

# Analysis of Risk Problems in Construction by R Software

Thi My Dung Do, Thanh Quang Khai Lam

**Abstract:** Due to the characteristics of the investment process and construction production having diversity, high specifics, the large cost for the investment in construction works, the long time, a lot of effects by many natural factors and many other characteristics, so the risk is always a potential factor that can occur and cause unpredictable consequences at any time. Especially, when conducting construction works in the market economy conditions of relevant units such as construction unit, supervision consultancy unit, design consultancy unit, investor, operators, etc., it will always face many risks. Therefore, it is required that managers have methods to determine the level of risk. Predicting the risks in construction works will help construction managers have a basis to anticipate the risks and have a plan to prevent and resolve when the problems occur. R Software is an open-source code software used for statistical and graph analysis, unlike other software that must be licensed to use, this software we can download for free from [r-project.org](http://r-project.org) homepage. Most business analysis techniques are supported by R. Evidence of the power of R is the award and praise from prestigious magazines or communities in the world such as New York Times, Forbes, Intelligent Enterprise, InfoWorld and The Register. In this article, the author will present some applications of R software for predicting risks in construction works.

**Keywords:** Risk, construction risk, risk management, risk analysis, risk prediction...

## I. INTRODUCTION

In the world, there are many authors studying on the risk, basically, the approach to the problem has no big difference, but the methodology to solve the problem may be different. In this paper, the authors would like to state the views of some authors:

- In the view of Nguyen Nghi [16]: Risk management is an accurate technique to identify threats to the success of the project, focusing attention on activities to eliminate the risks and implement plans to reduce or mitigate the effects and increase the success of the project. This includes the plan that maximizes the positive factors related to the risks (positive risks). The risk management is a collection of project management activities, implemented together with traditional management functions such as planning and engineering cost management at project and function levels.

According to Nguyen Nghi, the risk management is divided into 2 main areas: The risk management plan and the risk control. The model includes activities to be completed in the commencement of the project implementation, usually within three months as from the date of signing the contract, and activities during the entire time of contract implementation when the project is being developed. The risk management report identifies the risk status of the project until they stop threatening the project.

- The risk management according to the view of William R. Duncan (PMI Standards committee): The risk management includes processes related to identifying, analyzing and responding to the project risks. This also means maximizing positive results and minimizing negative results. The risk management includes the following main processes:

- Risk identification: identify the risks that may affect the project and the nature of each risk.
- Risk quantification: assess the risks and their effect on the output of the project.
- Planning for dealing with the risks: identify necessary steps to cope with the risks.
- Management for dealing with the risks: prepare for changes or arising in the process of the risks.

- In Sukulpat Khumpaisal's article [23], this article focuses on the risks of the construction bidding process. In addition, the appropriate risk identification method will also be introduced in this article. The proposed method begins with establishing a risk profile, risk avoidance, basic risk assessment and effective risk mitigation for participants in the project management, especially architects or managers of the project to understand the risks involved in the construction bidding process including how to minimize the risks.

- In the study of Nerija Banaitiene and Audrius Banaitis [18], it is mainly analysis of the risks and the risk management in construction companies in Lithuania.

- The study by Acelya Yildiz, Irem Dikmen, Mustafa Birgonul, Kerem Er-coskun, Selcuk Alten Proceedings Editors [2] proposes a risk mapping method for international construction projects.

- In the study of Dr Patrick. X.W. Zou, Dr Guomin Zhang and Professor Jia-Yuan Wang [21]. This article aims to identify and analyze the risks relating to the development of project construction from project stakeholders and the view of life cycle. By surveying, postal questions are used to collect the data.

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Based on a comprehensive assessment of their appearance and effect on project objectives, this study identifies twenty major risks. This study shows that these risks are mainly related to (based on rankings) contractor, customers and designers, with a few related to government agencies, subcontractors / suppliers. and external problems.

According to survey results of Ernst & Young for organizations that have failed in real estate investment projects in developing countries including Asia, there is up to 73% of real estate business owners who acknowledge that their business is facing the difficulties relating to the risk assessment and profit expectations of the project. More than 50% of senior managers are concerned that the business performance of all businesses is reduced by a number of large projects. The reason is that each project usually lasts at least 3-5 years, during that time, the amount of money spent is much larger than the income. With the success rate in implementing the real estate projects, 50% of projects exceed the initial budget, 58% of projects are slower than the schedule, 42% of projects have the problems on quality after completion. These actual figures in Vietnam may be higher in the current period. According to Henri L. Beenhakker [7], J. Raftery [9], M. Rosenau [15] have defined the risk management from a conventional point of view that it is the process of identification, determination, analysis, measurement for the level of the risks, on that basis to select, implement and manage the activities to deal with the possible risks. - M. Dixon [14], a series of notable studies of the International Project Management Institute [20], Caltrans [3], D. Hilson [4], etc. give the definition of the risk management from the modern point of view that it is the process of making the most of potential opportunities in the future to bring the positive results and minimize the risks causing negative effects. - According to D. Barrie [5], the risk management is an organized effort to identify and quantify the possibility of the risks, at the same time, the plans are also proposed to eliminate or reduce the consequences from the risks. - Author Anthony Walker [1] also discussed the risk management in construction but mainly analyzed the investment activities. - The studies related to the risk management [14], [15], [20] have shown that the risk management is a complex task, including identifying the types of the risks that the project can face in the future; assessing the possibility of the risks and the level of effects caused by the risks; thereby finding the methods to manage and prevent and mitigate the damages from the risks; providing the measures to implement and adjust the actions in each specific case to cope with each risk. It can be said that each decision of the risk management of the project manager has a direct effect on the objectives, success and effectiveness of the project. This requires the project manager to grasp the necessary knowledge, contents and processes in the risk management of the project. - In construction, many authors mentioned the risk management of the project [8] [9] [10] [11]; The risk management and construction [15]; the risk analysis of BOT projects [24]; the risk management in construction industry [19].

In addition, there are many websites or articles on the risks in construction, but only at the analysis and finding out the risks in the stages such as construction, installation,

bidding, etc. or just giving the risks and the risk management measures.

R is a statistical language, also a chart language, it can be said to be a programming language. R comes from software named S, S software is software for data analysis and data management, the development process includes 3 stages:

- Stage 1 [17]: in 1988, when RA Becker, JM Chambers, and A Wilks participated together to develop a software called S, S2 version, it is only used in a research center of a telephone center. In addition to the telephone, it is also a very important scientific and technological research center of the United States.

- Stage 2 [17]: In 1992, Chambers, Hastie created a third version called S3.

- Stage 3 [17]: in 1998, JM Chambers turned S into a commercially available product called S4.

## II. INTRODUCTION ABOUT R SOFTWARE

S is a software for real professionals on the statistics, so it is difficult to use. R was originally by 2 statisticians Ross Ihaka and Robert Gentleman (a statistician, he specialized in computing), they were from the University of Auckland, New Zealand, they contacted JM Chambers to turn the S software to become a new and free software for the statistical community around the world to use, JM Chambers was a scientist, so he did not care about commercial problems and he agreed immediately. Thereby, Ross Ihaka and Robert Gentleman began to convert the code of S into R and we use it until today. [17] Since 1997, R software has become popular, so it is thought that it is necessary to have an executive group, called "R-core" including 15 people, they are on behalf of the international statistics community to manage the develop and maintain the R software for us to use today. The R Software is completely free, unlike other software such as: SAS, SPSS, etc. which are commercial statistical software, must buy copyright to use. It is a software that can run on many operating systems: Windows, Unix, MacOS. There are many analytical methods in it, the R software has not only popular analytical methods but also specialized analytical methods that other software may not have. For those using advanced data analysis methods, there are many methods not implemented in the software such as SAS, SPSS, etc., but the R has all those methods. The R Software is capable of describing the data in the form of charts, the form of charts described in the R is great because the R is also an analytical language, so it allows us to apply the design of the chart for the study. In addition, the R also has other utilities such as: the R is a statistical analysis language, allowing the development of user analysis, implementing all the statistical analysis models that we think, simulating, beautifully drawing the charts from simple to complex, allowing programming and deploying a new method, etc. Therefore, the R can be used to predict the construction risks.



### III. INTRODUCTION ABOUT THE PROJECT

Ho Chi Minh City is a geological area in relatively weak districts (except Cu Chi, Hooc Mon, District 12), especially the districts along the Saigon River, 30m above is usually mud, followed by fine sand and large grain sand. The geology changes complicatedly, so when the barrette pile is constructed, the problem is unavoidable. After applying the expert methods to collect the data on the percentage of problems when constructing the barrette pile in Ho Chi Minh City and the level of effect to the cost and construction time of the barrette pile (the author only consider the effect on the time here).

The authors use regression analysis to find the relationship between the problem and time, then use the R software to predict. Linear regression analysis is a method of analyzing the relationship between the dependent variable Y and one or more independent variables X. Modeling the use of the linear functions (level 1). The parameters of the model (or function) are estimated from the data. Call the percentage of problem occurrence as independent variable, symbolized as X, each surveyed data is  $x_i$ . Calling the percentage of the effect of the problem to the cost is the dependent variable, symbolized as Y, each surveyed data is  $y_i$ . From the research results [12][6], we conduct the analysis according to the following steps:

Step 1: Start the R

Step 2: Enter the commands of the R

Enter the survey data into the R, I order to examine the relationship (linear) between the two quantitative variables, we use the plot function to describe the image and the cor function to describe the level of correlation between the two variables.

### IV. PROGRAM AND RESULTS

```
> getwd()
[1] "D:/phuluc"
> x=c(13,11,12,11,9,7,7,13,15,8,8,5,15,6,7,12,10,11,8,9,1
4,11,13,9,12,11,12,15,11,12,9,9,7,6,11,12,10,10,10)
> y=c(30,35,37,32,27,25,25,33,35,24,20,15,40,17,25,34,2
9,35,23,25,32,35,37,28,30,37,35,42,29,31,28,30,25,20,31,32
,32,35,30)
> plot(x,y,xlab="%thời gian",ylab="% the incident
collapsed")
```

We have chart:

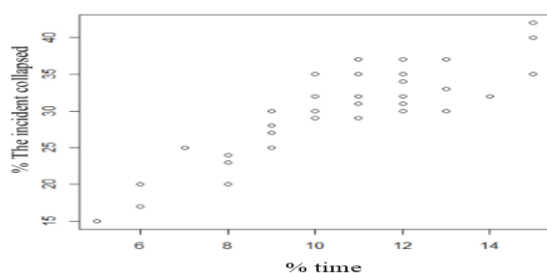


Fig. 1. Chart showing relationship between time and problem

Then we check the correlation coefficient:

```
> cor(x,y)
[1] 0.8691576
```

We see that the discrete graph and the correlation coefficient between x and y are large enough to allow us to

assume the linear relationship between x and y.

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i$$

Use function `lm()` (linear models) to find the estimates

$$\omega_1 = \int_{x_0}^{\infty} p(S) dS$$

> `lm(y~x)`

Call:

`lm(formula = y ~ x)`

Coefficients:

```
(Intercept)      x
      8.921      2.038
```

Then we have the equation showing the relationship between the cost and problem as follows:

$$\hat{y}_i = 8,921 + 2,038x_i$$

> `m1=lm(y~x)`

> `summary(m1)`

Call:

`lm(formula = y ~ x)`

Residuals:

```
      Min       1Q   Median       3Q      Max
-5.4474 -2.2971  0.6278  1.8156  5.7029
```

Coefficients:

```
      Estimate Std. Error t value Pr(>|t|)
(Intercept)  8.9213     2.0196   4.417 8.39e-05 ***
x            2.0376     0.1906  10.691 7.20e-13 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 3.049 on 37 degrees of freedom
Multiple R-squared:  0.7554,    Adjusted R-squared:  0.7488
F-statistic: 114.3 on 1 and 37 DF, p-value: 7.204e-13
> anova(m1)
```

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
Residual standard error: 3.049 on 37 degrees of freedom  
Multiple R-squared: 0.7554, Adjusted R-squared: 0.7488

F-statistic: 114.3 on 1 and 37 DF, p-value: 7.204e-13

> `anova(m1)`

Analysis of Variance Table

Response: y

```
      Df Sum Sq Mean Sq F value    Pr(>F)
x       1 1062.41  1062.4  114.29 7.204e-13 ***
Residuals 37  343.95    9.3
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Step 3: Develop predictive model:

After the predictive model of the cost has been checked and the rationality has been established, we can draw a line of performance of the relationship between the problem and the cost by using the `abline` command as follows (object of analysis is `m1`):

> `abline(m1)`

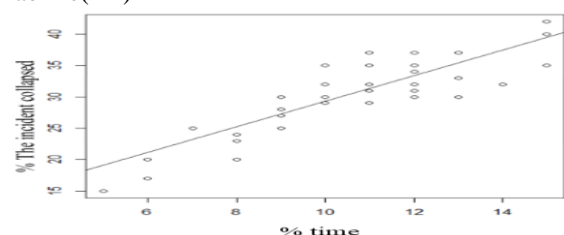
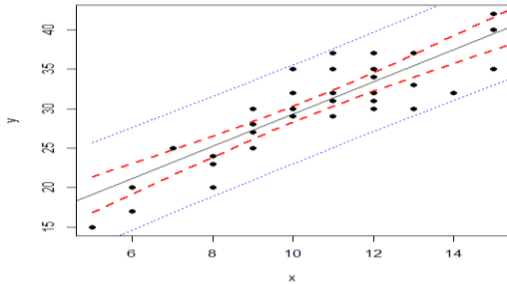


Fig. 2. A line of performance of the relationship between the relationship. Between % of collapsed wall problem of the hole (x) and % of time (y).



```
> new=seq(min(x),max(y),length=50)
> predint=predict(m1,data.frame(x=new),interval="prediction")[,c("lwr","upr")]
> confint=predict(m1,data.frame(x=new),interval="confidence")[,c("lwr","upr")]
> plot(y~x,pch=16)
> abline(m1)
> matlines(new,cbind(confint,predint),lty=c(2,2,3,3),col=c("red","red","blue","blue"),lwd=c(2,2,1,1))
```



**Fig. 3. Predicted value and 95% of confidence and new value**

The chart above draws the average predicted value  $\hat{y}_i$  (straight line in black), and the 95% confidence of this value is the red line. In addition, the blue line is the confidence interval of the predictive value % of the time for % of new problems in the population.

## V. CONCLUSION

1. After forecasting the risk occurrence by the linear regression method and using the R software for the analysis, if the construction unit finds that with the percentage of the risks such as analysis, the unit is not enough capability to solve, the unit should not accept the bids from the beginning.

2. If the construction unit finds that with the percentage of the risks such as analysis, they accept the bids, they will have the measures to deal with the risks and the preventive measures.

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