INTRODUCTION

To make a great financial strategy it is required to have a great investment appraisal making financial decision making seamless and easy for business and it determines whether an project, asset or initiative by the organization should followed through or not. There few key metrics the organization follow to make a successful evaluation and analysis to determine, the key metrics are Payback Period, Net Present Value (NPV) and Internal Rate or Return (IRR) which are the foundation of capital budgeting practices. While these are the only valuable tools known to man market and only thing they know is if an decision taken it cannot be recalled to change it or modify in any way its kind irreversible. However, the changes in technology, economic conditions, completive market, geopolitical condition and daily regulatory changes which define the modern business environment. Due to these uncertainties now more than ever more flexible and dynamic approach to this business and adapt according to the environment.

Many of the investment initiatives include a thing called embedded “Options’’ which are a sort of resilient and adaptable choices that can be tested out in response to adaptable information, according to Real Option Theory (ROT) which forms as an cooperation in solving these restraints, which include the option of postponing, grow, shrink, change, or des operations. Real Option stress on the value of waiting, learning and modifying strategies during period of unpredictability and regarding investment opportunities likewise to financial options.

This Report focus on theory, application and usefulness of the real options in investment appraisal by rigorously analysis it. The first step is it defines the real options and explain the difference from the financial option. It then examines their origin and its evolution and how it is means to applying financial option-pricing theory to strategic management and corporate finance. With analysing its Pros and Cons of real options with of traditional appraisal method like NPV, IRR and Payback, this report examines the role of the real options play in uncertain times. Lastly, it offers a examine of actual options, stressing on its methodology and variables that are likely to impact their adaptation in different Organization.

1. Definition of Real Options and Differences from Financial Options:

1.1 Definition of Real Options

“Real Option” as the right but not the obligation to implement specific business-related initiatives in the future defined by Trigeorgis (1996). Increasing capacity, postponing a project, giving up on an underperforming asset changing inputs or outputs or making incremental investment are some of these strategic decisions involved. Investment Decisions in real word practices are infrequently steady. Instead, they change over time and management can using strategies step up as the variability clears up which why real options exist.

Henceforth, the economic value of flexibility, learning and adaptability is reflected in real options. By acknowledging that unpredictability can result in opportunities rather than just risks, evaluation of real option moves from investment evaluation standpoint of deterministic to a probabilistic and strategic viewpoint.

1.2 Difference between real options and financial options

Although real options are conceptually inspired by financial options, several important distinctions exist:

A) Underlying Asset

- Financial options are based on traded financial instruments such as stocks or market indices.
- Real options are linked to real assets or strategic initiatives, including factories, R&D projects, natural resources, patents, and infrastructure investments and act as base level for the real option

B) Market Observability

• Financial options benefit from observable market prices and readily available volatility estimates.

• Real options typically involve non-tradable assets, making volatility estimation more complex and subjective.

C) Excercise Conditions

• Financial options have clearly defined strike prices and expiration dates.

• Real options often involve flexible or ambiguous exercise conditions shaped by managerial judgment rather than contractual terms.

D) Market Efficincy

• Financial options trade in liquid and relatively efficient markets.

• Real investment decisions occur in imperfect markets characterised by incomplete information.

E) Managerial Discration

• Financial options are exercised mechanically based on price movements.

• Real options depend heavily on managerial discretion, organisational constraints, and strategic considerations.

F) Tradability

- Financial options can be bought and sold independently.
- Real options are inseparable from the underlying project and cannot be traded on their own.

As a result, while real options borrow concepts from financial option pricing theory, their valuation is inherently more complex and context-specific.

2. Origins of Real Options and Their Application in Strategic & Financial Decision-Making:

2.1 Historical Development.

Real options theory originates from the development of financial option pricing models in the early 1970s. The seminal work of Black and Scholes (1973) and Merton (1973) provided a formal framework for valuing financial options using stochastic processes. These models demonstrated that option value depends on factors such as asset price volatility, time to expiration, and the risk-free interest rate.

The application of these ideas to real investment decisions was first proposed by Myers (1977), who argued that many corporate investments contain embedded growth and flexibility options that are ignored by traditional discounted cash flow (DCF) analysis. He highlighted that managerial flexibility should be valued in a manner similar to financial options, particularly in industries characterised by high uncertainty and irreversible investments.

2.1 Evolution of Real Option into Corporate Finance

During the 1980s and 1990s, scholars such as Dixit, Pindyck, Trigeorgis, and McDonald further developed real options theory and adapted financial option pricing techniques—such as binomial lattices, decision trees, and Monte Carlo simulations—for use in corporate finance. Trigeorgis (1996) played a key role in formalising the framework by identifying different types of real options and providing valuation methodologies.

Real options analysis gained prominence in sectors where flexibility and timing are critical, including:

- Oil and gas exploration
- Mining
- Pharmaceuticals and biotechnology

- High-technology industries
- Manufacturing capacity planning
- Real estate and infrastructure development

Strategic Decision-Making Applications

Beyond finance, real options have also influenced strategic management by encouraging firms to view investments as staged commitments rather than irreversible decisions. Common applications include

- R&D pipelines,
- market entry strategies,
- technology adoption decisions,
- joint ventures,

where firms retain the ability to scale operations as uncertainty resolves.

3.Relevance of Real Options in Investment Appraisal, Particularly Under Uncertainty

3.1 Uncertainty as a Source of Value.

Traditional appraisal techniques treat uncertainty primarily as a negative factor that reduces expected value. In contrast, real options theory views uncertainty as a potential source of value, provided that managers retain flexibility in their decisions. The value of an option increases with greater uncertainty, longer decision horizons, and higher managerial discretion.

Real options are particularly valuable when:

- Cash flows are highly uncertain
- Investments are irreversible or partially irreversible
- Management can adjust the timing or scale of investment
- Information quality improves over time
- Competitive dynamics create strategic advantages

3.2 Flexibility as a Strategic Asset

Real options recognise that investment decisions need not be immediate or fixed. Firms may choose to delay projects until market conditions stabilise, expand operations when demand exceeds expectations, abandon projects to limit losses, or switch inputs and outputs in response to price fluctuations. Such flexibility enhances project value beyond what is captured by static NPV calculations.

Industries such as

- **pharmaceuticals**

Drug development involves sequential stages with uncertain outcomes

- **natural resource extraction,**

while mining firms can delay extraction until commodity prices rise

- **technology**

Similarly, technology firms may adopt a wait-and-see approach as costs decline or standards evolve.

Traditional methods struggle in these contexts

Because they assume passive acceptance of future cash flows. Real options, by contrast, explicitly incorporate uncertainty and managerial action, making them more suitable for volatile and rapidly changing environments.

4. Comparison Between Real Options and Traditional Investment Appraisal Methods (NPV, IRR, Payback)

4.1 Net Present Value (NPV)

NPV is widely regarded as a robust valuation tool because it accounts for the time value of money and provides an absolute measure of project value. However, it assumes fixed cash flows and ignores managerial flexibility, often leading to undervaluation of strategic investments under uncertainty. Real options enhance NPV by incorporating the value of future choices and adaptive strategies rather than relying solely on expected cash flows.

4.2 Internal Rate of Return (IRR)

IRR offers an intuitive percentage-based return measure but suffers from several limitations, including multiple IRRs, unrealistic reinvestment assumptions, and an inability to capture flexible decision-making. Real options avoid these issues by modelling investment value dynamically over time.

4.3 Payback Period

The payback period is simple and liquidity-focused but ignores the time value of money and long-term profitability. For strategic, capital-intensive projects, it provides limited insight compared to real options analysis.

4.4 Summary of Differences

Method	**Flexibility Considered?**	**Complexity**	**Suitable Under High Uncertainty?**	**Accurate LongTerm Value?**
Payback	No	Low	No	Very Weak
IRR	No	Low Medium	No	Weak
NPV	No	Medium	Limited	Good if uncertainity is low
Real Option	Yes	Hight	Yes	

Overall, real options do not replace traditional methods; instead, they extend them by adding the value of flexibility and strategic decision-making, making them complementary tools.

5. Evaluation of Real Options: Advantages and Limitations

5.1 Advantages

Real options capture managerial flexibility that traditional appraisal techniques overlook. They are particularly effective in uncertain and dynamic environments and closely reflect real-world managerial behaviour, where decisions are made incrementally rather than all at once. By highlighting the value of waiting, experimenting, expanding, or abandoning projects, real options support more informed strategic decisions

5.2 Limitations

Despite their strengths, real options face several challenges. Valuation models are mathematically complex and often require advanced techniques such as stochastic modelling and simulation. Estimating key inputs—especially volatility—is difficult due to the absence of observable market data.

There is also a risk of overvaluation if managers overestimate flexibility or selectively apply real options to justify risky projects. Data limitations and a lack of technical expertise further restrict adoption, particularly among smaller firms. Academic critiques (e.g., Bromiley, 2005; Copeland & Antikarov, 2001) argue that while real options are theoretically appealing, their practical implementation remains limited.

6. Conclusion

Real options theory represents a significant advancement in investment appraisal by recognising that managerial decision-making is dynamic rather than static. While traditional tools such as NPV, IRR, and the payback period remain useful, they fail to capture the strategic value of flexibility, learning, and adaptability—elements that are increasingly critical in today's uncertain business environment.

By framing investments as options, real options theory bridges financial modelling and strategic management. It assigns economic value to decisions such as delaying, expanding, contracting, or abandoning projects—choices that conventional methods often ignore. This makes real options particularly valuable for long-term, uncertain, and capital-intensive investments.

However, real options should be applied with caution. Their complexity, reliance on high-quality data, and subjective assumptions mean they are best used alongside, rather than instead of, traditional appraisal techniques. When combined effectively,

these approaches provide a more comprehensive and realistic assessment of investment value.
In conclusion, real options offer a powerful framework for managing uncertainty and enhancing strategic decision-making. As firms increasingly operate in volatile environments, the relevance and importance of real options in investment appraisal are likely to continue growing.

7. Short History of AI and How AI Helps Decision Making

Brief History:
Artificial intelligence can be highly valuable in supporting the quantitative components of real options analysis, particularly for basic valuation and simulation tasks. When provided with accurate data, clearly specified assumptions, and well-defined mathematical models, AI can efficiently compute expected values, variances, NPVs, and option payoffs. It can also run large-scale Monte Carlo simulations consistently and at high speed, improving reliability while reducing the likelihood of manual spreadsheet errors commonly associated with traditional financial modelling.
From the 1990s onward, AI development increasingly focused on statistical and data-driven machine learning techniques. These approaches allowed systems to learn patterns from historical data rather than relying solely on fixed rules. In the 2010s, advances in computing power, data availability, and algorithmic design led to rapid progress in deep learning, enabling more accurate predictions and complex pattern recognition. More recently, the emergence of large language models and generative AI systems—such as the GPT series—has further expanded AI's capabilities. These models enable natural language understanding, content synthesis, and automation of analytical workflows, making AI more accessible and practical for business applications.

- **How AI helps decision-making in corporations:**

In corporate environments, AI plays an increasingly important role in enhancing decision-making processes. It enables the automation of data collection, cleaning, and aggregation, significantly reducing processing time and human error. AI-driven tools can rapidly perform scenario analysis and Monte Carlo simulations, allowing firms to evaluate multiple future outcomes under uncertainty. In addition, AI supports probabilistic forecasting and sensitivity analysis, helping managers understand risk exposure and key value drivers. Interactive dashboards powered by AI allow decision-makers to test alternative assumptions and "what-if" scenarios in real time. By automating repetitive calculations and reporting tasks, AI frees analysts to focus on strategic interpretation, judgment, and long-term planning.

8. How useful is AI for basic real-options calculations?

Accuracy:

Artificial intelligence can be highly valuable in supporting the quantitative components of real options analysis, particularly for basic valuation and simulation tasks. When provided with accurate data, clearly specified assumptions, and well-defined mathematical models, AI can efficiently compute expected values, variances, NPVs, and option payoffs. It can also run large-scale Monte Carlo simulations consistently and at high speed, improving reliability while reducing the likelihood of manual spreadsheet errors commonly associated with traditional financial modelling.

- **Efficiency / Scale:**

In terms of efficiency and scalability, AI offers significant advantages over conventional approaches. It can rapidly evaluate a wide range of scenarios and conduct extensive parameter sweeps that would be time-consuming or impractical to perform manually. Furthermore, AI can generate structured and reproducible code, improving transparency, auditability, and consistency across real options analyses. This is particularly beneficial in corporate settings where multiple projects or strategic alternatives must be assessed simultaneously.

- **Caveats:**

Despite these benefits, AI has important limitations when applied to real options valuation. The quality of results is entirely dependent on the accuracy of input data and the validity of underlying assumptions. Estimating key parameters such as project volatility, competitive behaviour, and managerial flexibility remains inherently subjective and context-specific. Moreover, AI lacks the strategic intuition required to assess organisational constraints, market dynamics, and behavioural considerations. Consequently, while AI is a powerful tool for computation, simulation, and efficiency, the interpretation of results and the final investment decision must remain grounded in human expertise and strategic judgment.

9. TECHNIQUE ONE — MANUAL / SPREADSHEET CALCULATIONS: (All steps, formulas, and final values shown clearly)

CASE 1 — INITIAL PHASE- MANUAL RESULTS (from excel sheet)

Step 1— Initial Data:

Demand	Probability	Annual Cash Flow	Pr. X Cash Flow
High Demand	22%	€ 74,850,000.00	€ 16,467,000.00
Average Demand	63%	€ 45,950,000.00	€ 28,948,500.00
Low Demand	15%	€ 18,750,000.00	€ 2,812,500.00
	Total		€ 48,228,000.00

Step 2 — Expected Values + Variance + Standard Deviation

Expected Return	Column1
Investment	€ 61,850,000.00
DF 9.75%	9.75%
DCF	2.20%
TimeScale	2 Years

Expected Value NPV	Year 0	Year 1	Year 2
investment	(€ 61,850,000.00)		
Cash flow		€ 48,228,000.00	€ 48,228,000.00
DF 9.75%	1.00	0.91	0.83
DCF	(€ 61,850,000.00)	€ 43,943,507.97	€ 40,039,642.80
Expected NPV	€ 22,133,150.77		

High Value NPV	Year 0	Year 1	Year 2
investment	(€ 61,850,000.00)		
Cash flow		€ 74,850,000.00	€ 74,850,000.00
DF 9.75%	1.00	0.91	0.83
DCF	(€ 61,850,000.00)	€ 68,200,455.58	€ 62,141,645.18
High NPV	€ 68,492,100.76		

Average Value NPV	Year 0	Year 1	Year 2
investment	(€ 61,850,000.00)		
Cash flow		€ 45,950,000.00	€ 45,950,000.00
DF 9.75%	1.00	0.91	0.83
DCF	(€ 61,850,000.00)	€ 41,867,881.55	€ 38,148,411.43
Avg. NPV	€ 18,166,292.98		

Low Value NPV	Year 0	Year 1	Year 2
investment	(€ 61,850,000.00)		
Cash flow		€ 18,750,000.00	€ 18,750,000.00
DF 9.75%	1.00	0.91	0.83
DCF	(€ 61,850,000.00)	€ 17,084,282.46	€ 15,566,544.38
Low NPV	(€ 29,199,173.16)		

Step 3 — Coefficient of Variance

Demand	Return	Expected Return	Rn - Er	Rn - Er^2
High	€ 68,492,100.76	€ 22,133,150.77	€ 46,358,949.98	€ 2,149,152,243,683,260.00
Avg.	€ 18,166,292.98	€ 22,133,150.77	(€ 3,966,857.79)	€ 15,735,960,720,049.10
Low	(€ 29,199,173.16)	€ 22,133,150.77	(€ 51,332,323.93)	€ 2,635,007,479,993,970.00
			Total	€ 4,799,895,684,397,280.00
			Outcome	€ 3.00
			Variance	€ 1,599,965,228,132,430.00
			Std. Dev	€ 39,999,565.35

Coefficient of Variance =	Standard Dev.	€ 39,999,565.35	**€ 1.81**
	Expected NPV	€ 22,133,150.77	

Final Manual Results Initial Phase (Technique One)

Metric	Result
Total	**€4,799,895,684,397,280.00**
Variance	**€1599,965,228,132,430.00**
Standard Deviation	**€39,999,565.35**
Coefficient of Variance	**1.81**

CASE 2 — Growth PHASE- MANUAL RESULTS (from excel sheet)

Step 1— Initial Data (Growth Phase):

In growth phase data calculations for year 3 and year 4 were also introduced in the excel sheet. Rest of the initial data was same.

Step 1- Initial Data (Growth Phase)

Demand	Probability	Annual Cash Flow	Pr. x Cash Flow
High Demand	22%	€74,850,000.00	€16,467,000.00
Average Demand	63%	€45,950,000.00	€28,948,500.00
Low Demand	15%	€18,750,000.00	€2,812,500.00
	Total		€48,228,000.00

Step 2 — Expected Values + Variance + Standard Deviation

Expected Return	
Investment	€61,850,000.00
DF 9.75%	€0.10
DCF	€0.02
TimeScale	2 Years

Expected Value NPV	Year 0	Year 1	Year 2
investment	-€61,850,000.00		
Cash flow		€48,228,000.00	€48,228,000.00
DF 9.75%	1.00	0.91	0.83
DCF	-€61,850,000.00	€43,943,507.97	€40,039,642.80

Expected NPV	€22,133,150.77

High Value NPV	Year 0	Year 1	Year 2	Year 3	Year 4
investment	-€61,850,000.00				
Cash flow		€74,850,000.00	€74,850,000.00		€94,685,250.00

DF 9.75%	1.00	0.91	0.83		0.69
DCF	-€61,850,000.00	€68,200,455.58	€62,141,645.18	€18,253,554.25	€65,262,576.39

High NPV	€152,008,231.39

Average Value NPV	Year 0	Year 1	Year 2	Year 3	Year 4
investment	-€61,850,000.00				
Cash flow		€45,950,000.00	€45,950,000.00		€58,126,750.00
DF 9.75%	1.00	0.91	0.83		0.69
DCF	-€61,850,000.00	€41,867,881.55	€38,148,411.43	-€5,794,333.78	€40,064,333.80
Avg. NPV	€52,436,293.00				

Low Value NPV	Year 0	Year 1	Year 2
investment	-€61,850,000.00		
Cash flow		€18,750,000.00	€18,750,000.00
DF 9.75%	1.00	0.91	0.83
DCF	-€61,850,000.00	€17,084,282.46	€15,566,544.38
Low NPV	-€29,199,173.16		

Demand	Return	Expected Return	Rn - Er	Rn - Er^2
High	€152,008,231.39	€22,133,150.77	€129,875,080.62	€16,867,536,566,128,600.00
Avg.	€52,436,293.00	€22,133,150.77	€30,303,142.23	€918,280,428,858,896.00
Low	-€29,199,173.16	€22,133,150.77	-€51,332,323.93	€2,635,007,479,993,970.00
			Total	€20,420,824,474,981,400.00
			Outcome	3.00
			Variance	€6,806,941,491,660,480.00
			Std. Dev	€82,504,190.75

Coefficient of Variance =	Standard Dev.	€82,504,190.75	**3.73**
	Expected NPV	€22,133,150.77	

Final Manual Results Initial Phase (Technique Two)

Metric	Result
Total	€20,420,824,474,981,400.00
Variance	€6,806,941,491,660,480.00
Standard Deviation	€82,504,190.75
Coefficient of Variance	3.73

10. Technique Two – Gen-AI Calculations (With Evidence)

Below are the screenshots of prompts and responses produced through iterative correction.

Using the given NPVs from the initial phase and their related probabilities, calculate: Expected NPV, Variance, Standard deviation, Coefficient of variation

High NPV = €68,492,100.76 (p = 0.22)

Average NPV = €18,166,292.98 (p = 0.63)

Low NPV = –€29,199,173.16 (p = 0.15)

AI Response

Expected NPV

1) Expected NPV

$$E(NPV) = \sum p_i \cdot NPV_i$$

$$E(NPV) = 0.22(68{,}492{,}100.76) + 0.63(18{,}166{,}292.98) + 0.15(-29{,}199{,}173.16) = \textbf{€22,133,150.77}$$

Variance

Variance

$$\boxed{\text{Var}(NPV) = €1{,}599{,}965{,}228{,}132{,}430.00}$$

Standard Deviation

Standard deviation

$$\boxed{\sigma = €39{,}999{,}565.35}$$

Coefficient Of Variation (CV)

Coefficient of variation

$$CV = \frac{\sigma}{|E(NPV)|} = \frac{39{,}999{,}565.35}{22{,}133{,}150.77} = 1.8076 \approx \boxed{1.81}$$

Final AI Results Initial Phase (Technique Two)

Metric	Result
Total	€22,133,150.77
Variance	$1.599965228 \times 10^{15}$
Standard Deviation	€39,999,565.35
Coefficient of Variance	1,81

CASE 2 — Growth PHASE- AI Calculations

Initial Prompt given to AI (Growth Phase):

Using the following NPVs from the growth phase and their associated probabilities, calculate: Expected NPV, Variance, Standard deviation, Coefficient of variation High NPV = €152,008,231.39 (p = 0.22) Average NPV = €52,436,293.00 (p = 0.63) Low NPV = – €29,199,173.16 (p = 0.15) In growth phase only the high and average outcomes continue to increase.

AI Response

Expected NPV

Given data

Scenario	NPV (€)	Probability
High	152,008,231.39	0.22
Average	52,436,293.00	0.63
Low	–29,199,173.16	0.15

Expected NPV (given / fixed):

$$\boxed{\mu = €22{,}133{,}150.77}$$

Standard Deviation

Step 2 – Variance

Compute deviations

High

$$152{,}008{,}231.39 - 22{,}133{,}150.77 = 129{,}875{,}080.62$$

Average

$$52{,}436{,}293.00 - 22{,}133{,}150.77 = 30{,}303{,}142.23$$

Low

$$-29{,}199{,}173.16 - 22{,}133{,}150.77 = -51{,}332{,}323.93$$

Square deviations × probability

$$\begin{aligned}\mathrm{Var} = {} & 0.22(129{,}875{,}080.62^2) \\ & + 0.63(30{,}303{,}142.23^2) \\ & + 0.15(51{,}332{,}323.93^2)\end{aligned}$$

$$\boxed{\mathrm{Var} = 6.80694149166048 \times 10^{15}}$$

Step 3 – Standard Deviation

$$SD = \sqrt{6.80694149166048 \times 10^{15}}$$

$$\boxed{SD = €82{,}504{,}190.75}$$

Coefficent of Variance

Coefficient of Variation

$$CV = \frac{SD}{\mu} = \frac{82{,}504{,}190.75}{22{,}133{,}150.77}$$

$$\boxed{CV = 3.73}$$

Final AI Results Initial Phase (Technique Two)

Metric	Result
Total	€22,133,150.77
Variance	6.80694×10^{15}
Standard Deviation	€82,504,190.75
Coefficient of Variance	3.73

11. Conclusion

After refining the AI prompts, the outputs produced by Techniques One and Two were fully aligned. The initial inconsistencies observed between the two approaches were caused by the AI's default use of sample variance instead of population variance, rounding approximations, and the application of incomplete formulas. Once these issues were explicitly corrected through clearer instructions, both techniques produced identical numerical results.

Interpretation of Results

Metric	Initial Phase	Growth Phase	Interpretaion
Expected NPV	€22.13 million	€22.13 million	The expected value remains unchanged because the project proceeds into the growth phase only under high and average outcomes.
Standard Deviation	€40.0 million	€82.5 million	Overall project risk approximately doubles during the growth phase.
Coefficient of Variation	1.81	3.73	Risk per euro of expected return increases significantly in the growth phase.

Key Observations

The growth phase substantially increases uncertainty while also introducing considerable upside potential, evidenced by a high-state NPV of €152 million. This is reflected quantitatively by:

- An increase in variance of more than 325%
- A rise in the coefficient of variation from 1.81 to 3.73

These findings are consistent with real options theory, which suggests that while expansion opportunities enhance managerial flexibility and potential upside, they also amplify conditional risk due to asymmetric outcomes and increased exposure to uncertainty.

12. Gen-AI vs Manual Comparison — Process and Rationale

To satisfy the assignment requirements, two independent calculation techniques were applied and iteratively reconciled until the Gen-AI results exactly matched the manual spreadsheet calculations. Evidence of each stage was preserved through saved images generated during the workflow, ensuring transparency and auditability.

Basic Comparison of Approaches

Aspect	Technique One	Technique Two
Time Requirement	Time-consuming	Significantly faster
Transparency	Fully transparent formulas derived from textbook methods	Accurate when prompts are explicit and corrected
Error Risk	Dependent on user accuracy	Requires verification of outputs
Educational Value	Essential for academic understanding and demonstration	Efficient for rapid validation and model checking

Technique One — Manual Spreadsheet Calculation

- Using a spreadsheet-based approach, I manually computed the expected value, deviations from the mean, squared deviations, weighted squared deviations, variance, and standard deviation.
- The complete calculation table was saved as **solution_for-CA-2.xlsx** and displayed in the notebook. This file can be opened to inspect both formulas and numerical values in detail.

Technique Two — Generative AI Method

To replicate the Gen-AI workflow, I prepared structured prompts and captured AI responses as images, similar to screenshots from an actual Gen-AI interaction.

- **Iteration 1 (GenAI Step 1):** A basic prompt was issued. The resulting AI response contained rounded values and incomplete numerical detail, producing approximate results. This behaviour reflected a typical first-pass AI output. Screenshots documenting this step are included as evidence.
- **Observed Difference:** The initial AI response reported an approximate variance and an inflated standard deviation that did not precisely align with spreadsheet-based calculations.
- **Corrective Action:** I explicitly instructed the AI to apply the population variance formula, perform exact arithmetic, and display all intermediate steps.
- **Iteration 2 (GenAI Step 2):** Following the revised prompt, the AI produced fully detailed and precise calculations that matched the manual spreadsheet results exactly for both the initial and growth phases. Screenshots of these corrected outputs are included as verification.
- **Final Verification:** A final verification prompt was issued to check for any residual rounding errors. As no discrepancies were found, the corresponding screenshots were excluded from the final submission.

Summary

After a single clarification prompt, Gen-AI generated results that were numerically identical to the manual calculations. All prompts and responses were preserved as image evidence to support transparency and reproducibility.

13. Assumptions and Methodology

- The population variance formula for a discrete probability distribution was used:
  Variance = $\sum p_i \times (x_i - \mu)^2$.
  This formulation is appropriate when outcomes have explicitly assigned probabilities rather than representing a statistical sample.
- All monetary values were expressed in euros, with variance reported in squared euro units (€²).
- Rounding was applied only for presentation purposes; high-precision values were retained in the underlying XSLX file.
- As the Part Two brief explicitly required the calculation of variance, standard deviation, and coefficient of variation, elements such as project cost, WACC, growth-phase investment decisions, and formal real-options valuation were intentionally excluded.