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A MULTIVARIATE REGRESSION MODEL FOR PREDICTING PRODUCTIVITY IN POTTERY INDUSTRY: CASE STUDY OF JALPAIGURI DISTRICT, WEST BENGAL

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Abstract

Pottery is one of the most ancient and popular form of Indian village craft. In a predominantly rural country with a very low income, pottery plays an important role to provide subsistence to people. Besides providing employment to artisans, the sector offers job opportunities to non-artisans during slack seasons of agriculture and to other tertiary sector employees. An overwhelming majority of the pottery industrial units is found in Jalpaiguri district, in the state of West Bengal. These are mostly concentrated in rural areas. The competition from the substitutes like plastic items is a major problem for the development of this sector. The study is based on data collected through field survey from 67 sample units covering 30 villages of the district. The purpose of the study is to examine the relationship among the identified factors related to productivity of pottery and make predictions for the development of this industry in the study area. Multiple regression model is used in the present study with a set of eight independent variables. Based on the analysis some policy measures are suggested for the development of the said sector.

Introduction

Pottery is one of the most ancient and popular form of Indian village craft. The services of the potter are indispensable to the rural folk and to a smaller extent to the urban population. Hence, in a predominantly rural country with a very low income and simple needs, pottery plays an important role (Meena et. al., 2005). Besides providing employment to artisans, the sector offers job opportunities to non-artisans during slack seasons of agriculture and to other tertiary sector employees.

A large number of pottery units are found in Jalpaiguri district, in the state of West Bengal. These are mostly concentrated in rural areas. Traditional in nature, the industrial activities are carried on household basis and are characterized by low technology and low levels of production (Kasemi, 2011). The artisan himself is the proprietor and works on his own initiative and with his own capital. As scientific and technical knowledge is lacking due to illiteracy and poverty, the techniques of production remain inferior and the products lack standardisation. The market of the products is mainly local and partly extended to urban areas. Besides, middlemen play a powerful role in marketing these indigenous products. They usually place order with the artisan and collect materials at less rate than the market price. The competition from the substitutes like plastic items is a major problem for its development (Lakhsman, 1966).

Productivity simply indicates the relation between the value-added (VA) or the quantity supplied and the inputs of production. Every incremental increase in productivity implies increased value-generation (value-added) with regard to inputs (Gurak, 1999). It is an involved process accounted for the actions and reactions of numerous social and economic factors or operators. Some of these operators directly determine the above mentioned process while some others operate indirectly. These factors are again closely interconnected with one another and a change in one is reciprocated by the others (Sao, 2009). Multiple regression provides a mean of objectively assessing the degree and character of the relationship among these factors forming the variate of independent variables and then examining the magnitude, sign and statistical significance of the regression coefficient for each independent variable (Rubenfield, 2011).

Objectives

The main objectives of the study are:

- To examine the relationship among the identified factors related to productivity of pottery industry.
- To make predictions for the growth and development of the industry.
- To suggest some policy measures for the development of the industry.

Study Area

The district Jalpaiguri is located between 23°16' N to 27°00' N latitude and between 88°04' E to 89°53' E longitudes covering an area of 6227 km2 (Fig.1). The district is bounded in the north by Darjiling district and Bhutan, in the east by Assam, in the south by Bangladesh and Koch Bihar district, in the west by parts of Bangladesh and Darjiling district. As per the Census 2011, the district had a population of 3,869,675 of which male and female were 1,980,068 and 1,889,607 respectively. Average literacy rate of the district is 73.25 per cent. The economy is chiefly agrarian although the industrial belt is gradually attempting to expand its periphery. The sprawling tea gardens of the district constitute the chief asset of this district. Other major agrarian products of the district like jute, paddy, potato, etc. also make a significant contribution to the district's revenue pool. Good proportion of rural industries like pottery, bamboo-work, cane-work, blacksmithy, rope-making etc. are found in the district which have been developed depending on the locally available natural resources. These industries are means of livelihood of a large number of rural people of the district.

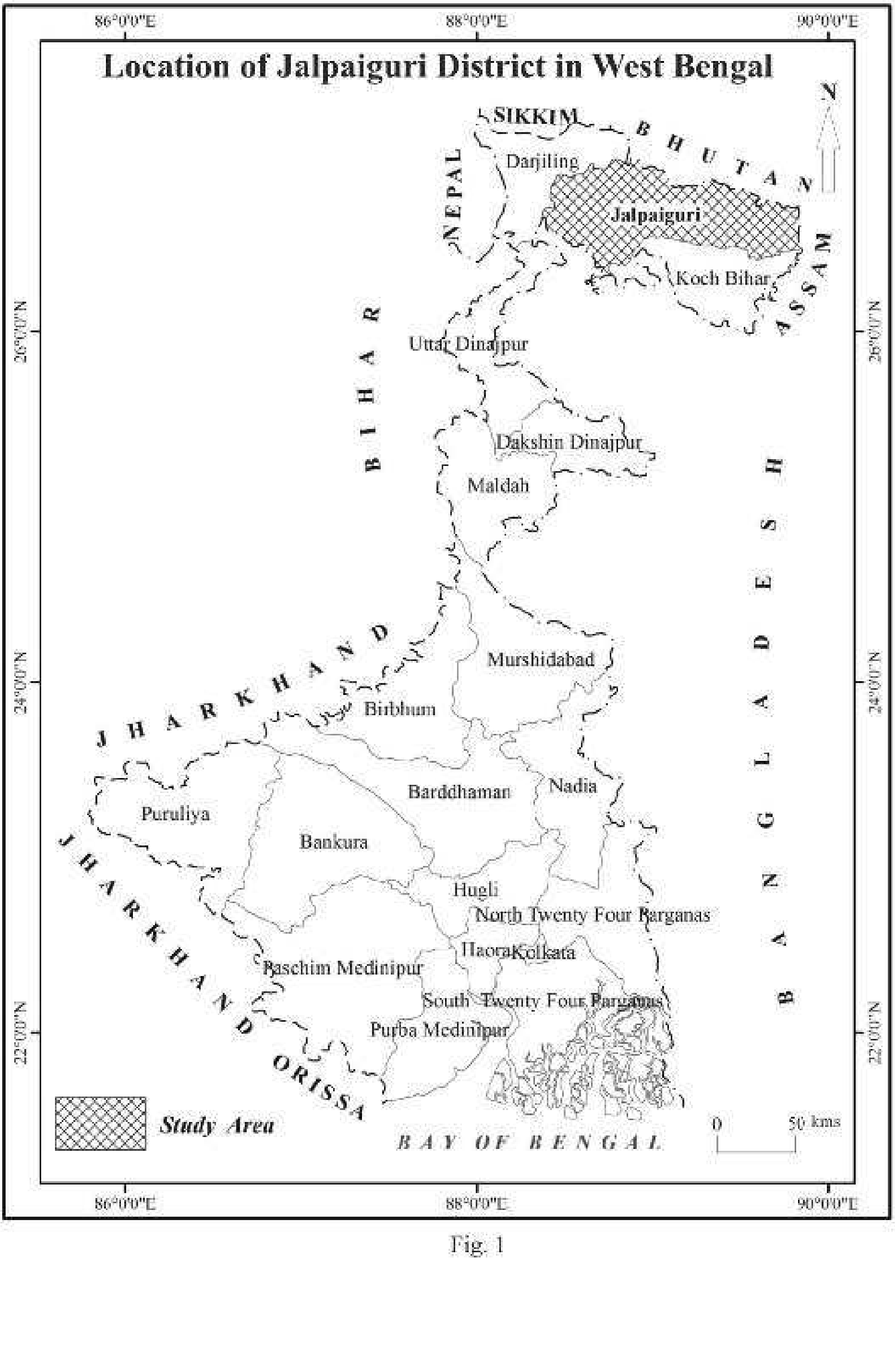
Database

The present study is based on primary survey, designed to collect data on the general and economic performances of the pottery industry. 67 sample units have been selected from 30 villages located in 13 Community Development Blocks of the district. Simple random sampling method has been adopted for the present investigation. The sampling has been done with the help of random number table (Random Sampling Number arranged by Tippet).

Methodology

Productivity of pottery industry comprises of several interdependent subsystems each involving several variables or factors. Multiple regression model is used in the present study to predict productivity (dependent variable) of pottery industry. In the process of estimating the model, several factors related to it are identified as model variables (Mishra, 1980).

Multiple regression analysis, a form of general linear modelling, is a multivariate


86°0'0"E
88°0'0"E
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Location of Jalpaiguri District in West Bengal
N
SIKKIM
BHUTAN
NEPAL
Darjiling
Jalpaiguri
ASSAM
Koch Bihar
BIHAR
Uttar Dinajpur
Dakshin Dinajpur
Maldah
BANGLADESH
JHARKHAND
Murshidabad
Birbhum
Barddhaman
Nadia
Puruliya
Bankura
Hugli
North Twenty Four Parganas
Haora
Kolkata
Paschim Medinipur
South Twenty Four Parganas
Purba Medinipur
ORISSA
Study Area
BAY OF BENGAL
0
50 kms
26°0'0"N
24°0'0"N
22°0'0"N

Fig. 1

statistical technique used to examine the relationship between a single dependent variable and a set of independent variables. Each independent variable is weighted by the regression procedure to ensure maximal prediction from the set of independent variables. The weights denote the relative contribution of the independent variables to the overall prediction and facilitate interpretation as to the influence of each variable in making the prediction, although correlations among the independent variables complicate the interpretative process. The set of weighted independent variables forms the regression variate, a linear combination of independent variables that best predicts the dependent variable. The regression variate, also referred to as the regression equation or regression model, is the most widely known example of a variate among the multivariate techniques (Hair et al., 2009). In the present regression model, productivity of pottery industry is the dependent variable. Eight parameters like standard mandays, duration of daily hours of operation, experience, and educational level of the workers etc. have been identified as the predictors.

Based on the computed data collected from field survey the model has been constructed using statistical software SPSS-17. The method of least square has been used to estimate the equation.

Variables of the Model

The mechanism of productivity in pottery industry is a very complicated process in which a large number of socio-economic and physical factors act and react with each other. These factors are identified as variables of the model and are symbolically expressed as follows:

- Y Productivity per unit (defined by total revenue from sale minus cost of goods and services bought) in Rs.
- X_1 Standard mandays is defined as total man-hours worked per unit / 8 (taking as standard shift hour)
- X_2 Duration of daily working in hours
- X_3 Value of working capital in Rs.
- X_4 Age of the workers in years (in code taking a 5 point scale (1-5)
- X_5 Experience level of the workers (in code taking a 3 point scale (1-3)
- X_6 Educational level of the workers (in code taking a 5 point scale (0-4)
- X_7 Percentage of finished products sold to customers
- X_8 Percentage of finished products sold to middlemen

Model Fit and Anova

From Table 1 the coefficient of determination (R^2) value is found to be 0.922. It reveals that 92.2 per cent of the variability of the independent variables is accounted for by the model. Since this R-squared value is very high (close to 1) the regression model appears to be very useful. As with simple regression, it is necessary to look the p-value of the F-test to see if the overall model is significant. From the Anova (Table 2), p-value (0.000) is found to be less than the chosen alpha level of 0.05, which indicates a good fit of the overall model. In other words, it can be said that the model is statistically significant and all the independent variables have relationship and reliably predict the independent variable.

Discussion

The unstandardized coefficients (Table 3) yield the prediction equation which may be estimated as:

$$Y \text{ predicted} = 4961.604(\text{constant}) + 62.914X_1 - 138.601X_2 + 13.040X_3 + 52.341X_4 + 95.942X_5 + 126.626X_6 + 46.253X_7 - 231.751X_8$$

The estimate reveals the amount of increase in productivity that would be predicted by 1 unit increase in the predictor. It can be

Table1: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.926	.922	.921	1064.63169

a. Predictors: (Constant), X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8

b. Dependent Variable: Y

Table 2: Anova

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	7.904E9	8	9.880E8	871.650	.000[a]
Residual	6.574E7	58	1133440.629	-	-
Total	7.969E9	66	-	-	-

a. Predictors: (Constant), X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8

b. Dependent Variable: Y

Table 3: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficient	t	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (constant)	4961.604	622.699		7.968	.000	3715.135	6208.072
X_1	62.914	4.091	.750	15.377	.000	54.724	71.103
X_2	-138.601	43.668	-.088	-3.174	.002	-226.013	-51.189
X_3	13.040	14.299	.022	.916	.363	-15.443	41.524
X_4	52.341	39.996	.036	1.309	.196	-27.721	132.402
X_5	95.942	32.741	.094	2.930	.005	30.404	161.480
X_6	126.626	39.018	.098	3.245	.002	48.523	204.729
X_7	46.253	10.657	.099	4.340	.000	24.921	67.584
X_8	-231.751	20.845	-.247	-11.118	.000	-273.476	-190.025

a. Dependent Variable: Y

noted that the independent variables which are not significant, their coefficients are significantly different from 0. The regression model reveals the following features -

(i) The constant value of the equation is found to be 4961.604. It is statistically significant (because its p-value is 0.000, which is smaller than chosen alpha of 0.05), thus making a substantive contribution to the prediction.

(ii) The variable standard mandays (X_1) influenced productivity positively. The coefficient for this variable is 62.914. It tells that for every unit increase in standard mandays, a 62.914 unit increase in productivity is predicted, holding all other variables constant. The coefficient is statistically significant as it is significantly different from 0 if we use alpha of 0.05, because its p-value is 0.000, which is smaller than chosen alpha of 0.05. Table 3 shows that standard mandays (X_1) bears the largest Beta coefficient of 0.750, indicating that this variable has the highest impact on productivity of pottery than the other variables. Thus, a one standard deviation increase in standard mandays leads to 0.750 standard deviation increase in predictive productivity when all other variables in the model held constant.

(iii) Duration of hours of operation (X_2) is negatively related to productivity as revealed by the coefficient of this variable (-138.601). The negative impact of duration of daily hours of operation is surprising because conceptually higher duration of operation always favour larger production which is collectively determined by the size of the unit (in terms of employment) and working capital. So this variable is expected to influence productivity positively. The negative influence may be due to an interaction with the independent variable. However, the coefficient is found to be statistically significantly different from 0, since its p-value (0.000) is less than alpha (0.05). Its negative Beta coefficient of -0.088 indicates that one standard deviation increase of duration of hours of operation leads to -0.088 standard deviation decrease in the dependent variable with all other variables in the model held constant.

(iv) Value of working capital (X_3) is positively related with productivity. It is obvious that productivity is favourably influenced by increase in working capital as higher working capital is required either for purchase of better quality of raw materials resulting into more profitable products or for more production thereby increasing in value added through sales maximization approach. Coefficient value for this variable is 13.040 which is statistically insignificant as it is not significantly different from 0. Its p-value (0.363) is definitely larger than alpha (0.05). Value of working capital (X_3) has the smallest Beta of 0.022 indicating the lowest impact on the predicted variable.

(v) Age of the worker (X_4) has a coefficient value of 52.341 and is positively related with productivity. This is due to the fact that it is customary among younger generation to pick up the skill of operation informally from quite an early age so that with increasing age the workers become more experienced and better skilled. This coefficient is also not statistically significant since it is not significantly different from 0, because its p-value is found to be 0.196, which is larger than chosen alpha of 0.05.

(vi) Experience of the workers (X_5) has favourable influence on productivity. Experienced workers are better skilled and produce better quality products ensuring higher returns per unit of product. Coefficient value for this variable is 95.942. This is statistically significant as its p-value (0.000) is <alpha (0.05).

(vii) Influence of education (X_6) is also found to be favourable on productivity. Favourable influence of this variable may be explained by the fact that the educated workers manage the profession in a better and organised way than the uneducated or less educated workers. However, coefficient for this variable is 126.626 which is statistically significant since its p-value 0.002 is less than alpha (0.05).

(viii) Percentage of finished goods sold to customer (X_7) has increasingly influenced productivity. The positive influence is obvious because retail customers pay higher price than what middlemen pay for the same goods. However, coefficient of this variable is also found to be statistically significant because it is significantly different from 0 and has a p-value of 0.000 which is less than alpha (0.05).

(ix) Coefficient of products sold to middlemen (X_8) is -231.751. This is negatively related to the dependent variable. The adverse impact of this variable may be due to the fact that middlemen always exploit the artisan workers and pay less price than the direct customers (Sao and Chhetri, 2008). Coefficient for this variable is found to be statistically significant since it is significantly different from 0 with a p-value (0.000) which is <alpha (0.05). This variable has a negative Beta coefficient of -0.247 which indicates that a one standard deviation increase in the percentage of goods sold to middlemen leads to 0.247 standard deviation decrease in the predicted productivity with all other variables in the model held constant.

Policy Recommendations

The analysis reveals that standard mandays, hours of daily operation, working capital, experience, and education are important factors which influence the productivity of pottery industry. In order to raise productivity, the basic recommendation therefore, is to provide adequate capital, raw materials, marketing facilities etc. These will obviously increase the standard mandays as well as daily hours of operation.

The development of the sector needs improvement of skill of the artisans through training and education. The experienced and educated entrepreneurs can handle problems more competently (Remi, et al., 2010). They can use the human as well as capital resources more efficiently through division of labour, provision of better working conditions etc. However, the exposure to formal education is imperative as transfer of learning can be better facilitated to make acceptance of innovative techniques. Government, through District Industries Centres (DICs) and other organizations should make comprehensive policy plan for such training, technical support and education. Workshops and training programmes can be organised in different blocks or at least in the clusters for the benefits of the workers. The provision of raw materials to the whole lot of artisans, dispersed over wide areas, is not in tune with the requirements. The wide dispersal of the artisans and their weak financial position necessitates that their small requirements of raw materials need to be made available at the needed time and at their doorsteps. As such it is recommended that a common organisation should handle the raw material problems at the block and district levels. There is an immediate need for the organisation of cooperative societies on the ground that they will take up the issue of supply of raw materials, purchase of finished goods from the artisans, marketing and provision of credits (Bhattacharya, 1980). For this purpose, cooperative societies should be given adequate financial assistance by the government. Establishment of such societies will free the artisans from the clutches of middlemen who always squeeze profit. Since inadequate capital is a problem of the sector, loans should be provided to the entrepreneurs. Co-operative banks, commercial banks and rural banks can play an important role in this connection.

Conclusions

The analysis reveals that productivity of the pottery industry is determined by several socio-economic factors. The multiple linear regression model has provided insight into the relationships among the variables in the prediction of the dependent measure. All the variables positively influenced the productivity of the pottery industry except variables like duration of daily hours of operation (X2) and percentage of goods sold to middlemen (X8). Among all the variables standard mandays (X1) has the highest impact on productivity while value of working capital (X3) has lowest as revealed by their respective Beta coefficients. The results reiterate that the factors such as standard mandays (X1), experience (X5), education (X6), products sold to customer (X7) and percentage of goods sold to middlemen (X8) are the significant predictors of productivity of pottery industry in the study area. It is therefore, necessary to realize the suggested policy measures so that value of predictors may increase sufficiently, because an increase of predictors ensures the increase of productivity.

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