An Empirical Analysis to Identify the Technology Adaptation Gaps in Cluster of Glass Products in West Bengal

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***Abstract*—**The focus of this paper is to identify different barriers of technology adaptation in clusters of Micro, Small and Medium Enterprises (MSMEs) of Glass Products in West Bengal through productivity based efficiency analysis and policy intervention to address it. In spite of globalization and economic liberalization the manufacturing sector of Indian MSMEs is still using the traditional technology (almost 85% - 90%) comparing to efficient one as per different MSME census. The present MSME policies and studies are not directly emphasizing intra-cluster dynamics of a cluster related to technology adaptation. The bench marking method used here will address productivity based intra-cluster dynamics to identify the barriers. West Bengal is one of the major players of India in terms of number of MSMEs and employment generation in this sector and we have considered the cluster of Glass Products as a model. Our empirical model shows how to identify the different parameters for non-adapting the technologies of this cluster. The same model can be used for different other manufacturing cluster of MSMEs.

***Keywords*—**Clusters; Efficiency Analysis; Glassware and Glass Products; Micro Small and Medium Enterprises (MSMEs); Probit Model; Productivity.

***Abbreviations*—**Data Envelopment Analysis (DEA); Micro Small and Medium Enterprises (MSMEs).

I. INTRODUCTION

THE importance of Micro Small and Medium Enterprises (MSMEs) in the social and economic development of the nation is well established. The MSME sectors are the nursery of entrepreneurship and are driven by innovation and steered by the entrepreneur's creativity towards products, process implementation strategy. As per the report MSME sectors contribute nearly about 8% of the country's GDP, 40% of its exports, and 45% of the production and manufactured output. In India, the MSME sectors provide employment to about 60 million people through 26 million enterprises [7]. In fact, Small and Medium Enterprises (SMEs) contribute about 90% of the business around the world [Subramanyam & Reddy, 12]. So it is equally important in global economy. Generally, different study says SMEs employ nearly 50% of the world's workforce. Employment per one lakh rupees investment in MSMEs is 1.39 is higher in comparison to big industries i.e. 0.2 [Biswas & Chakrabarti, 2]. SMEs have played a crucial role in the manufacturing and export sectors of South-East Asia e.g. Thailand, China, Sri Lanka, Egypt, Indonesia, and Vietnam. In India, MSMEs play a significant role in the sectors of service, agriculture and industry. One of major critical factor that affects the growth of MSMEs is technology. The growth and development of MSMEs leads to economic prosperity as these contribute to the Gross Development Product. According to MSME census units of MSMEs are using four different source of technology i.e. foreign, domestic collaborating company/unit and domestic R&D institutions/specialized agency/organization. It is difficult for the MSMEs to invest in the research and development activities and it is also not possible for them to acquire the latest and most-modern technologies that are available in the global market due to high costs and other factors. In fact, study says that 85-90% MSMEs in India are using traditional technology for production [Biswas et al., 3] even after post liberalization. Even so, it is heartening that Micro Small and Medium Enterprises are adopting various best international practices and policies in order to enhance their competitiveness in both domestic and global market [Harper, 8] marginally. Holmstrom [9] argues that Bangalore's major industries are in electronics and engineering related activities. Most of the country's leading telecommunications enterprises such as Indian Telephone Industries are Bangalore-based. The easy availability of affordable and technically-qualified personnel and highly skilled labor will remain an important element in

international competitiveness of Bangalore in the knowledge intensive sectors. Rapid technical development has been an important feature of Bangalore's industrial landscape. Wade [15] states that Bangalore has become a significant international location for leading TNCs such as Philips, IBM, Hewlett Packard, Motorola, 3M, Novell, Texas Instruments, British Aerospace which either set up the units of joint venture with Indian partners or have their own facilities. It is essential for the government to undertake massive efforts and provide incentives and technical support to MSMEs in their endeavour of latest / modern technology acquisition, innovation, up- gradation, and adaptation [7]. In spite of presence of different policies on incentives on capital most of the MSMEs are not benefited from the schemes for different reasons. Our study will try to analyse empirically the intra-cluster dynamics to find out the reason of barriers for technology adaptation. The model can be replicated for the other cluster of MSMEs. As per MSME Fourth Census [10] West Bengal holds 12th Rank in terms of number of MSME Clusters.

II. RELATED WORK

The MSMEs face a lot of issues with respect to access to capital, market, skill, technology, and access to bank credit etc. These problems are quite unique to the sector's nature. Access to timely and adequate credit at reasonable cost is considered to be the most critical issue faced by the MSME sector. In the global environment, it is essential for these enterprises to be competitive in order to survive and thrive. To ensure competitiveness of these enterprises, it is important that there is availability of skilled manpower, and that infrastructure, and technology are highly advanced and competitively modern with respect to global trends [Vasant Desai, 14]. These enterprises are either located and function within the urban areas or else, are located in industrial estates. Sometimes these mushroom in an unorganized manner in rural areas. Therefore, the available infrastructure, including water, roads, and power may be very poor and unreliable. Apart from these, micro small enterprises sectors in India (with some exceptions) are characterized by low technology levels and this may act as a handicap in global markets [Taranand Singh Tarun, 13]. Although India enjoys the benefits of a large manpower pool (human resources), the sector faces continuous challenges in sourcing manpower with right skill sets for particular areas such as marketing, services and manufacturing, etc. Generally, the human resources problems are further worsened by low retention rate. MSME sectors are credited with high level of creativity and innovation, which also have capacity to lead to higher level of failures. Access to equity capital is considered a genuine problem. Generally, absence of equity capital proves to be a major challenge to the development of knowledge-based sectors.

The significance of technology in a production process cannot be denied. It is obvious that generation of new technology demands considerable capital investments. Costly technologies may not be effective for these small units due to large investments, maintenance and lack of skilled labourer. In Indian economy, enterprises operating on a larger scale can adopt sustainable technologies for the benefit of small units. The general practice is that the rich countries would invent superior techniques of production and use them, while enterprises in the poorer countries would import, and adapt these, for local use [Bardhan & Udry, 1]. Even in domestic pattern the R&D labs from privately and Govt. funded generally invent the technologies and transfer it on cost basis. Subsidies on different technology transfer schemes are there to afford the technologies. Unfortunately, in spite all effort technology adoption is meagre in MSMEs. In 1990s enterprise sector was also bifurcated with a significant part reserved for Small Scale Industries (SSI) for their sustainability. After the globalization and economic liberalization, the process of de-reservation of products has been introduced. As a result big industries have been also allowed to enter the sectors reserved for the SSIs. As a result MSMEs faced steep competition to sustain in global economy [Biswas & Chakrabarti, 2]. In unorganized manufacturing sector it was revealed that the units whose sources of finance is informal showing more productivity than whose were from formal source [Biswas & Biswas, 5]. Only surgical cluster in India in Baruipur, West Bengal are facing steep competition due to lack of technology intervention and proper marketing [Biswas & Bandyopadhyay, 4]. In spite of Government intervention the cluster are not able to using common facility centre due to non-availability of right technology. It is obvious that different cluster faces different barriers to adopt new efficient technologies which include sources of finance, availability of technology, skills and other social factors.

III. OBJECTIVE

The main objective of this study to develop a model to productivity analysis and identify the parameter of non-adopting modern technology by the units of the cluster of Glass Products which includes mainly optical glasses etc. in West Bengal. This model may be applied for the other cluster also.

IV. ECONOMETRIC MODEL AND OUTCOMES

4.1. Data Analysis and Data Interpretation

Polkinghorne [11] described that the data analysis and interpretation of data involves a number of closely related operations that are performed with the purpose of summarizing the collected data and organizing these in such a manner that they will yield answer(s) to such research questions or suggest hypothesis or questions if no such questions or hypothesis had initiated the study. Similarly Onwuegbuzie & Teddlie [6] have noted that the analysis and interpretation of data involves the objective material in the possession of the researcher and his subjective reaction and desires to derive from the data the inherent meaning in their

relation to the problem. To avoid making conclusions of interpretation from insufficient data or invalid data the final analysis must be anticipated in detail when plans are being made for collecting information.

We have collected the data from the MSME cluster of Glass Products. The cluster is situated in Howrah District of West Bengal. We have collected data from 42 units of the cluster.

4.2. Statistical Tools Employed

This study employs quite a few statistical tools to analyze the primary data collected. These are:

i. Graphical method
ii. Cobb-Douglas Production Function
iii. Data Envelopment Analysis
iv. Probit Model

4.2.1. Graphical Method

The process of representing the gathered data in the form of figures or visual form is referred to as graphical method. There are several graphical representation forms such as bar charts, histograms, scatter figures and pie charts in this study.

4.2.2. Productivity of the Cluster

The Responsiveness of output due to change in capital and labour has been measured. Cobb-Douglas production function has been used to measure the output elasticity of capital and labour. The analysis will help to understand that scaling up will increase the productivity or not.

For the measurement of productivity and returns to scale among the MSMEs, we use a simple Cobb-Douglas production function of the following form.

$$Q = A.K\alpha L\beta$$

$$\text{Log e } Q = \text{Log e } A + \alpha \text{ log e } K + \beta \text{ log e } L$$

The symbols have their usual meanings. If $\alpha + \beta$ exceeds 1, it is a case of increasing returns to scale (IRS). It is considered as constant returns to scale (CRS) if the sum is equal to 1 and diminishing return to scale (DRS) if less than 1.

4.2.3. Efficiency of Cluster Unit

How efficiently the cluster units were using the factors of production. This was observed through Data Envelope Analysis (DEA) which allows comparison of the relative performance of the units through benchmarking method. This will also help to segregate intra-cluster groups of units with similar efficiency.

4.2.4. Factors of Inertia among Stakeholders

Probit Model is one of vividly used the categorical model, in most cases the response is Binary.

Remember that regression is a method of fitting a line to your data to compare the relationship of the response variable or dependent variable (Y) to the independent variable (X).

$$p(Y=0/1) = a + b\,X + e$$

Where

• a =y-intercept • b =the slope of the line • e =error term

A binomial response variable refers to a response variable with only two outcomes.

In this research the collected primary quantitative data were analysed using the following statistical tool.

Up gradation of technology is highly constrained by the inertia of the cluster stakeholders. We want to find out the factors that are inducing the inertia. The basic idea is to know if a stakeholder is reluctant to adapt modern technology then what are the significant factors that are inducing the inertia of that stakeholder.

On the basis of our primary survey through structured Questionnaire we have formulated a Probit model to determine the magnitude and direction contributory factors.

4.3. Software Tool Used

The statistical tools were implemented with the help of the following software:

4.3.1. Microsoft Excel

In this study the Microsoft Excel was used to create graphs for the calculated percentages from the gathered primary data.

4.3.2. R-Studio

R-Studio is the business analytics software acronym for Statistical Package for different analysis. It is a famous statistical program used in different scientific disciplines. Almost all types of data analysis and management can be handled well with R- Studio. Using R-Studio the user can make graphs, manipulate data and perform statistical techniques varying from means to regression.

V. ANALYSIS AND OUTCOMES

Table 1: Weighted Average Output

Cluster	Sample Units	Output (Rs. lacs)	Capital (Rs. lacs)	Labour	l/k*	Weighted Average O/P
Glassware	42	955	395	287	0.727	1.52
*l/k <- Labour usage for every 1 lacs of capital (if l/k<1<-Capital Intensive, l/k>1<-labour intensive); Weight (l/k) is used for for calculating average output (O/P)						

The above chart shows glass product manufacturing cluster is capital intensive.

Table 2: Descriptive Statistics (Capital, Labour, Gross Output)

Glass Products	Sample	Parameter	Min	Mean	Median	Max	Mean Average Deviation	Std Deviation	Std Error
Glassware	42	Output (lacs)	0.014	22.731	1.789	407.924	2.374	68.221	10.527
		Capital (lacs)	0.009	9.395	1.425	161.272	1.742	25.465	3.929
		Labour	1.000	6.833	4.000	50.000	2.965	10.131	1.563

Table 3: Pearson Correlation Matrix

Glassware			
	Output	Capital	Labour
Output	1		
Capital	**0.94**	1	
Labour	0.66	0.69	1

From the correlation matrix we can found that the correlation between output and capital is significantly high for Glass manufacturing cluster where the processes are more capital intensive.

Table 4: Estimated Coefficient

3	Model	Estimated Coefficients		t	Sig.	Adj R^2
		Elasticity	Std. Error			
Glass Products	(Constant)	0.60	0.41	-1.23	0.2246	0.69
	Capital (Lacs)	0.58	0.12	4.88	0.0000	
	Labor	0.79	0.28	2.80	0.0080	

From the results it is clear that all the output elasticity for capital and labour are significant for the clusters.

Table 5: Determination of Returns to Scale Overall Cluster

Cluster	Cobb Douglas Function (Y)	β_k	β_l	$\beta_k+\beta_l$	Scale
Glass Products	$0.60K^{0.58}L^{0.79}$	0.58	0.79	1.37	IRS
*β_l and β_k are the output elasticity of labour and capital respectively; IRS is Increasing return to Scale					

The Cluster is running under Increasing Return to Scale.

Table 6: Variance Inflation Factors (VIF)

Cluster	VIF (K or L)
Glass Products	1.86

Multi co-linearity among the inputs was checked by analysing the Variance Inflation Factors (VIF) of the model. Rule of thumb for analysing VIF: If VIF<5, very low degree of co-linearity present between the explanatory variables. This proves the model is valid.

Table 6: Hypothesis Testing

Cluster	Calculated F Statistics	df1	df2	Tabulated F Statistics	Null Hypothesis
Glass Products	46.81	2	39	3.41	Rejected

H0=ln(α)=βk= βl=0 (linearization of the model is not significant)

H1=not all coefficients are simultaneously zero, i.e., model is statistically significant.

The tabulated statistics is being obtained at 5 % level of significance. From the above table it can be unambiguously concluded that the Null Hypothesis is rejected for all the clusters as well the as the overall level at 5% level of Significance.

In this study two sources of technology are used for Analysis. They are the following:

- Others (Outsourced from abroad, domestic collaboration and domestic R&D)
- Primitive (Indigenous technology used)

Table 7: Determination of Returns to Scale according to Sources of Technology

Cluster	Technology Source	Model	Estimated Coefficients		t	Sig.	Adj R^2
			Elasticity	Std. Error			
		Labor	1.20	0.48	2.52	0.0215	
Glass Products	Traditional	(Constant)	0.45	0.47	-1.69	0.1019	0.71
		Capital (Lacs)	0.50	0.13	3.77	0.0007	
		Labor	0.98	0.34	2.85	0.0078	
	Others	(Constant)	1.45	1.24	0.30	0.7783	0.37
		Capital (Lacs)	0.86	0.39	2.20	0.0792	
		Labor	0.28	0.61	0.46	0.6678	

Table 8: Determination of Returns to Scale Sources of Technology Wise

Cluster	Tech Source	Cobb Douglas Function	β_k	β_l	$\beta_k+\beta_l$	Scale
Glass Products	Traditional	$0.45K^{0.50}L^{0.98}$	0.5	0.98	1.48	IRS
	Other	$1.45K^{0.86}L^{0.28}$	0.86	0.28	1.14	IRS

All units irrespective of sources of technology are running under increasing returns to scale. Only output elasticity of capital for the units who are using other technology source is higher than the capital.

Table 9: Variance Inflation Factors (VIF) according to Sources of Technology

Cluster	Tech Source	VIF (K or L)
Glass Products	Traditional	2.15
	Others	1.09

No multi co-linearity persists. Rule of thumb for analysing VIF: If VIF<5, very low degree of co-linearity present between the explanatory variables.

Table 10: Hypothesis Testing

Cluster	Tech Source	Calculated F Statistics	df1	df2	Tabulated F Statistics	
Glassware	Traditional	40.80	2	31	3.27	Rejected
	Others	3.09	2	5	5.79	Accepted

H0=ln(α)=βk= βl=0 (linearization of the model is not significant)

H1=not all coefficients are simultaneously zero, i.e., model is statistically significant.

For the other sources of technology null hypothesis is accepted.

5.1. Data Envelope Analysis (DEA) for Efficiency Measurement of the Units of the Cluster

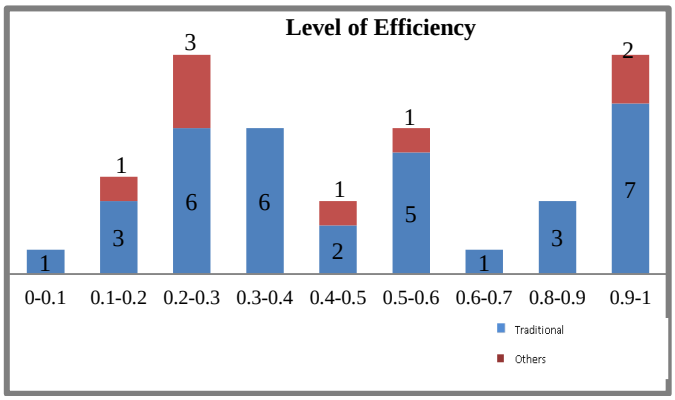

Figure 1: Efficiency Measurement of Glass Products Cluster

In this cluster, out of 42 units only 9 units are working at the efficient level, i.e., 21% of the firms are efficiently utilising the inputs. Among those, only 22% are using outsourced technology. On the other hand, the productivity is higher for Traditional technology when compared to the outsourced technology.

5.2. Probit Model to Calculate the Factors of Inertia

The idea behind this model is to identify the factors behind the inertia of transition among the stake holders in adaption of modern technology.

The basic model formulated is as follows:

P(Tech_Soucre=0|1) ~ f(anci_unit, woman_ent, power_src, emp_total, gop_200102, mkt_val_fa, acc_exist, comp_exist)

5.3. Variable Description (Abbreviation used for Calculation)

Anci_unit<- whether the unit is an ancillary or not (YES=1, NO=2)

Women_ent<-Whether the unit is a Women or not (YES=1, NO=2)

Power_src<- which power source is being used (No energy required=1; Coal, Traditional Energy, Firewood=2; Oil, LPG, Electricity=3)

emp_total<- Labour used

GOP_201112<- Gross output for 2011-12

Mkt_val_fa<- Market value of fixed capital

Acc_exist <- Whether any balance sheet for transaction is managed or not (YES=1, NO=2)

comp_exist<- Whether computer is used in the unit (YES=1, NO=2)

By different iteration in accordance with AIC criteria it was found that four factors significantly affect the inertia for transition towards adaption of modern technology. The results for each cluster are shown below:

Table 11: Akaike Information Criterion (AIC)

	Model Selection : AIC Value	
Cluster	All Variable	Selected Variable
Glassware	47.78	34.30

The best fitted model is determined by minimum Akaike Information Criterion (AIC) for a given combination of factors. By different iteration in accordance with AIC criteria it was found that four factors significantly affect the inertia for transition towards adaption of modern technology. The results for each cluster are shown in the next level.

Table 12: Estimated Coefficient of the Cluster

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-1.3885	0.8574	-1.62	0.105
COMP_EXIST	0.7223	0.9641	0.749	0.454
ACC_EXIST	-0.3121	0.7045	-0.443	0.658
Output_std	1.697	1.5109	1.123	0.261

5.4. Model Validation

Table 13: Durbin-Watson Test or D-W Test

lag	Autocorrelation	D-W Statistic	p-value
1	-0.25294	2.486491	0.216

Null Hypothesis
H0: Disturbances are uncorrelated
H1: Disturbances are correlated

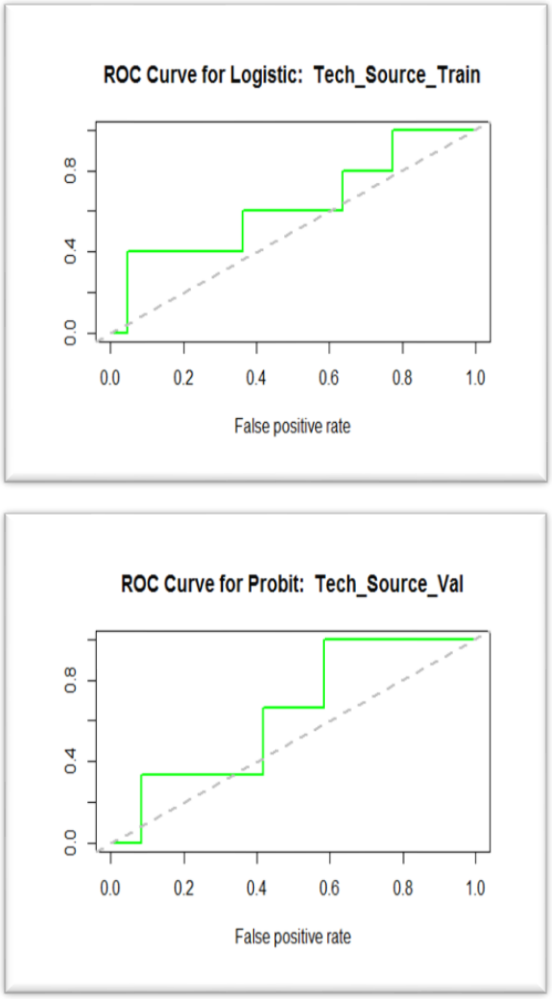

Figure 2: Receiver Operating Characteristics (ROC) Curve for Model Validation Training (Train) and Validation (Val) Set

Table 14: The Area Under Curve (AUC)

Set	AUC
Validation	0.64
Training	0.71

The Area Under Curve (AUC) shown in yellow from the grey line the show how well the Binary Classification has made by the model.

VI. Conclusion

The cluster is operating in Increasing Returns to Scale (IRS) which in turn implies that a proportionate raise in one of the input will leads to increase in output more than that.

It can also be said that the trend is responsive of output due to change in labour will be higher than change in capital for the units those who are using traditional source of technology.

The output elasticity of capital significantly higher for all the clusters which indicate a high demand for labour among all the clusters.

The demand for capital Glassware is higher for the units who are using other source of technology.

The results indicate that the average efficiency of units where technology is being outsourced is higher than the units using primitive technology.

This might indicates that the technology is inadequate for this cluster as from the scale determination we have observed that the cluster is operating in IRS, i.e., introduction of appropriate technology will raise the productivity that in turn will increase the output of the cluster.

The units in Glassware which have maintained their balance sheet has a higher inertia towards not accepting the modern Technology.

The units having higher output have less inertia in accepting modern technology across the cluster.

Existence of Computer has a mixed effect in different types of cluster in Glassware the presence of computer will reduce the inertia of adapting new technology.

VII. Limitation of the Research

Samples are selected from Cluster of registered manufacturing MSME Units. Service sectors are not included.

Unregistered units are also not included here. But the generic model can be used for other cluster also.

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