacturers

c. From both sources

Analysis of surveyed data

The average surveyed data is presented in the table

Value label	Frequency	Missing	Total	Response rate
a.	4	35	39	10.25%
b.	25	14	39	64.10%
c.	10	29	39	25.64 %

Q5. If you are not at all buying machineries from the local sources, Please identify the reasons given below. [Please tick ALL that apply]

a. Low quality machine []

b. Low performance

c. Life of the machinery is short

d. Balancing problem

e. Spare parts are not available

f. Higher power consumption

g. Low productivity

h. Lack of bank loan for locally made machineries

1. If others, [please specify]

Analysis of surveyed data

Value label	Frequency	Missing Cases	Total	Response rate (%).
a	21	17	38	55.26
b	20	18	38	52.68
c	19	19	38	50.0
d	16	1	38	57.89
e	17	21	38	44.73
f	18	20	38	47.36
g	20	18	38	52.68
h	29	9	38	76.31
I	14	24	38	36.84

Sample –181, Response rate 22, Response- 40, Missing case-2, valid cases -38

Sample calculation on ref 5a.

Number of response is 21.

Response rate is = 21/38x100 = 55.26%.

Q6. Do you like to buy partial machineries from the local sources and install these together with the imported machineries in your industrial project? [Please tick one]

a. Yes

b. No

Analysis of surveyed data

Value label	Frequency of response	Missing case	Total	Response (%)
a.	10	28	38	26.31
b.	28	10	38	73.68
Total	38		38	100

Sample -181, Response rate 22, Response- 40, Missing case-2, Valid cases –38,

Sample calculation on ref 6a..

The number of respondent is 10.

Response rate is= 10/38x100= 26.31%

Q7. If yes, please identify the reasons given below? [Please tick ALL that apply]

a. To reduce the project cost

b. To reduce dependence on the foreign sources

c. To get cheaper after sales services for the plant machineries

d. To reduce procurement (management) cost

e. If others, [please specify

Analysis of surveyed data

Value label	Frequency of response	Missing cases	Total	Response (%)
a.	30	8	38	78.37
b.	20	18	38	52.63
c.	18	20	38	47.36
d.	11	27	38	29.72
e.	7	31	38	18.42

Sample -181, Response rate 22%, Response- 40, Missing case-2, Valid case 38.

Sample calculation on 7a,

No of response on the option a is 30.

Response rate is 30/38x100=78.94%.

Q8. If no, please identify the reasons given below [Please tick ALL that apply]

a. Balancing problem

b. Have no experience on such type of work

c. Would reduce productivity in the plant

d. Could be make problem in the quality of the product

e. Might have problem to obtain certificate for quality of the products

f. If others, [please specify

Analysis of surveyed data

Value label	Frequency of response	Missing cases	Total	Response (%)
a	22	16	38	57.89
b	16	22	38	42.10
c	17	21	38	44.73
d	15	23	38	39.47
e	12	26	38	31.57

Sample-181, Response rate-225, Response-40, Missing case 2, Valid cases-38.

Sample calculation on ref 8a.

No of response on option a is 22.

Response rate is 22/38x100 = 57.89%.

Q9. As, you are using locally made machineries, Please rank the capability of the manufactures for providing the after sales services in the scale of 1- 5 [1is for the best, 5 is for worst] [please tick ALL that apply]

a. Spare parts supply	1 2 3 4. 5
b. On call service	1 2 3 4 5
c. Break down maintenance	1 2 3 4. 5
d. Delivery time for the machinery	1 2 3 4. 5
e. Supply of the technical documents	1 2 3 4 5
f. Qualified service technicians	1 2 3 4. 5
g. Supply the machinery as the desired quality	1 2 3 4 5

Analysis of surveyed data

Value label	Frequency	Missing cases	Total	1	2	3	4	5
a	20	18	38	0.0	0	0	60.00	40.00
b	26	12	38	0.0	0	0	68.42	31.58
c	28	10	38	8.1	0	0	51.15	42.85
d	33	5	38	0.0	0	0	39.40	60.60
e	30	8	38	0.0	0	0	33.33	66.66
f	31	7	38	0.0	0	0	51.33	48.38
g	32	6	38	0.0	0	0	43.75	56.25

Q10. If, the local manufacturers some time failed to maintain the supply schedule, please identify the reason from the given options. [Please tick <u>ALL</u> that apply]

a. Due to the lack of business capital

b. Due to the lack of skilled technicians

c. Due to the lack of manufacturing machine tools

d. Due to the lack of infrastructure support

e. Due to the lack of quality raw materials

f. Due to lack of t skill management

g. Due to the lack of testing lab

h. Others [please specify]

Analysis of surveyed data

Value label	Frequency of response	Missing cases	Total	Response (%)
a	28	10	38	73.68
B	19	19	38	50.0
C	23	15	38	60.52
d	22	16	38	57.89
e	20	18	38	52.63
f	19	19	38	50.0
g	30	8	38	78.94
h	6	32	38	15.78

Sample -181, Response rate 22%, Response-40.

Missing case 2, valid case 38.

Sample calculation on 10a.

Response on the option a is 28.

Response rate is 28/38x100= 73.68%.

Q11. What percentages have you spent on the locally made machineries in the following terms?

Value label	Category of the machineries	1998	1999	2000	2001	2002	2003
a.	Low tech						
b.	High tech						
c.	Peripheral						
d.	Generic						
Total	Total						

Analysis of surveyed data

Average surveyed data are presented in the table

Value label	1998	1999	2000	2001	2002	2003
a.	1.2	1.21	1.21	1.2	1.22	1.23
b.	0.64	0.65	0.65	0.64	0..66	0.65
c.	3.4	3.69	3.86	4.11	4.2	4.3
d.	2.12	2.13	2.34	2.55	2.2	2.67
Total	7.36	7.68	8.01	8.56	9.05	8.85

Sample -181, Response rate 22%, Response-40,

Missing case 1, valid case 39

Sample calculation on peripheral machine

No of response on generic machineries for 1998 is 39.

The range -Minimum 1.7%

- Maximum 2.5%

The total value of the generic machinery for 39 respondents is 82.68

The average value is = 82.68 /39= 2.12 %

Mode=2.15, Standard deviation (σ) = 0.36,

Median(M) = 2.13

Acceptable data limit=+3σ -3σ = 3.2-.03.

Q12. If you have reduced the budget for the locally made machineries, please identify the reasons given below? [Please tick ALL that applies].

a. The machineries are not available

b. The quality of the machineries have reduced significantly

c. The capacity of the after sales services have reduced

d. The price for the ICM is increased

e. The finance from the bank is not available for locally made machineries

Analysis of surveyed data

Value label	Frequency of response	Missing cases	Total	Response (%)
a	20	18	38	52.62
b	12	26	38	31.5
c	14	24	38	36.84
d	10	28	38	26.31
e	8	30	38	26.66

Sample -181, Response rate 22%, Response-40, Missing case 2, valid case 38

Sample calculation: ref 12a, no of response on the option a is 20

Response rate is 20/38x100= 52.62%.

Q13. If you have increased the budget for the locally made machineries what were be the reasons? [Please tick ALL that apply]

a. The machineries are available due to increase the manufacturing capacity in the local plant

b. The quality of the machineries have improved

c. The capability of after sales services have improved

d. The price of the machineries has reduced

e. Fiancée from bank for the locally made machineries is available

Analysis of surveyed data

Value label	Frequency of response	Missing cases	Total	Response (%)
a	23	15	38	60.8
b	12	26	38	31.5
c.	14	24	38	36.84
d	8	30	38	21.05
e	6	32	38	15.78

Sample -181, Response rate 22%, Response 40

Missing case 2, valid case 38.

Sample calculation on 12a

No of response on the option a is 23

Response rate is 23/38x100 = 60.52%.

Q14. Please rank the machinery sourcing tools in the following terms? [Please insert the figure in all boxes that apply]

a. You are reluctant to use (Not important) Rank -1

b. You are giving little attention to use (Little important) Rank -2

c. You are convinced to use (Moderate important) Rank-3

d. You are giving top priority to use (Important) Rank -4

SL	Product promotion tools	1	2	3	4
a	Use Procurement management				
b	Use of yellow pages				
c	Choice of suppliers through promotion materials				
d	Choice of suppliers by using advertisement available in the trade magazine				
e	Web-based sourcing				
f	Technical seminar				
g	Choice supplier through advertisement in newspaper				
h	Supplier's selection by using advertisement available in the television.				

Analysis of surveyed data

Value label	Response frequency	Missing case	Total	1	2	3	4
a.	37	3	40	5.00	7.5	10.00	77.50
b.	40	0	40	7.50	10.0	12.50	70.00
c.	39	1	40	7.50	12.5	12.50	67.50
d.	40	0	40	12.5	10.0	15.00	62.50
e.	38	2	40	2.50	5.0	27.50	65.00
f.	37	3	40	5.00	2.50	22.50	70.00
g.	36	4	40	32.5	10.0	7.50	50.00
h.	39	1	40	42.5	10.0	32.50	15.00

Sample -181, Response rate 22%

Response-40, Missing case-0, valid case 40.

Sample calculation on 14a.

No of response on the option is 2.

Reponses percentage is 2/40x100 = 5%

Q15. As, you are using locally made machineries, please rank the performance of the manufacturing groups having the following employment size in the scale of 1-5 (1 is for the best performance, 5 for the worst] [Please tick ONE that apply].

a. Employee size, 10 people 1 2 3 4 5

b. 11-20 people 1 2 3 4 5

c. 21-30 people 1 2 3 4 5

d. 31-40 people 1 2 3 4 5

e. 41-50 people 1 2 3 4. 5

Performance ranks of the ICM manufacturing enterprises

Label	Identification label	Number of response	Performance rank
a	At 10	2	5
b	11-20	4	4
c	21-30	6	3
d	31-40	10	2
e	41-50	18	1
Total		40	

Sample -181, Response rate 22%, Response-4, Missing case-0, valid case 40.

Q16. In implementation phase, what percentages of locally available industrial technology were used in your project? [Please insert the figure in percentages in boxes that apply]

Sl NO	Industrial sub sectors	From local sources (%)	From foreign sources (%)
1.	Pharmaceutical industries		
2.	Fruit juice manufacturing industries		
3.	Carbonated drink manufacturing industries		
4.	Fish processing industries		
5.	Textile industries		
6.	Garments industries		
7.	Vegetable oil processing industries		
8.	Tea processing industries		
9.	Leather processing industries		
10.	Sugar cane processing industry		
11.	Drinking water bottling industries		
12.	Dairy processing industries		
13.	Fertilizer and chemical industries		

Survey analysis data

The average value of use of industrial technology is shown in following table.

Sl NO	Industrial sub sectors	From local sources (%)	From foreign sources (%)
1.	Pharmaceutical industries	20.0	80.0
2.	Fruit juice manufacturing industries	7.2	92.8
3.	Carbonated drink manufacturing industries	6.0	94.0
4.	Fish processing industries	25.0	75.0
5.	Textile industries	15.0	85.0
6.	Garments industries	8.0	92.0
7.	Vegetable oil processing industries	7.7	92.3
8.	Tea processing industries	6.6	93.4
9.	Leather processing industries	6.0	94.0
10.	Sugar cane processing industry	4.0	96.0
11.	Drinking water bottling industries	25.0	75.0
12.	Dairy processing industries	5.0	95.0
13.	Fertilizer and chemical industries	3.0	97.0

Q17. Please indicate the investment you have made to procure the locally made machineries in the following schedule.

After sales service parameter	Investment on locally made machineries in percentage of the total investment					
	2003	2002	2001	2000	1999	1998
Pharmaceutical industries						
Fruit juice manufacturing industries						
Carbonated drink manufacturing industries						
Fish processing industries						
Textile industries						
Garments industries						
Vegetable oil processing industries						
Tea processing industries						
Leather processing industries						
Sugar cane processing industry						
Drinking water bottling industries						
Dairy processing industries						
Fertilizer and chemical industries						

Surveyed data are presented in table

After sales service parameter	Investment on locally made machineries in percentage o f total investment					
	2003	2002	2001	2000	1999	1998
Pharmaceutical industries	16.3	16.1	15.9	15.6	15.2	14.9
Fruit juice manufacturing industries	6.3.	6.6	6.3	6.7	6.3	6.2
Carbonated drink manufacturing industries	4.2	4.1	4	3.9	4.0	4.2
Fish processing industries	15.5	15.3	15.1	14.7	14.4	14
Textile industries	14.5	14.6	14.2	13.9	13.5	13.3
Garments industries	17	16.9	16.7	16.5	16.3	15.8
Vegetable oil processing industries	9.4	9.1	9.1	8.9	8.9	8.3
Tea processing industries	9.3	8.9	8.3	8.2	8.0	7.3
Leather processing industries	9.3	9.2	9.0	8.9	8.5	8.1
Sugar cane processing industry	10.3	9.6	9.3	9.2	8.30	8.0
Drinking water bottling industries	17	16.9	16.7	16.5	16.3	15.8
Dairy processing industries	9.0	8.7	8.4	8.3	8.1	7.3
Fertilizer and chemical industries	8.6	8.3	8.1	8.0	7.3	6.9

Group B

Q18. How many years has your company been in manufacturing business? (Please tick one)

a. 3-5 years

b. 6-8 years

c. 12-14 years

d. 15- 18 years

Analysis of surveyed data

Value label	Frequency of response	Missing Cases in options	Total	Response (%)
a.	35	110	145	24.13
b.	56	89	145	38.62
c.	22	123	145	15.54
d.	17	128	145	11.62
e.	25	120	145	10.34

Sample 700, Response- 150.

Response rate 21.42 %.

Missing case –5. Valid cases -145.

Sample calculation-on 18a.

Response rate is 35/145x100= 24.13 %

Q19. Are you producing industrial capital machinery?

a. Yes

b. No

Surveyed data are presented in table

Value label	Frequency of response	Missing cases	Total	Response rate (%)
a.	101	44	145	69.65
b	44	101	145	30.35
Total	145			100

Sample 700, Response-150, Response rate 21.42 %.

Missing case–5, Valid cases -145.

Sample calculation on 19a.

Response rate 101/145x100 = 69.65%.

Q20. If yes, Please indicate the types given below [Please tick ALL that apply]

a. Low-tech machineries

b. High-tech machineries

c. Peripheral machineries

d. Generic machineries

Surveyed data are presented in table

Value label	Frequency of response	Missing cases	Total	Response rate (%)
a	16	124	140	11.50
b	10	130	140	7.00
c	92	48	140	65.50
d	22	118	140	16.0

Sample 700. Response- 150, Response rate 21.4%.

Missing case 10, valid cases 140.

Sample calculation on 20a.

No of responses are 26

Response rate is 16/140 x100=11.5%.

Q21. Please indicate the growth in sales of your products in the following schedule [Please fill up all box that apply]

Year of operations	Growth in sales in %
a.1999	
b.2000	
c.2001	
d.2002	
e.2003	

Analysis of surveyed data

The average data on growth of sales is shown in table

Year of operation	Growth in sales in %
a.1999	4.9
b.2000	4.8
c.2001	5.0
d.2002	5.1
e.2003	5.0

Q22. What is your best choice of sales and marketing strategy given below to speed up the sales of your products? [Please insert the figure in all the boxes that apply]

Sales strategy	In indicate current use	Indicate future use
a. Through own sales and marketing team		
b. Through trading company		
c. Through project engineering company		

Analysis of surveyed data

Value label	Frequency of response	Missing case	Total	Current use (%)	Future use (%)
a	120	28	148	65	30
b	110	38	148	15	25
c	133	15	148	20	45

Sample-700, Response-150, Response rate 21.4%.

Missing case 2, Valid cases 148.

Sample calculation on 22a.

The range Minimum 55%

Maximum 76%

The average = 65%

Q23. What was your sale in 2002? [Please fill in appropriate box]

a. Age group 3-5 years — Million tk

b. Age group 6-8 years — Million tk

c. Age group 9-11 years — Million tk

d. Age group 12- 14 years — Million tk

e. Age group 15- 18 years — Million tk

Analysis of surveyed data for the year 2002

Value label	Frequency of response	Total	Average sales million tk
a.	35	35	2.54
b.	56	56	3.04
c.	22	22	6.08
d.	17	17	6.85
e.	15	15	6.6

Sample 700, Response- 150, Response rate 21.42%.

Missing case –5. Valid cases –145.

Sample calculation 23a.

Total sales 88.9 million tk.

Average sales = 2.54 million taka

Stand Dev. .0.389.
Acceptable data range, Maximum = 2.54+3x0.389=4.43
Minimum = 2.54-3x0.389=01.38

Q24. What was the sales growth in the last five years in your enterprise? (Please insert figure in all boxes that apply)

In last five years	1998	1999	2000	2001	2002	2003

Analysis of surveyed data

In last five years	1998	1999	2000	2001	2002	2003
	4.5	4.9	5.2	5.5	5.75	5.8

Sample 700, Response- 150, Response rate 21.42 %.
Missing case2. Valid cases148.
Sample calculation: Based on 2002

Average data is used for the assessment.

The minimum growth is 5.1%.

Maximum is 6.4%.

The average is 5.75%.

Q25. Have you made special price to increase the demand for your products? If yes, please indicate. (Please insert figure in all boxes that apply).

Types of products	Price reduction in %	Demand growth in %	Corresponding year of business operation
a.			
b.			
c.			
d.			

Survey data of the following manufacturing companies is presented in the tabular form.

Types of products	Price reduction in %	Demand growth in %
a. Electrical equipment	5.0 7.0 8.0 10.0 12.0	13.0 14.0 16.6 18.0 18.4
b. Water softener machine	6.0 8.0 10.0	14.0 15.0 18.0
c. Liquid mixture machine.	8.0 12.0 16.0	12.0 16.0 21.0
d. Stainless steel tank	7.0 11.0 13.0	12.5 16.0 19.0
e. Gear box	7.5 10.0 11.5	14.0 15.0 18.0

Q26. Please indicate the operating cost of your enterprises in the following schedule.

a. Maximum equivalent to US\$ per unit of products

b. Minimum equivalent to US\$ per unit of products

Surveyed data are presented in table

Value label	Average cost US\$	Frequency of response.
a	500.0	100
b	1250.0	120

The ration of the cost 1250/500.

=1:2.5.

Q27. How many persons your firm has been employed? [Please tick one that apply]

Up to 10

11-20

21-30

31-40

41-50

Surveyed data are presented in table

Average surveyed data is used and presented in the table

Identification label	Frequency of response	Missing case	Total	Response rate (%)
a	37	111	148	25
b	60	88	148	40.5
c	24	124	148	16.2
d	15	123	148	10.13
e	12	136	148	8

Sample-700, Response-150, Response rate-21.42%.

Missing case–2. Valid cases -148

Sample calculation: Based on option 27a the assessment was done.

The number of response is 36.

Response rate =37/148x100 = 25.%

Q28. What were your sales in the following terms? [Please fill in appropriate box]

1 Employees within 10

Year of operation	1998	1999	2000	2001	2002
Million tk					

2. Employees within 10-20

Year of operation	1998	1999	2000	2001	2002
Million tk					

3. Employees within 20-30

Year of operation	1998	1999	2000	2001	2002
Million tk					

4. Employees within 30-40

Year of operation	1998	1999	2000	2001	2002
Million tk					

5. Employees within 40-50

Year of operation	1998	1999	2000	2001	2002
Million tk					

Surveyed data are presented in table
All are average data

Groups	1998	1999	2000	2001	2002	Frequency of response
Group 1	1.87	2.05	2.14	2.3	2.54	37
Group 2	2.31	2.45	2.65	2.85	3.04	60
Group 3	5.22	5.39	5.62	5.82	6.08	24
Group 4	5.78	6.05	6.32	6.55	6.85	15
Group 5	5.72	6.02	6.28	6.48	6.8	12

Sample 700, Response- 150, Response rate 21.42 %

Missing case –2. Valid cases –148, Sample calculation.

Total sale for 1998=69.19 mill, Range=1.1-2.7, Average=1.87

Standard dev(σ)=0.386., Acceptable data limit= Maximum 1.87+3σ=3.028 million

Minimum 1.87-3σ=0.71

All data are accepted

Q29. Please indicate whether are you currently using or have plan to use (within next five years) the follow machine tools [Please tick *ALL* that apply]

a. Automatic machine tools

b. Semi automatic machine tools

c. Manually operated machine tools

d. Mixed of all types.

Surveyed data are presented in table

The average data on use of machine tools is shown in the following table

Value label	Use of machine tools (%)
a.	13.4
b.	22.
c.	57.0
d.	7.6

Q30. Please indicate whether are you currently using or have plan to use (within next five years) the computer aided manufacturing technologies in your plant? [Please tick *ALL* that apply]

a. Currently you are using

b. You have plan to use

c. You have no plan to use

Surveyed data are presented in table

Value label	Response frequency	Missing cases	Total	Response (%)
a	22	120	142	15.4
b	54	88	142	38
c.	66	76	142	46.6

Sample 700, Response-150 response rate 21.4%.

Missing case 8, valid case -142.

Sample analysis on 30a.

(22x100)/142=15.4%

Q31. How much you have spent on the AMT for the improvement of quality of the products and productivity in the production line for following period [Please tick ALL that apply]

Year business operation	Percentage of total revenues
a. 1998	
b. 1999	
c. 2000	
d 2001	
e.2002	
f.2003	

Surveyed data are presented in table

Value label	Frequency of response	Average value in million take
a.	82	3.25
b.	110	3.5
c.	130	3.7
d.	111	4.0
e.	117	3.9
f.	121	4.1

Sample-700, Response-150, Response rate-21.4%.

Sample analysis on 31a

Total investment = 266.52 million

Average is =266.52/82

=3.25 million

Q32. How you are managing the employees to perform the job? [Please tick one that apply]

a Employees are used for dedicated job

b One employees are used for many job

Surveyed data are presented in table

Value label	Valid cases	Total	Response (%)
a.	8	8.0	5.60
b.	134	134.0	94.40
Total	142	142	100

Sample-700, Response-150, Response rate-21.42%.

Missing case--8. Valid cases-142.

Sample analysis on 32.a

Average (134x100)/142= 94.40 % are used for many job.

Q33. What were the sales of your product in the following period [Please tick ALL that apply].

a In last five years	1998	2000	2002
a. If you have spent 3.5 % on AMT of your total revenue			
b If you have spent 4 % on AMT of your total revenue			
c If you have spent 4.5 % on AMT of your total revenue			

Surveyed data are presented in table

Value label	Total response	Total sales in million taka			Average sales in million tk		
		1998	2000	2002	1998	2000	20002
a.	13	91.0	107.9	110.5	7.0	8.3	8.5
b	15	112.5	129	132	7.5	8.6	8.8
c.	17	134.3	156.9	158.1	7.9	9.2	9.3

Group-C

Q34. Please identify the import duty and tax elements on the raw materials that have been imposed by the government. Please insert the fig in percentage [in all boxes that apply]

	1-5	6-10	11-20	21-30	31-40
a Basic import duty(%)					
b. VAT(%)					
c. Licence fee(%)					
d Licence fee(%)					
e General service charge and others(%)					
f VAT at sales end(%)					

Surveyed data are presented in table

Value label	Frequency of response	Missing cases	Total	1-5(%)	6-10(%)	11-20(%)	21-40(%)
a.	9	1	10				90%(9)
b.	8	2	10			80%(8)	
c.	8	2	10	80%(8)			
d.	10	0	10	100%(10)			
e.	8	2	10	80%(8)			-
f.	8	2	10	80%(8)			-

Sample-46, Response-10, Response-21.73%.

Sample calculation on 34a.
Missing case-1, Valid cases 9.

Q35. Please rank the barriers to the business of the raw materials in the following scale.

Impact of existing policy on business	Identification	Index
You are very happy with the existing import policy and you can make significant amount money profit from the business and	Very good	1
You are happy with the existing import policy and you can make money profit from the business.	Good	2
You are accepting the existing import policy as you can make a small about of money profit from the business.	Acceptable	3
You are not happy but obliged to accept the existing import policy as still you can survive with the business.	Of little acceptable	4
You are not happy and the existing import policy is not acceptable to you as the business is not giving money profit for survival.	Not acceptable	5

a. Money transfer for raw materials import 1 2 3 4 5

b. VAT payment 1 2 3 4 5

c. Import duty payment 1 2 3 4 5

d. Materials handling charge in the port 1 2 3 4 5

e. Materials handling from the port to destination 1 2 3 4 5

f. Procurement Processing time 1 2 3 4 5

Surveyed data are presented in table

Value label	Frequency of response	Missing case	Total	1	2	3	4	5
a	9	1	10			2	5	2
b	10	0	10			4	5	1
c	9	1	10			4	5	1
d	8	2	10			3	4	1
e	10	0	10			4	5	1
f	9	1	10			3	4	2

Sample-46 Response-10, Response 21.73%.

GROUP-D

Q36. What is the key strategic policies that are going to be undertaken by the government for the development of ICM manufacturing SMEs [please tick ALL that apply as per the scale].

(a) Implementation of the strengthening activities in future (1)

(b) Implementation of the strengthening activities in the near future (2)

(c) Immediate implementation of the strengthening activities (3)

Government policy support programmes	Rank 01	Rank 02	Rank 03
a Strengthening training for capacity building for manufacturing technicians and industrial technology			
b Adopt policy to reduce the import duty and VAT on the raw materials			
c Extend support for the development of the manufacturing infrastructure			
d Extend advisory services for business expansion			

Surveyed data are presented in table

Value levle	Frequency of response	Missing case	Total	Rank 1	Rank 2	Rank 3
a	10	0	10	70%	20%	10%
b	10	0	10	20%	70%	10%
c	10	0	10	80%	10%	10%
d	10	0	10	60%	20%	20%
e	10	0	10	10%	20%	70%

Sample 47, Response 10, Response rate 21.27%

Missing- 0, valid case 10,

Q37. What are the specific policies that are going to be implemented by the government for the development of the infrastructure facilities to speed up the growth of the ICM manufacturing SMEs ? [Please tick ALL that apply]

1. for immediate implementation,
2. for the implementation in the near future,
3. for the implementation in the future

Infrastructure parameters	1	2	3
a Institutes to conduct training program for the development of industrial technology			
b Implementation of tax-and VAT free industrial zones			
c Extending bank services to finance for SMEs			
d Extent Bank services to finance for SMEs			
e Extending advisory services to the entrepreneurs for the development of business and general services			

Surveyed data are presented in table

Value label	Frequency of response	Missing case	Total	1	2	3
a.	10	0	10	10%	80%	10%
b.	10	0	10	20%	60%	20%
c.	10	0	10	20%	60%	20%
d.	10	0	10	20%	70%	10%
e.	10	0	10	20%	30%	50%

Sample-47,Response-10,response rate-21.27%.
Missing-0, Valid case-10.

Q38. Please rank the infrastructure support programs that are going to be implemented by the government for the development of the ICM Manufacturing SMEs. [Please tick one that apply], [1 for immediate implementation, 2 for the implementation in the near future, 3 for the implementation in the future].

Infrastructure parameters	1	2	3
a. Laboratory			
b. Telephone /Fax			
c. Low cost business capital			
d. Internet			
e. Storage/Bonded wire house facilities			
f. Sales sub contracting net work			

Analysis of Surveyed data.

Value level	Frequency of response	Missing case	Total	1	2	3
a.	9	1	10	1	7	1
b.	8	2	10	1	5	2
c.	9	1	10	2	6	1
d.	7	3	10	1	5	1
e.	9	1	10	2	2	5
f.	8	2	10	1	6	1

Sample size-47, Response- 10, Response rate 21.27%

Missing case 0, valid case 10.

Q39. Whey government will undertake the programs for development ICM manufacturing SMEs ? Please identity the followings and rank in the scale of 1-3, [please tick <u>ALL</u> that apply].

1. For not important,
2. For important,
3. For very important

a. For the development of manufacturing industry 1 2 3

b. For the development of import substitute products 1 2 3

c. For employment generation 1 2 3

d. For the development of industrial technology 1 2 3

Surveyed data are presented in table

Value level	Frequency	issing case	Total	1	2	3
a	10	0	10	20%	(70%)	10%
b	10	0	10	10%	30%	*(60%)
c	10	0	10	(80%)	10%	10%
d	8	2	10	25%	25%	*(50%)

Sample-47, Response-10, Response rate-21.27.

Missing-0, Vales case-10.

Sample calculation.-of 39a.

No of two respondents have respond on the rank 1.

The rate of response =

2/10x100=20%.

APPENDIX-F

Data book

Data book was established during the visit in manufacturing industries in Bangladesh. Data were collected from the ICM manufacturing enterprises and as well as from the general manufacturing industries. The average values on AMT growth, supply of industrial technology and demand for locally made ICM was used to formulate the tables. Data were collected by the following procedures:

i. Through interview with the sales managers of ICM manufacturing enterprises
ii. From the sales document of the ICM manufacturing enterprises
iii. From purchase document of general manufacturing industries
iv. Interview with purchase managers of general manufacturing industries

A. Growth on AMT and sales of locally made ICM

Table F.1 Average values of growth on AMT VS demand

Sl. NO	Growth on AMT	Demand for locally made ICM in % of total demand
a.	3.5	8.0
b.	4.5	9.3
c.	5.0	9.8
d.	6.0	10.5
e.	6.25	11.0

B. Industrial technology supply from local sources and sales of locally made ICM

Table F.2 Average values of supply of industrial technology VS demand.

Sl. NO	Industrial technology	Demand for locally made ICM in % of total demand
a.	11.0	8.0
b.	12.0	9.5
c.	13.0	9.7
d.	14.0	11.2
e.	14.5	13.

C. Growth on AMT, supply of Industrial technology local sources and sales of locally made ICM

Table F.3 **Growth on AMT, supply of Industrial technology local sources VS demand.**

Sl. NO	Growth on AMT	Industrial technology	Demand for locally made ICM in % of total demand
a.	3.5	11.0	8.0
b.	4.5	12.0	9.0
c.	5.0	13.0	9.5
d.	6.0	14.0	10.0
e.	6.25	14.5	10.5

D. Operating cost for manufacturing enterprises

Table F.4 Operation cost per unit machine.

Sl NO	Types of machineries		Range of expenditure US$ per unit machine	Average expenditure US$ per unit machine
1	Generic machineries; Centrifugal pump, Agitator, gear box etc .		500-700	600.
2	Low tech machine; Pressure vessel, mixture machine, tank with level controller etc	Semi automatic machine	700-900.	800.
		Automatic machine	900-1100.	1000.
	High tech machine; Reverse osmosis, electric transformer and switch gear etc.		1100-1350.	1250.

Appendix G

Publications and seminar

1. Shahidul, I. M., Ahmed, M., Hashmi, M.S.J., " State of Advanced Manufacturing Technology in Industrial Capital Machinery Manufacturing Small and Medium Sized Enterprises in Bangladesh", Journal of I.E.B, 2004, PP- 33-38.

2. Shahidul, I. M., Ahmed, M., Hashmi, M.S.J," Impact of S & T policy on the growth of capital machinery manufacturing SMEs in Bangladesh", 2nd International conference of ASME-BSME on thermal Engineering, 27-29 December 2003, Dhaka Bangladesh.

3. Shahidul, I .M., Ahmed, M., Hashmi, M.S.J " Impact of AMT on the growth of capital machinery manufacturing SMEs", 4th International Mechanical Engineering Conference and annual paper met. 28- 31-December 2004, Dhaka Bangladesh

APPENDIX-H

The value of coefficients of AMT and Industrial technology

The basic equation for demand of locally made ICM, growth of AMT and the supply for locally developed industrial technology is:

$Z = a + bx + cy.$

From the Table F.3, the following equations can be derived:

$8=a+3.5b+11c$ (i)

$9=a+4.5b+12c$ (ii)

$9.5=a+5b+13c$ (iii)

$10=a+6b+14c$ (iv)

$10.5 = a+6.25b+14.5$ (v)

By subtracting equation (i) from (V) the relation between b and c is obtained which is;

$C= (2.5-2.75b)/3.5$ (vi)

Using the value of c in equation (ii), the relation between a and b is obtained which is;

$a= (1.5+15.25b)/3.5$ (vii)

By replace the relation of a and c in equation (iii) the value of b is obtained which is;

$b=0.25.$

By replacing the value of b in equation (vii), the value of a is obtained which is;

$a=1.52.$

By replace the value of b in equation (vi), the value of c is obtained which is;

$C=0.51.$

PRELIMINARY QUESTIONNAIRE

Group A. General manufacturing industries

Q.1 How much you have spent on the followings in the last five six years?

Major parameters of investment	
Land	
Building	
Capital machinery and technology	
Total	

Q.2 How much you have spent on the following ?

	% of the total				
Locally available resources	2002	2001	2000	1999	1998
Spare parts					
Troubles shooting					
Industrial technology for Plant expansion					
Industrial technology for Plant implementation					
Capital machineries for plant expansion					

Q.3 Please give your choice of use on the following procurement tools?

SL No	Sourcing tools	Merit of choice
a	Use procurement management	
b	Use yellow pages	
c	Choice suppliers through promotion materials	
d	Choice suppliers by using advertisement available in the trade magazine	
e	Web-based sourcing	
f	Technical seminar	
g	Choice supplier through advertisement in newspaper	
f	Choice suppliers by using advertisement available in the television.	

Q.4 Please identify the procedure you are currently using for the procurement of industrial capital machinery.

a. Turnkey procedure (machinery and technology from one source) ☐
b. Single machinery from different manufacturers/Suppliers. ☐

Q.5 Please identify the procedure you will be using in future for procuring industrial capital machinery.

a. Turnkey procedure (machinery and technology from one source) ☐
b. Single machinery from different manufacturers/Suppliers. ☐

Q.6 Please rank the procurement barriers of locally made ICM

Scale of procurement barriers

Scale of barriers	Types of barriers	Rank
Not barrier	Can easily be over come	1
Of little barrier	Can easily be over come but there is some production lose	2
Moderate barrier	Operation of machineries gets little difficult.	3
Strong barrier	Operation of machineries gets difficult.	4
Very strong barrier	Operation of machineries gets very difficult.	5

Parameters of barriers	Rank of barriers
Low quality machine	
High lead time	
Short supply of after sales services from the local manufactures	
Bank financing is poor for locally made ICM	
Short supply of industrial technology	
Short supply of technical documentation	
lack of communication facilities in ICM manufacturers	
Lack of testing facilities to measure the quality of the machineries.	
lack of experience	
The lack of skilled technicians in the manufacturing enterprises	

Q.7 What is your investment growth on capital machinery in the following years?

Parameters	1998	1999	2000	2001	2002
Investment on Industrial Capital machinery					

Group B. ICM Manufacturing enterprises.

Q.8 Please identify the Ownership nature of your firm

Type of the enterprises (No of employee)	Ownership pattern			
	Family	Partnership	Private	

Q.9 What is the Age of your firm?

Types of the industries(No of employee)	3-5 years of age	6-8 years of age	9-11 years of age	Age 12+

Q.11 Please tick in the relevant box

Parameters	Currently using	Have plan to use	Have no plan to use
Computer aided manufacturing (use of NC, CNC machine)			
Computer aided Engineering (Computer base désign analysis)			
Computer aided production planning (Use of software based planning)			
Computer aided Quality control (Use of computer for quality analysis)			
Computer aided design (Use AutoCAD or other graphics software)			
Computer aided supply chain management (use spread sheet or custom software)			
Production order planning management (use spread sheet or custom software			
Production progress monitoring (MPM) management (use spread sheet or custom software			

Q. 11 Computer application in manufacturing business

Manufacturing employees t	Number of employees currently employed				
	0	1-2	3-5	6-8	8+
Skilled technician					
Diploma engineer					
Engineering graduate					
Post graduate in science and engineering					

Q.12 Please tick in the appropriate box

Categorical machine tools	Manual operated	Semi automatic	Automatic
a. Lathe machine			
b. Drilling machine			
c. Surface grinding machine			
d. Shaper machine			
e. Milling machine			
f. Boring machine			
g. Welding machine			
h. Metal forming machine			
i. Surface coding			
j. Metal cutting machine			

Q.13 Identify the manufacturing employment

Category wise management employee	Number of employees currently employed				
	0	1-2	3-5	6-8	8+
Cost accountant (%)					
Business management (%)					
Sales and Marketing (%)					
Personal management (%)					

Q.14 How much you have spent to set up your industry (excluding land and building) ?

Type of the firm	Investment in TK

Q.15 What is the skilled composition of manufacturing technicians?

Type of the firms	Unskilled	Semi skilled	Skilled	Total

Q.16 What is the wage structure in your firm?

Type of the firms	Unskilled	Semi skilled	Skilled

Q.17 What types of machinery are you producing?

a.Low tech

b.High tech

c.peripheral

d.Generic

Q.18 Please identify the marketing tools currently you are using?

SL No.	Marketing tools	In order of preferences
a.	Product image	
b.	Reputation of the company	
c.	Price	
d.	Personal sales effort	
e.	Having strong after sales service	
f.	State-of-art technology	
g.	Advertising Media	
h.	Web base marketing	

Q.19 Please identify your marketing strategy

Label	Marketing strategy	Present use	Future planning
a	By using own sales team		
b	Through treading company		
c	Through project engineering company		

Q.20 Please rank manufacturing barriers based on the following scale

Scale of Rank

Strength of barrier	Types of barriers	Rank
Not barrier	Can easily be over come	1
Of little barrier	Can easily be over come, but money profit is reduced	2
Moderate barrier	Reduce money profit but the operation of business gets little difficult.	3
Strong barrier	Reduce money profit but the operation of business gets difficult.	4
Very strong barrier	Reduce money profit but the operation of business gets very difficult.	5

(i) External barriers

Parameters of barriers n	Rank
Low quality raw material	
Lack of infrastructure	
High tax on raw materials	
High tax on sales	
High VAT on sales	
Bank finance	
Not enough demand	
Update information of manufacturing technology	
Information of demand	
Trained technician	
Local payment terms	
Testing facilities	
Quality (ISO) certificate	
Promotional work	
Technical documentation	
Government attitude toward the development of ICM manufacturing SMEs	
Sub contracting net work	
Import duty of the Capital machinery	
Wage policy	
Lack of responsiveness to the new product	
Industrial engineering capability	
Short supply of skilled manufacturing staffs (70%)	

(ii) Internal Barriers

SLNo	Internal barriers	Rank
a	Promotion work	
b	Technical documentation	
c	Lab facilities	
d	Manufacturing infrastructure	
e	Lack of time	
f	Qualified management	
g	Inadequate financial means	
h	Inadequate R&D facilities	
i	Capability of Motivation	
j	Market survey facilities	
k	Clean business strategy	
l	Human resources development policy	
m	Industrial engineering capability	

Q.21 Please rank the strength of your manufacturing infrastructure
Scale

Order	Parameters	Quality level
1	If totally absent in the manufacturing plant	Poor
2	Have partial facility in the enterprise	Acceptable
3	Fully installed to meet the requirement	Good
4	Fully installed to meet the requirement and have some standby facilities to cover the risk	Very good

Infrastructure parameters	Poor	Acceptable	Good	Very good
Laboratory				
Transportation				
Computer				
Fax				
Telephone				
Banking				
Internet				
Storage facilities				
Raw materials supply				
Sales sub contracting net work				
Technical and advisory services				
Market information				