IMPACT OF TECHNOLOGY DENSITY ON THE AGRO PROCESSING SMES: AN INSIGHT STUDY ON BANGLADESH

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1. Introduction

What affect the speed with which A technology spreads throughout SMEs? This is a question which should concern us greatly to face the turn-in competitive market. 'The Small and Medium Size Enterprise (SME) is known as an engine of economy [1]. This vital employment generating sector is more important in developing countries [2]. Since, in the developing countries agriculture primarily plays a dominant t role there is a huge production of prime agro products. By setting up agro processing industries, high value added products can be produced in order to increase employment opportunities and to contribute to GDP. Moreover, agro processing SMEs can play an addition,' important role to adopt indigenous technology for processing of these primary products. It is true that developing economy always lends to adopt low cost technology from locally available sources [3]. In Bangladesh agriculture is continuing to play an important role in terms of production, employment generation and contribution to GDP [4].

Since last two decades, the base of economy of Bangladesh is changing from agro economy to industrial economy. It is evident that manufacturing enterprises, of this country arc rendering significant contributions to employment generation, import substitution of products, development of indigenous technology and accelerated rate of GDP [5]. In the context of specially the South East Asian countries, about 90% industrial establishments are within the structure of SME. In countries lib; Singapore, Malaysia, Taiwan, Thailand and South Korea, contribution of SMEs to employment ranges 35 to 61% and contribution of value added products ranges from 22 to 40%. Although in the highly developed countries, the overall contribution of manufacturing industries to GDP is declining, but the manufacturing SMEs of these countries are growing and they remain as key employment – generating sector. The contribution of SMEs to GDP of Japan, the United States the UK, Canada and Germany and other various developed countries is including the-fact that their economy are still highly dominated by the manufacturing (M) SMEs [6].Even, in China (which newly entered into the market economy), the government has taken initiative to revise the policy support programmers for the development of SMEs aiming to set their economy on the M-SMEs. [6, 7, 8]. In the context of developing countries, among the M-SMEs, agro processing SMEs is one of the vital enterprises though which the available agro base resources of the rural area can easily be integrated with the national resources.

Technology is required to convert agro based resources m higher value added products. It is evident that value addition process is largely dependent on the density of technology. On the other hand it is also true that density of technology gets its bearing from the national Science and Technology (S &.T) policy i.e. technology acquisition policy. In this context, it can be demonstrated that the value added process of agro processing SME.s is largely dependent on the national S fit T policy [9,10].

The concentration of S & T is a driving force for industrial growth. But S &£ T policy is also heavily dependent on strength of basic science of a country. Indeed, basic science can be enhanced by the technological capability and capacity [13]. In order to increase technological capacity and capability, knowledge and skill on computer is essential. The knowledge and skill of computer can speed up the manufacturing capability which is mostly known as computer aided manufacturing (OM) (.11). In the modern manufacturing era CIM is a part of advanced manufacturing technology which is also known as AMT [12].

AMT has basically four components namely, i. computer integrated functions ii. manufacturing equipment iii. Skill of manufacturing employees iv. Skill of management employees [13].It can be visualized from the four components that for the processing of any raw materials, AMT is die key factor. Based on this concept, it can be argued that the technology density is dependent on AMT and if the concentration of AMT in .in enterprise is increased then the density of technology will also be increased.

For the convenience of this study, technology is further divided into three main components such as i. low-tech, ii. medium -tech iii. High tech [14] Based on the level of technology and its concentration technology density could be defined as;

Technology density (y) = (Available technology/Demand of technology to meet

Process requirement

$= Ta/T_D$

The value added capability of agro processing SMEs is dependent on many parameters. Among them, the skill of employees, level of automation and accuracy of machineries used for the processing system and as well as management capability In brief the value -iddei.1 capability is largely dependent on the density of technology. The value added index is defined .is the ratio of market value of finished product to market value of raw material [IvA] Hence

value added index of a product could be used as a tool to measure the technological capability and capacity of an agro processing enterprises. The value of IVA could also be used to measure the performance of M-SMEs.

Numerous efforts have been given to study on the performance of M-SMEs [15, 16] The evaluation of performances of SMEs is based on four key parameters of the farms such as: (a) size of employees (b) the degree of skills of human resources working (c) experience in business and (d) technology density. In this regard. Porter [17] suggests that the large sized firms are in good position to make strategic alliances with the others to improve their performance by sharing (heir knowledge and other resources. It is evident that performance of SMEs is usually poor due to its low technology density. However, performance of bigger size firm could be better due to its higher technology density.

In an increasingly open market, M-SMEs are in the face of strong competition of local and international markets. In addition to market competition, SMEs are suffering from die lack of skilled technicians, process machineries and business capital. Large firms and SMEs are different from each other with regards to their structure, performance, resource capability, business strategy and density of technology. Large firm and SMEs, in most cases are working in the same business environment, but their competitive strategies are different from each other. According to Thomas [18], the managerial styles and technology density are more important ways through which SMEs can compete with the larger firms in remaining competitive in the market place. In general, the competitiveness of manufacturing firms is largely dependent on the following key factors, i. the internal firm factors and ii. the external environment. The Internal and external firm factors can play an important role to speed up me growth and performance of SMEs by transforming the raw material to highly value added finished products and these factors are associated with a). Business capital b. Skilled human resources c. Management capability and d. Technological capability/Density of technology. Home [19], O’Farell [20] and Hitchens [21] believed that technological capability could play a vital role on value added process and performance of a firm. However, technology density is dependent on the rate of technology acquisition and diffusion in (he society and finally it can help to build sustainable indigenous technology.

2. Research Methodology

In order to collect primary data from agro processing SMEs oi Bangladesh, 50 processing industries and distribution centers of products were visited. Literatures relating to agro business were also studied in order to obtain current information on this sector. Surveyed data were analyzed by using appropriate statistical took. The results of this study arc presented in tabular form, 2D and 3D graphs. The basic conditions of this rest-arch are;

i. The surveyed enterprises were agro based SME.s, ii. Only Dairy, Fruit, Poultry, rush. Vegetable manufacturing SMEs were included in the study iii. The age of the surveyed SMEs ranged from 3-15 years iv. both backward and forward supply chains of raw materials and finished products were considered v. The surveyed SMEs used at least one AMT in manufacturing process and vi. at least use some locally available indigenous technology in •business process.

3. Distribution of surveyed Agro-processing SMIEs in the scale of technology density

Some degree of processing of bask agro products is necessary in order to get higher value added products. For processing and packing need knowledge, equipment, skill and process techniques, this is known as technology. The degree of value addition is largely dependent on the quality of processing machineries and process techniques i.e. quality of technology. It is obvious that the technology density is an input to the production process which could improve process quality of a product and in other word; a can by mentioned that the technology density could contribute to increase the value added index.

In this study, me technology density of Ju.ru processing SMEs was determined in order to examine the current value added capability of this sector. The current value added capability was determined by examining the following parameters;

i.. Source of existing technology,

ii Indigenous.-; technology density,

iii Categorical technology density .

iv. Growth of technology density

3.1 Distribution of Agro processing SMEs based on origin of technology

Surveyed and processing SMEs distributed based on its technology acquisition order to normally the current density of imported and indigenous technology. The status of technology density for the year 2005 of the surveyed enterprises is presented by Figur 1.

Figure 1: Status of technology Source

It can be viewed from Figure 1 that absolute density of foreign technology in agro processing SMEs is about 80%.The density of mixed technology (imported and indigenous) is about 20%.From this result, it is evident that this sector is highly dependent on foreign technology.

3.2 Indigenous technology density in agro processing SMEs

The indigenous technology density was examined in order to determine the technological capability of this sector. The surveyed result for the period of 2001-2005 is shown in Figure 2

Figure 2: Distribution of SMEs based on indigenous technology density

Figure 2 indicates that the maximum density of indigenous technology in the surveyed SMEs is about 20%.It also evident that in major percentage SMEs the density of indigenous technology is about 5%which is marginally poor and insignificant.

3.2 Category wise technology density in agro processing SMEs

Category wise technology density was evaluate in older examine products processing capability. The existing technology is divided into three parts namely, low-tech , medium tech, and high-tech (see appendix).Survey date of 50 agro processing SMEs for the period of 2001-2005 was analyzed and show in Figure 3.

Figure 3: Category wise technology density of agro processing SMEs

Figure 3 demonstrates that major percentage agro processing SMEs are based on low tech. It is also evident that only 40%SMEs are operated based on high tech Indeed, this results indicate that the agro processing SMEs are highly dominated by low-tech.

3.4 Growth trends of technology density in agro processing SMEs

Growth trend of technology density of agro processing SMEs was studied for the period of 2001-2005 in order to obtain the changes of technology phases. The phase of technology is depicted in Fig. 4.

Figure 4: Growth Characteristics of Technology density in Agro processing SMEs

Figure 4 demonstrates that density of low technology is significantly reduced while the density of high technology is increased. The density of medium technology of the surveyed SMSs also increased.

The surveyed result indicates that the current technology density agro processing SMEs is poor. The density of indigenous technology is also poor. Moreover major percentage SMEs are dependent on foreign technology. The result also demonstrate that over the year 0f 2001-2005, the technology density in agro processing SMEs in increasing significantly (the value of $r>0.5$).The trend of phase changes of technology of the three categories can be estimated by using the following equation;

Low tech $Y(lt) = 33-3.4x$

Medium tech $Y(mt) = 10.5+1.7x$

High tech $Y(ht) = 6.5+1.7x$

4 Current supply chain of agro products

Agro products are usually brought to processing centers prior to sending it to dealers or to distributors. It is observed that in distribution network, the supply chain management (SCM) concept is partially in use. It is also evident that both product processing technique and SCM are two key parameters of value added process of agro business. Indeed the strength of these two key parameters can dominate the value of finished products at the end users level.

The empirical structure of the current SCM and product processing of agro processing SMEs is presented in Figure 5.

Figure 5: Structure of supply chain

Here BSC Backward supply chain, Dealer Distribution of the products FSC Forward supply chain

The structure of SCM shown in figure 5 was used to identify and analyze the value added process.

4.1 Value added process

Different types of value added process are usually used in agro processing sector. The selection of value added process in dependent on available technology at farms level or at processing centers. For easy analysis, the available products processing system was divided into three classes such as: Low value added process based on low technology density and high value added process based on medium technology density and high value added process based on high technology density. The three classified value added finished products are shown in percent in Table 1

Table 1: Distribution of Agro Product

Scale / Products	1	2	3	Total
Dairy	55	30	15	100
Fish	60	30	10	100
Fruit	60	25	15	100
Meat	65	23	12	100
Vegetable	75	75	5	100

1- Product processing and packing by using low technology for low level value added products
2- Product processing and packing by using medium technology for medium level value added products
3- Product processing and packing by using high technology for high level value added products

Table 1 indicates that major percentages of basic agro products are directly sent to dealers / retailers without any processing and packing. In this case, the scope of value addition is marginally poor. It is also evident that a small percentage of agro products are process to produce higher value added products.

4.2 Degree of value addition

The value added index was estimated from the survey data and based on Figure 5 and Table which is listed in Table 2.

Table 2: Value added Index.

Scale / Products	1 I va	2 I va	3 I va	Maximum Value I va
Dairy	=1.2-1.4	=1.5-2	2-3	3.2
Fish	=1.2-1.4	=1.5-2	2-3	3.1
Fruit	=1.2-1.4	=1.5-2	2-3	3.1
Meat	=1.2-1.4	=1.5-2	2-3	3.0
Vegetable	=1.2-1.3	=1.3-1.7	=1.3-1.7	2.5

1-Based on low technology density,2- Based on medium technology density,3- Based on high technology density.

$$I(va) = \text{Value addition Index} = \frac{\text{Market value of finished products}}{\text{Market value of raw materials}}$$

Table 2 lists the value added index of few agro produces. The result indicate that at higher technology density, the value added index is higher. These results demonstrated that technology density has positive impact on the value added index.

5. Barrier analysis of Agro processing SMEs

Why the density of technology in agro processing SMEs is poor? And why the enterprises are reluctant to do processing, of their agro products? .To investigate on these queries, this study has examined the barriers of agro processing SMEs . The examination was earned out by dividing the barriers into two parts, (a) Internal barriers and (b) External barriers(22).

5.1 External Barrier

The external is defined as the barrier, which are generated from the socio-economic and government system and have created pressure on agro processing business. External barrier are measured in the scale of l-5, which is shown in 'Table – 3

Table 3: Identified External Barriers

List of Identified barrier	Rank of barriers	Source of barriers
Supply of trained technicians to handle product processing and packing	4	S&T policy is weak and lack of policy implementation agencies
Supply of indigenous Indus trial technology	4	S&T policy is weak and lack of policy implementation agencies
Supply of AMT from local source	5	S&T and Industrial policy is weak
Capital for purchasing total technology	5	Industrial and Funding policy are Weak
Supply of after sales services	4	S&T and training implementation are weak
Supply of parts	3	Supply source of machineries
Government attitude toward the development of agro processing SMEs	3	Industrial policy is not favorable
Payment system of the products	3	Business environment
Supply chain	3	BSC and FSC
VAT and duty payment	3	Revenue policy and attitude of the public servant
Industrial engineering capability	5	S & T policy is weak
Supply skilled manufacturing staffs	4	S & T policy is weak

Back ward supply chain – BSC, Forward supply chain FSC

It is evident from the list shown in Table 3 that the major sources of external barriers arc related to S & T and industrial polices of the-government. The results also indicate that the rank of major barriers arc higher (ranges 3-to-5).

5.2 Internal barriers

The internal barrier is defined as the barriers, which are generated from die agro processing SMEs and have created pressure on agro business. Internal barriers have been measured in the scale of 1-5 which is shown in Table 4.

Table 4: Internal barriers of Agro Processing SMEs

Internal barriers	Rank	Remark on Barriers
Marketing net-work and Promotion work	3	ISC and Industrial policy is poor
Knowledge on Processing and packing	3	S & T Policy is poor
Quality level	4	Business culture and Government policy
Manufacturing infrastructure	5	ISC and Industrial policy is poor
Business capital	4	Source of Business fund
Management Quality	4	Quality education and training
Inadequate R&D facilities	4	ISC is poor
Need and Demand Analysis Capability	3	Level of education and business strategy.

'' In-House supply chain ISC

It can be viewed from Table 4 that the rank of all identified barriers. are high (ranges 3-to-5). The results shown in Tables 3 and 4 indicate that internal and external barriers of agro processing SMEs arc very strong. From these results it can be argued that due to these strong barriers, the density of technology in this sector is remaining poor and these contribute to produce low value added products.

6. Impact of technology density on value added process

Technology is one of the most important determinants for processing of any raw materials. Indeed, the density of technology could have enhanced the growth of processing capability. Practice shows that high tech usually produces higher value added products.

6.1 Impact of Imported technology density on value added index

The surveyed data on 50 agro processing SMEs were analyzed and a represented in Figure 6. The impact of import based higher technology density on value added index is also shown in this figure.

Figure 6: Impact of imported technology density on the value added index.

From Figure 6 it can be viewed that technology density appears as a fuel to drive the value added index- The value added indexes from 1.4 to 27 has increased sharply at the increase of imported technology density up to 80%. It is also evident that with the increase of technology density from 80%-100%, the value added indexes remained almost constant. The surveyed data demonstrated that due to lack of quality after sale services from local sources for the imported machineries, the breakdown time of the imported machineries had increased which contributed to decrease in value added index by reducing the quality of products.

6.2 Impact of Imported and indigenous technology density on the index of value addition

The surveyed data on imported and indigenous technology were analyzed. The impact of category wise technology density is shown in Figure 7.

Figure 7: Impact of imported and local technology density on the value added index

It can be viewed from Figure 7 that the value added indexes had increased continuously from 1,4 to 3.1 at the input of 100% mixed technology density. Il means that due to use of certain percentage locally available indigenous technology, the breakdown time of die machineries had reduced which contributed to maintain the quality of the products.

From these results u can be concluded that higher technology density can increase the value added index to a certain level but only imported high technology density is not always suitable to attain maximum value added index. Ii can also be demonstrated that indigenous technology density is likely to be a driving factor to increase the value added index. This analysis lends lo give greater emphasis on the mix technology density to have a sustainable performance of agro processing SMEs.

7. Modeling of technology density for higher value added index

The impact of technology density on growth of value added index of agro processing SMEs was obtained which was shown in Article 3, 4, 5 and 6, The impact of both imported and indigenous technology was evaluated at a certain limited use of these two categories.

o determine the value added index of different combination of imported and indigenous technology density, a mathematical model was established by using a multiple correlation and regression method. The standard equation of multiple correlation and regression for the two technology density is shown by the equation 4:

$Z(I_{Va})=\beta_0+\beta_1 x_1+\beta_2 X_2+\varepsilon$

where, X_1- Density of imported technology

X_2 - Density of indigenous technology

B0 - Initial value of value added Index available in agro processing SMEs

β1 - Coefficient of Xi

β2 - Coefficient of X;

ε=Constant of systematic error

Z (I_{Va}) = Value added index at different value of X 1and

A few sets of data relating to density of imported and indigenous technology were obtained from the survey the surveyed data was used to determine the values of B0, B1, and B2 . In this particular case, the systematic error (e) is considered as "o". By substituting the values of B0, B1, and B2 equation 4, the following equation is obtained;

$Z -1.3 +0.011X_1 +0.025X_2$ (5)

By using Equation 5, a 3-D surface graph is plotted winch is shown to Figure 9. In this graph, the different available values of density of imported and indigenous technology and its corresponding value added indexes is plotted by using the sigma plot.

Figure 8: 3-D surface graph of technology density and its impact on value added index.

The Density of imported, indigenous technology, and value added index are presented by x, y, and z axes respectively.

It can be seen from Figure 9 that the value added index of different combination of technology should be obtainable within the value range shown in the plot. It is also evident from the data obtained from the industries that only few values of index for products were available at limited imported and indigenous technology. The unknown value of indexes at different combinations of technology density can easily be visualized from the graph shown in Figure 9. Therefore. Equation 5 and graph 10, provides the user with a very useful predictive tool for estimating density of imported and indigenous technology to enhance the value added process of agro processing SMEs.

Using Equation 5, the agro processing SMEs should be able to select the values of imported and indigenous technology needed to achieve their strategic value addition process in order to increase the total productivity. Thus, Equation 5 and die 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 and 3-D graph shown in Figure 9 are important tools for both agro-processing SMEs and government bodies as well.

8 Concluding remarks

The base economy of Bangladesh is gradually changing from agricultural to industrial. In this process of transformation one of the major catalysts is the small and medium enterprises- As the speed of transformation is expected to accelerate further it would be wise to examine the policy issues that may influence the process. Since the study suggests low level of indigenous technology in use in the SMEs particularly in the Agri-business sector of Bangladesh adoption of early government measure in this respect is essential. The most interesting finding of the study is that total dependence on foreign technology will hinder our professed goal of self reliance and ultimately will reduce productivity. In fact, the study shows that a mix of foreign and hefty share of local technology add more value to the output of the production process.

Those who profess overnight adoption of foreign technology discarding indigenous one may find the study results quite intriguing. The optimum mix of technology can contribute to speed up industrial growth, is well as increase the diffusion and absorption of foreign technology with the local one.

The importance of science and technology has been amply identified in the study as the major contributor to technological development in Agro-SMEs which is at present dominated by foreign technology (80%).