

ASSESSING THE IMPACT OF COSTS ON TOTAL INVESTMENT OF OFFICE TOWER CONSTRUCTION PROJECT

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Abstract

The article "Assessing the Impact of Cost on the Total Investment of Office Tower Construction Project" focuses on the application of the Monte Carlo simulation method to analyze the impact of costs on the total investment of the Sunwah Tower office building project. This method assesses risks, sensitivities, and correlation matrices in analyzing cost factors. Using the Monte Carlo simulation, the author has generated different scenarios regarding project-related costs, thereby evaluating the impact of each scenario on the total investment. By varying the values of input variables in the model, such as construction, equipment, and contingency costs, the author analyzes the potential impact of these changes on the project's total investment. Through risk analysis and sensitivity analysis, the author identified important factors influencing the total investment and proposed effective investment options to minimize risks and optimize returns.

Keywords: *Impact assessment; Investment potential evaluation; Cost risk analysis; Monte Carlo simulation method; Total investment optimization.*

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1. Raising the issue

The office real estate industry faces significant challenges and opportunities in the modern era. Technological shifts, changes in working models, and the impacts of social, economic, and political factors have created an

increasingly complex and uncertain business environment. With these changes, real estate investors and office developers need an in-depth and comprehensive understanding of factors affecting investment decisions and project success. The COVID-19 pandemic has increased uncertainty and greatly impacted the global office real estate industry. Remote work and flexible work arrangements have become a prevalent trend. At the same time, governments and international organizations have introduced new policies and regulations to support and promote investment in this sector. Meanwhile, risk management has also become an important factor in ensuring project success in an increasingly volatile business environment. Investors must assess and mitigate risks through tight risk management measures, increasing adaptability and ensuring sustainability during the investment process. Domestic research papers have focused on key aspects of investing in office leasing projects in Vietnam. The papers provide detailed analyses of the impacts of construction costs, equipment costs, bank loan interest rates, and cost risks on investment levels and investment returns of office projects. The paper "Nghiên cứu ảnh hưởng của chi phí thiết bị đến hiệu quả đầu tư dự án văn phòng" by Lê Thị Phương Thảo and colleagues [1], focused on analyzing the impact of equipment costs on investment returns of office projects. The research method included collecting data on equipment costs and investment returns of

office projects in Vietnam from 2016 to 2023. The study used return on investment (ROI) analysis to evaluate investment returns and linear regression analysis to analyze the relationship between equipment costs and ROI. The results showed that equipment costs significantly impact the investment returns of office projects. Each 1% increase in equipment costs corresponds to a 0.5% decrease in ROI. However, the impact of equipment costs on project investment returns depends on various factors such as equipment type, quality, and usage period. Therefore, investors must select equipment suitable for usage needs and investment budgets to optimize investment returns in office projects. Another paper titled "Phân tích rủi ro chi phí và ảnh hưởng đến hiệu quả đầu tư dự án văn phòng" by Bùi Thị Thanh Huyền and colleagues [2], focuses on an important aspect related to office project investment. The research method in this paper aims to identify cost risks in office projects, analyze the impact level of each cost risk on project investment returns, and propose cost risk mitigation solutions. The results showed that common cost risks in office projects include increased construction material prices, design changes, construction delays, and unexpected costs. The impact level of each cost risk on project investment returns depends on various factors. Based on the paper's conclusions, it can be seen that cost risks significantly impact office project investment returns. This requires effective cost-risk management measures to optimize

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investment returns. Investors must consider and propose cost risk mitigation solutions, such as identifying potential risk sources, developing contingency plans, tightly controlling construction processes, and monitoring actual costs. We will continue with international studies, focusing on key factors such as construction costs, government policies, and risk management to better understand their impacts on office project investment decisions. The paper "The Impact of the COVID-19 Pandemic on Office Building Investment" by David Brown et al. [3] applied regression analysis to evaluate the relationship between construction costs and investment levels. Data was collected from office building projects in China from 2010 to 2020. The results showed that construction costs negatively impact investment levels. The degree of impact depends on project scale, location, and market conditions. The paper's conclusion emphasizes that construction costs are an important factor affecting investment decisions in office building projects. The paper "The Role of Risk Management in Reducing Office Building Investment Costs" by Thomas White et al. [4] used a synthesis research method. To collect data and information, the authors analyzed documents related to risk management methods in office building construction investments, including research papers and practical documents such as guidelines, procedures, and risk management tools. Meanwhile, the authors also interviewed real estate and architecture experts on the role of risk management in reducing investment costs for office buildings. Interviewed experts included investors, project developers, contractors, architects, engineers, and risk management con

2. Overview of the Sunwah Tower Office Building Project

2.1. Project Introduction

The Sunwah Tower office building project is located in a prime location in the bustling Sala urban area, bringing many transportation infrastructure advantages. It is a modern architectural structure remarkable for its unique and elegant design style. The 25-storey block building is constructed in phases, creating a light and graceful impression. Located in the bustling central area, only 10 minutes from the city's major arterial roads, it brings great business convenience. Sunwah Tower has facilities such as shopping malls, restaurants, and entertainment areas. At the same time, it creates a professional and dynamic working environment with a modern office service system. With outstanding

advantages in terms of prime location, diverse amenities, and elegant architecture, Sunwah Tower promises to be the ideal solution for the standard office space needs of companies in the city center.



Figure 1. Rendering of the Sunwah Tower office building project

2.2. Determining the Functional Services of the Sunwah Tower Office Building Project

Sunwah Tower is the first multi-functional office skyscraper in the Sala urban area, with a total floor area of 32,100m2 on a construction land area of more than 7,200m2. The main function of the building is the office rental area, which has a total area of nearly 17,000m2 from the 4th to 25th floor. It is designed flexibly and can be divided into various office rooms to meet the needs of businesses and companies. Meanwhile, the 1st to 3rd floors are mixed-use blocks serving food, shopping, and entertainment. The 1st floor also has a conference center for events. The basement is a parking area for customers. Sunwah Tower commits to modern facilities and services to meet work needs and improve business efficiency.

Table 1. Statistics of floor areas for the Sunwah Tower office building project

Number	Description	Total area (m ²)	Service block (square meters)					Public Block (m ²)
			Office 1	Office 2	Office 3	Services	Conference Center	
I	Land area	7 250,80						
II	Basement floor area	3 848,21						
1	Motorbike parking area	465,80						
2	Car parking area	914,34						
III	Builttable area	28 251,93						
III.A	Podium	9 907,90						
1	The first floor	3 848,21				1,006	649	1,873
2	The second floor	2 892,98				1,682		1,029
3	The third floor	3 166,71				750		2,009
III.B	Tower volume	18 344,03						
1	The fourth floor	800,88	122	125	350			114
2	The fifth floor	800,88	100	158	290			114
3	The sixth floor	800,88	100	158	290			114
4	The seventh floor	800,88	100	158	290			114
5	The eighth floor	800,88	100	158	290			114
6	The ninth floor	800,88	100	158	290			114
7	The tenth floor	800,88	100	158	290			114
8	The eleventh floor	800,88	100	158	290			114
9	The twelfth floor (Technical floor)	800,88						666
10	The thirteenth floor	800,88	100	158	290			114
11	The fourteenth floor	800,88	100	158	290			114
12	The fifteenth floor	800,88	100	158	290			114
13	The sixteenth floor	800,88	100	158	290			114
14	The seventeenth floor	800,88	100	158	290			114
15	The eighteenth floor	800,88	100	158	290			114
16	The nineteenth floor	800,88	100	158	290			114
17	The twentieth floor	800,88	100	158	290			114
18	The twenty-first floor	800,88	100	158	290			114
19	The twenty-second floor	800,88	100	158	290			114
20	The twenty-third floor	800,88	100	158	290			114
21	The twenty-fourth floor	800,88	100	158	290			114

Number	Description	Total area (m ²)	Service block (square meters)					Public Block (m ²)
			Office 1	Office 2	Office 3	Services	Conference Center	
22	The twenty-fifth floor	800,88	100	158	290			114
23	The roof floor	724,67						
IV	Total floor area excluding basements	28 251,93						
V	Total floor area, including basements	32 100,14						

3. Determination of total investment of the project

Estimating the total investment is an important factor in financial planning, allocating resources, and studying the technical and economic feasibility of the project during the analysis of the Sunwah Tower project. The project owner has estimated based on legal bases, including Based on Decision No.510/2023/QĐ-BXD issued by the Ministry of Construction [5] regarding the average capital investment ratio for estimating construction, installation, and equipment costs, Applying Circular No.11/2021/TT-BXD issued by the Ministry of Construction [6] guidance on calculating investment consulting costs, contingency costs, management costs, and other costs. On that basis, the project owner develops a detailed estimate of the total investment for each component in the project to evaluate the feasibility.

Table 1. Total investment estimate of the Sunwah Tower office building project

Number	Cost items	Pre-tax (Million VND)	Tax (Million VND)	Post-tax (Million VND)	Parameter
1	Land cost	253 778,00	25 377,80	279 155,80	G _{lt, tbc}
2	Construction cost	344 145,60	34 414,56	378 560,16	G _{td}
3	Equipment cost	54 377,60	5 437,76	59 815,36	G _{tt}
4	Project management cost	6 531,80	-	6 531,80	G _{oDa}
5	Investment consultancy cost	24 664,63	2 453,97	27 118,60	G _{tv}
6	Other costs	13 811,21	1 209,88	15 021,09	G _{lc}
7	Contingency cost	69 730,88	6 973,09	76 703,97	G _{sp}
Total		767 039,72	75 867,06	842 906,78	V _{tt}

Based on (Table 2) the summary of costs of items under the Sunwah Tower project, The total estimated investment for the entire preparation of investment and implementation of this project is 842,906.78 million VND. This figure is estimated based on major cost factors for the initial budgeting work. The main expected costs include land cost, construction, equipment, investment consultancy, other costs, and contingency reserve for risks that may arise during project implementation. These are direct factors affecting the total investment. Accurately determining the total investment for the project is important for Providing basic information to evaluate capital mobilization ability, capital planning, detailed budgeting, and ensuring socio-economic effectiveness when implementing the project.

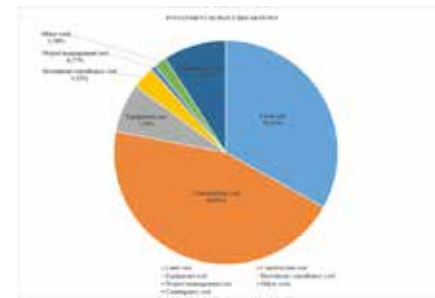


Figure 2. Pie chart showing the cost allocation ratio of the project's investment costs

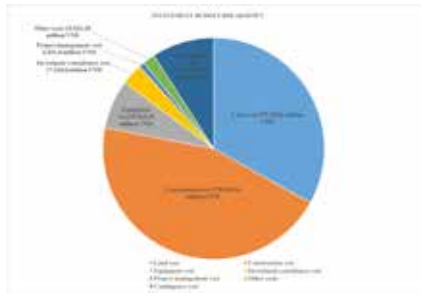


Figure 3. Pie chart showing the funding proportion for each investment cost item

Based on the project cost item summary table and the two pie charts allocating the project investment cost ratio (Figure 2) and funding proportion for each cost item (Figure 3), we can compare and evaluate: The construction cost has the highest value of 378,560.16 million VND, accounting for 44.91% of the total investment. Next is the land cost, 279,155.80 million VND, accounting for 33.12% of the total investment. The contingency cost is 76,703.97 million VND, accounting for 9.1% of the total investment. By comparing and evaluating the cost allocation data in the summary table and two pie charts, the three highest-value items are construction cost, land cost, and contingency cost. These are the direct factors affecting the total investment of the project. Accurately determining these cost items is crucial to developing the financial plan, reasonably allocating investment capital, and ensuring effective and efficient project implementation. Recommendations include continuing to study, evaluate, and adjust the details of the above cost items appropriately to reflect realities and develop detailed plans for funding sources and disbursement schedules for each cost item. Close monitoring of the investment implementation process is also important to adjust any errors incurred timely, ensuring progress, quality, and maximum efficiency.

4. Risk analysis

Risk analysis plays a key role in ensuring project feasibility and safety. One commonly applied method is Monte Carlo simulation to assess the impact of uncertain factors on economic and technical outcomes. Based on the risk factors in (Table 3), the simulation will frequently reproduce the project scenario to evaluate investment costs under volatile conditions. This helps clarify trends and the extent of risk impacts on results and propose the most appropriate risk mitigation measures for the project.

Table 3. Risk variable factors for Monte Carlo simulation

Number	Description	Base data	Minimum 2%	Maximum 5%	Likeliest
1	Land cost	279,155.80	273,572.68	293,113.59	279,155.80
2	Construction cost	378,560.16	370,988.96	397,488.17	378,560.16
3	Equipment cost	59,815.36	58,619.05	62,806.13	59,815.36
4	Project management cost	6,531.80	6,401.16	6,858.39	6,531.80
5	Investment and construction consulting cost	27,118.60	26,576.23	28,474.53	27,118.60
6	Other costs	15,021.09	14,720.67	15,772.14	15,021.09
7	Contingency costs	76,703.97	75,169.89	80,539.17	76,703.97
	Total investment	842,906.78			842,906.78

4.1. Risk assessment

The author conducted a Monte Carlo simulation to quantify the impact of uncertain factors on the project. Monte Carlo simulation is a technique that frequently retrieves random values of risk variables from predetermined probability distributions. The simulation process was performed with 50,000 repetitions, allowing a comprehensive assessment of the impacts of risk variables on the project's economic and technical performance indicators, including effects on investment costs and financial performance. The simulation results table summarized important statistical indicators to evaluate the project's probability distribution and volatility under risk conditions.

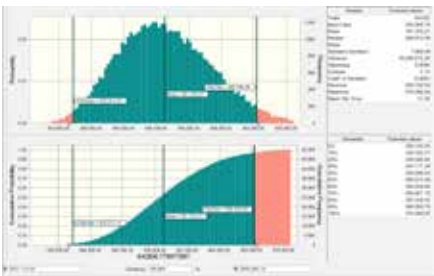


Figure 3. Risk assessment chart of the project by Monte Carlo simulation method

The simulation results (Trials) of 50,000 times ensure the accuracy and diversity of the simulation process. The base case value is 842.906 million VND, representing the initial estimated total investment of the project. The

mean value is 851.333 million VND, indicating the total expected costs according to the mean value after considering the impact of risk factors. The median value is 850.913 million VND, reflecting the stable result of the project when considering volatile factors. The standard deviation is 7,060.9 million VND, showing that the fluctuation level of the total project cost is reasonable. Statistics on the project's mean, median, and standard deviation values are within permitted limits, reflecting that project risks have been comprehensively and effectively assessed and controlled. The probability of scenarios increasing costs above initial estimates is low, confirming the feasibility and effectiveness of the project. The simulation fully revealed the potential impacts of risks, providing a rigorous scientific basis for assessing feasibility in practical implementation. Overall, it can be affirmed that the risk assessment method applied to the project is appropriate and effective.

4.2. Sensitivity analysis

A sensitivity analysis was carried out to identify which input variables strongly impact the project's projected cost results. This is a key analysis to evaluate the project model's sensitivity when cost variable changes occur. In this analysis, the sensitivity chart method will be applied to quantify the impact of each main cost factor on the estimated total investment. Specifically, the chart will evaluate the fluctuation of each variable as a percentage of the initial value to identify which cost items have the most significant impact on the project's estimated total capital investment budget. The analysis results will provide a scientific basis to propose appropriate risk management solutions, contributing to effective cost management throughout the project implementation process.

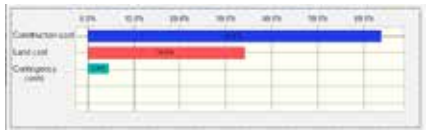


Figure 4. Sensitivity chart analyzing the impact of costs on the fluctuation of total investment

Items	Contribution to total risk	Rank
Construction cost	81.8%	1
Land cost	24.8%	2
Contingency cost	2.4%	3

Figure 5. Sensitivity chart analyzing the impact of costs on the fluctuation of total investment

Based on the analysis results of fluctuations in three main cost factors: Construction cost, land cost, and contingency costs; as well as the relationship between them and the fluctuation of the project's total investment, we can conclude that the construction cost factor accounts for 63.62% of the project's fluctuations with the highest correlation coefficient of 0.77. This indicates that construction costs most significantly and strongly affect the fluctuation of total investment compared to initial estimates. Next, land costs account for 34.02% and a correlation coefficient of 0.57, showing that this factor also has a significant impact. In contrast, contingency costs only account for 2.37% and the lowest correlation coefficient of 0.15, with the least influence. Therefore, construction and land costs are considered the two factors that need the strictest risk management to control fluctuations in total project costs.

4.3. Correlation assessment

According to the results of the analysis of sentiment and variation contribution in the previous section, construction costs, and land purchase are the two most important cost factors affecting the rate of variation of the expected total investment capital. Therefore, this section will apply the Monte Carlo simulation method to quantify the relationship and co-variation between these two cost variables by calculating many independent distribution scenarios. rights and related links, thereby predicting different specific investment outcomes.

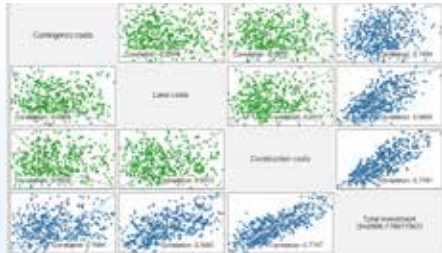


Figure 6. Correlation matrix modeling the cost variables

The correlation matrix analysis results show correlations between cost factors and their impacts on the project's total

investment. Based on the correlation matrix, the high correlation coefficient of 0.7747 between construction costs and total investment shows that construction costs play the most important role in determining total capital. The 0.5665 correlation between construction and land costs indicates a synchronous fluctuation trend between these two factors. This provides useful risk management information when construction cost fluctuations can predict corresponding changes in land costs. This helps project management consider and apply effective measures to limit total cost fluctuations. However, the remaining comparisons in the matrix show a weak correlation, meaning no strong relationship exists between them and the project's total investment.

5. Conclusion and recommendations

5.1. Conclusion

Through analyzing the total investment of the project and factors affecting the project such as land purchase costs, construction, equipment, project management, investment consulting construction, reserves and other costs, it shows that the estimated total investment of the project is 842,906.78 million VND is appropriate, in which construction costs are the largest factor with an estimated value of 378,560.16 million VND, accounting for up to 44.91% of total investment, land purchase costs 279,155.80 million VND, accounting for 33.12% is the second most influencing factor. The result of risk analysis using the Monte Carlo simulation method shows that the index values regarding the average value, median, and standard deviation of the project are all within the allowed limits, reflecting that the project's risks have been well assessed and controlled, sensitivity analysis shows that construction costs have the strongest influence of 63.62% on the total investment fluctuations, followed by land purchase costs of 34.02%. We conclude that the Sunwah Tower office high-rise project is fully feasible regarding economics and technology.

5.2. Recommendations

According to the actual project implementation, it is necessary to monitor

and make specific adjustments to the items, especially construction and land purchase costs. Cost breakdown tables for each cost item must be detailed for each construction phase to allow for timely adjustments. Develop a specific risk management plan with control measures and risk mitigation, such as clearly defining the responsibilities of relevant parties, establishing appropriate cost reserves, and applying effective contract management for each main risk source, such as material price increases, construction delays, and force majeure natural disasters. Develop a financial plan, capital schedule, and detailed quarterly disbursement plan for each project preparation, construction, and completion stage to ensure adequate capital according to the progress set. Establish a professional project management team to monitor progress, strictly control construction costs and quality of works, and timely detect emerging issues.

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