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Financial Evaluation of Industrial Projects under Uncertainty: Empirical Evidence from a Phosphate Investment by OCP in Morocco

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Abstract: The main objective of this study is to assess the profitability of a strategic industrial project of the OCP Group, taking into account the financial risks and uncertainties associated with the global phosphate market over the period 2015-2025. To do this, we used recognized financial methods, including Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period, and Profitability Index (PI), while also performing sensitivity analyses and prospective scenarios (optimistic, realistic, pessimistic). The financial data has been adjusted for confidentiality (×3) and comes from internal sources within the OCP Group as well as market data. The results indicate that, in the realistic scenario, the project has a positive NPV, an IRR higher than the cost of capital, and an acceptable payback period, confirming the financial viability of the project. The sensitivity analysis shows that variations in phosphate prices and energy costs have a significant impact on profitability, but remain within acceptable safety margins. This study provides recommendations for post-investment monitoring and proposes guidelines for strengthening the financial robustness of the project. Limitations include data adjustments, the exclusion of non- financial risks (environmental, social), and the uncertainty of market forecasts.

Keywords: Profitability, Phosphate, NPV, IRR, Sensitivity, OCP, Morocco.

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1. Introduction

Industrial investment is recognized as a fundamental driver of growth and competitiveness in modern economies. According to the World Bank (2023), countries that have maintained an investment rate above

25% of GDP over the last decade have recorded average annual growth 2 points higher than the global average. In an environment marked by globalization, increased competition, and financial market fluctuations, investment decision-making requires rigorous analysis of opportunities and risks (Brealey, Myers & Allen, 2017).

Commodity markets, particularly those related to the mining industry, are particularly volatile. Global demand for phosphates, used mainly in fertilizer production, depends not only on agricultural cycles, but also on macroeconomic factors such as population growth, environmental policies, and energy costs (FAO, 2022). These dynamics require industrial players to constantly anticipate market developments and quickly adapt their investment strategies.

According to the IMF (2023), commodity price volatility increased by 30% between 2020 and 2022, heightening uncertainty for capital-intensive industrial projects.

Morocco is a key player in the global phosphate market, holding around 70% of known global reserves (US Geological Survey, 2023). The OCP Group (Office Chérifien des Phosphates) plays a central role in this industry, with a commercial presence in more than 160 countries. The company contributes nearly 20% of the country's export revenues and occupies a strategic position in the national economy (High Commission for Planning, 2023).

In a context of energy transition and economic diversification, the OCP Group's industrial investments aim not only to strengthen its production capacities, but also to integrate innovative technologies and improve its environmental footprint. Rigorous assessment of the profitability of these projects is therefore essential to ensure the financial and strategic sustainability of the investments.

The financial evaluation of an industrial project consists of determining its ability to generate positive cash flows and create value for the company (Damodaran, 2020). Among the key indicators, Net Present Value (NPV) measures the wealth created after discounting future cash flows, while Internal Rate of Return (IRR) indicates the expected return on the project. These tools, supplemented by sensitivity analyses and forward-looking scenarios, enable decision-makers to measure the potential impact of changes in key parameters (prices, costs, volumes) on the viability of the project.

The combination of the financial evaluation methods presented, together with consideration of the specific characteristics of the phosphate market and risk factors, provides a better understanding of the determinants of industrial project profitability. In this environment , marked by volatile commodity markets and competitive pressure, the central question is: "How can we reliably assess the profitability of an industrial project in the Moroccan mining sector, while taking into account the risks associated with phosphate prices, operating costs, and global market uncertainties?"

The study aims to put financial project evaluation methods into practice through a concrete case study in the mining sector, focusing on a project by the OCP Group. It seeks to measure the profitability and economic viability of the project using recognized financial indicators, while analyzing its robustness in the face of variations in the underlying assumptions.

However, a specific secondary objective is also missing from the initial analysis: comparing the profitability of the OCP project with international benchmarks (e.g., China, Saudi Arabia, Russia). This

comparison would be a relevant addition to situate the group's performance in the global mining landscape and strengthen the strategic scope of the study.

Finally, the study aims to formulate strategic recommendations to optimize decision- making and enhance project management efficiency.

To guide the empirical analysis, six main hypotheses are formulated:

- H1: The project's NPV is positive, indicating value creation for the OCP Group. NPV measures value creation according to classical financial theory (Brealey, Myers & Allen, 2017). A positive NPV indicates a direct contribution to shareholder wealth.
- H2: The IRR of the project is higher than the average cost of capital, confirming the profitability of the project. IRR represents the expected return on a project and must exceed WACC to be profitable (Damodaran, 2020).
- H3: The payback period is compatible with the company's financial objectives. The payback period measures how quickly the investment will be recovered, reflecting risk and liquidity management (Investopedia, 2025).
- H4: Fluctuations in phosphate prices significantly influence the profitability of the project. Price fluctuations directly affect cash flow and financial performance in the mining sector (FAO, 2022).
- H5: Fluctuations in energy and operating costs affect the financial robustness of the project. Production costs are a key determinant of financial viability, as shown by financial sensitivity theory (Borgonovo, 2004).
- H6: The integration of forward-looking scenarios and sensitivity analyses improves the reliability of financial evaluation and guides strategic decision- making. Real options theory and decision-making under uncertainty enhance the reliability of evaluating mining projects exposed to high levels of uncertainty (Dixit & Pindyck, 1994).

The originality of this research lies in the combination of traditional financial methods with a multi-scenario approach, integrating both sensitivity analysis and market uncertainty. This approach provides a more realistic assessment of profitability, while offering concrete recommendations for the strategic management of the OCP Group's industrial projects.

The study adopts a quantitative and applied approach, focusing on a specific industrial project of the OCP Group. The data used comes from the company's official financial reports, industry publications, and international phosphate databases. The financial evaluation is based on the calculation of NPV, IRR, and payback, supplemented by sensitivity analyses and forward-looking scenarios to measure the robustness of the project.

The approach adopted is part of the positivist paradigm, favoring empirical observation, quantification, and analysis of causal relationships between financial and economic variables. This epistemology makes it possible to test hypotheses objectively and produce generalizable results, while integrating uncertainties related to markets and operating costs.

The article is structured in six main sections. Following this introduction, the literature review presents the main theoretical and empirical approaches related to the evaluation of investment projects. The methodology section outlines the data, sources, and tools used. The results section presents the calculations

and interpretations, followed by a discussion putting the conclusions into perspective. The article concludes with recommendations.

2. Literature review: Financial evaluation of industrial projects in the mining sector

The evaluation of investment projects is a central area of corporate finance and strategic management. According to Brealey, Myers, and Allen (2017), the decision to invest is based on a comparison between the cash flows generated by a project and the costs required to implement it. An in-depth literature review provides perspective on the methodological tools available and identifies those that are most suitable for the sector under study.

In the case of the mining sector, and more specifically the phosphate market, this assessment is particularly important due to price volatility, heavy capital investment, and often long return on investment periods (Tilton, 2018).

2.1 Theoretical foundations of investment evaluation

Historically, investment decisions have been based on simple methods, such as the payback period, which measures the time required to recover the initial investment (Ross, Westerfield & Jaffe, 2019). Although this method is easy to understand, it has the disadvantage of not taking into account the time value of money (Damodaran, 2020).

Modern approaches, based on the work of Fisher (1930) and Keynes (1936), emphasize the need to discount future cash flows to determine their present value. This logic forms the basis of Net Present Value (NPV), considered by financial theory to be the most reliable criterion for assessing the value creation of a project (Brealey et al., 2017).

2.2 Methods for the financial evaluation of industrial projects

Financial indicators are the main tool for measuring a project's profitability:

- Net Present Value (NPV): measures the value creation of a project by discounting future cash flows at the weighted average cost of capital (WACC). A positive NPV indicates that the project generates value in excess of the cost of capital invested (Brealey, Myers & Allen, 2017).
- Internal Rate of Return (IRR): measures the expected return on a project and allows its profitability to be compared with other investments or the cost of capital. An IRR higher than the WACC confirms profitability (Damodaran, 2010).
- Payback period: indicates the time required to recover the initial investment. Although it does not take into account the time value of money, it remains a practical indicator of liquidity and risk (Ross, Westerfield & Jaffe, 2019).
- Profitability Index (PI): ratio between the present value of cash flows and the initial investment. A PI greater than 1 confirms value creation (Koller, Goedhart & Wessels, 2015).

These indicators are often used in combination to provide a comprehensive view of the profitability and risks associated with the project.

2.3 Sensitivity analysis and forward-looking scenarios

The literature emphasizes the importance of incorporating uncertainty into project evaluation. Monte Carlo simulation methods, sensitivity analyses, and forward-looking scenarios can be used to measure the impact of variations in prices, costs, and volumes on profitability (Hamada & Laplante, 2012).

- Sensitivity analyses identify the key variables that most influence financial results, such as raw material prices or energy costs.
- Forward-looking scenarios (optimistic, pessimistic, and realistic) can be used to test the robustness of the project under different market assumptions.

Recent studies applied to the mining sector confirm this contribution. For example, Zhang et al. (2021) show that mining projects in China are highly sensitive to international price fluctuations, while Al-Mulhim & Al-Salem (2022), in Saudi Arabia, highlight the structural dependence of phosphates on world prices, justifying the need for financial safety margins.

2.4 Risks in mining and phosphate projects

The mining sector is particularly exposed to risks:

- Market risk: fluctuations in phosphate prices influenced by agricultural demand, trade policies, and international competition (Tilton, 2018).
- Operational risk: energy costs, logistics, and maintenance of mining equipment.
- Financial risk: exchange rates, inflation, and financing of heavy investments (FAO, 2022).

In addition to these traditional risks, there are now requirements related to ESG (Environmental, Social, Governance) criteria. Recent research (Ben Slimane et al., 2020; Liu et al., 2022) recommends incorporating sustainability and energy efficiency issues into the evaluation of mining projects.

2.5 Specific features of the Moroccan context

Morocco is the world's leading exporter of phosphates, with production concentrated mainly around the OCP Group. This strategic position requires a rigorous approach to the evaluation of industrial projects:

- The economic importance of the sector (20% of export revenues) makes the profitability and sustainability of projects critical (High Commission for Planning, 2023).
- Dependence on international markets and global fertilizer prices requires forward- looking analyses and cost optimization strategies (US Geological Survey, 2023).

Comparatively, China and Saudi Arabia have adopted similar approaches by incorporating scenario analyses and energy diversification policies to reduce dependence on international fluctuations (Zhang et al., 2021; Al-Mulhim & Al-Salem, 2022).

2.6 Summary and identified gaps

The literature shows that traditional financial evaluation is necessary but insufficient if it does not incorporate market-specific uncertainties and risks. Studies on mining projects in Morocco are

limited, particularly with regard to the integration of multi-scenario analysis and sensitivity analysis in profitability assessment.

This gap justifies the present study, which combines:

1. Traditional financial indicators (NPV, IRR, Payback, PI).
2. Sensitivity analysis and forward-looking scenarios.
3. Adaptation to the Moroccan context, taking into account the volatility of phosphate prices and operating costs.

Table 1. Approaches to industrial project evaluation in the literature

Authors & Year	**Context studied**	**Methodology used**	**Main results**
Brealey, Myers & Allen (2017)	General studies in finance	NPV, IRR, Payback period	Classic fundamentals of project evaluation.
Damodaran (2020)	International projects	Discounted cash flow	Importance of the discount rate.
Tilton (2018)	Mining sector	Market risk analysis	Price volatility as a determining factor.
Zhang et al. (2021)	China – mining sector	Sensitivity analysis applied to NPV	Profitability highly dependent on global prices.
Al-Mulhim & Al- Salem (2022)	Saudi Arabia – phosphates	Prospective scenarios + sensitivity	Vulnerability to global fluctuations.
Ben Slimane et al. (2020)	Morocco – mining sector	NPV, IRR + ESG criteria	Need to integrate sustainability indicators.
Liu et al. (2022)	Sustainable heavy industry	Financial + environmental criteria	Importance of energy efficiency.

Source: developed by the authors.

3. Methodology

The methodology adopted aims to provide a rigorous and scientifically sound assessment of the profitability of a strategic industrial project of the OCP Group. The approach taken is based on an applied quantitative framework, combining traditional corporate finance tools with an in-depth case study that incorporates the specificities of the global phosphate market.

According to Yin (2018), case studies are appropriate when analyzing a complex phenomenon in its real context, using both internal data and macroeconomic indicator . In this context, our analysis combines real financial data, macro-sector variables, and forward-looking scenarios constructed to test the robustness of the results.

The methodological design also aims to empirically test the six hypotheses formulated in the introduction (H1 to H6), using proven financial tools and applying sensitivity analyses.

3.1 Type of research and approach adopted

This study is an applied research project aimed at decision-making, adopting a deductive approach. It starts from theoretical models of investment valuation (Brealey, Myers & Allen, 2017; Damodaran, 2020) and corporate finance principles to apply them to a specific case.

The approach follows four main steps:

1. Collection and structuring of data from internal and external sources.
2. Application of standard financial tools (NPV, IRR, Payback, IP).
3. Performing sensitivity analyses on critical parameters (prices, costs, volumes).
4. Construction and simulation of forward-looking scenarios to test the robustness of the project.

This approach allows us to respond to hypotheses H1 to H6 by combining validation using financial indicators with an assessment of resilience in the face of uncertainty.

3.2 Sources and nature of data

Three sets of data are used:

- Internal data from the OCP Group: Initial investment amount, annual production forecasts, operating costs and fixed expenses, projected cash flow.
- Sectoral and macroeconomic data: Global phosphate prices (US Geological Survey, 2023), energy cost trends (International Energy Agency, 2023), exchange rates, and reference discount rates (Central Bank of Morocco, 2023).
- Documentary and academic sources: Academic studies on the evaluation of mining investments (Benhaddou & Chafik, 2022; Laaroussi, 2023), institutional reports (FAO, 2022).

3.3 Financial indicators

The financial evaluation is based on the following key indicators:

- Net Present Value (NPV): calculated by discounting future cash flows at the weighted average cost of capital (WACC). A positive NPV validates hypothesis H1.
- Internal Rate of Return (IRR): the rate that equates NPV to zero. Comparing it with WACC allows us to verify H2.
- Payback period: the period required to recover the initial investment, in relation to H3.
- Profitability Index (PI): ratio between the present value of cash flows and the initial investment.
- Sensitivity analysis: evaluates the effect of ±10% and ±20% variations in prices, costs, and volumes, testing H4 and H5.

These indicators provide a comprehensive view of the profitability and value created by the project.

3.4 Justification of WACC = 8%

The choice of an 8% discount rate is based on the average cost of capital observed in the international mining sector. According to KPMG (2022), the WACC for mining projects generally

ranges between 7% and 10%, depending on country risk and debt profile. The OECD (2022) recommendations suggest using country risk-adjusted discount rates to improve the robustness of financial analyses.

For Morocco, this rate is consistent with:

- The key interest rate set by Bank Al-Maghrib (3% in 2023),
- A country risk premium estimated at 4.5% (World Bank, 2023),
- A sector-specific premium for extractive industries (~0.5%).

Thus, a WACC of 8% reflects a conservative median value that is consistent with industry standards.

3.5 Software tools and simulations

Financial calculations and simulations were performed using several tools:

- Microsoft Excel: for basic financial calculations (NPV, IRR, PI, Payback).
- @Risk (Palisade): for Monte Carlo simulations applied to forward-looking scenarios and sensitivity analyses.
- MATLAB: for processing cash flow series and validating results through modeling.

The combined use of these software programs ensures the robustness and reproducibility of the results.

3.6 Risk analysis

The study includes a detailed risk analysis using:

Sensitivity analysis: identification of the key variables that most influence financial results (phosphate prices, production costs, exchange rates).

Forward-looking scenarios: Three scenarios are considered:

- Optimistic: 15% price increase, stable costs.
- Realistic: central assumptions based on internal data (×3).
- Pessimistic: 15% price decrease, 10% increase in energy costs.

These scenarios enable H6 to be tested by incorporating the uncertainty dimension into the assessment.

3.7 Methodological limitations

Despite the rigor of the approach, certain limitations remain:

- Financial forecasts are based on assumptions that may change over time.
- Scenario and sensitivity analyses cannot anticipate all exogenous variables (economic crises, natural disasters).

- Internal financial data has been adjusted by a multiplier factor (×3) to ensure confidentiality, which may reduce external validity and complicate direct comparison with other studies.
- The study focuses primarily on financial and operational aspects, without thoroughly integrating the environmental and social impacts of the project.

3.8 Methodological process diagram

The methodological process can be represented schematically in four steps:

Figure 1. methodological process.

4. Results and analysis

The assessment of the profitability of the OCP Group's industrial project is based on financial data adjusted in accordance with the methodology described above. In order to preserve the confidentiality of internal data, all financial amounts presented in the tables have been multiplied by three.

This section presents the results in six subsections, covering costs, financing, revenue and expense forecasts, and key financial profitability indicators. Each result is accompanied by an analysis to test hypotheses H1 to H6.

4.1. Overall cost and financing of the project

4.1.1. Overall project cost

The first table shows the breakdown of the overall cost of the "DAP Lines D, E, F" project. It can be seen that the largest share is devoted to buildings and facilities, followed by equipment and tools.

Table 2. Project investment cost (in MAD)

Expense item	**Initial amount (MAD)**
Studies and engineering	900,000,000
Equipment and tools	1,260,000,000
Buildings and facilities	1,800,000,000
Other expenses	540,000,000
Total	4,500,000,000

Source: compiled by the authors.

The total cost of the project amounts to MAD 4.5 billion, confirming the scale of the initial investment.

4.1.2. Commissioning of the lines

The following table shows the commissioning schedule for the three production lines. The ramp-up will be gradual over three years.

Table 3. Commissioning of the various lines

Line	**Year of commissioning**
Line D	2025
Line E	2026
Line F	2027

Source: compiled by the authors.

This phasing allows the financial burden to be spread out and production to be adapted to market needs.

4.1.3. Financing method

The study distinguishes between two main sources of financing: equity and bank loans.

Table 4. Project financing method (in MAD)

Source of financing	**Initial amount (MAD)**
Equity	1,800,000,000
Bank loans	2,700,000,000
Total	4,500,000,000

Source: compiled by the authors.

The financing structure combines 40% equity and 60% bank debt, or MAD 1.8 billion and MAD 2.7 billion, respectively. This ratio reflects a classic balance for large-scale industrial projects.

4.2. Asset depreciation

4.2.1. Equipment and tools

Depreciation is calculated over five years, in accordance with accounting standards.

Table 5. Projected depreciation of equipment and tools (MAD)

Year	**Initial depreciation (MAD)**
1	252,000,000
2	252,000,000
3	252,000,000
4	252,000,000
5	252,000,000
Total	1,260,000,000

Source: compiled by the authors.

Straight-line depreciation allows expenses to be smoothed out and gradually reduces the tax impact by a total of MAD 1.26 billion. This allows expenses to be smoothed out and optimizes the tax impact.

4.2.2. Buildings and facilities

Depreciation of buildings is planned over 10 years, which corresponds to the standard period used in the mining sector.

Table 6. Building depreciation schedule (MAD)

Year	Initial depreciation (MAD)
1	180,000,000
2	180,000,000
3	180,000,000
4	180,000,000
5	180,000,000
6	180,000,000
7	180,000,000
8	180,000,000
9	180,000,000
10	180,000,000
Total	1,800,000,000

Source: compiled by the authors.

Depreciation planned over 10 years, i.e., MAD 180 million per year, for a total of MAD 1.8 billion. This schedule is in line with mining industry standards.

4.3. Activity and revenue forecasts

4.3.1. Changes in sales prices

In order to project the commercial dynamics of the project over a ten-year horizon, several assumptions have been made regarding price trends, turnover, and total revenue.

Table 7. Projected increase in selling price over 10 years (MAD)

Year	Initial price/unit (MAD)
1	9,000
2	9,450
3	9,900
4	10,350
5	10,800
6	11,250
7	11,700
8	12,150
9	12,600
10	13,050

Source: compiled by the authors.

Projection of steady growth of 5% every two years, rising from MAD 9,000 to MAD 13,050 per unit over ten years. A cautious but realistic assumption, based on trends in the phosphate fertilizer market.

4.3.2. Turnover

Table 8. Projected turnover over 10 years (MAD)

Year	Initial turnover (MAD)
1	3,600,000,000
2	3,780,000,000
3	3,960,000,000
4	4,140,000,000
5	4,320,000,000
6	4,500,000,000
7	4,680,000,000
8	4,860,000,000
9	5,040,000,000
10	5,220,000,000

Source: compiled by the authors.

Revenue has grown steadily, rising from MAD 3.6 billion to MAD 5.2 billion over ten years. This growth can be explained by both the increase in the selling price and the gradual commissioning of production lines.

4.3.3. Total products

The change in total revenue logically follows that of turnover, confirming the expected growth in industrial activity.

Table 9. Total projected revenue (MAD)

Year	Initial revenue (MAD)
1	3,900,000,000
2	4,095,000,000
3	4,290,000,000
4	4,485,000,000
5	4,680,000,000
6	4,875,000,000
7	5,070,000,000
8	5,265,000,000
9	5,460,000,000
10	5,655,000,000

Source: compiled by the authors.

Growth parallel to revenue, reaching MAD 5.65 billion in year 10. Confirms the strength of commercial momentum.

4.4. Estimated costs and expenses

4.4.1. Total expenses

This section presents the evolution of total expenses and their breakdown into specific items.

Table 10. Estimates of total project expenses (MAD)

Year	Initial costs (MAD)
1	2,400,000,000
2	2,520,000,000
3	2,640,000,000
4	2,760,000,000
5	2,880,000,000
6	3,000,000,000
7	3,120,000,000
8	3,240,000,000
9	3,360,000,000
10	3,480,000,000

Source: compiled by the authors.

Steady increase from MAD 2.4 billion (year 1) to MAD 3.48 billion (year 10). Average increase of MAD 120 million/year, mainly related to energy costs and payroll.

4.4.2. Breakdown of expenses

Table 11. Detailed project expenditure forecasts (MAD)

Expense item	Initial expenditure (MAD)
Raw materials	1,200,000,000
Labor	600,000,000
Energy costs	$450,000,000
Miscellaneous expenses	$150,000,000
Total	2,400,000,000

Source: compiled by the authors.

The cost structure shows a high dependence on raw materials (50% of total expenditure). This highlights a risk linked to the volatility of global input prices. High dependence on global input prices, source of risk (H2).

4.5. Net income, CIF, WCRF, and cash flows

This subsection brings together the main financial indicators used to assess the projected profitability of the project: net income, cash flow (CAF), working capital requirements (BFR), and cash flows.

4.5.1. Net income

Table 12. Projected net income from investments (MAD)

Year	Initial net income (MAD)
1	1,500,000,000
2	1,575,000,000
3	1,650,000,000
4	1,725,000,000
5	1,800,000,000
6	1,875,000,000
7	1,950,000,000
8	2,025,000,000
9	2,100,000,000
10	2,175,000,000

Source: compiled by the authors.

Net income grows steadily, rising from MAD 1.5 billion in the first year to over MAD 2.1 billion in the tenth year. This trend confirms the soundness of the business model, with a growing net margin.

4.5.2. Cash flow (CAF)

Table 13. Cash flow (CAF)

Year	Initial CAF (MAD)
1	1,800,000,000
2	1,875,000,000
3	1,950,000,000
4	2,025,000,000
5	2,100,000,000
6	2,175,000,000
7	2,250,000,000
8	2,325,000,000
9	2,400,000,000
10	2,475,000,000

Source: compiled by the authors.

The net cash flow follows the same trend as the net income. It increases from MAD 1.8 billion to MAD 2.47 billion, strengthening the project's ability to self-finance and limit recourse to debt.

4.5.3. Working Capital Requirements (WCR)

Table 14. Working capital requirement (WCR) and variations (MAD)

Year	Initial WCR (MAD)	Change (MAD)
1	600,000,000	+600,000,000
2	750,000,000	+150,000,000
3	900,000,000	+150,000,000
4	1,050,000,000	+150,000,000
5	1,200,000,000	+150,000,000
6	1,350,000,000	+150,000,000
7	1,500,000,000	+150,000,000
8	1,650,000,000	+150,000,000
9	1,800,000,000	+150,000,000
10	1,950,000,000	+150,000,000

Source: compiled by the authors.

Working capital requirements are steadily increasing from MAD 600 million to MAD 1.95 billion, reflecting a growing need for cash to finance the operating cycle. This trend is consistent with business growth but requires careful cash management.

4.5.4. Cash Flows

Table 15. Cash Flow Calculation (MAD)

Year	CF (MAD)	Change in working capital requirement (MAD)	Cash Flow (MAD)
1	1,800,000,000	-600,000,000	1,200,000,000
2	1,875,000,000	-150,000,000	1,725,000,000
3	1,950,000,000	-150,000,000	1,800,000,000
4	2,025,000,000	-150,000,000	1,875,000,000

5	2,100,000,000	-150,000,000	1,950,000,000
6	2,175,000,000	-150,000,000	2,025,000,000
7	2,250,000,000	-150,000,000	2,100,000,000
8	2,325,000,000	-150,000,000	2,175,000,000
9	2,400,000,000	-150,000,000	2,250,000,000
10	2,475,000,000	-150,000,000	2,325,000,000

Source: compiled by the authors.

Available cash flows are increasing significantly, reaching more than MAD 2.3 billion in the tenth year. This confirms the project's ability to generate excess cash flow despite the growth in working capital requirements.

Table 16. Sum of discounted cash flows (8% WACC)

Year	Cash flow (MAD)	Discount factor (8%)	Discounted cash flow (MAD)
1	1,200,000,000	0.926	1,111,200,000
2	1,725,000,000	0.857	1,478,325,000
3	1,800,000,000	0.794	1,429,200,000
4	1,875,000,000	0.735	1,377,563,000
5	1,950,000,000	0.681	1,327,950,000
6	2,025,000,000	0.630	1,275,750,000
7	2,100,000,000	0.583	1,224,300,000
8	2,175,000,000	0.540	1,174,500,000
9	2,250,000,000	0.500	1,125,000,000
10	2,325,000,000	0.463	1,076,475,000
Total	-	-	12,999,263,000

Source: compiled by the authors.

The discounted cash flow totals nearly MAD 13 billion, confirming that the project creates economic value in excess of the cost of capital (WACC = 8%).

4.6. Summary profitability indicators

4.6.1. Average Rate of Return (ARR)

Table 17. Average Rate of Return (ARR) – in MAD

Year	Net income (MAD)	Capital employed (MAD)	ARR (%)
1	1,500,000,000	9,000,000,000	16.7
2	1,575,000,000	9,000,000,000	17.5
3	1,650,000,000	9,000,000,000	18.3
4	1,725,000,000	9,000,000,000	19.2
5	1,800,000,000	9,000,000,000	20.0
6	1,875,000,000	9,000,000,000	20.8
7	1,950,000,000	9,000,000,000	21.7
8	2,025,000,000	9,000,000,000	22.5
9	2,100,000,000	9,000,000,000	23.3
10	2,175,000,000	9,000,000,000	24.2

Source: compiled by the authors.

Overall TRM ≈ 20.4%, with annual growth of 16.7% to 24.2%. Performance significantly above industry standards.

4.6.2. Net Present Value (NPV) and Profitability Index (PI)

Table 18. Net Present Value (NPV) and Profitability Index (PI)

Scenario	Adjusted NPV (MAD)	Initial investment (MAD)	PI
Optimistic	$4,129,203,540	9,000,000,000	1.46
Realistic	2,836,002,360	9,000,000,000	1.31
Pessimistic	1,021,443,980	9,000,000,000	1.11

Source: compiled by the authors.

- Optimistic: NPV = MAD 4.13 billion; PI = 1.46
- Realistic: NPV = MAD 2.83 billion; IRR = 1.31
- Pessimistic: NPV = MAD 1.02 billion; IRR = 1.11

In all scenarios, NPV > 0 and PI > 1, confirming the viability of the project (H3 validated).

4.6.3. Internal Rate of Return (IRR)

Table 19. Internal Rate of Return (IRR)

Scenario	IRR (%)	Comparison with WACC (8%)
Optimistic	18.6	✓ Higher than WACC
Realistic	14.2	✓ Higher than WACC
Pessimistic	9.3	✓ Higher than WACC

Source: compiled by the authors.

- Optimistic: 18.6%
- Realistic: 14.2%
- Pessimistic: 9.3%

The IRR is higher than the cost of capital (WACC = 8%) in all three scenarios, confirming that the investment is profitable. It remains higher than the WACC of 8%, validating the profitability of the project even in the pessimistic scenario (H1 and H2 confirmed).

4.7. Operational profitability

Beyond the financial indicators of value creation (NPV, IRR, IP), it is relevant to assess operational profitability through management ratios. These indicators measure the efficiency of operations and the performance of invested capital.

Main ratios calculated:

- Net margin = Net income / Revenue
- Operating margin (EBITDA/revenue) = EBITDA / Revenue
- Return on Assets (ROA) = Net income / Total assets
- Return on Equity (ROE) = Net income / Shareholders' equity

Table 20. Operating profitability ratios

Year	Net margin (%)	Operating margin (%)	ROA (%)	ROE (%)
1	41.7	50.0	16.7	83.3
5	41.7	48.6	20.0	100.0
10	41.7	47.4	24.2	121.0

Source: compiled by the authors.

These results show:

- A stable net margin of 41–42%, which is well above the global average for mining industries (20–25% according to Deloitte, 2022).
- An operating margin close to 50%, indicating excellent control of operating expenses.

- Strong growth in ROA and ROE ratios, reflecting high profitability on invested capital and reinforcing the financial soundness of the project.

4.8. International benchmark

To assess the performance of the OCP project, it is useful to compare its financial indicators with similar projects in other phosphate-producing countries or in the mining sector:

Table 21. International benchmark – Phosphate projects

Project (country)	**IRR (%)**	**NPV/Investment (IP)**	**Net margin (%)**
OCP Morocco (current project)	14.2	1.31	41.7%
Ma'aden (Saudi Arabia, 2021)	12–13%	1.20	28
Wengfu (China, 2020)	10–11	1.15	25
Mosaic (United States, 2019)	9–10	1.10	22

Source: compiled by the authors.

Comparative analysis:

- The OCP project shows financial profitability above industry standards (IRR = 14.2% compared to 9–13% elsewhere).
- The profitability index (1.31) is higher than that observed in Chinese or American projects, reflecting greater value creation.
- The net margin of 41.7% is highly competitive, almost double that of international competitors.

These results confirm OCP's leadership position in the global phosphate industry, supported by controlled production costs and favorable price competitiveness.

5. Discussion and results

The results obtained through the various tables and financial indicators (NPV, IRR, TRM, IP, Payback, Discounted Cash Flows) provide an in-depth assessment of the profitability and robustness of the industrial project under study. This section discusses the results on four levels: verification of assumptions, critical analysis, links with the literature, and strategic implications for OCP, before concluding with limitations and prospects.

5.1. Verification of assumptions

- H1 (positive NPV): Confirmed in all three scenarios (optimistic, realistic, pessimistic). The NPV varies between MAD 1.02 and 4.13 billion (after adjustment ×3), demonstrating robust value creation even under unfavorable conditions. This is consistent with classical financial theory, according to which a positive NPV is an essential decision criterion (Brealey, Myers & Allen, 2017).
- H2 (IRR > WACC): Validated in all scenarios. The IRR remains higher than the weighted average cost of capital (8%), ranging from 9.3% (pessimistic) to 18.6% (optimistic). These results confirm that the project is profitable and capable of generating a return higher than the cost of financing.
- H3 (Payback compatible with financial objectives): Validated in the optimistic and realistic scenarios (2 years 10 months and 3 years 4 months, respectively). In the pessimistic scenario, the payback period extends to 4 years and 2 months, which remains reasonable by mining industry standards.
- H4 (Sensitivity to phosphate prices): Confirmed. Price fluctuations have a direct effect on NPV

and IRR, reinforcing the importance of proactive price risk management (FAO, 2022).

- H5 (Sensitivity to energy and operating costs): Confirmed. Increased energy costs significantly reduce NPV and extend the payback period. This illustrates the project's dependence on operating costs, in line with the work of Borgonovo (2004).
- H6 (Usefulness of forward-looking scenarios): Validated. The use of scenarios and sensitivity analyses made it possible to anticipate the impact of different market developments, reinforcing the robustness of the assessment and the quality of strategic decisions (Dixit & Pindyck, 1994).

5.2. Critical analysis

Beyond simply confirming the hypotheses, a critical reading of the results is required:

- Strengths of the project:
  - A high NPV in all three scenarios, guaranteeing value creation.
  - Confirmed financial resilience even under pessimistic conditions.
  - Operating profitability above mining industry standards (net margin > 40%).
- Weaknesses and areas for caution:
  - Although the IRR is higher than the WACC, it remains moderate (9–14% in the realistic/pessimistic scenario) compared to other high-growth industries, which limits the project's attractiveness to certain investors.
  - Heavy dependence on global phosphate prices exposes OCP to external volatility that is difficult to control.
  - The project, which focuses on financial indicators, does not fully integrate ESG (environmental, social, governance) issues, which are becoming increasingly important in the evaluation of major industrial projects.

5.3. Link to international literature

The results are part of a broader set of international analyses on the profitability of mining and phosphate projects:

- The OCP case has a higher NPV and net margin than those observed for Ma'aden (Saudi Arabia), Wengfu (China), or Mosaic (United States), confirming its position as a competitive leader (Deloitte, 2022; USGS, 2023).
- The moderation of the IRR relative to the high NPV is consistent with the conclusions of Ross (2019), who points out that capital-intensive projects in the mining sector often generate significant value creation, but with internal rates of return limited by the heavy investment required.
- The integration of sensitivity and scenario analyses reinforces the relevance of real options approaches applied to extractive industries (Dixit & Pindyck, 1994).

5.4. Strategic implications for the OCP Group

The financial and comparative results suggest several strategic directions:

- Diversification of activities: reduce dependence on world prices by developing higher value-added products (specialized fertilizers, integrated agricultural solutions).
- Hedging policy and risk management: use market instruments (futures contracts, hedging) to stabilize cash flows in the face of price and currency volatility.
- Innovation and operational efficiency: invest in green technologies (renewable energies, process digitalization) to reduce sensitivity to energy costs.
- ESG integration: strengthen non-financial performance (carbon footprint, social inclusion, territorial responsibility) to meet international standards and attract responsible investors.

5.5. Limitations and outlook

Despite the solid results, certain limitations should be mentioned:

- Assumptions of macroeconomic and sectoral stability may be challenged by exogenous shocks (geopolitical, climatic, regulatory).
- The financial projections do not fully incorporate currency risks or potential changes in environmental standards.
- The analysis remains focused on the financial dimension, without measuring social and territorial impacts (employment, local development).

These limitations open up avenues for future research:

- Develop dynamic models for forecasting prices and costs.
- Study the impact of technological and digital innovations on profitability.
- Incorporate a systematic assessment of socio-economic and environmental externalities.

6. General conclusion

The World Bank (2022) emphasizes that industrial investment in natural resources can be an engine of inclusive growth, provided that environmental and social criteria are integrated.

The objective of this research was to assess the profitability of a strategic industrial project within the OCP Group, taking into account the uncertainties inherent in global phosphate markets and energy costs. The approach combined traditional financial evaluation methods—Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period, and Average Rate of Return (ARR)—with sensitivity analyses and forward-looking scenarios to obtain a robust and multidimensional assessment.

The results confirm the validity of the six research hypotheses:

- NPV remains positive in all scenarios, confirming net value creation (H1).
- The IRR exceeds the weighted average cost of capital (WACC = 8%), confirming the profitability of the project (H2).
- The payback period, ranging from 2 years 10 months to 4 years 2 months, remains consistent with mining industry standards (H3).
- The high sensitivity to phosphate prices and operating costs (H4, H5) confirms their central role as risk drivers.

The integration of forward-looking scenarios (H6) proved essential to enhance the reliability of the assessment and inform strategic decision-making.The study thus demonstrates that it is possible to reliably assess the profitability of a mining project in Morocco by using rigorous financial indicators combined with a multi-scenario approach. The OCP Group's project is economically viable and strategically relevant, with proven resilience to the volatility of key parameters. Yes, the project is profitable in all scenarios, but its performance is highly dependent on prices and costs, which calls for proactive risk management.

Three priority recommendations emerge for the OCP Group:

1. Implement a strategy to hedge against price risk through forward contracts or long- term commercial partnerships.
2. Invest heavily in renewable energy and energy efficiency to reduce vulnerability to energy costs and strengthen competitiveness.
3. Systematically integrate ESG (environmental, social, governance) indicators into investment decisions in order to meet international standards and ensure the sustainability of the project.

This research makes a twofold contribution:

- Empirically, it provides a rigorous application of the multi-scenario method and sensitivity analyses to the specific case of a Moroccan mining project, which is still rare in the regional literature.
- Methodologically, it demonstrates the value of combining traditional financial indicators (NPV, IRR, TRM) with forward-looking approaches inspired by real options theory in order to better capture the uncertainty inherent in extractive industries.

To enrich the assessment of the profitability and sustainability of mining investments, three priority areas are proposed:

1. In the short term: develop dynamic price and cost forecasting models that incorporate volatility and exogenous shocks.
2. In the medium term: analyze the impact of technological innovations (digitalization, automation, artificial intelligence) on project productivity and profitability.
3. In the long term: incorporate an in-depth assessment of socio-economic and environmental impacts in order to measure broader value creation (beyond financial profitability).

In short, the OCP Group's industrial project combines economic viability, strategic relevance, and the ability to adapt to global market uncertainties. However, the value created will depend on the group's ability to anticipate fluctuations, innovate in risk management, and fully integrate non-financial issues into its investment strategy. According to UNCTAD (2023), the global phosphate fertilizer market will grow at an average annual rate of 3.5% until 2030, supporting investment in this sector.

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