IMPACT OF CONSTRUCTION MATERIAL COST VARIATION ON THE ON THE FEASIBILITY OF BUILDING PROJECTS IN DEVELOPING COUNTRIES: A CASE STUDY IN VIETNAM RISK

Soo-Yong Kim [1], Luu Truong Van [2], Byeong-Gi Yoo [3] and Luong Thanh Dung [4]

[1] Division of Construction Engineering, Pukyong National University, San 100 Yongdang-Dong Nam-Gu Busan, 608 – 739, Korea

[2] Interdisciplinary Program of Construction Engineering and Management, Pukyong National University, San 100 Yongdang-Dong Nam-Gu Busan, 608 – 739, Korea

[3] Executive Director, Project & Construction Management Dept., KUNWON ENGINEERING CO., LTD, Dowon B/D 10F, 719-5 Yeoksam-Dong, KangNam-Gu, Seoul, Korea

[4] Department of Civil Engineering, HCMC University of Architecture, HCMC, Vietnam

Abstract

This paper presents a study on the impact of variation of construction material prices on the feasibility of building projects in Vietnam. The paper makes use of Monte-Carlo simulation for financial risk analysis of net present Value (NPV) and internal rate of return (IRR). To well illustrate the influencing, a case study is presented. The research results show that there is a strong correlation between steel prices, gold prices, and $US exchange rate. Outputs of statistics also reveal that the concurrent variation of prices of cement, steel, sand, brick, formwork and stone has strongly negative impact on NPV and IRR of building projects. The results also indicate that the proportion of steel cost to total construction cost is 17.95% which is the cause of risks for the feasibility of building project in Vietnam. The paper stresses that feasibility study of building project must integrate the impact of construction materials prices in order to mitigate risks in developing countries as Vietnam.

Keywords: Monte Carlo simulation, feasibility study, building projects, Vietnam.

Symbols

APP	Appropriate probability distribution
FDI	Foreign direct investment
HCMC	Ho Chi Minh City
IRR	Internal Rate of Return
MCS	Monte Carlo simulation
NPV	Net Present Value

1. Introduction

Many people appraise Vietnam as a promising economy, and admire the growth of competitiveness and investment opportunities coming from economic integration of the country. For instance, in the first 6 months of 2006, Ho Chi Minh City (HCMC) attracted US$ 997.7 million of foreign direct investment (FDI), accounting for 30% FDI of the whole Vietnam[1]. Many of the projects are in high-rise buildings, infrastructure development, education, health, and transportation. In this circumstance, developers are facing a number of problems such as inflation and structural issues. On the other hand, real estate transactions in Vietnam have recently been under a prolonged chill due to strong increase of gold price [2]. In order to make a quick sale, several people reduced sale prices of their houses but they were unsuccessful. Therefore, the increase of gold prices and the escalation of construction materials prices have caused the negative impact on the investors' benefits. The goal of this study aimed to evaluate the impact of variation of gold price, crude oil price, construction material price, and $US exchange rate on NPV and IRR of high-rise building projects in HCMC.

The objectives of the study were:

- To collect the data of risk variables such as the price of gold, crude oil, construction materials, and $US exchange rate.
- To collect the data of cost components in total construction cost from accomplishing high-rise building in HCMC.
- To develop a model for the Monte-Carlo simulation (MCS) using Crystal Ball
- To evaluate the influence of risk variables on the output of the model as NPV and IRR

2. Literature Background

Flanagan and Norman [3] suggested that risk management system consists of four steps: (1) risk identification; (2) risk classification; (3) risk analysis; (4) risk response, and adds more risk attitude before taking risk response. The essence of risk analysis is that it attempts to find out all possible alternatives and to analyze the various outcomes of any decision. Figure 1 shows the systematic way to do risk analysis.

The utilization of simulation technique in the financial project appraisal under uncertainty in the building investment has performed in several international journals and conferences. Researches have been continuously undertaken to analyze project risks in the feasibility study. Isaksson and Stille [4] conducted the MCS to estimate tender price and budget for a tunnel project. The predictions obtained from the estimation model as shown is realistic. For example, the total construction cost and time obtained from the model correspond fairly well to the actual construction cost and time. The use of the proposed model also shows the tunneling method that is most suitable for the actual geological and hydro-geological conditions can be selected by this method. Balas and Ergin [5] used the MCS for a harbor project in Turkey. The authors emphasizes that the application of MCS can provide the probability distribution of random variables, and the correlation between these variables are described with an acceptable accuracy, which should be obtained from data accumulated over a sufficient number of years. In this paper, the probability of construction completion times were estimated at the planning phase for the case study of Mezitli Yacht Harbor, where the probability distributions of random variables were obtained from the governmental archives. Malini [6] employ the MCS for risk evaluation of bridge projects. The simulation outputs include NPV, IRR and payback period. Considered risky variables are construction cost, operation and maintenance cost, and traffic volume. In this paper, the cash-flows adequacy was examined under scenarios related to options of project financing. Chee and Yeo [7] conducted the MCS to evaluate risk of a power generation project. The authors identified risky variables including electricity generation, un-escalated capital expenditure, tariff, O&M cost, etc. Tuan [8] employed the MCS for risk evaluation of industrial building projects in Vietnam. Vy [10] conducted the MCS to evaluate the financial feasibility of apartment buildings in Vietnam with NPV and IRR as outputs. Risky variables include cost of reinforcing steel and cement and productivity of construction activities. The study indicates that the cost of reinforcing steel and cement are the main cause of risks for the contractor's primer cost. Little effort has been devoted to evaluate risk from the variation of construction material cost. Therefore, a distinct need has emerged for studies of the variation of material cost that influencing on NPV and IRR of building projects in developing countries as Vietnam.

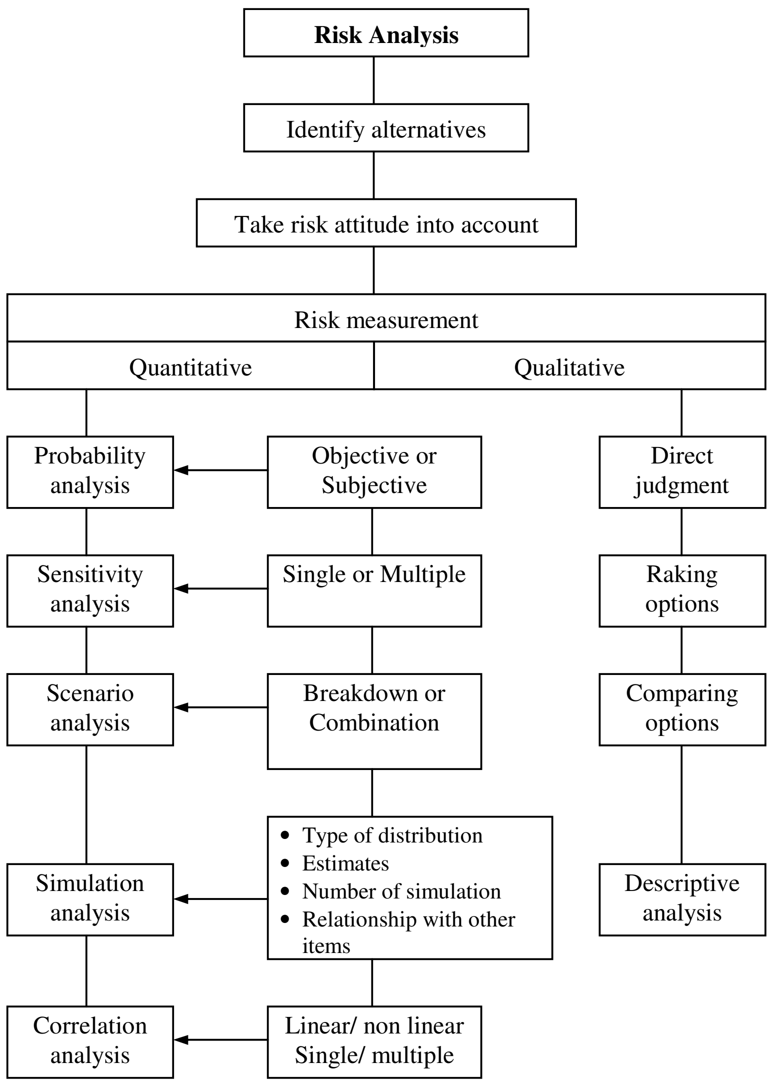

Figure 1. The systematic procedure of risk analysis (Source: Flanagan [3])

3. Research Methodology

Figure 2 describes the research framework of this study.

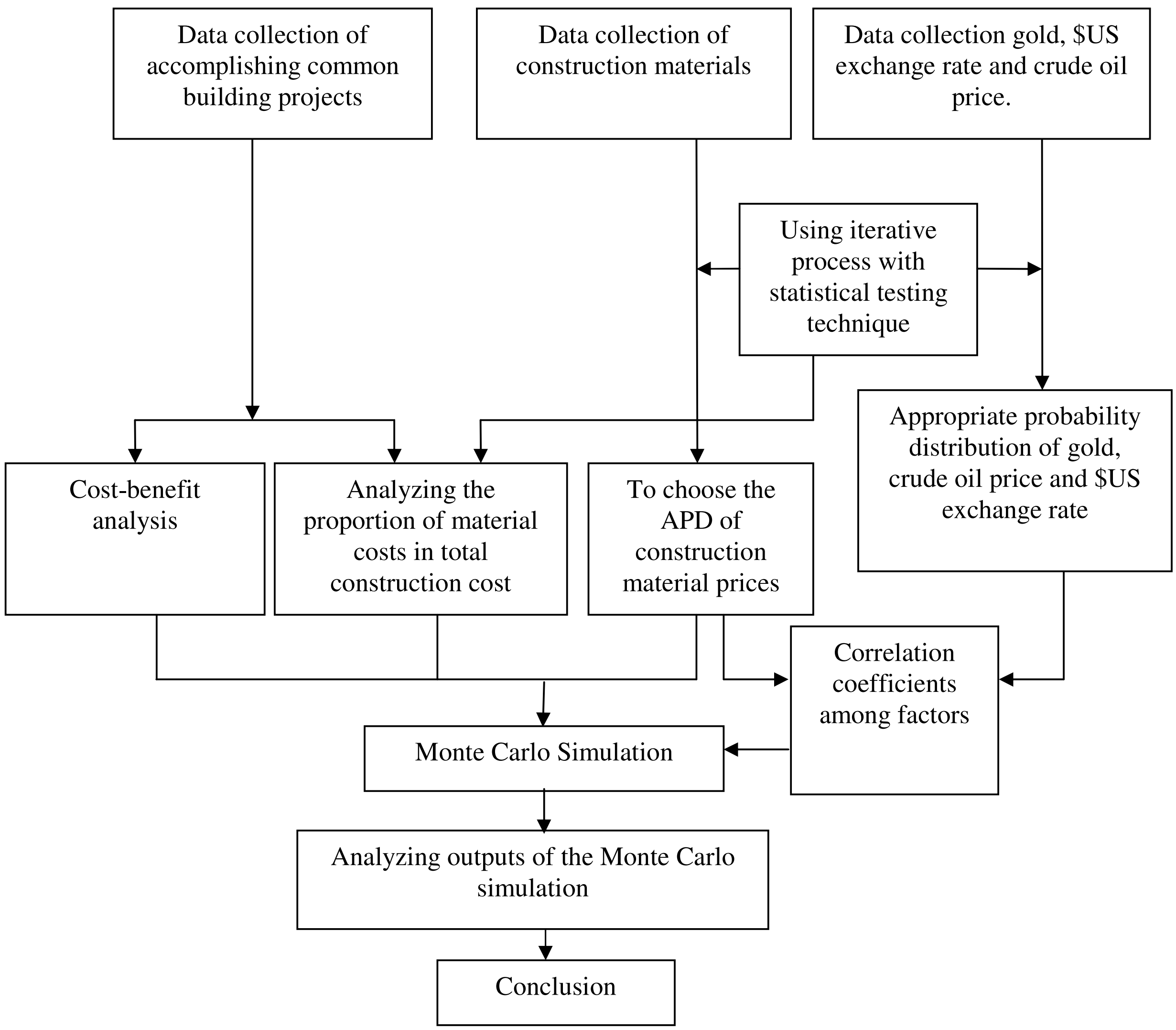

Figure 2. Diagram of the research framework

Based on studies of the construction process, site interviews, questionnaire, and literature, many risky factors were identified. It is difficult to consider all the variables affecting the NPV and IRR; therefore, this study focuses on the following major risk variables:

- Construction materials: steel bars, cement, stone, macadam, brick, sand, and wood formwork.
- Other factors: crude oil, gold price, and $US exchange rate (using direct US$ exchange rate: US$:VND).

The outputs of the simulation are NPV and IRR of common building projects.

Data collection

This study utilized different tools that are a questionnaire, site interviews, and site visits to fill out data forms. A questionnaire was designed to collect data from consultants and contractors who are specialists in cost-benefit analysis and in building construction, respectively. It aimed to collect the proportion of each cost item to the total construction cost and the impact level of crucial materials on the total construction cost. Copies of the questionnaires were distributed to 250 construction professionals who worked for 10 building projects in Ho Chi Minh city. Authors received 141 responses with a response rate of 56.4%. Ten building projects were visited to interview for collecting more information about cost performance. Reviewers were asked to provide information based on building projects that they have done and are currently doing. Moreover, the historical data of construction material prices and other factors were collected from Department of Finance in HCMC and The Marketing News (a government news). In addition, the detailed estimates of total construction cost from 10 common building projects were collected.

Professionals in the industry understand that the probability distribution function, which can be consider as the heart of a simulation model, is an unknown dimension [9]. Therefore, it is very important to choose an appropriate probability distribution (APD) to use in the simulation. Determining an APD is an iterative process in which the probability distribution function of each risk variable is determined by using "Batch Fit Function" of Crystal Ball.

It is necessary to make the following assumptions:

- There are no expected changes about environment and other nature factors that affect the cost.
- There is no expected change in current government policies related to construction industry.
- Construction escalation rate is equivalent to domestic inflation rate
- There are no large changes from creditors to project's owners in terms of loan rate and discount rate.
- The owner's finance is strong.
- Resource in the labor market is not scarce.

Finally, a spreadsheet model for calculating NPV and IRR has been developed. Risks were incorporated in the conceptual design phase of common building projects by utilizing a MCS approach. This simulation model is applied to a case study of the BINH THANH project in Vietnam.

4. Findings and discussion

After preparing and building the simulation model, risky variables are defined, and the simulation process starts. The study resulted in the following findings:

4.1. Correlation between various prices

Data Analysis Function in Excel is used to find the correlation between gold price, construction material price, and crude oil price. Table 1 illustrates the correlation coefficient among them. These coefficients are considered in the simulation process.

The gold price has correlated with $US exchange rate, steel price, wood formwork, crude oil price, and sand price with the correlation coefficients of 0.941, 0.8, 0.792, 0.778, 0.629, respectively. The $US exchange rate has correlated with steel price, wood formwork, crude oil price, and sand price with the correlation coefficients of 0.886, 0.846, 0.791, 0.698, respectively. The crude oil price has correlated with wood formwork, sand price, and steel price with the correlation coefficients of 0.912, 0.799, and 0.662, respectively. In summary, the gold price, $US exchange rate, and crude oil price have strong correlation with the steel price, while the cement price has no correlation with them. This is accounted by lack of steelworks in Vietnam; consequently, the cost of steel bars highly depends on the import of raw steel that is paid in US dollars. It should be noted that Vietnam is classified as a country with the transaction economy. As a result, people have the habit to assess the price of goods based on the gold price, and crude oil price. Moreover, up to now Vietnam had no refine oil factory, thus the escalation of crude oil price results in increasing construction materials price because of higher transportation cost. However, there are some correlation coefficients have no economical meaning. But these correlation coefficients are indispensable for Monte Carlo simulation process in order to obtain the simulation process as close the reality as good.

Table 1. Correlation matrix of the material prices

	Gold price	$US exchange rate	Crude oil price
Gold price	1.0000		
$US exchange rate	**0.9408**	1.0000	
Crude oil price	**0.7779**	**0.7910**	1.0000
Steel bars price	**0.8002**	**0.8853**	**0.6617**
Portland cement price	0.0854	0.1149	0.4680
Brick price	-0.22333	-0.02632	-0.38268
Sand price	**0.6287**	**0.6980**	**0.7987**
Wood formwork price	**0.7915**	**0.8457**	**0.9115**

4.2. The proportion of cost items to the total building cost

The table 2 illustrates that the proportion of steel cost to total building cost is largest (17.95%). This means that the variation of the steel price has a strong effect on the total investment of projects. The proportion of cement cost, wood formwork cost, and brick price to total building cost are 10%, 4% and 2%, respectively. These findings may be incorrect in larger samples.

Table 2 The proportion of each cost item to the total building cost

No.	Construction materials	The proportion	Variance	Standard deviation
1	Cement	9.57%	0.000008	0.002777
2	Steel	17.95%	0.000349	0.018695
3	Brick	2.98%	0.000037	0.006071
4	Sand	1.48%	0.000007	0.002724
5	Stone 1x2mm	1.80%	0.000003	0.001655
6	Stone 4x6mm	0.09%	0.000000	0.000357
7	Wood formwork	3.88%	0.000107	0.010367

4.3. Case study

The simulation is applied to a case study of a large-scale project that is located in BINH THANH district, HCMC. The project has four high-rise buildings containing 1,911 apartments with the total construction area of 32,775 m2. The total estimated investment cost is VND 979 billion, and the project duration lasts 7 years (2005-2011.)

A sensitivity analysis has been taken to measure the variation of NPV and IRR with the fluctuation of steel price and cement price. Figure 3 represents the negative impact of steel price variation on the project's NPV and IRR with the linear regression equation of y = -78838x + 58075.

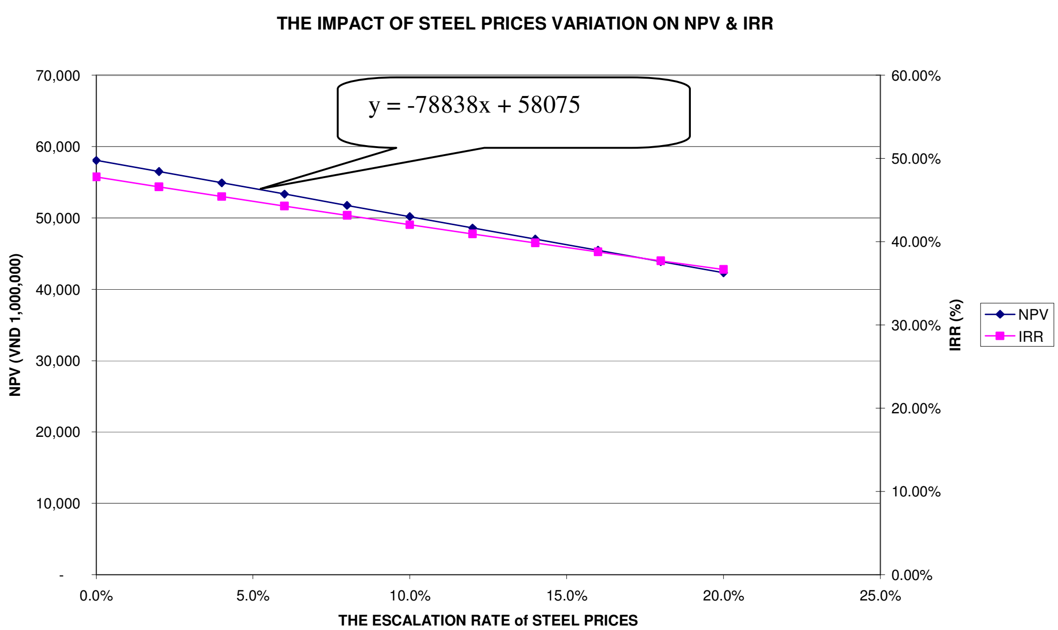

Figure 3. The impact of steel price escalation on NPV and IRR

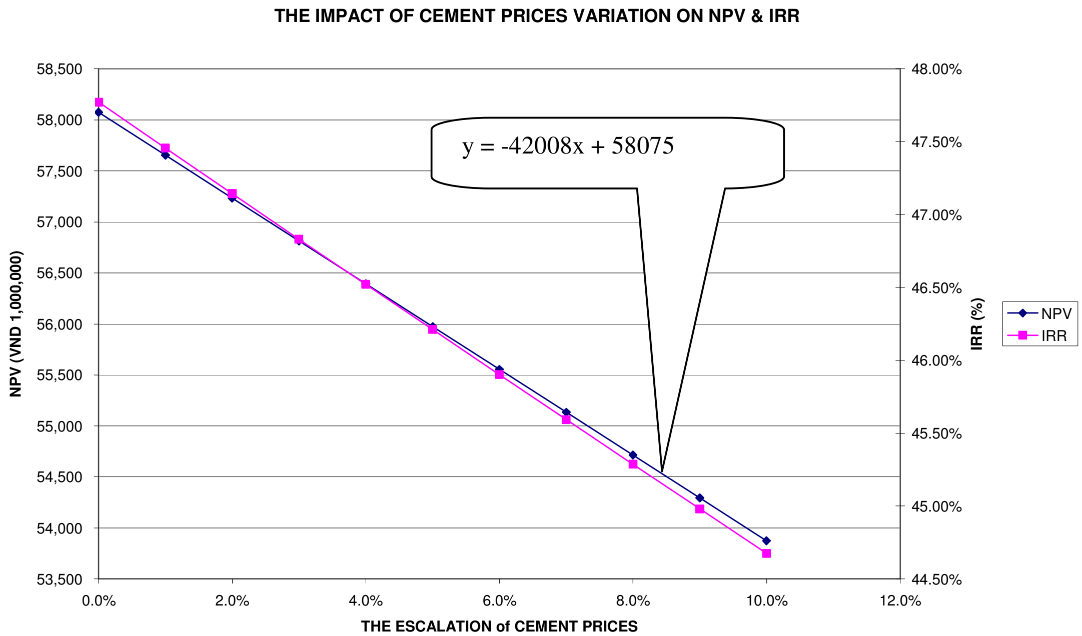

Figure 4 The impact of cement price escalation on NPV and IRR

Similarly, figure 4 represents the negative impact of cement price variation on the project's NPV and IRR. The equation of linear regression for NPV under the cement price escalation is y = -42008x + 58075. It is obvious that the steel price has more negative impact on NPV and IRR than the cement price.

A Monte Carlo simulation of 10,000 trials is performed by using Crystal Ball. The variation of NPV and IRR of a tested project are evaluated in three situations. In situation 1, the model ran under the variation of steel price only. As shown in table 3, the steel price variation is a main risk to NPV and IRR of building projects. In the best situation, the NPV will reduce up to VND 13.95 billion comparing with the expected NPV.

Table 3. The simulation outputs with the variation of steel price only

The simulation output	Expected value	Variance	Standard Deviation	Min	Max
NPV (1000 VND)	57,862,951	5E+12	2,308,980	43,905,962	69,151,308
IRR	47.61%	0.03%	1.73%	37.72%	56.47%

Table 4 depicts the simulation outputs under the fluctuation of cement price only. It seems that the NPV and IRR of building projects are less sensitive to cement price. Moreover, the NPV is of VND 3.7 billion less than the expected NPV at its worst. Owners should consider this possibility when they make a decision to invest the project.

Table 4. The simulation outputs with the variation of cement price only

The simulation output	Expected value	Variance	Standard Deviation	Min	Max
NPV (1000 VND)	58,093,402	7E+11	863,044	54,397,527	61,076,081
IRR	47.79%	0.00%	0.65%	45.06%	50.05%

In third situation, NPV and IRR have a change for the worst under the concurrent variation of cement, steel, brick, sand, and wood formwork prices. Table 4 indicates the reduced proportion of NPV to the expected NPV is approximately 20%. Therefore, the owners of building projects should consider this matter to make decision in the conceptual design.

Table 5. The simulation outputs with the concurrent variation of various prices only

The simulation output	Expected value	Variance	Standard Deviation	Min	Max
NPV (1000 VND)	57,750,591	9.98E+13	3,127,236	46,347,064	70,681,239
IRR	47.53%	0.05%	2.34%	39.38%	57.74%

5. Conclusion

The paper presents the impact of various construction material prices on the financial criteria NPV and IRR using the Monte-Carlo simulation. The research resulted in the strong correlation between several factors such as steel price, cement price, gold price, $US exchange rate, and crude oil price, while the cement price has no correlation with them. The proportion of steel cost to total building cost is largest (17.95%), which implies that variation of the steel price has a strong effect on the total investment of projects.

A spreadsheet model is applied to a case study project. The conclusions from a case study are:

- There is negative impact of steel price and cement price variation on NPV and IRR.
- There is the negative impact of steel price variation on the project's NPV with the linear regression equation of $y = -78838x + 58075$ under fixing other factors. As a result, it seems that the steel price variation is a main risk to NPV and IRR of building projects.
- The financial criteria as NPV and IRR have not much change under the variation of cement price.
- NPV and IRR have a change for the worst under the concurrent variation of cement, steel, brick, sand, and wood formwork prices.
- Expected of NPV of the project is of VND 57,750,591,000 under the concurrent variation of cement, steel, brick, sand, and wood formwork prices. It is very useful for owners' making decision that depends on taking risk level

Although these findings should not be generalized and applied to all building projects in Vietnam, they present very useful information. In this context, NPV and IRR of building projects have a change for the worst under the concurrent variation of steel price, cement price, gold price and $US exchange rate. It is useful for owners or developers of building projects in Vietnam to predict the loss of their benefit at the worst under the concurrent variation of various factors in the construction market. Moreover, in further studies, researchers should go through with other kinds of building projects such as office buildings, apartments as well as other factors. Data from other projects with similar scope and type should be analyzed in order to make more validation of the proposed model.

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