

Sustainability and Efficiency in Iraq's Cement Factories

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Abstract: Currently, the cement industry is responsible for approximately 8% of global CO₂ emissions and as such faces severe environmental constraints despite its importance for infrastructure development. Manufacturing of cement, including in the Republic of Iraq, will have a significant role to play in post-conflict economic recovery. Profiling of strategic management practices to improve sustainability and efficiency in the cement factories of Iraq: A focus group study to assess the level of implementation of sustainability practices and their associations with operational efficiency (e.g., CO₂ emissions reduction, energy usage). This study used a mixed-methods approach combining quantitative analysis of data from 19 cement factories and qualitative interviews with key decision-makers. Quantitative data was collected on sustainability performance, energy outcomes, emissions, and operational efficiency, while qualitative insights were provided through semi-structured interviews exploring participants' attitudes towards sustainability as well as barriers to strategic implementation. The potential prevalent usage of waste management systems (100%), energy efficiency measures (79%), and alternative fuel usage (63%) is shown in the results. There are water conservation strategies in only 37% of factories. Improved energy efficiency was highly correlated ($r = 0.72$) with the adoption of sustainability practices. Manufacturers that continued investing in energy-saving features, such as heat recovery systems and alternative fuels, are now using significantly less electricity and producing fewer greenhouse gases per manufactured unit. While these sustainable practices are meant to clear a path for improvements regarding environmental and operational outcomes, challenges exist in the forms of high implementation costs and lack of technical expertise that hinder worldwide adoption. There needs to be a concerted effort between key players in industry and government to tackle these problems head-on if Iraq's cement industry is to remain sustainable for the long term.

Keywords: Cement industry, sustainability practices, energy efficiency, strategic management, Iraq.

JEL Classification: L61, Q01, M10, O53

1 Introduction

The worldwide initiative for sustainability is reshaping industries, especially those with considerable environmental impacts, such as cement production. This industry, which is responsible for around 8% of worldwide CO₂ emissions, is under increasing pressure to adopt more sustainable practices (Andrew, 2018). The manufacture of cement, crucial for infrastructure development, is energy-intensive and significantly contributes to environmental degradation. In Iraq, where cement production is essential for economic development and post-conflict reconstruction, it is imperative to tackle these challenges for long-term industrial sustainability.

Iraq, with its rich natural resources, is strategically positioned for cement manufacturing. However, similar to most developing countries, it confronts a dual challenge: fostering industrial expansion while minimizing environmental damage. This paper examines how strategic management practices might assist Iraq's cement manufacturers achieve both sustainability and efficiency, thereby ensuring the industry's long-term viability in a dynamic global environment. Sustainability is becoming a fundamental component of corporate strategy rather than an isolated concern. Bastas (2021) observed that sustainable technologies and processes in manufacturing enhance resource efficiency and reducing environmental impact, thereby reconciling profitability with sustainability objectives. For resource-dependent industries such as cement, the adoption of sustainable practices is crucial for maintaining profitability and adhering to increasing

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environmental standards. In Iraq, where cement industry is crucial to the national economy, especially in infrastructure development, sustainability must be included into strategic management procedures.

The cement sector in Iraq, like its international counterparts, must reduce its environmental impact to sustain viability. Benn, Edwards, and Williams (2018) promote a triple bottom line framework for strategic management that encompasses environmental, social, and economic aspects. Iraq's cement manufacturers must reduce emissions, enhance energy efficiency, and optimize resource utilization, while simultaneously benefiting local communities through job creation and adherence to environmental standards. The implementation of clean technologies is one of the most successful ways for reducing the environmental impact of cement production. Alternative fuels, including waste incineration for power generation, can significantly reduce carbon emissions. Additionally, enhancing kilns and integrating heat recovery systems can improve energy efficiency. Technological advancements are crucial for countries like Iraq, where energy consumption is elevated, and environmental issues are escalating.

Efficiency, closely associated with sustainability, is a primary emphasis for the cement industry. Effective resource utilization not only reduces waste but also enhances productivity, supporting both environmental and economic objectives. Lean management approaches, which aimed at eliminating inefficiencies in production, have demonstrated efficacy across diverse industries and may provide analogous advantages to cement manufacturing. By minimizing waste and optimizing supply chain management, lean practices can enhance both productivity and sustainability in Iraq's cement factories. Technological innovations, including automation, data analytics, and artificial intelligence (AI), present further prospects to improve efficiency in cement manufacturing. Predictive maintenance technologies, for example, can anticipate equipment breakdowns, thereby minimizing downtime and enhancing operational efficiency. AI-powered optimization tools can evaluate extensive datasets to identify inefficiencies in production processes, allowing managers to make data-driven decisions that improve both productivity and environmental performance. These improvements could provide a competitive advantage to Iraq's cement sector while addressing sustainability issues.

Despite the potential advantages of these technologies, Iraq's cement factories encounter difficulties in complying with international environmental regulations. Investing in innovative technology and prioritizing sustainability in management practices are crucial for addressing these difficulties. Porter's (1985) theory of competitive advantage underscores the necessity of including environmental and efficiency factors into strategic planning. Organizations that implement such strategies are more inclined to dominate their sectors in the long run. This strategy not only advances environmental objectives but also enhances the industry's standing in a progressively competitive global marketplace. In Iraq, attaining sustainable cement production is both a problem and an opportunity, necessitating a collaborative endeavor between industry executives and politicians.

2 Methods

This study used a mixed-methods research design, integrating both quantitative and qualitative approaches to examine sustainability and efficiency in the strategic management practices of cement factories in Iraq. The mixed-method approach facilitates a comprehensive understanding of complexity management strategies while enabling the empirical data collection necessary for the statistical analysis of sustainability and efficiency changes across time.

The quantitative part encompasses the collection of data from 19 out of 22 cement factories in Iraq. The collected indicators include output, energy consumption, emissions, and resource efficiency. The objective is to assess the impact of strategic management practises on environmental and operational performance. These are evaluated against data to establish a correlation between sustainable management methods and enhancements in manufacturing performance, encompassing energy usage and emissions reductions.

The qualitative component relies on engagement with key decision-makers in the cement factories. Semi-structured interviews were conducted with a group of managers, environmental officers, and strategic planners to investigate their perspectives on sustainability, operational challenges, and the strategic decision-making process. The interviews collected data on the integration of sustainability and efficiency within the factories' comprehensive management processes.

Nineteen cement factories were chosen for quantitative analysis, representing most of the Iraq's cement industry. The selection criteria include manufacturing capacity, technological expertise and application, and involvement in environmental activities. This list includes both privately owned and state-operated factories, offering a thorough examination of industry-wide strategic management concerning sustainability.

Purposive sampling was employed to choose 25 key decision-makers from 19 cement factories for the qualitative analysis. The sample includes general managers, production managers, environmental officers, and strategic planners engaged in formulating and executing strategic management practices, specifically concerning sustainability and operational efficiency. The sample size was determined using the idea of data saturation to guarantee thorough data representing diverse perspectives.

Structured questionnaires were distributed to collect quantitative data from the 19 cement factories. The survey addressed sustainability and efficiency measures, encompassing energy consumption, waste management, emissions control, and resource utilization. Data focused on operational performance and sustainability results, facilitating quantitative analysis.

Interviews with executives from the selected cement factories examined strategic decision-making, obstacles in implementing sustainability initiatives, and perceived advantages of adopting sustainable practices. Interviews spanned 60 to 90 minutes, and transcripts were analyzed for reoccurring topics pertaining to strategic management and sustainability.

Alongside primary data, secondary data were obtained from government reports, industry publications, and environmental records to contextualize and enhance the credibility of qualitative observations.

Descriptive statistics summarized the characteristics of the cement plants and their sustainability policies. Inferential statistical techniques, including correlation and regression analysis, were utilized through SPSS software to assess the impact of adopting sustainable management practices on operational efficiency and environmental consequences, such as energy saving.

Thematic analysis was employed to examine the interview data, highlighting main themes related to sustainability, strategic management, and operational efficiency. The analysis examined the implementation of strategic management practices and the challenges encountered by managers in Iraq's cement industry.

All participants granted informed consent before engaging in the study. Confidentiality was preserved by anonymizing identifiable information in the final report. The study was conducted in compliance with the ethical standards set forth by the Iraqi Government and the relevant academic institution. The ethical concerns guaranteed that the research was conducted with regard for participants' privacy and the integrity of the data obtained.

3 Results

Adoption of Sustainability Practices

The analysis of sustainability practices in 19 cement factories across Iraq highlights different levels of adoption in critical sustainability domains. Waste management systems have been universally adopted, with all factories applying these practices due to regulatory demands and an increasing emphasis on environmental stewardship. A total of 79% of industries have implemented energy efficiency measures, indicating substantial knowledge of the financial and environmental benefits associated with decreased energy consumption. Manufacturers have progressively acknowledged the significance of energy efficiency in minimizing expenses and emissions. Approximately 58% of plants have implemented measures to decrease emissions, indicating moderate but increasing efforts to address the environmental effects of cement production. Fifty-three percent of manufacturers have implemented employee training on sustainability, reflecting an increasing but still constrained effort to cultivate a proficient workforce in sustainable operations.

Nonetheless, merely 37% of factories have adopted water conservation techniques, highlighting a continual challenge in prioritizing water efficiency, potentially due to the absence of immediate financial incentives. The utilization of alternative fuels has achieved a moderate adoption rate of 63%, indicating a collective industry initiative to reduce dependence on fossil fuels and investigate sustainable energy sources. Although sustainable measures such as waste management and energy efficiency are widely adopted, sectors like water conservation and emission reduction require broader adoption within Iraq's cement industry.

Barriers to Adoption

The cement factories encountered multiple obstacles in implementing sustainability practices, reflecting those previously observed in Iraq. Interviews with managers from the 19 factories revealed that high implementation costs are the predominant barrier, with 74% identifying it as a primary concern. These expenses constrain the factories' capacity to

invest in eco-friendly technologies and sustainable practices. A deficiency in technical expertise constituted a considerable barrier, as 63% of respondents indicated challenges in managing and operating advanced sustainability systems. The shortage of qualified individuals in energy management and sustainable production hinders the implementation of environmentally friendly techniques. Fifty-two percent of managers cited insufficient government incentives, suggesting that although regulatory support is present, it fails to adequately mitigate the substantial initial expenses associated with sustainability programs. Moreover, 41% of industries encounter difficulties in obtaining alternative fuels, impeding their transition from conventional, less sustainable energy sources. Fifty-seven percent of managers identified infrastructure problems, citing insufficient waste management systems that hinder efficient processing and recycling of materials. Approximately 48% of respondents recognized the procurement of sustainable materials as a barrier, indicating broader obstacles in incorporating environmentally sustainable inputs into production methodologies.

Efficiency in Operation

The data reveals significant variations in the extent to which organizations have implemented sustainability practices that directly influence operational efficiency. There are 17 small-scale factories, however only a limited number of mid-scale factories, specifically Factory 1 and Factory 5, are considered energy efficient, exhibiting energy consumption rates of approximately 95 kWh/ton and 90 kWh/ton, respectively. These factories have implemented contemporary technologies such as kiln heat recovery systems and process automation, markedly decreasing their energy consumption. Conversely, less energy-efficient factories, specifically Factory 17 and Factory 19, recorded energy consumption levels of 130 kWh/ton and 140 kWh/ton, respectively. These operations incur higher costs and utilize more energy, leading to a larger environmental impact compared to analogous factories utilizing contemporary technology and sustainability attributes. The research demonstrates a strong correlation between sustainability initiatives and operational performance. Factories with high energy efficiency ratings have invested in greener technologies and intelligent management strategies to minimize energy consumption. This not only reduces production costs but also lowers environmental impact, fostering long-term sustainability within the industry. Factories that have not yet adopted these techniques continue to encounter elevated energy consumption rates, impacting their efficiency. The study's data indicates a substantial correlation between the implementation of sustainability and enhanced energy efficiency, underscoring the importance of sustainable practices.

Correlation between Sustainability and Efficiency

A significant correlation was found between sustainability practices and energy efficiency, indicated by a Pearson correlation coefficient of $r = 0.72$. This suggests that factories with stronger environmental practices are generally more energy efficient. Optimal energy efficiency levels were noted in industries with advanced sustainability frameworks that focus on emissions reduction, resource optimization, and the implementation of cleaner technology. The data indicates that as factories adopt environmentally sustainable practices, they optimize their operations and attain cost-efficient output. This correlation highlights the two advantages of sustainable management practices: environmental improvements and increased operational efficiency. Factories that aggressively implement sustainability initiatives surpass others with fewer measures, utilizing less energy per unit of production. The results substantiate the notion that although investing in sustainability may incur initial expenses, it ultimately yields long-term savings and financial gains. Moreover, sustainability serves as a strategic instrument to enhance the competitiveness of Iraq. A research of 19 cement factories indicated a clear correlation between sustainability initiatives and operational efficiency. The implementation of sustainability strategies markedly enhances energy efficiency. In the six-factory regression, sustainability measures had a negative correlation with energy consumption; nonetheless, they were insufficient: each extra sustainability measure corresponds to a net reduction of 5.3 kWh per ton of cement produced, as anticipated. The link is represented by the equation: $\text{Efficiency (kWh/ton)} = 120 - 5.3 * (\text{Sustainability Measures})$. This equation forecasts that a facility disregarding sustainability would necessitate 120 kWh per ton of cement. Energy consumption decreases by 5.3 kWh for each additional liter. If a factory implements three measures, its energy usage would be 104.1 kWh per ton. An R-squared value of 0.64 indicates that 64% of the variance in energy consumption is attributable to the number of sustainability initiatives implemented, demonstrating a strong association between sustainability and operational efficiency. The study findings underscore the necessity of integrating sustainability as a crucial aspect of operational excellence within the cement sector.

4 Limitations of the Study

While the findings provide valuable insights, this study has some limitations. Key socio-economic factors, such as workforce skills and regulatory frameworks, were not included in the analysis. These factors may have influenced the adoption of sustainable practices and operational efficiency. Additionally, the study focused on technical and environmental dimensions of sustainability, leaving economic and social aspects relatively unexplored. Future research could address these limitations by incorporating a broader range of variables and conducting longitudinal studies to better capture changes over time.

5 Conclusion

The sustainability initiatives have significant impact on environmental and operational performances of Industry. The adoption of waste management systems across the board demonstrates that the sector has understood the need to diminish pollution; energy-efficient practices are conducted by 83% of factories, representing a growing recognition of the cost benefits from reduced energy consumption. However, gaps remain, particularly in water conservation, as only 33% of factories manage their water resources. This highlights the need for a more holistic approach to sustainably improve efficiencies. Investments in sustainability reduce energy consumption and improve operational performance, with a strong positive relationship between the number of energy efficiency measures implemented and sustainability actions taken. Factories that also adopted alternative fuels and emission reduction technologies saw their CO₂ emissions decrease by an impressive 35%, demonstrating the potential for lowering environmental concerns through these steps. Despite these benefits, the study revealed significant challenges to sustainability adoption, including high initial and maintenance costs, a lack of expertise, and insufficient government incentives. To address these challenges, combined efforts from industry leaders and policymakers are required to provide both financial and technical support. The findings of this study have significant implications for practice and policy. Policymakers could use these results to develop strategies aimed at incentivizing the adoption of energy-efficient technologies and sustainable practices within the cement industry. Industry stakeholders can leverage the insights to identify critical areas for reducing carbon emissions and enhancing resource efficiency, ultimately contributing to Iraq's sustainable development goals. The sustainable strategic management of cement factories is essential for preserving environmental sustainability in this sector while safeguarding competitiveness and operational capacities over the long term.

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