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WATER INTENSITY OF THE INDIAN CEMENT SECTOR: AN EVALUATION OF ITS PERFORMANCE AND IMPROVEMENT

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Abstract
The Indian cement industry is poised to grow and play an even greater role in the economy as it continues to develop. In such an important industry, the reduction in water per unit of real turnover is vital for the industry to sustain itself. In this study, we calculate the water intensity of nine companies in the cement sector, which make up more than 80 percent of the market share. Water intensity per unit of real turnover is calculated using secondary data available from the company reports of nine companies for the years 2016-2017 to 2023-2024. Subsequently, changes in water intensity were ascertained using simple linear regression trend models. Additionally, the sector's water intensity for each year was estimated using a weighted harmonic means, and changes over time were ascertained similarly. Our findings suggest that out of the nine companies selected; only three have reduced their water intensity to the point where the reduction is statistically significant with two companies with a statistically significant increase. The changes in the remaining four companies, three of which show an apparent reduction, are statistically insignificant at the 5 percent level. This insignificant reduction is also the case when the sector's water intensity is seen over time.

Introduction

Background

Among the Sustainable Development Goals (SDGs) only 17% of the targets have either been met or are on track to be met, and four goals: SDG 1 (No poverty), SDG 6 (Clean water and sanitation), SDG 13 (Climate action), and SDG 16 (Peace, justice and strong institutions) do not have a single target on track to be met by 2030 (United Nations, 2024). The importance of water for the survival of human society cannot be overstated, and its efficient use as set in target 6.4 must be sought after. While the majority of water is used for agriculture, its use in industries is also noteworthy. Developing countries such as India are expected to witness a growth in their industries in the process of development, and the question of water and its efficient use in industries is worth raising. Aiming for industries to use water more efficiently is necessary since inefficient usage would render production unsustainable. For developing countries like India, an unsustainable path for production will lead to a dead end.

As one of India's core industries, cement plays and will continue to play a big role while country's infrastructure grows. Although it is the second largest producer of cement in the world, India still possesses ample room for growth (Rao,2016). Its growth seems obvious since as the country develops, its infrastructure will grow, and so will the demand for cement and its production. Within this context, increasing the efficiency of companies within this sector with regards to water ought to be an important target. The Government of India in its *National Water Policy 2012* has noted the need to increase efficiency of "industrial processes" (Government of India, Ministry of Water Resources, 2012). This recognition of industries needing to improve upon their efficiency vis-à-vis water can be seen as a positive step, but only an actual increase in efficiency can make the production process sustainable. This study makes use of the data on water withdrawal to ascertain how far have companies in this important core sector paid attention to their efficiency vis-à-vis water. We are aware that companies may use water in what are considered to be more responsible sources of water (rainwater harvesting for instance), but the central figure that we are concerned with here is water

withdrawal relative to turnover. In such a case, the otherwise important question of withdrawing water from more responsible sources takes a backseat. We are focused on questions on water intensity in the cement sector across time, both in individual companies and the sector as a whole.

This issue is one that both the United Nations and the Government of India have recognised for economic activities. But does the cement sector in India recognise it in action, and have companies within the sector moved towards this target of reduction? That is what this study will be looking into by starting from the point of water intensity.

Literature Review

Water Efficiency

Water efficiency can be measured in terms of water relative to the production output (either in terms of unit of production or in currency form) or alternatively production output in terms of water consumed (Sengupta, 2018). The SDGs make use of the latter and term it as "water-use efficiency", while the Business Responsibility and Sustainability Report (BRSR) makes use of the former and calls it "water intensity". Regardless of how it is measured, water intensity is a capable tool in measuring the water efficiency of an industry (Sengupta, 2018). Industrial water usage is set to increase over time in India (Joseph et al., 2019; Suresh, 2021) which makes such a measure even more important.

The measure of water intensity as it stands within the BSRSs is not without criticisms. It has been touted as an "unclear indicator", as the calculation of water withdrawal in terms of turnover could lead to a lower water intensity if the value of the products increase, with both the turnover and the water withdrawal being the same (Yadav & Srivastava, 2024).

Environmental Sustainability and Cement Sector

Prior studies in the sphere of environmental sustainability in the cement sector across the world have noted the sector's emissions and its energy usage (Ahmed et al., 2021; Cantini et al., 2021; Madlool et al., 2011; Mandal & Madheswaran, 2010). This limited approach has been underscored by studies which have found that landscape of reporting on sustainability of companies in India is limited to "basics" of recycling and energy efficiency (Mahajan, 2022). This however does not imply that usage of water and its consequences on sustainability have not been studied. Notably, a case study was carried out in an Iranian cement production plant using the water footprint to measure the water intensity of production (Hosseinian & Nezamoleslami, 2018).

Research gap

The literature that exists has either focused on other aspects of environmental sustainability of the cement sector (Ahmed et al., 2021; Cantini et al., 2021; Madlool et al., 2011; Mandal & Madheswaran, 2010), highlighted the consequences instead of the efficiency of water usage (Kudtarkar, 2018) or has made plant-level studies on water efficiency (Hosseinian & Nezamoleslami, 2018). We were therefore, able to identify a gap in the literature on the question of water intensity of companies in the cement sector. For this study, we limit ourselves to finding the water intensity of companies in the Indian cement industry and the sector as a whole.

Objectives

We have laid out the following objectives for this study:

1. Determination of water intensity of individual companies in the Indian cement sector from 2016-2017 to 2023-2024, that is, a period of 8 years.

2. Ascertaining the improvement or deterioration of each company's water intensity during this period.
3. Estimation of water intensity of the cement sector for the study period and the change in water intensity of the sector as a whole for the selected time period.

Methodologies Adopted

Data sources

The companies in this study were picked from CRISIL ESG Rankings (CRISIL ESG Ratings & Analytics, 2024). The cement companies in that list formed the initial set of companies for collecting data. These were the companies for which data on water withdrawal, turnover, and profits was collected from companies' annual reports, sustainability reports, and any other report that contained the information necessary for this study.

However, the initial list of companies had to be truncated since data was unavailable for some companies. This unavailability was due to the differences in companies' reporting prior to the BRSR or, as in some cases, companies not being obligated to create any reports, and them not making any. Even if companies did report on water withdrawal, there were irregularities among them when it came to the earliest year of reporting. These factors led us to land on a combination of years and companies that that would offer us the highest number of data points. The highest number of data points was attained with data of nine companies (see Table 1) for eight years (2016-2017 to 2023-2024). The selected companies had over 80% of the market share in the year 2020 (India Brand Equity Foundation (IBEF), 2022) and therefore our set of companies can be a representative of the whole cement sector to some extent.

Formulae and tools

Water intensity has been measured as follows:

$$I_{ct} = \frac{W_{ct}}{T_{ct}} \quad \dots(i)$$

Here I_{ct} is the water intensity of company c, at year t for all companies and years selected for this study. W_{ct} and T_{ct} stand for the water withdrawal and turnover for company c, at time t respectively. Since turnover is a monetary figure, it is subject to inflation, whereas water withdrawal is not. This would lead to an underestimation of water intensity, implying improved water efficiency, where it may not be the case. To counter this, we deflate the value of turnover for a given year by the wholesale price index for cement for that year. Therefore, when we state turnover, we do not mean the nominal turnover of that company in that year. Instead, we refer to this deflated value and use it for further calculation. The wholesale price indices for each year have been obtained from the respective RBI Bulletins (Reserve Bank of India, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024). This would provide us with an idea of water intensity of each company sans the impact of inflation on company turnover.

With the water intensity of each company now known, we would be able to calculate trend lines of each company's water intensity. We do this by making simple linear regression trend models for each company. The simple linear regression trend model is of the form:

$$W_c = a_c + b_c \cdot t \quad \dots(ii)$$

In this case, the intercepts (a_c) and slopes (b_c) of each trend line would indicate how each company has performed, and improved over this time period. The value of the intercept would provide us with the

baseline of a company's water intensity, whereas the value of the slope would give us a sense of how the company has changed in terms of its water intensity. Simple linear regression trend models are calculated using the GNU Regression, Econometric and Time-series Library (GRETL).

Assuming that much like in 2020, the selected companies form a large portion of the market share, we can estimate the sector's water intensity for the time period of our study. We estimate this using the weighted harmonic mean of the companies for each year. We calculate the weighted mean using the "a_hmean" command in the COINr package (Becker et al., 2022), making use of the deflated turnover as the weights. With this estimate now obtained for each year, we can form a trend line equation similar to what we did with each individual company. Not only would this trend line serve us with the industry's baseline and change, it would also serve as the benchmark to assess the performance of each company for each year, vis-à-vis the sector.

It is worth noting here that two companies, ACC Limited and Ambuja Cements Limited, switched their financial year to April-March from January-December in 2023-2024, and had a fifteen month financial year from January 2022 to March 2023. To adjust the monetary figures for these companies, we took quarterly figures and clubbed them together as needed to be consistent with the April-March year used by all other companies for this time period. In case of water withdrawal, we assumed that it was uniform across the year, and made necessary adjustments to convert it from a January-December year to an April-March year.

Findings

In Table 1, we lay out values of water intensity for the selected companies over the eight years picked for this study. We are able to see both how water intensive companies were in a given year, and how much the water intensity for each company has changed over the years.

Table 1: Water Intensity of Companies (Inflation adjusted) [Litre/Rs. 1000]

	2016-2017	**2017-2018**	**2018-2019**	**2019-2020**	**2020-2021**	**2021-2022**	**2022-2023**	**2023-2024**
ACC Limited	146.02	136.29	111.57	92.45	79.77	44.47	75.68	98.65
Ambuja Cements Limited	35.86	31.59	27.36	28.54	27.38	27.65	23.80	23.35
Dalmia Bharat Limited	29.70	25.33	23.86	25.94	33.67	44.80	46.51	43.47
JK Cement Limited	38.02	37.52	33.91	31.31	31.11	28.47	30.63	34.46
JK Lakshmi Cement Limited	46.18	35.22	30.98	30.67	28.64	27.75	24.46	21.84
Orient Cement Limited	68.43	61.96	54.83	74.51	77.51	70.96	71.46	54.75
Sagar Cements Limited	28.54	27.41	41.31	33.56	27.33	43.54	49.23	49.34
Shree Cement Limited	27.91	25.49	21.16	22.10	20.28	19.12	25.82	26.09
UltraTech Cement Limited	64.73	54.33	57.00	53.57	63.01	66.35	59.92	53.79

Source: Authors' calculations on data obtained from company reports.

Based on the information obtained from Table I, we can calculate the trends of water intensity for each company. Table 1 also puts the trends of individual companies in context, as our findings after Table 2 can be understood better if taken along with the table on which it has been built upon.

Table 2: Simple linear regression trend model of companies in the cement sector 2017-2024 (T = 8)
Dependent Variable: Water Intensity

		Coefficient	p-value
ACC Limited	Constant	143.58	0.0002
	Time	-10.10	0.0332
Ambuja Cements Limited	Constant	34.99	<0.0001
	Time	-1.51	0.0015
Dalmia Bharat Limited	Constant	19.48	0.0038
	Time	3.27	0.0083
JK Cement Limited	Constant	37.24	<0.0001
	Time	-0.90	0.0802
JK Lakshmi Cement Limited	Constant	43.3568	<0.0001
	Time	-2.8085	0.0012
Orient Cement Limited	Constant	66.638	<0.0001
	Time	0.0363	0.9808
Sagar Cements Limited	Constant	23.8604	0.0029
	Time	3.0377	0.0212
Shree Cement Limited	Constant	24.5144	<0.0001
	Time	-0.2263	0.6836
UltraTech Cement Limited	Constant	59.087	<0.0001
	Time	-0.1322	0.8826

Source: Authors' calculations.

As is evident upon viewing Table II, only three companies have significantly decreased in water intensity over this period: ACC Limited, Ambuja Cements Limited and JK Lakshmi Cement Limited. ACC Limited was able to reduce its water intensity over time, although the higher reduction could be due to its average (intercept term) being much higher than other companies, thus providing more room for improvement. Even with such reductions, it is consistently the most water intense company within the sector during this period as can be seen in Table I. Additionally, if we focus on the last three years of the selected period, that is from 2021-2022 to 2023-2024, we see a consistent increase in water intensity, and if such trend continues, the reduction that we have seen here will not hold for long. For Ambuja Cements Limited, the intercept term is much lower than ACC Limited, and therefore there is less room for improvement. JK Lakshmi Cement Limited has reduced its water intensity in this period as well. Examining Table I also makes it worth noting that for the year 2023-2024, JK Lakshmi was the most water efficient company in the sector as well.

Out of the remaining six companies, two have witnessed a statistically significant increase in water intensity over this period: Dalmia Bharat Limited and Sagar Cements Limited. Looking into Table I, we find that both the companies have grown their water intensity from figures less than 30 liters per INR 1000 of turnover (in real terms) to values more than 40 liters per INR 1000 of turnover (again, in real terms). In case of Sagar Cements Limited, it is just short of 50 liters per INR 1000. While these figures are still less than that of ACC Limited, Orient Cement Limited, and UltraTech Cement Limited, this upward trend is a matter of concern.

All other companies have only seen insignificant changes in their water intensity during this time. Of the four companies, three have shown statistically insignificant reductions and one has displayed

insignificant increase. JK Cement Limited shows a reduction in their water intensity during this period, although the coefficient is not statistically significant at 5% level of significance. What we can infer from this is therefore that although an apparent reduction has taken place over this time, it is not significant enough for us to drive to any conclusion on changes in JK Cement's water intensity over this period. Therefore, on the question of reduction of water intensity reduction, we remain somewhat doubtful. Shree Cement Limited shows a small reduction in water intensity during this time. Additionally, this reduction in water intensity across time (that is, the slope coefficient), as can be viewed in Table II is also statistically insignificant, implying that the apparent reduction cannot be inferred to be an actual reduction in water intensity. Table II shows that the slope coefficient of UltraTech Cement Limited's water intensity is negative, implying that the company has reduced its water intensity. This reduction however, is not statistically significant and therefore keeps our idea on the company's changes with regards to water intensity inconclusive. Orient Cement Limited shows a statistically insignificant model and therefore any increase that might appear is largely due to chance. On its own, the increase itself is not a large number, and the increase can be seen as negligible.

To summarize the changes in water intensity of companies during this period, we find that out of nine companies, six have reduced their water intensity, although only half of them have reductions that are statistically significant. Among the three companies for which we find an increase in water intensity only one is statistically insignificant.

So far, we have seen how individual companies have performed on the question of water intensity. We now move on to seeing the performance of the sector in its entirety, to the extent that it is possible. Table III shows the weighted harmonic mean of water intensity of the whole sector. Since the selected companies have at least more than 80% of the market share (India Brand Equity Foundation (IBEF), 2022), the weighted harmonic mean should be able to give us a fair estimate of the sector's water intensity. Upon observation, we see that while the sector's water intensity has reduced in the first two years, it has hovered around the 37-38 literlitreINR 1000 mark. Looking back at Table II where three companies have significantly reduced their water intensity and two companies have significantly increased it, a stagnancy like this is not out of the realm of possibility.

Table 3: Weighted Harmonic Mean of Water Intensity in the Cement Sector [In Litre/Rs. 1000]

	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Weighted harmonic mean	45.20	40.02	37.06	37.23	37.95	37.37	38.82	38.04

Source: Authors' calculations.

Table 4 depicting the simple linear regression trend model of the weighted harmonic means shows a similar picture as well. Although there is a reduction, its p-value is 0.1251, and therefore insignificant even at the 10% level albeit not by a large margin. What this implies is that while some companies in the sector have reduced their water intensity, others have either not done it well enough, or have done the opposite. This has led to a situation where the sector appears to have made very little improvement in its efficiency vis-à-vis water.

Table 4: Simple linear regression trend model of the cement sector 2017-2024 (T = 8)
Dependent Variable: Water Intensity

	Coefficient	Std. Error	t-ratio	p-value	
Constant	41.8798	1.838	22.79	<0.0001	***
Time	-0.6484	0.364	-1.78	0.1251	
R-Squared	0.346				

Source: Authors' calculations.

Conclusion

Sustainable water usage is indispensable, and an efficient usage of this priceless resource is just a single step towards this goal. So far, the global economy is lagging behind on its way to reach the SDG target of increasing water-use efficiency. As our findings suggest, the case is no different for this sector. With only three companies significantly reducing their water intensity over an eight year period, and two companies showing a significant increase, there is a long way to go in terms of reducing water intensity. The trend for the sector also reveals a grim picture, where although there has been a reduction, it is not statistically significant implying therefore that the companies in this sector has failed, as a whole, to reduce their water intensity. Given the importance of the sector and its potential for growth, the time to act is now. Since the sector as a whole has been unable to reduce its water intensity, stakeholders need to take a more vigilant attitude towards efficient usage of water. Regardless of how it is sourced, reducing water intensity in itself should be a target for stakeholders concerned with sustainable usage of water. Using up more water than what is needed means less water available to certain stakeholders, such as the population residing near the plants. It is these stakeholders who need to be made aware and empowered. Companies should, own their own accord, work towards reducing their water intensity similar to what a few companies have achieved.

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