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Investigating the technical and scale efficiency of cement companies in Saudi Arabia

Mohammad Naushad[a*]

[a]*Assistant professor, College of Business Administration, Prince Sattam Bin Abdulaziz University, Alkhraj, Saudi Arabia*

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A B S T R A C T

Cement & material sector is instrumental in infrastructural development of any economy. The same holds about Saudi cement sector which has contributed substantially to the economic and construction boom in Kingdom of Saudi Arabia (KSA). The cement sector of KSA holds the highest place among other GCC countries. Though, during the last couple of years, the sector seems to be grappled with capacity and weighted down due to certain reasons. Nevertheless, almost all of the cement companies in KSA are underplaying their actual capacities. Still, plenty of untapped growth opportunities for cement sector are available in KSA and other GCC countries. Henceforth, considering the growth potential and taking cue from the current scenario of KSA cement sector, the current study endeavors to measure the efficiency of listed cement companies in KSA. The study endeavors to be engrossed in identifying a set of companies which plays on efficiency frontier. Therefore, the technical efficiency performance of fourteen listed cement companies in KSA was measured using Data Envelopment Analysis (DEA) methodology. Two basic models of DEA methodology (i.e. CRS & VRS) were used to estimate the pure and technical efficiency of identified DMUs over a period of four years from 2016 to 2019. The study reveals that over a period of four years and on an average efficiency scale, only 23% of the firms were purely technically efficient on a CRS scale, while 46% of the firms were technically efficient. Only 23% of the firms were scale and technically efficient. Though, companies in the sector have a vast potential to outperform on efficiency front. Yet, the overall efficiency level among Saudi cement companies are remained depressing. Moreover, the study has noticed that the companies which are inefficient did not have a considerable distance from the efficiency frontier. The study also provided significant insights on the input factors causing inefficiency and suggestion to achieve the total technical efficiency. Furthermore, the efficiency analysis also provided benchmarking firms, which are efficient under several criteria for others to imitate their best practices for becoming a significant player on efficiency frontier.

1. Introduction

Cement & material sector has been instrumental in infrastructural development of Kingdom of Saudi Arabia (KSA). The construction boom in KSA contributed substantially to production growth of the sector (Alsultanny & AlZuhair, 2017). Cement sector of KSA with an annual production capacity of 72.4 million tons holds the highest place among other GCC countries (Roychoudhury, 2020). However, actual production of sector in 2018 was 42.2 million tons (i.e. less than 46 percent from historical high of 61.5 million tons in 2015) (General Authority for Statistics, 2018). During the last couple of years, the sector seems to be grappled with capacity and weighted down due to several factors (USSABC, 2019). Some of the critical factors for slow growth and demand in the sector could possibly be the steep decline in mega projects, reduction in energy subsidies, increase in transportation cost as an offshoot of reduction in subsidies (Balakrishnan & Al-Moammar, 2018). However, removal of export ban of 2008, announcement of new infrastructural projects like new NEOM city, Riyadh-metro project, government emphasis on the industry and investment friendly policies etc. potentially amplified the growth prospects of

* Corresponding author.

E-mail address: n.mohammad@psau.edu.sa (M. Naushad)

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sector. Though the sector is negatively affected by some parallel shortcomings like, lack of alternate source of energy, old/upgraded production lines, high transportation costs, utilization of capacity, etc. Such kind of bottleneck and events hampered the Saudi cement companies' path to achieve the sustainable competitive advantage over other giant players of Gulf region. However, Cement companies in KSA are striving to be efficient by adopting several measures like, Saudi Cement company which is considered as the cement industry pioneer in the region and market leader (https://www.saudicement.com.sa) has rejuvenated itself and continued its' commitment to quality standards of the Saudi Arabian Standards Organization (SASO), as well as other International Standards. The Yanbu Cement Company demolished its old production lines in 2017 to focus on its more modern and efficient lines. The company has enhanced the access to clinker stockpiles that would mean that the company will not lose any market share in the event of inefficient lines being dismantled. Yamama Cement Company has opted to dispose its old and inefficient lines to ensure the energy efficiency and market competitiveness (Roychoudhury, 2020). Since the cement sector is considered as highly capital intensive which rely on economies of scale to be profitable (Alsultanny & AlZuhair, 2017; Ogayon, 2014). The fierce competition in international markets and slowdown caused by recent pandemic and economic crisis made it imperative for business enterprises to form such strategies which could enhance their competitiveness, productivity and efficiency (Mukherjee, 2018; Naushad et al., 2020; Naushad & Sulphey, 2020). In KSA, cement sector has been in recessionary phase during 2016-1018 (USSABC, 2019). Though almost all of the cement companies in KSA are underplaying their actual capacity (Alsultanny & AlZuhair, 2017). However, the opportunity available in KSA and other GCC countries are in plenty for cement sector. Therefore, by taking cue from the current scenario of KSA cement sector, the current study endeavors to measure the efficiency of listed cement companies in KSA. The study endeavors to be engrossed in identifying a set of companies which plays on efficiency frontier. The findings will help peers benchmark their best practices and become efficient to take the advantages of opportunities available in external environment. Efficiency will be measured in twofold, i.e. technical & scale efficiency by adopting Data Envelopment Analysis (DEA) methodology. DEA approach is an important operation research technique by which relative efficiency of companies is evaluated. It is highly popular & utilized non-linear technique which helps in reinforcing the decision making. In DEA methodology we are supposed to select the appropriate set of input and output variables. DEA method calculates various types of efficiency such as technical and pure efficiency for individual sample companies, called Decision Making Units (DMUs). Using this approach one can also determine whether the current level of input and output is sufficient or it needs to be modified. This could be determined by adopting increasing return to scale or decreasing return to scale approach. By this way this research can help company's management recognize inefficient activities in order to deliver recommendations in improving its operations. Furthermore, it could assist investors in recognizing the market leaders in terms of efficiency front. The contribution of this study will help in strengthening the cement sector at efficiency front.

The rest of the paper is organized as follows. The next section will point out the existing gap available in literature by review of literature. The third section is the methodology section, which will elaborate the DEA methodology in details along with details of data and input & output variables. The next section presents the empirical results and discussions. Finally, section five will conclude the study by pointing out the future scope of further research.

2. Literature review

The primary focus of manufacturing sector relies on securing and maintaining the efficiency frontier. Primarily, any efficiency study found in literature are grounded on how efficiently a manufacturing or service unit utilizes inputs to generate desired output. Basically, the more efficient is the firm in generating output, the more profitable it is. Initial efficiency studies use to apply ratio analysis and other linear techniques like regression etc. (see. e.g. Ertuğrul & Karakaşoğlu, 2009; Cubbin & Tzanidakis, 1998; Shleifer, 1985). But with the advent of Data Envelopment Analysis (DEA), efficiency studies have noticed a remarkable improvement in analysis and results. DEA methodology is dependent on a set of appropriate input and output. Therefore, any efficiency study based on DEA will explore the available literature to find out the most suitable inputs and outputs. Like other studies, the current study also focuses on to mark the highly appropriate input and output measures vested in literature by reviewing the existing and available literature. Cement industry produces two kinds of output; one is desirable in the form of cement & clinker and the other is undesirable in the form of CO_2 emissions and other emissions (Mandal, 2010; Zhang et al., 2016). Firms endeavors to maximize & optimize the desirable output and focuses on to minimize the undesirable one. There are both kinds of studies available which explore the desirable and undesirable outputs. Apergis et al. (2015), Khalili-Damghani et al. (2015), Mandal (2010) and Riccardi et al. (2012) are among some of the studies which utilized the set of inputs and outputs to know the level of undesirable output. Since our focus is on desirable output, we only consider the desirable output measures available in literature. Most Likely to production function in other industry, cement industry also utilizes the factors of productions in generating the desired output. Usually, the generic five factors of production namely land, labor, capital, information and other resources are considered as input to any production function. However, it varies industry to industry with some additional variables based on the nature of industry. There are studies like, Madau et al. (2017) utilized the generic production factors (e.g. land, labor, capital, cows and other expenses-fixed & variable) as input and production as output to find out the technical efficiency and total factor productivity changes in European dairy farm sector. Sharma (2008) explored the efficiency of top 20 Indian cement companies by utilizing the expense-based inputs (raw material, salaries and wages, power and fuel and capital employed) and revenue (sales) as output. Similarly, Muhammad et al. (2018) applied the slack based Window analysis DEA model on large panel sample from 2005-15 of Indian cement industry by taking almost alike set of inputs and outputs. Both studies argued that cement companies in India must reduce a specific set of input

to maximize the output. Ogayon (2014) calculated the Malmquist Productivity Index (MPI) with technical efficiency by adding assets as an input to expenses related inputs and production as output to revenue related output. Similar to cement industry, there are other studies focusing on the manufacturing/production function in diverse background and industry. Per instance, Ran and Hui (2006) focused on listed Chinese coal companies by taking total capital number of employees, operating costs as inputs and net profit and operating profit as output. Fang et al. (2009) calculated the relative efficiency of USA and Chinese listed companies by adopting operating costs, total assets and numbers of employees as input variables and earnings per share, operating revenue and net profit before tax as output variables. Rezitis and Kalantzi (2016) estimated the efficiency of Greek food and beverages industry by taking 2 input (labor and capital) and 1 output (production) variables. Charoenrat and Harvie (2017) conducted a DEA efficiency study on Thai manufacturing SMEs by adopting value added as output and labor & capital as input. Hosseinzadeh et al. (2018) conducted a study on Australian mining company by taking total revenue as output and employee benefits, cost of capital & depreciation as input variables. One of the commonalities found among the studies mentioned above and focusing manufacturing as one of the production functions could be seen as it utilized expenditure as inputs and income as output. However, there are multiple studies on cement sector available in literature but among most of studies, the focal point has remained the financial efficiency by utilizing the different sets of inputs and outputs. Baskaya and Öztürk (2012), Kaviani and Abbasi (2014) and Mansory et al. (2014) are among some of the studies conducted on cement sector but focusing on financial efficiency. Importantly these studies utilize the financial performance indicators (like ROA, ROE, and other ratios) to calculate the financial efficiency of cement industry in different context. So far as the studies concerned in middle east and specifically in KSA are concerned, it does not indicate any concrete evidence. Thus, we could not cite any study specific to efficiency of cement sector in KSA. There are other DEA studies which could be seen easily in different sectors of KSA and GCC region like, Al-Faraj et al. (2006), AlKhathlan and Malik (2010), Assaf et al. (2011), Naushad and Malik (2015), Naushad (2019), Sulphey and Naushad (2019) did efficiency study about KSA banking sector, Almulhim (2019) and Naushad et al. (2020) conducted DEA based efficiency studies on insurance sector of Saudi Arabia. Henceforth, the current study is concerned on the technical and scale efficiency of Saudi cement sector. Moreover, after reviewing a number of empirical researches on efficiency performance among cement sector using DEA, we may cite an interesting observation, that most of the DEA based efficiency study is interested in production efficiency utilized, expenses incurred for production as input and production yield as output.

3. Methodology

3.1 Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) approach is a non-parametric linear programming technique utilized to measure efficiency of homogeneous units called, Decision Making Units (DMUs) with a set of specified input and output. DEA is defined as a set of best attainable positions obtained as a locus of maximum or minimum constrained values (Hsueh-Liang, 2005). Thus, the industry in a specific year which operates on the production frontier is said to produce its potential or maximum output by following the 'best practice' techniques. Moreover, DEA model helps decision makers to earmark DMUs among efficient and non-efficient units (Mansory et al., 2014). In the context of this study, we are interested in finding the technical efficiency of companies from cement industry of Kingdom of Saudi Arabia (KSA). As it is well known that DEA allows construction of the 'best' frontier based on the data of homogenous units only. Originally, DEA was propounded by Charnes et al. (1978) which used to estimate the efficiency of production function. Generally, DEA models are divided into two groups of input-oriented and output-oriented. Input-oriented models are those that utilize given input to obtain the maximum amount of output but output-oriented models obtain less input without any change in output rate (Momeni & Shahkhah, 2011). These models are further test upon a scale of return parameter. The scale of return could be either Constant Return to Scale (CRS) or Variable Return to Scale (VRS) based on input/output orientation. We have focused only on input orientation for the current study as We are interested in estimating the technical efficiency of manufacturing industry, i.e. cement industry. In an input-oriented model, a unit will be considered inefficient if the possibility of raising output will exist without raising an input or reducing output. The constant return to scale model is propounded by Charnes et al. (1978) and popularly known as Charnes Cooper and Rhodes (CCR) model. As per the model, CRS efficiency for a constant production function can be obtained by solving the following linear function:

$$max\emptyset_k = \frac{\sum_{i=1}^{s} w_i\, y_{ik}}{\sum_{j=1}^{m} u_j x_{jk}}$$

subject to

$$\frac{\sum_{i=1}^{s} w_i\, y_{ik}}{\sum_{j=1}^{m} u_j x_{jk}} \leq 1, \forall\, k\ k = 1,2,3 \ldots\ldots\ldots n$$

$$w_i\,, u_i \geq 0\,, \forall\, k, j$$

where,

$y_{ik} = Quantity\ of\ Output\ 'i'\ formed\ by\ DMU_K$ $\qquad$ $w_i = Weight\ assigned\ to\ output\ y$

$x_{ik} = Quantity\ of\ input\ 'i'\ formed\ by\ DMU_K$ $\qquad$ $u_j = Weight\ assigned\ to\ output\ x$

This fractional program can be converted into a linear program as below to estimate the relative efficiency of DMUs.

$$max\emptyset_k = \sum_{i=1}^{s} w_i y_{ik}$$

subject to

$$\sum_{j=1}^{m} u_j x_{jk} = 1$$

$$\sum_{i=1}^{s} w_i y_{it} - \sum_{j=1}^{m} u_j x_{jt} \leq 0 \qquad t = 1, \ldots\ldots\ldots\ldots, n$$

$$w_i \geq \varepsilon \; u_j \geq \varepsilon \quad i = 1 \ldots\ldots\ldots\ldots\ldots s \quad j = 1, \ldots\ldots\ldots\ldots\ldots m$$

The efficiency score could be obtained by solving the above linear equation. A DMU will be considered efficient in relation to others only when $\emptyset_k = 1$. If $\emptyset_k < 1$, it will be inefficient. The data for the current study was collected from the cement companies listed in the stock exchange of KSA. The data was primarily taken from the publicly available audited financial results of companies. Wherever it is not available the individual annual reports of companies were consulted. Thus, the data was collected for the year from 2016 to 2019. Overall, fourteen companies' data for four years were collected. These fourteen companies are called as Decision Making Units (DMUs) for DEA analysis. So, by this way we could find fourteen observations of DMUs for four years.

3.2 Input and Output Variables

The most important thing for DEA analysis is the appropriate selection of input and output variables. As observed from the literature review section, the most appropriate input and output variables could be obtained by reviewing the existing literature available on the topic. Since we are interested in finding the technical efficiency of a production unit, the highly utilized inputs and output from existing literature could be seen as expenses incurred for obtaining the output and revenue generated from the operation function. Table 1 provides the summarize version of input and output variable utilized in the study. As mentioned in earlier section the choice of input and output rely on publicly available audited data.

Table 1
Description of Input and Output Variables

	Variables	Description	Measurement Unit
Input Variables			
1	Cost of Goods Sold	Sum of expenses, incurred in sales.	000, SAR
2	Total Expenses	Cost of sales plus other expenses incurred in one financial year.	000, SAR
Output Variables			
1	Sales	Total amount of sales made in a financial year.	000, SAR
2	Total Revenue	Sum of revenue generated from operations	000, SAR

A thumb rule that is applicable in DEA studies is that DMUs should be 3 times greater than the number of inputs and outputs used in the model (Cooper et al., 2011). Since the number of our input and output are four all together and the number of DMUs are 14 in study, i.e. ($\emptyset > 3(\sum k)$). Which means that our DMUs are three times greater than the sum of input and output all together. Therefore, the study qualifies the data sufficiency norms and data is empirically sufficient to draw the empirical results. The data thus collected was analyzed by using DEAFRONTIERSOLVER®, an adds-in to Microsoft Excel. The efficiency scores are reported in Table 2 and discussed in the next section.

4. Results and discussion

The calculated relative efficiency scores for each DMU under study are reported in Table 2. From the results reported in Table 2 we can easily notice a consistent pattern of efficient companies over the years. Where, the number of efficient companies varies between 3-4 on CRS framework. However, upon relaxation of this framework from CRS to VRS, we see that number of efficient companies on efficient frontier increases from 3-4 to 5-8. Year-wise results mentioned in Table 2 indicate that there are noticeable variations across years in technical and pure technical efficiency level. Among other fourteen companies, there appears to be an upward trend of efficiency among three companies namely City cement, Northern cement and Yanbu cement. The average efficiency of City cement company increased from 88% in 2016 to 100% in 2019. While, Northern cement has grown from 62 to 65 percent only during the period of four years. And Yanbu cement has become fully efficient in 2019 from 85 percent of efficiency in 2016. Moreover, only one company, i.e. QACCO remain technically efficient during the entire study period. The least efficient among all found to be Tabuk Cement Company (TCC), which recorded a declining trend in efficiency from 65 percent in 2016 to 57 percent in 2019. Although, other companies under study render the mixed results over the entire study period. On the other hand, if we observe the average percentage of technically efficient and technically in-efficient DMUs over the entire study period, it gives a gloomy picture. There are only 23.21% DMUs found to be efficient on CRS criteria while 76.79 remined in-efficient. There were 46.43% efficient DMUs on VRS criteria over the year found to be efficient while 53.57% found to be in-efficient. However, efficient DMUs on Scale efficiency criteria remain same as CRS, i.e. 23.21%.

Table 2
Yearly Detailed Efficiency Scores of DMUs

NO	DMU	2019				2018				2017				2016			
		CRS	VRS	SE	RTS	CRS	VRS	SE	RTS	CRS	VRS	SE	RTS	CRS	VRS	SE	RTS
1	ACC	0.7363	0.7719	0.9538	CRS	0.6081	0.6215	0.9783	IRS	0.8438	0.8497	0.9930	IRS	0.7711	0.7770	0.9923	IRS
2	CITY CEMENT	1.0000	1.0000	1.0000	CRS	1.0000	1.0000	1.0000	CRS	0.8476	0.8834	0.9595	CRS	0.8876	0.9585	0.9260	CRS
3	EPCCO	0.6622	0.6660	0.9942	IRS	0.7644	0.7773	0.9834	IRS	0.7051	0.7198	0.9796	IRS	0.6394	0.6655	0.9608	IRS
4	HCC	0.9680	1.0000	0.9680	IRS	0.7774	1.0000	0.7774	IRS	1.0000	1.0000	1.0000	CRS	1.0000	1.0000	1.0000	CRS
5	JOUF CEMENT	0.5573	1.0000	0.5573	IRS	0.5082	1.0000	0.5082	IRS	0.7281	0.8426	0.8641	IRS	0.6228	0.7167	0.8689	IRS
6	NAJRN CEMENT	0.6332	0.6833	0.9266	IRS	0.5201	0.6202	0.8386	IRS	0.5930	0.6484	0.9145	IRS	0.6175	0.6537	0.9447	IRS
7	NORTH CEMENT	0.6524	0.6558	0.9948	CRS	0.7745	0.7825	0.9897	IRS	0.7594	0.7653	0.9923	IRS	0.6281	0.6308	0.9957	IRS
8	QACCO	1.0000	1.0000	1.0000	CRS	1.0000	1.0000	1.0000	CRS	1.0000	1.0000	1.0000	CRS	1.0000	1.0000	1.0000	CRS
9	SAUDI CEMENT	0.8189	1.0000	0.8189	DRS	1.0000	1.0000	1.0000	CRS	1.0000	1.0000	1.0000	CRS	1.0000	1.0000	1.0000	CRS
10	SPCC	0.8195	1.0000	0.8195	DRS	0.9310	1.0000	0.9310	DRS	0.9261	1.0000	0.9261	DRS	1.0000	1.0000	1.0000	CRS
11	TCC	0.5761	0.7344	0.7844	IRS	0.4303	0.6693	0.6429	IRS	0.5411	0.9141	0.5919	IRS	0.6532	1.0000	0.6532	IRS
12	UACC	0.8386	1.0000	0.8386	IRS	0.7292	1.0000	0.7292	IRS	0.8247	1.0000	0.8247	IRS	0.4570	1.0000	0.4570	IRS
13	YCC	1.0000	1.0000	1.0000	CRS	0.8718	0.9927	0.8782	DRS	0.9132	0.9659	0.9454	DRS	0.8587	0.8601	0.9983	CRS
14	YSCC	0.7918	0.7995	0.9903	DRS	0.6788	0.6826	0.9944	DRS	0.7148	0.7212	0.9911	IRS	0.7674	0.7716	0.9946	IRS
Number of Technically effi-		03	08	03		03	07	03		03	05	03		04	06	04	
Number of Technically in-ef-		11	06	11		11	07	11		11	09	11		10	08	10	

Annotations: *DMUs= Decision Making Units, CRS= Constant Return to Scale, VRS= Variable Return to Scale, SE= Scale Efficiency, RTS= Return to Scale, IRS= Increasing Return to Scale, DRS= Decreasing Return to*

The intergroup analysis of DMUs' average efficiency score indicates that during the study period from 2016-2019, the average efficiency level ranged between 55% to 100% (see Table-3).

Table 3
Average efficiency score of DMUs during study period

DMUs	CRS	VRS	SCE
ACC	0.7398	0.7550	0.9794
CITY CEMENT	0.9338	0.9605	0.9714
EPCCO	0.6928	0.7072	0.9795
HCC	0.9363	1.0000	0.9363
JOUF CEMENT	0.6041	0.8898	0.6997
NAJRN CEMENT	0.5909	0.6514	0.9061
NORTH CEMENT	0.7036	0.7086	0.9931
QACCO	1.0000	1.0000	1.0000
SAUDI CEMENT	0.9547	1.0000	0.9547
SPCC	0.9191	1.0000	0.9191
TCC	0.5501	0.8295	0.6681
UACC	0.7124	1.0000	0.7124
YCC	0.9109	0.9547	0.9555
YSCC	0.7382	0.7437	0.9926

Annotations: *DMUs= Decision Making Units, CRS= Constant Return to Scale, VRS= Variable Return to Scale, SE= Scale Efficiency.*

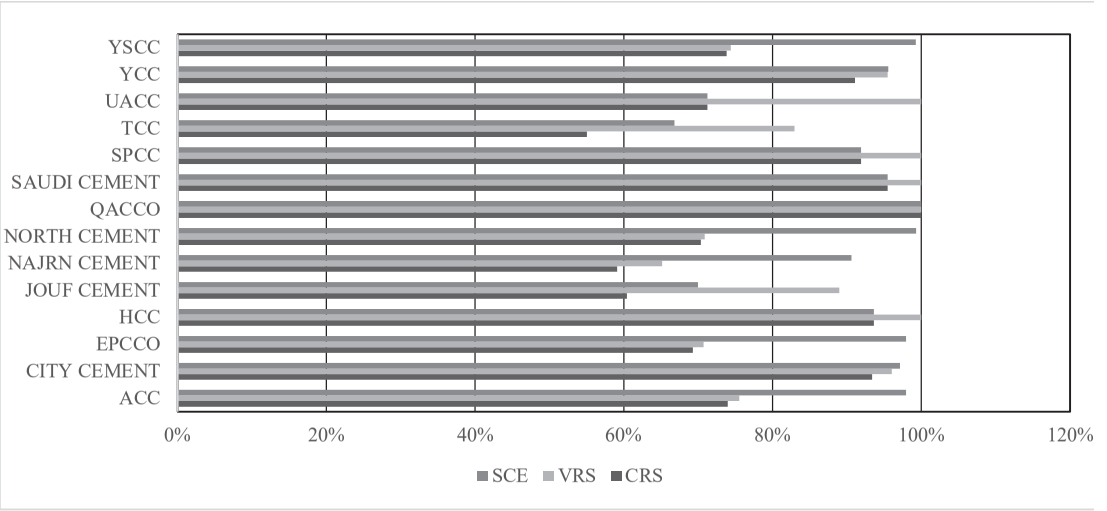

Fig. 1. Technical and Scale Efficiency of Saudi Cement companies during, 2016-2019

Companies like QACCO found to be efficient throughout the study period in utilizing their inputs. Moreover, there are other companies like, HCC, SAUDI CEMENT, SPCC and UACC also found to be efficient on an average. Among them Saudi cement company proclaimed to be the "leader in the Saudi cement industry in terms of efficiency, quality and profitability". The results mentioned here support the claim of the company. However, there are other companies which remain inefficient on technical scale need to work upon the contraction of their inputs. Nevertheless, one of the prominent advantages of DEA analysis is that it provides direction for inefficient DMUs to come on efficiency frontier and be efficient. Therefore, based on achieved efficiency score it can be suggested that companies like, ACC should contract their inputs from 25 to 27 percent to be efficient on efficiency frontier. City cement should contract around 4 to 7 percent. EPCCO should contract around 30 to 31 percent. JOUF CEMENT, NAZRAN CEMENT & TCC should contract around 11 to 40 percent, 35 to 41 percent and 17 to 45 percent respectively. While, YCC and YSCC should go for around 5 to 9 percent and 26 to 27 percent contraction in their inputs in order to be efficient. Figure-1 indicates that out of 14 DMUs only 5 DMUs reach to 100 percent efficiency level. Which almost count to thirty six percent of overall population of DMUs.

5. Summary and conclusion

This paper has endeavored to investigate the technical and scale efficiency of listed cement companies in Saudi Arabia. The study could be considered as one of the important studies among cement sector in KSA. Other studies (e.g. Alsultanny & AlZuhair (2017), Roychoudhury (2020)) available in literature evaluated the market share and other aspects of cement companies in KSA. However, there are efficiency studies available for other sectors in KSA. Input oriented BCC and CCR, DEA models were used to measure the efficiency. The study found that QACCO, SAUDI CEMENT and HCC were the three companies which could be considered as market leader of sector in terms of efficiency. Interestingly, these lead the sector in terms of market share altogether and revenue generation. The study has also revealed that other companies in the sector were also potential to outperform on efficiency front. However, the overall efficiency level among Saudi cement companies remained depressing. Over a period of four years and on an average efficiency scale only 23% firms are CCR-efficient, while 46% firms are BCC-efficient, 36% of the firms maintained Pure Technical Efficiency and only 23% of them were scale and technically efficient. Moreover, the study has noticed that the companies which were inefficient did not have the considerable distance from the efficiency frontier. The study has also provided significant insights on the input factors causing inefficiency and suggestion to achieve the total technical efficiency. Furthermore, the efficiency analysis also provides benchmarking firms (who are efficient in several criteria) for others to imitate their best practices for becoming a significant player on efficiency frontier. The study could be seen as the first of its' kind among the Saudi cement sector. However, the study did not capture the impact of current pandemic (COVID19) situation due to unavailability of appropriate data. Therefore, in future a study can be carried out by taking more data points to compare the pre and post pandemic scenario.

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Appendix- A

SN	DMU NO	DMU CODE	FULL FORM
1	DMU1	ACC	Arabian Cement Company
2	DMU2	CITY CEMENT	City Cement Company
3	DMU3	EPCCO	Eastern Province Cement Company
4	DMU4	HCC	Hail Cement Company
5	DMU5	JOUF CEMENT	Al Jouf Cement Company
6	DMU6	NAJRN CEMENT	Najran Cement Company
7	DMU7	NORTH CEMENT	Northern Region Cement Company
8	DMU8	QACCO	Qassim Cement Company
9	DMU9	SAUDI CEMENT	Saudi Cement Company
10	DMU10	SPCC	Southern Province Cement Company
11	DMU11	TCC	Tabuk Cement Company
12	DMU12	UACC	Umm Al-Qura Cement Company
13	DMU13	YCC	Yanbu Cement Company
14	DMU14	YSCC	Yamama Cement Company