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RESEARCH PAPER

Factors Responsible for Inventory Turnover at Traditional Red Brick Kilns of Sindh, Pakistan

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ABSTRACT

This research is about finding impact of different factors / costs on overall inventory turnover at a traditional and manual red brick kiln of Sindh. After noting shortage of bricks in target area it was need of the time to conduct such study. Inventory is stock of bricks that are manufactured at kilns. Inventory turnover ratio tells about the sales skill of the kiln management. It tells about times brick inventory is sold. Higher ratio is better. The main product inventory is red brick. Sample includes random 90 kilns sub divided into small, medium and large sizes. Research is applied, with questionnaire form and survey technique used. Kiln Inventory model is simple multiple linear regression model. SPSS is used. Variables are inventory turnover (Y variable), clay order size, clay orders, fuel order size , fuel orders ,holding cost and ordering cost. Production of average bricks is 230429, 2465477 and 7147059 bricks for small, medium and large kilns respectively. Inventory turnover ratio is 10 , 9.6 and 8.7 for small, medium and large kilns respectively. SPSS results tell that model used is valid with adjusted R^2 of 0.473. All variables are significant (except one). Strongest beta/coefficient of the model is that of 'holding cost' of inventory. Clay orders (Quantity) has negative insignificant impact on the Inventory Turnover at an average kiln. Intercept tells that if all dependent variables are zero still kilns will turn over (i.e. sale) inventory 4.8 times (±1.7). Clay Orders and clay order size have both negative relationships with Inventory T.O. kiln should purchase to minimize inventory costs such as holding costs and ordering costs . Clay economic order quantity should be (EOQ) 131, 558 and 1099 maunds for small, medium and large kilns. Fuel economic order quantity should be (EOQ) 55, 1491 and 3869 maunds for small, medium and large kilns**.** Turnover is biggest for small kilns so should be taxed less.

KEYWORDS Inventory, Inventory Turnover, Red Brick, Kilns

Introduction

Inventory is stock of bricks that are manufactured at kilns. This research is about finding impact of different factors / costs on overall inventory turnover at a traditional and manual red brick kilns of Sindh. This ratio tells about the sales skill of the kiln management. It tells about times brick inventory is sold. Higher ratio is better.

Clay is main ingredient for the manufacturing of the bricks at kiln. Average clay delivery time from supplier is 3 days. Tractor trolleys are used to bring clay at kiln site. Clay is acquired from local area either via contract or retail.

Fuel is the most important cost at kilns especially for small size kilns. Good quality fuel decreases amount of Bhelli (Inferior) bricks. Fuel used at kilns is of two types. Special fuel is required to start initial fire at the kiln at the start of each chakar (Cycle)or sustain fire for long time in a chakar(Cycle).

Holding Cost is carrying cost. It includes cost of storage, rent, electricity, depreciation, spoilage, theft, interest, insurance, and taxes in a year. There is no spoilage cost for fuel, except theft.

Ordering cost is logistical cost. These are costs for purchasing a clay/fuel order. It may include One Phone cost, Unloading of clay (labour), Clay Transport cost, etc.

Demographically there is no North Sindh officially. It is for the convenience that such demographic distribution is used here in this research. There are many districts of the North Sindh. But for this research only three districts are chosen i.e. Khairpur, Sukkur, and Larkana. North Sindh traditional kilns are divided into three categories by scholar based on production level , infrastructure, land area and annual operating time i.e. small, medium and large kilns. Production of average bricks is 230429, 2465477 and 7147059 bricks for small, medium and large kilns respectively. Large kilns can produce 15 Million bricks in a year. Average acreage is 1, 3.5 and 5.5 acres for small, medium and large kilns. On the average there are 21, 49 and 108 laborers at small, medium and large kilns respectively. 35 kilns don't produce bricks in winter season as it is difficult to dry and demand is also low. Net profit is 281808, 3647403 and 14908971 Rs for small, medium and large kilns as calculated in income statement.

This simple multiple linear kiln inventory regression model tells about factors affecting inventory turnover at a kiln. Variables are inventory turnover (Ratio), Clay order size, Clay orders, Fuel order size , Fuel orders ,Holding cost and Ordering cost

Inventory Turnover: It is Y variable in the model.. Inventory is stock of bricks that are manufactured at kilns. This ratio tells about the sales skill of the kiln management. It tells about times brick inventory is sold. Higher ratio is better.

Beginning Inventory (of Finished goods): It is remaining product from previous year production cycle. B.I of bricks could not be sold in the last year.

Ending Inventory (of Finished goods): Bricks which are no sold at the end of year.

Clay orders and clay order size: Clay is main ingredient for the manufacturing of the bricks at kiln. Average clay delivery time from supplier is 3 days. Tractor trolleys are used to bring clay at kiln site. Clay is acquired from local area either via contract or retail. Through contract procurement of clay kiln managers procure one/two jaraibs of local land on tender or contract. Clay up to 2 to 3 meters is dug up by machines and transported back to kiln for brick making. *Pathan* community is involved in digging and providing clay to kilns. It is not local labour. 62 kilns use contract way of clay procurement.

Fuel orders and order size: Fuel is the most important cost at kilns especially for small size kilns. Good quality fuel decreases amount of Bhelli (Inferior) bricks. Fuel used at kilns is of two types. Special fuel is required to start initial fire at the kiln at the start of each chakar (Cycle)or sustain fire for long time in a chakar(Cycle)

Average (fuel and clay) holding cost :It is carrying cost. It includes cost of storage, rent, electricity, depreciation, spoilage, theft, interest, insurance, and taxes in a year. There is no spoilage cost for fuel, except theft. Holding cost of clay and fuel is calculated separately and averaged in final.

Average (fuel and clay) ordering cost: It is logistical cost. These are costs for purchasing a clay/fuel order. It may include ,One Phone cost , Unloading of clay (labour), Clay Transport cost, etc. Ordering cost of clay and fuel is calculated separately and averaged in final.

Literature Review

Soil is dug to acquire clay for brick making and this cause pits formation. Procurement of clay causes floods in the plains of Nile river around Khartoum. Sometimes this prevents cultivated land to have beneficial sediments being deposited. (Ahmed et al., 2010; Alam, 2006). Brick making is technical process involving many step i.e. procurement, tempering, moulding, drying/loading, firing and sorting. Kilns function at full capacity during December to March. (Palash Patra et al., 2015) Brick is ceramic in nature formed inside fire temperature range of 900-1200^{o}C. Bricks are not burnt properly. Some are highly burnt while some are burnt at low temperature. Inputs for brick making used were dung, wood, clay and labour. Their costs and benefits were calculated separately. From late July to end of September it was considered off season or dry season. While production season starts from October to July each year. And in both seasons input and output change accordingly (Abdalla et al, 2012). Labour, dung fuel, rent and wood fuel costs are 57%, 22%, 6% and 13% of total costs at average kiln.(Abdalla et al, 2012). Fuel used mostly is coal and bricks are used within 25 km radius of the area. high use of fuel causes fire and flames to affect surrounding fertile lands. According to them fuel cost is the largest cost of brick making i.e. around 30-35%. (Palash Patra et al., 2015). Pakistan kilns are less energy efficient and use cheap fuel to make bricks thus there is problem of pollution. (Kaleemullah sheikh et al., Sindh 2020). Red brick is main product and usually cow dung or fire wood is burnt to produce it. Only 2% of the bricks are manufactured by using fossil fuel. This causes urban GHG (Greenhouse gases) problem as low combustion efficiency of used fuels. (Abdalla et al, 2012). Dung was dried and then burnt to find ratio of carbon dioxide and other nitrogenous gases released. (Abdalla et al, 2012). Cow dung can be used both for agricultural and brick making purposes. But around Khartoum it is utilized in brick making process only because it is cheap. (Abdalla et al, 2012)

Research Methodology

After observing shortage of bricks in area, it was the need of the time to check relation between brick inventory sale and kiln operating variables.

Nature of research is applied, restricted to target area and distributed through three years of doctoral thesis process. Population includes 90 kilns of North Sindh. It is sample size. Sampling is non random purposive sampling with focus on the 3 target districts of Sindh, Pakistan. Data is primary and collected by survey of the 90 kilns. Instruments of research include survey and interviews based on questionnaire form. Results are valid / reliable with literature and overall doctoral thesis results.Data analysis techniques used are regression, ANOVA with hypothesis testing. SPSS statistical software is used.Variables selected are explained further as,

Inventory Turnover: following formulae are used;

Inventory Turnover = COGS/Average Inventory

(Average Inventory = Total Production/2)

COGS= Cost Of Goods Sold

Clay orders and clay order size: Following formulae are used;

Total clay trolleys needed= Total Production/Bricks made from 1 trolley

One trolley's weight of clay (maunds)=(Average weight of brick*bricks made from 1 trolley) /40

Note: Average weight of one brick is in kilograms. There are 40 kilograms in one *maund*.

Maund cost= Biomass rate per trolley/one trolley's clay weight

Annual clay demand= total clay trolleys*one trolley's clay weight

Total clay cost= One trolley clay rate*total clay trolleys needed

Fuel orders and clay order size :Fuel demand and cost for the special fuel is calculated as;

Per *chakar* fuel trolleys= per *chakar* fuel/fuel maunds per trolley

Total fuel trolleys used at kiln = Perchakar fuel trolleys* Number of chakars

Cost of one trolley= *maunds* in trolley* maund cost

Annual fuel demand = per fuel chakar*total chakars

It will be calculated in maunds and kilograms.

Per Brick Fuel used = Annual fuel demand/total production

It will be calculated in maunds and kilograms.

Bricks made per maund of fuel= total production/annual fuel demand

Cost of fuel = Number of fuel trolleys * Cost of one trolleys

Average (fuel and clay) holding cost: Formula for holding cost;

H.C= (Q/2)*H

Q is quantity in an order

H = Sum of All holding Costs /Total production

Holding cost of clay and fuel is calculated separately and averaged in final.

Average (fuel and clay) ordering cost: Formula for ordering cost is as;

O.C. = (D/Q)*S

D is annual clay/fuel demand

S is cost of placing an order. It is usually transport cost of a clay/fuel order.

Ordering cost of clay and fuel is calculated separately and averaged in final.

Kiln inventory model regression: SPSS is used. Simple multiple regression is performed for all six "x" variables with following hypotheses to test. But normality test is performed first of all.

At aggregate level Regression model's overall significance is tested

H_0: $\beta_1 = 0$, $\beta_2 = 0$... $\beta_6 = 0$ (i.e. there is no relation between x and y variables at all)

H_1: $\neq 0$ (It means at least one of the "x" variables shows a relation with dependent variable.)

At individual level following testable hypotheses are formed

H_1: Clay orders (Quantity) at kiln has sufficient impact on overall inventory turnover.

H_2: Clay order size at kiln has sufficient impact on overall inventory turnover.

H_3: Fuel orders (Quantity) at kiln has sufficient impact on overall inventory turnover.

H_4: Fuel order size at kiln has sufficient impact on overall inventory turnover.

H_5: Average holding cost at kiln has sufficient impact on overall inventory turnover.

H_6: Average ordering cost at kiln has sufficient impact on overall inventory turnover.

Results and Discussion

Inventory Turnover

Beginning inventory of Bricks (i.e. last year's unsold brick quantity): Following results were achieved when quantity of unsold bricks of last year was asked. BI for small kilns is 23571 bricks, for medium kilns is 167714 bricks and 196382 bricks. For district khairpur BI is 177121 bricks, for Larkana is 58200 bricks and for Sukkur 127071 bricks.

Ending Inventory of Bricks (i.e. unsold brick quantity in present year): EI for large kilns is 76290 bricks, for medium kilns 32424 bricks and for small 11250 bricks. EI for large khairpur kilns is 42348 bricks, for Larkana kilns is 26000 bricks and for Sukkur kilns is 11250 bricks.

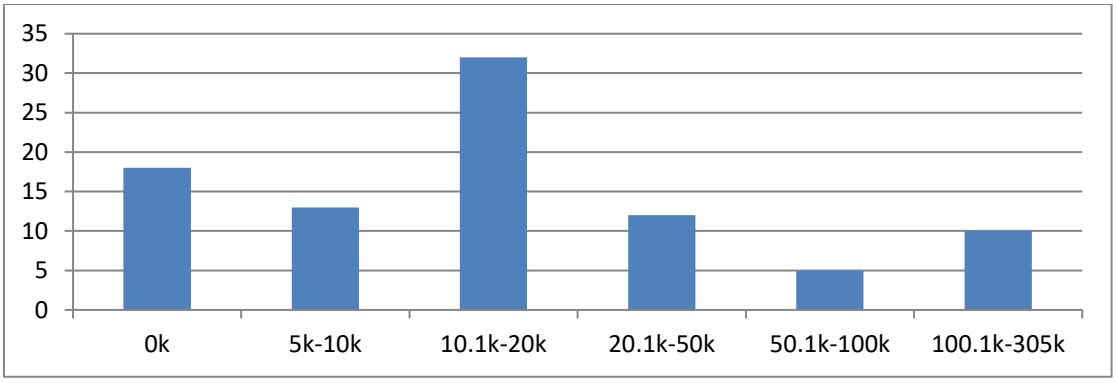

Figure 1: Kilns with levels of ending inventory

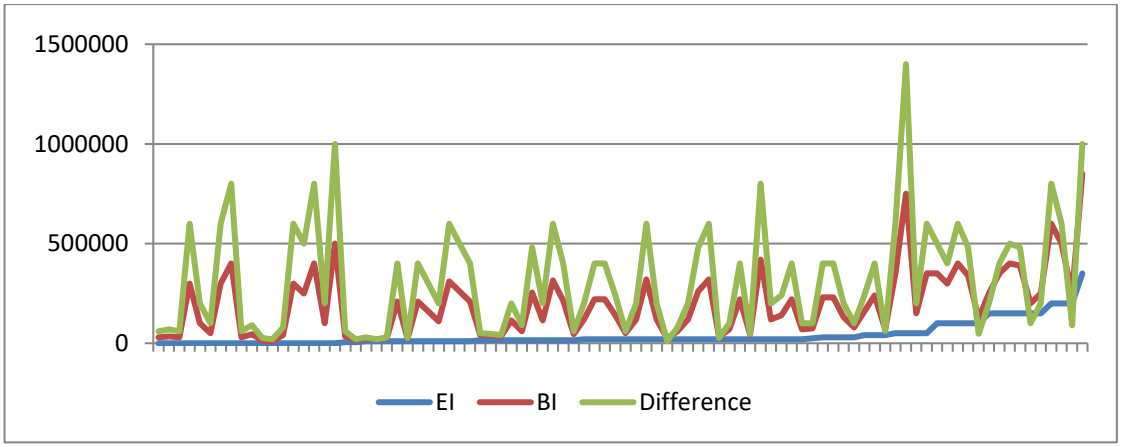

Figure 2: Difference between E.I. and B.I. of the kiln

Efficiency for Inventory usage is as,

Table 1
Efficiency for Inventory usage for 90 kilns

Ending Inventory	200k	150k	100k	300k	40k	25k	20k	5k	10k	30k	15k	50k	0k
efficiency	-0.87	-0.32	-0.16	0.3	0.37	0.5	0.53	0.66	0.68	0.7	0.76	0.77	1
Quantity	3	6	5	1	3	1	22	2	11	4	10	4	18

EI usage efficiency for Khairpur is 57%, for Larkana 60% and for Sukkur 27%. Following district table was generated for three types of the kiln.

Table 2
average inventory and Turnover

Ratio	Large Kiln	Medium Kiln	Small Kiln
Average Inventory	3573529	1232738	115214.3
Turnover	8.7	9.6	10

Main kiln jobs at kiln are molding, drying , carrying .stacking, putting carry, firing and *Nikasi*.

It is important to note that 71 % of the inventory time at medium kiln is associated with main brick essential jobs. 60 % time of large kiln and 66.5% for small kiln.

Table 3
Clay Analysis

Item	large	Medium	small
Clay trolleys	2257.019	841.71	84.71443
Biomass Rate per trolley	320.5882	341.6667	389.2857
One trolley clay weight (weight)	233.375	216.7083	205.7857
Cost of maund	1.424722	1.668306	1.922244
Clay annual demand (Maund)	511654.4	178256	17016.07
Average brick weight (kg)	2.858824	2.890476	2.942857
Bricks made from 1 trolley	3270.588	2995.238	2800

Clay Procurement Analysis is as,

Table 4
Clay Procurement Analysis

Kiln Type	Contract	retail	Total	Retail %
Large	29	4	33	12.12121
Medium	31	11	42	26.19048
Small	2	12	14	85.71429

On the average weight of one brick at large kilns is 2.85kg, medium kilns 2.89kg and 2.94kg for small kilns. Large kilns make 14.11 bricks per maund, medium 13.95 and 13.68 by small kilns. Large kilns make 3.27thousand bricks per trolley, medium 2.99 thousand bricks and 2.8 thousand bricks per trolley by small kilns.

Table 5
Clay usage efficiency

overall average (Bricks made)	Bricks made per maund	efficiency	Kilns Q
13.97	11.11	79.52756	2
13.97	12.12	86.75734	2
13.97	12.5	89.47745	3
13.97	12.9	92.34073	5
13.97	13.33	95.41875	50
13.97	15.38	110.0931	9
13.97	16	114.5311	19

Total clay cost analysis: Transport cost is not added.

Table 6
Total clay cost analysis

Kiln Type	total clay cost (Rupees)	trolleys
Large	726695	2257
Medium	289959	841
Small	31801	84

Clay cost decrease by 50Rs per maund if bought via contract not by retail. 62 kilns buy via contract.

Table 7
Kiln Fuel usage analysis

Item	Large	Medium	Small
Over all fuel cost	12514832.4	3809524	160075
Quantity	38327.3529	12098.93	924.6429
Avg per maund cost	320	319.2857	167.1429
total fuel orders	112.610411	56.85669	26.18129
avgmaund per order	335.882353	313.3333	41.07143
Trolleys	105.875117	54.33288	24.25272
per chakar trolleys	6.9195845	8.229223	7.196939
per chakar fuel	2336.76471	2098.81	243.9286
maund per trolley	335.882353	313.3333	41.07143
Annual fuel demand(Maund)	35988.2353	11500	830.3571
Annual fuel demand(Kg)	1439529.41	460000	33214.29
cost of one trolley	109620.588	103916.7	7064.286
maund fuel per brick	0.00488307	0.004689	0.003804
kg fuel per brick	0.19532267	0.187555	0.152148
bricks per maund	250.175167	262.9234	279.1415
normal fuel cost	11710588.2	3621024	138225

Following is the list of different fuel types used at kilns.

Table 8
Different kiln fuel types

S.No	Fuel description	Fuel type
1	Normal	Fire wood (date palm branches and leaves, cotton wood, etc) (for small kilns)
2	Normal	Dung or manure or *Shena*
3	Normal	Waste (Rubber, plastic shoes etc)
4	Normal	*Tootar* (of rice)
5	Normal	*Furt* (types : mustard /Rai and chickpea/channa)
6	Normal	*Bakas* (sugarcane residual from mill)
7	Normal	Coal
8	Normal	*Booro*
9	Special	Hard wood etc

Fuel procurement mode: Fuel is procured in two ways i.e. Contract or Retail. 65 kilns procure via contract

Table 9
Kiln Inventory Model SPSS Model summary, ANOVA and coefficients

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.713[a]	0.509	0.473	1.69769

a. Predictors: (Constant), AvgOC, ClOrdSiz, ClOrders, FuelOrSize, FuelOrders, AvgHC

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	247.7	6	41.283	14.324	.000[b]
	Residual	239.218	83	2.882		
	Total	486.917	89			

a. Dependent Variable: InvTO

b. Predictors: (Constant), AvgOC, ClOrdSiz, ClOrders, FuelOrSize, FuelOrders, AvgHC

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.827	1.171		4.124	0
	ClOrdSiz	-0.017	0.004	-0.331	-3.939	0
	ClOrders	0	0	-0.133	-1.063	0.291
	FuelOrSize	0.007	0.002	0.414	3.621	0.001
	FuelOrders	0.013	0.004	0.376	3.264	0.002
	AvgHC	0.001	0	0.51	4.354	0
	AvgOC	0.006	0.001	0.47	5.481	0

a. Dependent Variable: InvTO

Regression Equation generated is

InvTO = 4.827- 0.331ClOrdSize- 0.133ClOrders + 0.414FuelOrSize + 0.376FuelOrders + 0.510AvgHC + 0.470AvgOC ±1.7

Kiln Inventory Model is valid as all variables are significant (except one). Strongest beta is that of holding cost of inventory. Clay orders (Quantity) has negative insignificant impact on the Inventory Turnover at an average kiln. Adjusted R^2 is 0.473. Intercept tells that if all dependent variables are zero still kiln will turn over (i.e. sale) inventory 4.8 times (±1.7). Clay orders variable has not impact on the inventory turnover. Clay Orders and clay order size have both negative relationships with Inventory T.O.

Conclusion

Main kiln essential jobs at kiln are moulding, drying , carrying .stacking, putting carry, firing and Nikasi. It is important to note that 60 % of the inventory time at large kiln is associated with main brick essential jobs, 71 % time of medium kiln and 66.5% for small kiln.

Sometimes owner buys in retail and other times he buys directly from kiln as whole. Storage or inventory management for the owner is a big problem that's why he buys in batches. It saves future cost.

Inventory management is very difficult task for kiln management. There is a percentage of bricks that are not good when manufactured. Usually 20-40 bricks out of 1000 bricks made are defective (*Bhelli Bricks*). It is result of burning process and there is always probability of this defect in the production process, as it is not human error. Rain, storm, etc may cause damage to newly formed bricks that are put out in sun light to dry. Operating cycle is very unstable in the kiln industry.

kilns are at open spaces in rural areas. They need to protect their inventory of clay, fuel, bricks stored at site. Chokidar is hired for specific period usually during active months. *Chokidaar* is responsible for the security of the bricks, unused fuel, other inventory items and the protection of the *Munshi* office.

Kiln Inventory model is simple multiple linear regression model. It is valid as all variables are significant (except one). Inventory is stock of bricks that are manufactured at kilns. This ratio tells about the sales skill of the kiln management. It tells about times brick inventory is sold. Higher ratio is better. Inventory turnover ratio is 8.7, 9.6 and 10 for large, medium and small kilns respectively. Strongest beta/coefficient of the model is that of 'holding cost' of inventory. Clay orders (Quantity) has negative insignificant impact on the Inventory Turnover at an average kiln. Economic Order Quantity for clay is131, 558 and 1099 maunds for small, medium and large kilns. Adjusted R^2 is 0.473. Intercept tells that if

all dependent variables are zero still kiln will turn over (i.e. sale) inventory 4.8 times (±1.7). Clay orders variable has not impact on the inventory turnover. Clay Orders and clay order size have both negative relationships with Inventory T.O.

Recommendations

kiln should purchase to minimize inventory costs such as holding costs and ordering costs . Clay economic order quantity should be (EOQ) 131, 558 and 1099 maunds for small, medium and large kilns. Fuel economic order quantity should be (EOQ) 55, 1491 and 3869 maunds for small, medium and large kilns**.** Turnover is biggest for small kilns so should be taxed less.

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