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THE DETERMINANTS OF EFFICIENCY IN THE CEMENT INDUSTRY OF PAKISTAN: AN APPLICATION OF DEA AND VALUE ADDED APPROACH

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ABSTRACT

This study examined the determinants of efficiency in the Pakistani cement industry. The value-added approach was employed to select the variables for analysis. The data was collected for the years 2009-2018 and was analyzed in two phases. Firstly, the efficiency score for each company was calculated using the DEA approach. Secondly, Tobit regression was employed to determine the relationship of these efficiency scores with their hypothesized factors. The results suggested that Sales Growth, Basic Earning Power, Liquidity, Asset Turnover, and EBITDA Margin had a positive relationship with Technical Efficiency.

KEYWORDS

Data envelopment analysis (DEA), cement manufacturing sector, financial determinants of efficiency, technical efficiency

The Determinants of Efficiency in the Cement Industry of Pakistan: An Application of DEA and Value Added Approach

Every thriving economy has a variety of financial and non-financial contributors. Today, Pakistan faces tremendous economic challenges considering the rapid rise of other South Asian economies like India, Bangladesh and Sri Lanka. The continuous surge in Pakistan's real Gross Domestic Product (GDP), according to the economic survey of Pakistan (ESP) 2017-2018, has been associated with prominent contributions from the country's manufacturing and services sectors. The stock exchange of the country is blooming due to the investors' increasing trust in the establishment and recognition of its potential to make Pakistan a rising economy in the upcoming future. The government of Pakistan initiated a housing scheme that will provide shelter to the homeless as well as to the government employees. The prime minister of Pakistan, Imran Khan, announced the plan regarding housing scheme in one of his election campaigns, while he was still unelected. This campaign sparked a ray of hope among those who did not possess any residence. However, due to various political and economic setbacks, the government could not proceed with the implementation of the housing scheme. In 2019, the establishment started working on the prime minister housing scheme, also known as

Naya Pakistan Housing scheme (NPHS). It opened the door for several industries associated with the construction process, cement being one of them.

Another notable infrastructural development is one of the most awaited projects, China-Pakistan Economic Corridor (CPEC). The project was formally announced in 2013 by the then prime minister Nawaz Sharif when he visited China. The corridor will provide an easy trade route to China and the projects linked to CPEC will help Pakistan in overcoming electricity shortage, unemployment and other economic challenges. Moreover, these projects will be helpful in the development of rural areas of the country. Both countries have agreed to work for mutual benefits. Construction of hospitals, power plants, schools and other developmental projects will require materials like cement, glass and steel. There are numerous reports regarding the economic journey of Pakistan and its achievement as an emerging economy.

According to the Economic Survey of Pakistan 2017-2018, the cement industry has grown by 6.24 percent in comparison to the previous year growth of 4.40 per cent. Therefore, there is a necessity to delve into the factors of performance efficiency of this sector considering that empirical evidence from the past discussed the money-handling institutions, the banking and non-banking sectors, highlights a research gap. The key focus is to offer useful information that would help make decisions related to the progress, resource allocation and primal efficiency factors in the cement industry of Pakistan.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Firm Age and Efficiency

When investigating a company's efficiency, studying firm age and its impact on the overall efficiency of a business is imperative. Often it is assumed that the age of a company somehow affects its potential to perform better. Therefore, in this section, we will explore the reasons why Firm Age is a vital component in the variable set and whether it has an impact on a firm's performance or not. These studies will help understand the different approaches to measure the relationship between Firm Age and Efficiency in various locations and timeframes.

Faruq and Yi (2010) proposed the determinants of technical efficiency of manufacturing companies in Ghana. The study used the DEA approach to examine the sample that stretched across six manufacturing industries from 1991 to 2002. According to their findings, Ghana's manufacturing industries performed less efficiently than those in other countries. The researchers suggested that during the production process, there was a positive effect of firm characteristics on firm efficiency. These include Firm Size, Firm Age, Foreign Ownership, and Labour-Capital Mix. These results highlighted the developing stage of Ghana as well as the country's major economic contributor, agriculture. Moreover, there were several implications for the industrialization based on substitution of imports and foreign investment policies of Ghana.

Some studies suggest that aged companies are more efficient as compared to younger companies due to higher experience level. However, many pieces of research contradict this finding and found that firm age and efficiency have a negative relationship (Little et al., 1987).

Cheruiyot (2017) studied the factors of technical efficiency in the Kenyan manufacturing sector and applied a two-stage non-parametric approach to gauge the efficiency of the selected sample. We extracted the data from the survey report of the World Bank 2007 Regional Program for Enterprise Development. Tobit regression was employed to test the relationship between firm efficiency and its determinants. The results of the study suggested that the average score of Technical Efficiency was 68.3 percent having the least value of 53 percent. The results revealed that 63 percent of the chosen companies had an increasing return to scale, 33 percent of the sample indicated a decreasing return and only 2 percent of the firms had a constant return to scale. The age and size of companies were found to have a negative relationship with firm efficiency and had significant coefficient values. Moreover, the results showed a higher efficiency level of firms operating in Nairobi than those in Mombasa and concavity of Technical Efficiency with regards to the variables.

Burki and Terrell (1998) studied small-scale manufacturing companies in Gujranwala, Pakistan. The sample comprised of 153 companies from nine different industries. The analysis had two parts. Firstly, the researchers worked on the measures of scale and technical efficiency. Secondly, Tobit regression analysis was applied using these measures to the firm and entrepreneur attributes to find out the sources of efficiency among firms. The study revealed higher efficiency scores for newly established firms, firms lead by educated entrepreneurs, and firms that engaged in production subcontracting. Moreover, the results concluded that most firms operated below the optimum performance level.

Based on the above literature, we developed the following hypothesis.

H1: Firm age has a positive association with efficiency.

Firm Size and Efficiency

There are many ways to calculate Firm Size, but the most common method is by taking the natural log of total assets. This study assumes that firm size had a positive association with efficiency because the bigger the size of the firm the more resources it can allocate to its production process (Afza and Asghar, 2017; Alvarez and Crespi, 2003; Schiersch, 2013; Faruq and Yi, 2010; Chen and Sun, 2011).

There are numerous studies conducted on the factors of efficiency. The researchers measured efficiency through financial and non-financial determinants. Moreover, the past studies show various parametric and non-parametric ways for efficiency analysis. In an era, when the least developed countries were considered irrelevant and left unstudied, Taymaz and Saatci (1997) determined to understand the importance and extent of efficiency and technical advancements in the Turkish region. The study was based upon the idea that technical progress and production efficiency are vital for economic growth and global competitiveness. The sample consisted of three major industries in the Turkish manufacturing sectors that are the cement, textile and motor vehicles. The time chosen was the study 1987-1992 and stochastic production frontiers were used for the estimation of the collected panel data of plants. Time-based variables were introduced in the function of production to measure the direction and level of change in the technical progress of all three industries. The study also identified the sector-specific aspects which

had an impact on the technical efficiency of manufacturing plants. A positive link was found between the size of production plants and Technical Efficiency in the industries of motor-vehicles and cement. The results also revealed significant inter-sectoral differences between the levels of technical change and the aspects that influence the technical efficiency at the level of the production plant. Sub-contracting improved efficiency of user firms in all three industries that were cement, textile and motor vehicles. Moreover, ownership type, source of technology, legal status, product features, and regional accumulation came out to be the main determinants of firm-level efficiency.

Lundvall and Battese (2000) studied the Kenyan manufacturing firms and specifically targeted the industries of textile, food, metal and wood. The sample of the study comprised of 235 Kenyan manufacturing firms. The study collected unbalanced data to measure the functions of translog stochastic-frontier production. Each sector was analyzed separately to check whether there was a scientific relation of technical efficiency with firm size and firm age. The results suggested that there was a positive and significant effect of Firm Size among the wood and textile sectors. The age effect was found to be less systematic but was insignificant among all industries except textile.

According to Alvarez and Crespi (2003), large manufacturing firms perform better than smaller ones. The study offered a variety of determinants for technical efficiency in small manufacturing firms. A sample of 1,091 Chilean manufacturing firms for the time frame between April and July 1998 was chosen for empirical analysis using the DEA approach. The results highlighted a positive association of efficiency with workers' experience, upgrading of physical capital and innovative development in products. Other suspected determinants like owner's literacy, outward orientation and participation in some public programs did not have any effect on firm efficiency. The study indicated that the size of a firm does have an impact on its efficiency because it was noted that the larger firms performed better. The size of a business can be evaluated by multiple measures, including the number of employees, total assets, or other alternatives depending on the scope of the research. However, the total number of employees is considered as the most trusted measure of finding Firm Size.

In 2004, the efficiency analysis report of the African manufacturing sector was published. Soderbom and Teal (2004) chose the Ghanaian manufacturing firms as their study sample. The study aimed to examine three dimensions of performance in the sample for the period 1992-1997. The researchers observed technical efficiency, allocative efficiency, and technology among the firms. The results showed that factor diversity is not due to non-homothetic technology. Observable skills were quantitatively unimportant as compared with the determinants of productivity. These results indicated that large-scale firms encountered higher labour costs than small-scale firms. The results also point that firms with foreign ownership or the larger size did not have lower levels of technical efficiency and its dispersion in Ghanaian manufacturing firms was similar to that in other economies. The study suggested that there is a chance of substantial gains through the improvement of allocative efficiency if the firms level off these factor price differentials.

Oczkowski and Sharma (2005) assessed and modelled the determinants of firm efficiency across all manufacturing firms in Nepal. The translog stochastic-production frontier and maximum-likelihood econometric methods were used to conduct the aimed

analysis. The study's results revealed higher efficiency scores for larger firms and higher inefficiency scores for capital intensive firms. The study did not find any impact of foreign participation and export intensity on efficiency improvement. Moreover, it was found that higher protection leads to inefficiency. Overall, the results suggested that a strategy that encourages the development of large-scale industries and does not rely on foreign intervention is a game-changer for the efficiency improvement of a least developed country like Nepal.

Jorge and Suarez (2014) aimed an empirical study on the Total Factor Productivity, efficiency and its factors in the hotel industry for the period 1999-2007. The main motive behind this study was to analyze the managerial implications of the outcomes. The results indicated that innovation played a vital role in the productivity improvements with a significant variation due to geographical locations. Moreover, a decline in the efficiency level was observed with regards to adaptation to supply. Numerous factors influence the higher efficiency levels of the top hotels. The concentration of market shares to achieve efficiency gains and a curve between efficiency and hotel size was found in the results. There was a positive relationship between higher levels of administrative autonomy with efficiency and a negative relation with the commitment to quality. The study recommended incorporating intangible resources like customer satisfaction and service quality for further analysis.

Setiawan and Sule (2018) conducted an empirical investigation of technical efficiency and its contributing factors in state-owned enterprises in the Indonesian manufacturing sector. The researchers used the bootstrapped DEA approach to measure technical efficiency, and in the second stage, the panel data technique was used to estimate the effect of the determinants of technical efficiency. The study used firm-level surveyed data to measure the technical efficiency score that was arranged at the five-digit International Standard Industrial Classification (ISIC) level for the period 1980-2015. The results of the study show that the Indonesian manufacturing sector has technically inefficient state-owned enterprises. Moreover, the factors influencing Technical Efficiency were location, firm size, and level of technology, export engagement and the economic and financial crisis.

Based on the above literature, we developed the following hypothesis:

H2: Firm size has a positive association with efficiency.

Asset Turnover and Efficiency

The asset turnover ratio is used to evaluate how efficiently a firm utilizes its assets for the production of maximum possible output, that is, the revenues and therefore, is of great importance in the sight of investors and decision makers.

The literature highlights the positive and negative impact of asset turnover on efficiency or, as depicted in various studies, performance, profitability, or operational efficiency. There are several studies that emphasize the usefulness of total asset turnover in determining performance efficiency. McConaughy et al., 1998 conducted a statistical analysis on the performance of founding family controlled firms where asset turnover ratio was examined along with other relevant variables to study asset utilization. The results of the study indicated that the founding family controlled firms (FFCFs) had lower

total asset turnover than the non-FFCFs, but there is no statistically significant difference. Additionally, it was noted that the ownership match control firms had higher asset turnover as compared to the diffusely owned control firms. These results, despite having a different set of independent and dependent variables, suggest that studying asset turnover is imperative when examining the performance efficiency of firms. Therefore, this ratio is added in this study's variable set.

Warrad and Omari (2015) studied the impact of turnover ratios on the performance of Jordanian services sector, and the results indicated that these financial ratios play a significant role in determining the performance level of the services sector. The study suggests that these ratios can prove to be highly useful for future research and for providing useful insights about other sectors as well.

Tugas (2012) published a comparative analysis of the financial ratios of listed firms belonging to the education subsector from 2009 to 2011 in the Philippines. The study was conducted with the intent to raise awareness about the importance of financial ratio analysis and its role in reflecting the financial health of a sector. The results indicated that financial ratios play a major part in revealing a firm's financial performance and should be examined in depth for a smooth decision making process. The study indicates that since wealth creation is usually the top priority, financial ratio analysis and efficient management of resources should be the main focus of any business.

Considering multiple studies that indicate the vitality of the asset turnover ratio for studying the efficiency of a sector, it is assumed to have a positive association with efficiency (Patin et al., 2020; Fairfield and Yohn, 2001; Mahsud et al., 2011; Baik et al., 2013; Tugas, 2012).

We developed the following hypothesis:

H_3: Asset turnover has a positive association with efficiency.

Liquidity and Efficiency

The liquidity ratio, also known as the current ratio, indicates the ability of a firm to meet its short-term obligations which are known as those transactions that take place within 12 months.

Bhunia and Khan (2011) studied liquidity and working capital management in Indian steel companies. The results drawn from a sample of 230 private steel companies in India indicated a lower degree association between liquidity and profitability. The authors deemed liquidity as an important component of financial decision making as it affects efficiency, and it should be studied for examining different sectors in different time periods.

An important point was noted while studying liquidity that the level of liquidity increases in correspondence to firm's size. Therefore, it is assumed that this ratio would have a positive association with efficiency (Becchetti and Sierra, 2003; Baik et al., 2013; Bhunia and Khan, 2011; Goldar, Renganathan, & Banga, 2004; Richards and Laughlin, 1980; Ponikvar et al., 2009; Tugas, 2012).

Based on above literature, we developed the following hypothesis:

H_4: Liquidity has positive association with efficiency.

Tangibility and Efficiency

Tangibility is often studied as an integral part of capital structure studies and reports. There are mixed results in the literature regarding the impact of tangibility on efficiency.

Tangibility is assumed to be positively associated with efficiency because it indicates that a firm has enough fixed assets to provide to its creditors as a security and thus gets a chance to receive interest discounts (Jaishi and Poudel, 2019; Baik et al., 2013; Margaritis and Psillaki, 2010; Shah and Hijazi, 2004; Alberca and Parte, 2018).

Jaishi and Poudel (2019) conducted a study on the capital structure and firm efficiency in non-financial institutions in Nepal. The results were obtained by employing descriptive, correlation, and regression methods and highlights that if a firm invests more in its tangible assets, it will accelerate its efficiency.

Based on above literature, we developed the following hypothesis:

H_5: Tangibility has a positive association with efficiency.

Leverage and Efficiency

A firm relies on a mixture of equity and debt. However, too much debt is a negative indicator. Therefore, the debt to assets ratio of the cement industry of Pakistan was evaluated to check if it had a reasonable debt-equity mix (Mok et al., 2007; Baik et al., 2013; Warokka, Herrera, & Abdullah, 2011; Cheng and Tzeng, 2011; Tugas, 2012). Efficient firms have low levels of leverage whereas; firms having high leverage show inefficiency (Jaishi and Poudel, 2019).

Mok et al. (2007) empirically examined leverage, TE and profitability in the southern Chinese toy-manufacturing companies by applying a two-stage approach. 238 largest foreign-invested toy manufacturing companies based on output value were taken as the sample. The aim of the study was to test the effect of leverage on firm performance as measured by TE. The study also examined the effect of efficiency on profitability. DEA approach was applied in the first step to measure TE of the selected sample and in the second step regression analysis was applied to analyze the effect of leverage on efficiency and the effect of efficiency on profitability. The results revealed a positive effect of leverage on the TE. Moreover, a positive link between TE and profitability was found.

Ahmad et al. (2017) analyzed some important working capital management policies and efficiency in the manufacturing sector of Pakistan. For this analysis, 37 manufacturing firms were chosen as the sample for a period of five years i.e., 2009-2014. Two analytical approaches, DEA and Tobit regression analysis, were applied to test the data. The DEA results indicated that 15 firms required an increase in their inputs whereas six firms required a decrease in inputs to achieve better outputs. Moreover, 16 companies had to be consistent with their already existing proportion of inputs to maximize their outputs. The results of Tobit regression analysis revealed a negative effect of the average period of collection on efficiency. Furthermore, there was a significant positive effect of current, financial leverage and gross working capital turnover ratios on efficiency.

As mentioned previously, a proper debt-equity mix is crucial for every firm to operate. Therefore, this ratio is separately evaluated to check its association with efficiency and is backed by past literature (Burki and Terrell, 1998; Alvarez and Crespi, 2003; Oczkowski and Sharma, 2005; Faruq and Yi, 2010; Mahsud et al., 2011; Tugas, 2012; Jaishi and Poudel, 2019).

Based on above literature, we developed the following hypotheses:

H_6: Leverage has positive association with efficiency.
H_7: Debt to equity ratio has positive association with efficiency.

EBITDA Margin, Shareholder's Equity, and Efficiency

A firm's Profitability ratios highlight its ability to generate income from available resources. Profitability ratios are an excellent way to evaluate the financial health of a business and serve as an indicator to assess how effectively a firm manages its capital. Higher the ratio, the more successful a firm is in converting its inputs into profits.

According to Tsai et al. (2006), higher EBIDTA Margin reflects that the firm has free cash flow to pay returns to shareholders on their investments and to make investments for the business's expansion. Therefore, it was assumed that this ratio had a positive association with efficiency (Burki and Terrell, 1998; Tugas, 2012; Patin et al., 2020; Lesakova, 2007; Alvarez and Crespi, 2003).

According to Becker (1987), a decline in shareholder's equity reveals depreciation in a firm's total value. Shareholder's equity in a firm's capital indicates that it does not rely on debt alone but has financial strength and sustainability (Tugas, 2012; Baik et al., 2013; Patin et al., 2020; Brown and Heal, 1979; Afza and Asghar, 2017; Alberca and Parte, 2018).

Based on above literature, the following hypotheses were developed:

H_8: Shareholder's Equity has positive association with efficiency.
H_9: EBITDA margin has positive association with efficiency.

Sales Growth and Efficiency

Sales growth indicates that a firm is constantly growing and utilizing its resources efficiently. When a firm is evaluated by investors and shareholders, its sales growth is always taken into consideration. Sales growth is studied to assess operating efficiency as well as used as productivity measures in financial and non-financial sectors.

The past literature indicates sales growth as a measure for size, but it is also studied separately along with other related variables, including owner's experience, total assets, age, and number of employees to calculate profitability and performance.

Therefore, considering some of the most important studies that examine sales growth, the variable is assumed to have a positive association with efficiency (McConaughy et al., 1998; Goel and Sharma, 2015; Jaishi and Poudel, 2019).

Basic Earning Power (BEP) is used for evaluating a firm's capability to earn income from its sales. This ratio is considered important among shareholders to assess a firm's

financial ability. Basic earning power ratio reflects the true potential of a firm's assets to generate operating income. This ratio is measured by dividing the total number of operating earnings before the deduction of interest and taxes (EBIT) to total assets (Brigham and Houston, 2012).

The basic earning power ratio is assumed to have a positive association with efficiency (Connelly and Limpaphayom, 2004; Tugas, 2012; Klingenberg et al., 2013; Jumono et al., 2016).

Based on above literature, the following hypotheses were developed:

H_{10}: Sales growth has a positive association with efficiency.
H_{11}: Basic earning power ratio has positive association with efficiency.

RESEARCH METHODOLOGY

Efficiency analysis is so far, according to several past studies (Sharma, 2008; Sampaio et al., 2008; Ahmed and Mohamad, 2017; Lam and Shiu, 2008; Herr et al., 2011; Gok and Sezen, 2013; Eliasson et al., 2015; Bray et al., 2013; Malana and Malano, 2006), a better way to evaluate productivity and performance. The efficiency of a company or an industry is denoted by either 0 or 1. 0 stands for inefficiency whereas 1 represents maximum level of efficiency. The efficiency score lies between 0 and 1. Moreover, the scores closer to 0 represent lower levels of efficiency whereas scores near to the value of 1 are considered efficient. The companies listed on all Pakistan Cement Manufacturing Association (APCMA) as well as the PSX, which were 16 in total, were chosen as the sample. The years for data analysis were 2009-2018.

The chosen companies were ranked among the top companies in the PSX based on market capitalization and were chosen out of 19 companies that had some missing financial statements. This sample size was more than 80 percent of the population and therefore proved to be a good representative of the whole cement industry and is supported by Sharma (2008). Data was collected from the companies' annual reports. According to Burki and Terrell (1998), there are several assumptions that act as a basis for returns to scale. CRS which is also known as TE, is the ratio of the amount of inputs that an efficient company would have utilized to produce a unit of output to the actual amount that the company used. VRS measures a firm's efficiency on its own scale and does not employ any other scales during evaluation. Moreover, SE measures output loss due to conducting operations at an inefficient scale. TE is the product of PTE and SE and I mathematically written as:

$$TE_{CRS} = PTE_{VRS} \times SE$$

If a firm reduces its usage of inputs like labor, capital and other operating costs without compromising its rewards then, that firm is said to be efficient. The value-added approach was used for the data collection and analysis process. Using this approach, those variables that have an added value effect on the output variable and dependent variables (DV) were selected.

Framework of the Study

We have analyzed collected data in two phases. Farrell (1957) suggested that a firm's efficiency is evaluated by its ability to successfully produce as large an output from a given set of inputs as it possibly can. This remained an analytical basis in this study just as it was in previously published reports. The theoretical framework of the study, as illustrated in Figure 1, shows the independent and dependent variables of the two phases of analysis. Table 1 shows efficiency measurement based on two main inputs that are capital, labor and the total revenues or cash receipts as output variable (Taymaz and Saatci, 1997; Herr et al., 2011; Lam and Shiu, 2008; Oczkowski and Sharma, 2005; Sampaio et al., 2008). Table 2 shows the variables in the second phase of study. These variables were regressed with the efficiency scores by using Tobit Regression. Tobit regression is helpful when there is a continuous dependent variable that needs to be regressed and has a certain degree of skewness. This model provides upper range and lower range of the dependent variable hence making it easy to regress and interpret.

Equation 1 is the main regression equation of this study and the next two are given for further explanation of analysis.

Equation 1

$$\theta_1 = \alpha_0 + \beta_1 SGRWTH + \beta_2 FRMAG + \beta_3 FRMSZ + \beta_4 TANG + \beta_5 LEV + \beta_6 TURN + \beta_7 LIQUID + \beta_8 EQT + \beta_9 DBTEQT + \beta_{10} EBITDAM + \beta_{11} BEP + \varepsilon$$

Equation 2

$$\theta_2 = \alpha_0 + \beta_1 SGRWTH + \beta_2 FRMAG + \beta_3 FRMSZ + \beta_4 TANG + \beta_5 LEV + \beta_6 TURN + \beta_7 LIQUID + \beta_8 EQT + \beta_9 DBTEQT + \beta_{10} EBITDAM + \beta_{11} BEP + \varepsilon$$

Equation 3

$$\theta_3 = \alpha_0 + \beta_1 SGRWTH + \beta_2 FRMAG + \beta_3 FRMSZ + \beta_4 TANG + \beta_5 LEV + \beta_6 TURN + \beta_7 LIQUID + \beta_8 EQT + \beta_9 DBTEQT + \beta_{10} EBITDAM + \beta_{11} BEP + \varepsilon$$

where,

θ_1 = TE (DV)
θ_2 = PTE
θ_3 = SE
α_0 = Constant term
β_i = Intercept or slope
SGRWTH = Sales Growth
FRMAG = Firm Age
FRMSZ = Firm Size
TANG = Tangibility
LEV = Leverage
TURN = Turnover
LIQUID = Liquidity
EQT = Equity
DBTEQT = Debt to Equity
EBITDAM = Earnings before Interest, Taxes, Depreciation and Amortization
BEP = Basic Earning Power
ε = Error term

DISCUSSION

The results of phase 1 are attached in the Appendix. Tables 3, 4, 5, 6, and 7 show the highly efficient, efficient and inefficient companies for the years 2009-2018. The tables also indicate returns to scale for each company. The correlation matrix indicates whether a relationship between variables is positive or negative and the significance values indicate the strength of relationships. Table 11 shows that SGRWTH has a positive and significant relationship with Technical Efficiency whereas, FRMSZ has a negative relationship with it.

TURN and LIQUID are seen to be having a positive and significant correlation with TE whereas LEV and TANG are negatively related with TE (Alberca and Parte, 2018). According to Pushner (1995), high leverage does not increase efficiency and has a negative relationship with a firm's efficiency. Therefore, these results are justified. The Tobit regression tables also indicate that EQT and FRMAG are negatively correlated with TE.

DEQT has a positive correlation with TE but this relationship is not significant. TE is found to have a positive and significant relationship with EBITDAM as well as BEP. Moreover, some variables correlated with each other therefore, to avoid any error in regression, these variables were regressed separately.

The results of Tobit regression in tables 8, 9, and 10 show that SGRWTH was positively associated with TE and PTE while significantly influencing it. The results of SGRWTH are supported by McConaughy et al., 1998 and Goel and Sharma, 2015. Increase in sales does indicate that a firm is allocating its assets in the right way. This also shows that the company is striving to generate revenues with given resources as efficiently as possible. BEP is used for evaluating a firm's capability to earn income from its sales. This ratio is considered important among shareholders to assess a firm's financial ability. The ratio had a positive and significant relationship with TE. Since TE measures the quantity of inputs that an efficient firm would have utilized to produce a unit of output to the actual quantity that the firm used and SE measures output loss due to conducting operations at an inefficient scale, the BEP ratio was significant with these two DVs. TURN is used to evaluate how efficiently a firm utilizes its assets for the production of maximum possible output that is, the revenues. It had significant impact on TE, PTE and SE and was positively related with these variables too. These results are supported by Burki and Terrell (1998) who conducted an efficiency analysis on Pakistani firms.

EQT had a positive and significant impact on PTE. These results are supported by Afza and Asghar (2017). DEQT was significantly related with PTE and SE and a positive association was found with all three dependent variables but had a negative relationship with TE. These results are supported by the study of Burki and Terrell (1998). This indicates that firms perform more efficiently when they have a stable debt to equity ratio. TANG was found to be negatively related with all three DVs but had an insignificant association with SE (Alberca and Parte, 2018).

Tangibility indicates that a firm has enough fixed assets provide to its creditors as a security and thus gets a chance to receive interest discounts. The literature suggested that

efficient firms have higher tangibility ratio therefore, our results are valid. The results of LIQUID are supported by Mok et al., 2007. This indicates that efficient firms are capable to meet their short-term obligations, which are known as those transactions that take place within 12 months, more effectively. LEV had a negative association with the DVs and was insignificantly related with PTE. Overall, the main dependent variable which was TE had a positive relationship with SGRWTH, BEP, LIQUID, TURN and EBITDAM.

CONCLUSION, LIMITATIONS, AND PRACTICAL IMPLICATIONS

This study was conducted on the cement industry of Pakistan to check its performance and efficiency since it is among the top-ranked industries in the country. There were three DVs of this study, CRS, VRS and SE. These variables were derived from the first phase of data analysis where two inputs, capital and labor and one output, revenues, was selected for efficiency analysis. These efficiency scores then became DVs in the second phase of study. The companies chosen for analysis were members of APCMA and were listed on PSX too. The researcher preferred to choose a time-frame of at least 10 years as this provides a deeper insight about the performance fluctuations and is beneficial for future forecasting too. Therefore, this research chose to analyze data for the period 2009-2018. The DEA approach was used to analyze the data in the first phase and Tobit regression was employed in the second phase of the study. The results are supported by the existing literature and can be used as a basis for future research. The results indicated Sales Growth, Asset Turnover, Liquidity, Leverage, Tangibility, EBITDA Margin, Basic Earning Power, and Firm Age had a significant relationship with Technical Efficiency. In addition to this, SGRWTH, BEP, LIQUID, TURN and EBITDAM had a positive relationship with TE, therefore, five hypotheses of the study were accepted.

This study has some limitations. Firstly, Leverage was measured by total debt divided by total assets but if only interest bearing liabilities were selected as numerator then the ratio could have provided better results. Moreover, profit after tax could be used in place of sales to check the real income of the firms. The variable set can be further extended and number of employees can be added in the first phase of the study. This study can be explored further by including more industries and comparing them based on their contribution and productive efficiency. Moreover, identifying underdeveloped as well as urbanized sectors is essential due to the country’s dire need of progressive expansion.

The policy makers of CPEC and NPHS can use this study to get an overall perspective about the cement industry. This study will be a useful tool for those evaluating the performance of each cement company listed on the stock exchange. Furthermore, the finance department of Pakistan can use this study for efficient allocation of funds in the companies where there is a dire need of improvement and, keep future infrastructural projects in mind, special financial support to the selected companies. The research and development department of Pakistan as well as China can identify the gaps by considering this research and provide necessary and advanced production equipment where needed. Lastly, the companies discussed here can use the results of this research for cutting excessive costs and utilize those resources toward other parts of the production process.

Such studies are helpful to identify the areas within the industry that require improvement. However, this would be possible if Pakistan's think tanks and establishment work together and focus on the nation's financial health instead of personal gains.

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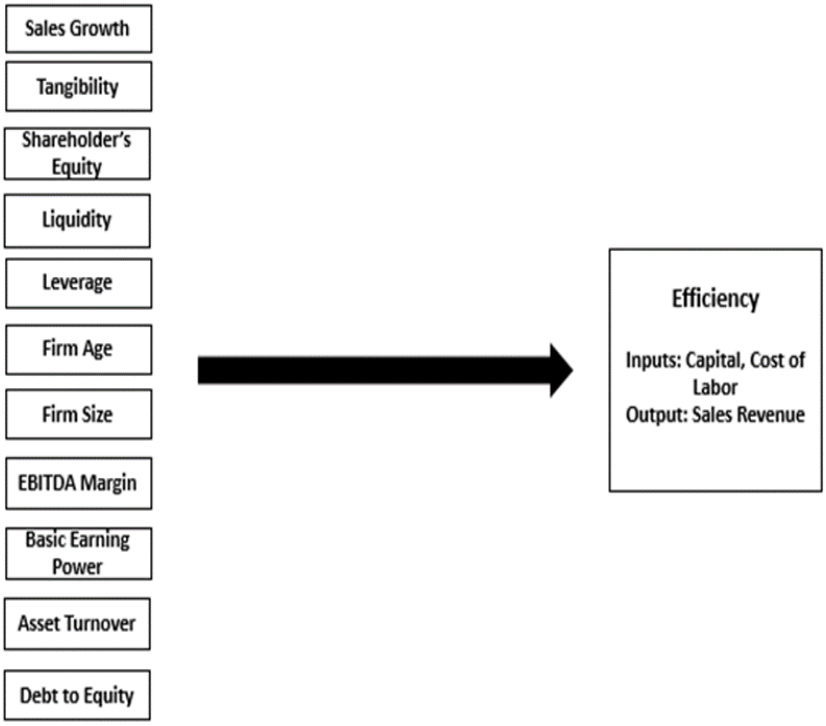

Figure 1: Theoretical Framework

Table 1
Phase 1 of Data Analysis

Variables	Input/ Output	Measurement	Studies
Capital	Input	Fixed Capital	(Taymaz and Saatci, 1997; Herr et al., 2011; Lam and Shiu, 2008; Oczkowski and Sharma, 2005; Mok et al., 2007; Sampaio et al., 2008; Burki and Terrell, 1998; Alvarez and Crespi, 2003; Oczkowski and Sharma, 2005; Faruq and Yi, 2010; Din et al., 2007)
Cost of Labor	Input	Cost of Labor	(Taymaz and Saatci, 1997; Herr et al., 2011; Lam and Shiu, 2008; Oczkowski and Sharma, 2005; Burki and Terrell, 1998; Alvarez and Crespi, 2003; Oczkowski and Sharma, 2005; Faruq and Yi, 2010; Mok et al., 2007; Sampaio et al., 2008).
Revenues	Output	Cash receipts or Net Sales Revenue	(Taymaz and Saatci, 1997; Herr et al., 2011; Lam and Shiu, 2008; Oczkowski and Sharma, 2005; Sampaio et al., 2008)

Table 2
Phase 2 of Data Analysis

Variables	Measurement	Studies
Sales Growth	Current sales minus previous sales divided by previous sales	(McConaughy et al., 1998; Goel and Sharma, 2015)
Firm Size	LOG of Total Assets	(Afza and Asghar, 2017; Alvarez and Crespi, 2003; Faruq and Yi, 2010; Chen and Sun, 2011)
Turnover	Sales divided by Total Assets	(Alvarez and Crespi, 2003; Mahsud et al., 2011)
Liquidity	Current Assets divided by Current Liabilities	Richards and Laughlin (1980)
Leverage	Total Liabilities divided by Total Assets	(Mok et al., 2007; Cheng and Tzeng, 2011)
Tangibility	Fixed Capital divided by Total Assets	Shah and Hijazi (2004)
Equity	LOG of Shareholder's Equity	Afza and Asghar, 2017
Debt to Equity	Total liabilities divided by Total Shareholders' Equity	(Burki and Terrell, 1998; Alvarez and Crespi, 2003; Oczkowski and Sharma, 2005; Faruq and Yi, 2010; Mahsud et al., 2011)
EBITDA Margin	EBITDA divided by Total Sales	(Burki and Terrell, 1998; Alvarez and Crespi, 2003; Tsai et al., 2006)
Basic Earning Power	EBIT divided by Total Assets	(Connelly and Limpaphayom, 2004; Tugas, 2012; Klingenberg et al., 2013; Jumono et al., 2016; Brigham and Houston, 2012)
Firm Age	LOG of Total years of a firm's existence	(Burki and Terrell, 1998; Lundvall and Battese, 2000; Faruq and Yi, 2010)

Table 3
Results of Data Envelopment Analysis in Phase 1

	2009				***2010***			
	TE	**PTE**	**SE**	**Returns to Scale**	**TE**	**PTE**	**SE**	**Returns to Scale**
Lucky Cement Limited.	1	1	1	-	1	1	1	-
Bestway Cement Limited.	0.807	0.907	0.89	DRS	0.924	0.938	0.985	DRS
D. G. Khan Cement Co. Ltd.	0.739	0.787	0.939	DRS	0.782	0.789	0.991	DRS
Fauji Cement Co Ltd.	0.393	0.402	0.977	IRS	0.36	0.393	0.917	IRS
Maple Leaf Cement Factory Ltd.	0.775	0.814	0.951	DRS	0.823	0.842	0.978	IRS
Kohat Cement Co. Ltd.	0.719	0.847	0.848	IRS	0.886	1	0.886	IRS
Cherat Cement Co. Ltd.	0.63	0.631	0.999	IRS	0.517	0.528	0.979	IRS
Pioneer Cement Ltd.	0.316	0.408	0.773	DRS	0.449	0.454	0.988	IRS
Power cement Limited	0.828	1	0.828	IRS	0.762	1	0.762	IRS
Attock Cement Pak Ltd.	1	1	1	-	1	1	1	-
Gharibwal Cement Ltd.	0.374	0.471	0.794	IRS	0.176	0.203	0.866	IRS
Dewan Cement Limited.	0.407	0.446	0.912	IRS	0.316	0.36	0.879	IRS
Thatta Cement Ltd.	1	1	1	-	1	1	1	-
Dandot Cement Co. Ltd.	0.424	0.774	0.548	IRS	0.132	0.832	0.159	IRS
Fecto Cement Ltd.	1	1	1	-	0.702	0.722	0.972	IRS
Flying Cement Company Ltd.	0.493	1	0.493	IRS	0.126	1	0.126	IRS
Mean	***0.682***	***0.78***	***0.872***		***0.622***	***0.754***	***0.843***	

Table 4
Results of Data Envelopment Analysis in Phase 1

	2011				***2012***			
	TE	**PTE**	**SE**	**Returns to Scale**	**TE**	**PTE**	**SE**	**Returns to Scale**
Lucky Cement Limited.	0.931	1	0.931	DRS	0.97	1	0.97	DRS
Bestway Cement Limited.	0.812	0.895	0.907	DRS	0.772	0.929	0.831	DRS
D. G. Khan Cement Co. Ltd.	0.749	0.825	0.908	DRS	0.633	0.745	0.85	DRS
Fauji Cement Co Ltd.	0.213	0.227	0.94	IRS	0.504	0.519	0.971	DRS
Maple Leaf Cement Factory Ltd.	0.616	0.681	0.905	DRS	0.609	0.628	0.97	DRS
Kohat Cement Co. Ltd.	1	1	1	-	1	1	1	-
Cherat Cement Co. Ltd.	0.544	0.674	0.806	DRS	0.577	0.789	0.731	DRS
Pioneer Cement Ltd.	0.646	0.658	0.982	DRS	0.573	0.601	0.952	IRS
Power cement Limited	0.6	0.854	0.703	IRS	0.695	0.883	0.787	IRS
Attock Cement Pak Ltd.	0.749	1	0.749	DRS	0.667	1	0.667	DRS
Gharibwal Cement Ltd.	0.262	0.263	0.996	IRS	0.767	0.797	0.963	DRS
Dewan Cement Limited.	0.209	0.231	0.904	DRS	0.248	0.25	0.992	DRS
Thatta Cement Ltd.	1	1	1	-	1	1	1	-
Dandot Cement Co. Ltd.	0.368	0.877	0.42	IRS	0.429	0.882	0.486	IRS
Fecto Cement Ltd.	0.663	0.787	0.842	DRS	0.697	0.905	0.77	DRS
Flying Cement Company Ltd.	1	1	1	-	1	1	1	-
Mean	***0.648***	***0.748***	***0.875***		***0.696***	***0.808***	***0.871***	

Table 5
Results of Data Envelopment Analysis in Phase 1

	2013				***2014***			
	TE	**PTE**	**SE**	**Returns to Scale**	**TE**	**PTE**	**SE**	**Returns to Scale**
Lucky Cement Limited.	0.64	1	0.64	DRS	0.796	1	0.796	DRS
Bestway Cement Limited.	0.559	0.786	0.711	DRS	0.96	1	0.96	DRS
D. G. Khan Cement Co. Ltd.	0.613	1	0.613	DRS	0.554	0.696	0.796	DRS
Fauji Cement Co Ltd.	0.43	0.571	0.753	DRS	0.452	0.495	0.913	DRS
Maple Leaf Cement Factory Ltd.	0.705	0.985	0.716	DRS	0.667	0.693	0.962	DRS
Kohat Cement Co. Ltd.	1	1	1	-	1	1	1	-
Cherat Cement Co. Ltd.	0.821	0.883	0.931	DRS	0.798	0.834	0.957	DRS
Pioneer Cement Ltd.	0.721	0.743	0.97	IRS	0.582	0.634	0.918	IRS
Power cement Limited	0.679	0.917	0.74	IRS	0.638	0.919	0.694	IRS
Attock Cement Pak Ltd.	0.932	1	0.932	DRS	0.999	1	0.999	DRS
Gharibwal Cement Ltd.	0.322	0.383	0.841	IRS	0.377	0.419	0.901	IRS
Dewan Cement Limited.	0.396	0.397	0.999	-	0.309	0.314	0.984	IRS
Thatta Cement Ltd.	0.707	1	0.707	IRS	0.612	1	0.612	IRS
Dandot Cement Co. Ltd.	0.068	1	0.068	IRS	0.391	1	0.391	IRS
Fecto Cement Ltd.	1	1	1	-	1	1	1	-
Flying Cement Company Ltd.	1	1	1	-	1	1	1	-
Mean	***0.662***	***0.854***	***0.789***		***0.696***	***0.813***	***0.868***	

Table 6
Results of Data Envelopment Analysis in Phase 1

	2015				***2016***			
	TE	**PTE**	**SE**	**Returns to Scale**	**TE**	**PTE**	**SE**	**Returns to Scale**
Lucky Cement Limited.	0.839	1	0.839	DRS	0.793	1	0.793	DRS
Bestway Cement Limited.	1	1	1	-	1	1	1	-
D. G. Khan Cement Co. Ltd.	0.657	0.658	0.999	DRS	0.542	0.556	0.975	IRS
Fauji Cement Co Ltd.	0.595	0.598	0.995	IRS	0.63	0.639	0.987	IRS
Maple Leaf Cement Factory Ltd.	0.704	0.708	0.995	IRS	0.72	0.752	0.958	IRS
Kohat Cement Co. Ltd.	0.705	0.706	0.998	IRS	0.793	0.917	0.865	DRS
Cherat Cement Co. Ltd.	0.449	0.472	0.951	IRS	0.321	0.347	0.926	IRS
Pioneer Cement Ltd.	0.773	0.79	0.978	IRS	0.513	0.518	0.989	IRS
Power cement Limited	0.696	0.748	0.931	IRS	0.683	0.995	0.686	IRS
Attock Cement Pak Ltd.	1	1	1	-	0.964	1	0.964	DRS
Gharibwal Cement Ltd.	0.514	0.525	0.98	IRS	0.424	0.439	0.964	IRS
Dewan Cement Limited.	0.395	0.401	0.984	IRS	0.408	0.443	0.92	IRS
Thatta Cement Ltd.	0.664	0.721	0.92	IRS	0.547	0.899	0.608	IRS
Dandot Cement Co. Ltd.	0.876	1	0.876	IRS	0.874	1	0.874	IRS
Fecto Cement Ltd.	1	1	1	-	1	1	1	-
Flying Cement Company Ltd.	1	1	1	-	1	1	1	-
Mean	***0.742***	***0.77***	***0.965***		***0.701***	***0.782***	***0.907***	

Table 7
Results of Data Envelopment Analysis in Phase 1

	2017				***2018***			
	TE	**PTE**	**SE**	**Returns to Scale**	**TE**	**PTE**	**SE**	**Returns to Scale**
Lucky Cement Limited.	0.635	1	0.635	DRS	0.724	1	0.724	DRS
Bestway Cement Limited.	1	1	1	-	1	1	1	-
D. G. Khan Cement Co. Ltd.	0.371	0.375	0.988	DRS	0.365	0.373	0.981	DRS
Fauji Cement Co Ltd.	0.534	0.536	0.997	IRS	0.602	0.621	0.969	DRS
Maple Leaf Cement Factory Ltd.	0.511	0.533	0.959	IRS	0.399	0.436	0.915	IRS
Kohat Cement Co. Ltd.	0.649	0.902	0.72	DRS	0.709	0.904	0.784	DRS
Cherat Cement Co. Ltd.	0.347	0.348	0.997	DRS	0.381	0.387	0.985	IRS
Pioneer Cement Ltd.	0.437	0.44	0.993	DRS	0.309	0.393	0.786	IRS
Power cement Limited	0.522	0.841	0.621	IRS	0.272	0.353	0.769	IRS
Attock Cement Pak Ltd.	0.469	0.472	0.992	DRS	0.467	0.52	0.899	DRS
Gharibwal Cement Ltd.	0.334	0.361	0.927	IRS	0.391	0.434	0.9	IRS
Dewan Cement Limited.	0.287	0.329	0.872	IRS	0.336	0.371	0.906	IRS
Thatta Cement Ltd.	0.557	0.753	0.739	IRS	0.654	1	0.654	IRS
Dandot Cement Co. Ltd.	0.579	1	0.579	IRS	0.348	1	0.348	IRS
Fecto Cement Ltd.	1	1	1	-	1	1	1	-
Flying Cement Company Ltd.	1	1	1	-	1	1	1	-
Mean	***0.577***	***0.681***	***0.876***		***0.56***	***0.674***	***0.851***	

Table 8
Tobit regression of Technical Efficiency from Constant Returns to Scale (CRSTE) as Dependent Variable

Variables	Coefficients	P-value
Sales Growth	.0754603	0.001
Tangibility	-.7362661	0.000
Equity	-.1835286	0.000
Debt to Equity	-.0009776	0.439
Firm Age	-.4128802	0.001
Basic Earning Power	.4434115	0.019
Firm Size	-.0751191	0.123
Liquidity	.0124463	0.552
Turnover	.4547211	0.000
EBITDA Margin	.1207323	0.013
Leverage	-.2834973	0.000

Table 9
Tobit regression of Technical Efficiency from Variable Returns to Scale (VRSTE) as Dependent Variable

Variables	Coefficients	P-value
Sales Growth	.1007436	0.012
Tangibility	-.6361183	0.000
Equity	-.2276975	0.000
Debt to Equity	-.002569	0.127
Firm Age	-.6632554	0.000
Basic Earning Power	.1027116	0.692
Firm Size	-.0091296	0.893
Liquidity	.0521443	0.067
Turnover	.6372778	0.000
EBITDA Margin	-.4590909	0.001
Leverage	-.0115215	0.909

Table 10
Tobit Regression of Scale Efficiency
(CRSTE/VRSTE) as Dependent Variable

Variables	Coefficients	P-value
Sales Growth	.0172543	0.293
Tangibility	-.1049391	0.216
Equity	-.0447502	0.118
Debt to Equity	-.0019648	0.057
Firm Age	-.1468931	0.150
Basic Earning Power	.304489	0.046
Firm Size	-.0001659	0.996
Liquidity	.0034105	0.824
Turnover	.1783158	0.005
EBITDA Margin	.0007919	0.986
Leverage	-.1698163	0.000

Table 11
Correlation Matrix

Variables		**Technical Efficiency**	**Pure Technical Efficiency**	**Scale Efficiency**
Sales Growth	Pearson Correlation: Sig. (2-tailed):	.181* 0.022	0.055 0.493	0.021 0.791
Firm Size	Pearson Correlation: Sig. (2-tailed):	-0.138 0.082	-.286** 0	-0.017 0.834
Asset Turnover	Pearson Correlation: Sig. (2-tailed):	.581** 0	.418** 0	.262** 0.001
Liquidity	Pearson Correlation: Sig. (2-tailed):	.236** 0.003	.176* 0.026	0.059 0.457
Leverage	Pearson Correlation: Sig. (2-tailed):	-.280** 0	-0.144 0.07	-.208** 0.008
Tangibility	Pearson Correlation: Sig. (2-tailed):	-.482** 0	-.469** 0	-0.074 0.35
Shareholder's Equity	Pearson Correlation: Sig. (2-tailed):	-0.054 0.496	-.183* 0.021	0.024 0.763
Debt to Equity	Pearson Correlation: Sig. (2-tailed):	0.081 0.31	-.219** 0.005	0.033 0.675
EBITDA Margin	Pearson Correlation: Sig. (2-tailed):	.312** 0	-0.076 0.34	0.129 0.103
Basic Earning Power	Pearson Correlation: Sig. (2-tailed):	.391** 0	0.152 0.056	.225** 0.004
Firm Age	Pearson Correlation: Sig. (2-tailed):	-.241** 0.002	-.304** 0	-0.088 0.268

Note: * Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).