Guidelines for effective Variation Order determination strategy

Henri Desyardi¹, Yusuf Latief¹, Budi Susilo Soepandji¹

¹ Civil Engineering Department, University of Indonesia, Depok, Indonesia

Abstract. Variation order means all changes to the job, which are ordered or approved as a change. The existence of variation order problems in the field that impact on the achievement of project targets and the company's profit target in the project comes from aspects of construction, administrative aspects, aspects of resources. From some cases projects have occurred with regard to variation orders causing increased cost of contract value (cost overruns). Questionnaire survey method is used to achieve the purpose of this research that is to identify and anticipate the cause of variation order which affect the cost in the project. The results show that the cause of variation orders on the project leads to increased costs based on aspects of construction, administration and resources. From these results can be avoided from the negative impact of variation order is the increase of cost.

1. Introduction

Variation Orders and Change Orders or also those who call them Change Authorization refer to the same object, namely 'Change' to the scope of work or in the standard Indonesian language, Change of Work Scope (PLK). Usually terms 'Charge Order' are often used by the US, and the terms 'Variation Order' are more widely used by the UK. Some references to terms of contracts that use the basis of the FIDIC (International Federation of Consulting Engineers) adopt the terms 'Variation', which actually also leads to the same meaning. So that for a project, it can be returned again in terms of what is used in a mutually agreed Work Contract, in defining the change (change) itself (Alex Iskandar, 2011). Based on the FIDIC in clause 13, the change in contract is defined in the form of variation and adjustment. Variation means all changes to the Work, which are ordered or approved as a change based on Clause 13 [Variation and Adjustment]. While adjustments are part of the variation which is divided into two types, namely adjustments due to changes in regulations and adjustments due to changes in costs. Changes in adjustments come from external project factors such as delays in work due to legislative changes and changes in project costs due to declining currency exchange rates (Maulana, 2016).

In this research, took a case study of the Elevated MRT phase 1 project package Civil Works. The Elevated MRT project phase 1 as the first time the project was built in Indonesia The scope of the work of the elevated MRT project Civil Works package includes civil development work (starting from foundation to super structural work) and depot building. For signalling and train work, it is done through other packages with different contractors. The design and built contract should not cause significant variation orders, but in reality there is a significant variation order in this project. (Project Documentation, 2017).

The elevated MRT project Civil Works package has several variation order, such as in the form of a single pier change into a portal, volume addition etc. with the variation order value reaching 16% (without extension of time claim) of the contract value, the project profit remains as planned, which is 5%. Turnover of contract value increases. The duration of the project which should have been completed in 56 months increased to 63 months. Until this time the variation order submission process and extension of time are still being attempted. This project will have the potential to decrease profits if the submission fails. (Project Documentation, 2017).
There is a problem in terms of variation order at site which affects the achievement of the project work target and the company's profit target in the project. O'Brien and Zilly (1991) explained that a large number of changes can have a cumulative and disturbing influence. If this impact is not compensated in variation order it can reduce the work time performance. Based on the description that has been explained in the background and problems of this research, some research questions can be formulated as follows:

**Research Question**: What are the causes of variation orders that affect the cost of the project?

**Input**: List of variation order causes

**Process**: Survey, Analysis

**Output**: Performance of Project (cost)

**Figure 1. Charts of Variation Order Type at MRT Project**

**Figure 2. Operational Model Scheme**

2. Previous study / Review Literature

2.1 Variation Order

Variation Orders in construction projects can be in the form of adding or reducing the volume of work listed in the contract, adding or reducing the type of work, and changing technical specifications according to the needs of the field. These changes have resulted in changes in the scheduling of project work and cost overruns. Variation orders are things that often occur in building and civil construction projects. This variation order is a form of design improvement that is already in a work contract. Briefly variation order can be defined as a modification of the original contract (Schaulfelbeger & Holm, 2002). According to Fisk (2006) variation order is an agreement between the owner and contractor to confirm the changes in the plan and the amount of cost compensation to the contractor that occurred during
construction, after the signing of the work between the owner and the contractor. The purpose of Variation Orders includes:

1. Change the contract plan with a special method of payment.
2. Change job specifications, including changes in payment and contract time from before.
3. Approval of additional new jobs, in this case including payments and changes in the contract.
4. Administrative purposes in determining the method of payment of extra work or additions.
5. Follow adjustments to the contract unit price if there is a specification change.
6. Submission of proposal incentive reduction if there is a change in value engineering proposal.
7. Adjust the project schedule due to changes.
8. Avoid disputes between the contractor and the owner.

(Ade & Sarwono, 2015)

2.2 Causes of Variation Orders That Impact on Costs on Projects

In an effort to achieve boundary-determined goals, as an important parameter for project implementation (Soeharto, 1995), which is known as three boundaries, consisting of cost / budget, schedule / time and quality. For this time / time limit, the project will be carried out according to the specified time and end date. Settlement time is one of the achievements of the project (Henry, 2005). O’Brien and Zilly (1991) describe very large responsibilities that can produce a cumulative and publishing role. At this time cannot be compensated in the order variation can reduce the work time performance. The causes of variations in the order of the phenomena in chapter 1 above are categorized into several aspects. (Such as construction aspect, administration aspect and resource aspect. (Gumolili, 2012)

3. Research Method

3.1 Expert Validation Data Collection

Based on the results of a literature review that has identified the factors causing the Variation Order, expert validation is then carried out to determine whether the expert agrees with the existing variables, adds or subtracts variables, and corrects the sentence in the question.

3.2 Survey Pilot Data Collection

Based on the factor variables and the cause of the Variation Order that has been chosen by the expert, proceed to the pilot survey data collection stage to ensure that the variable will be easily understood by the respondent.

3.3 Respondent Data Collection

Based on the factor variables and causes of Variation Orders that have been selected by experts and easily understood through a pilot survey, followed by data collection of respondents. From the results of data collection results of filling out the respondents' questionnaires, the results is performed using the AHP (Analytical Hierarchy Process) method to find out that each of the 10 most dominant factors and causes of Variation orders that affect costs. After that the results are validated by expert validation from MRT project team.

In general, the questionnaire given to respondents consists of two topics: First, the questionnaire captures background information of the respondents. Second, factors derived from literature were listed such that respondents were able to score each factor regarding impact of Variation Order variable to the cost. 1-5 Liker scale was used: 1 means have not impact; 2 means 1-25% impact of cost; 3 means 25-50% impact to the cost; 4 means 50-75% impact to the cost; 5 means 75-100% cost impact. The questionnaire also included open-ended questions which allow respondents to include other factors not listed in the questionnaire. (Thomas L Saaty, 2012).
4. Finding

4.1 Variable data from literature study
From the aspect development (Gumolilli, 2012) and collected several literature, there are 244 variables of causes of Variation Order, as in the following table:

| No | Factors that cause Variation Order | Causes of Variation Order |
|----|----------------------------------|---------------------------|
| X1 | Construction Aspects             |                           |
| X1.1 | Planning and Design               |                           |
| X1.1.1 | Errors and planning and design   | 1. There are countless structural components |
|        |                                  | 2. There are regulatory standards that are not applied |
|        |                                  | 3. There is no role model for similar projects |
| X1.1.2 | Design changes                   | 1. Budget efficiency     |
|        |                                  | 2. Failure of land acquisition |
|        |                                  | 3. Mistake of plan assumptions |
| X1.1.3 | Changes to work methods          | 1. Lack of knowledge & experience |
|        |                                  | 2. The use of different tools |
|        |                                  | 3. The initial work method is not productive |
| X1.1.4 | Errors and omissions in determining volume estimates | 1. Design drawings are too general |
|        |                                  | 2. The tender period is too short |
|        |                                  | 3. Experienced inexperience |
| X1.1.5 | Contracts that are incomplete    | 1. Article contracts adopt similar projects |
|        |                                  | 2. There is an Article without a clear explanation of the verse |
|        |                                  | 3. Mistake of plan assumptions |
| X1.1.6 | Contracts that are less strict   | 1. There is a “winged” article |
|        |                                  | 2. Explanation of an ambiguous article |
|        |                                  | 3. There is a counter definition between the articles |
| X1.1.7 | Termination of temporary contract | 1. There has been no cash advance |
|        |                                  | 2. There is no budget clarity |
|        |                                  | 3. Changes in government policies |
| X1.1.8 | Incompatibility between drawing and contract | 1. Drawings and contracts are made only based on similar projects |
|        |                                  | 2. Drawings and contracts are made general |
|        |                                  | 3. Drawings and contracts are less specific |
| X1.1.9 | Incompatibility between drawing and field conditions | 1. Drawings are only based on similar projects |
|        |                                  | 2. Drawings are not updated on land acquisition |
|        |                                  | 3. Drawings are less specific |
| X1.1.10 | Incompatibility in original design specifications | 1. Specifications and designs are made only based on similar projects |
|        |                                  | 2. Specifications and designs are made general |
|        |                                  | 3. Specifications and designs are less specific |
Table 1. List of Variation Order factors and causes variable that influence to the cost

| No          | Factors that cause Variation Order                                                                 | Causes of Variation Order                                                                 |
|------------|----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| X1.1.11    | Excerpt from incomplete specifications                                                            | 1. Quotation of specifications is only based on a similar project                           |
|            |                                                                                                   | 2. Quotations of specifications made general                                                 |
|            |                                                                                                   | 3. Specification quotations are made without seeing the contract drawing                   |
| X1.1.12    | Unclear details                                                                                    | 1. The tender period is too short                                                           |
|            |                                                                                                   | 2. Only based on similar projects                                                           |
|            |                                                                                                   | 3. Made general                                                                             |
| X1.1.13    | Poor document coordination                                                                         | 1. Document creation is only based on a similar project                                     |
|            |                                                                                                   | 2. Documents made general                                                                   |
|            |                                                                                                   | 3. The document is created without checking other documents                                 |
| X1.1.14    | Additional scope of work                                                                           | 1. There are countless structural components                                                |
|            |                                                                                                   | 2. There are regulatory standards that are not applied                                       |
|            |                                                                                                   | 3. There is no role model for similar projects                                              |
| X1.1.15    | Reducing the scope of work                                                                          | 1. Budget efficiency                                                                       |
|            |                                                                                                   | 2. Failure of land acquisition                                                              |
|            |                                                                                                   | 3. Mistake of plan assumptions                                                              |
| X1.1.16    | Value Engineering                                                                                  | 1. Budget efficiency                                                                       |
|            |                                                                                                   | 2. Failure of land acquisition                                                              |
|            |                                                                                                   | 3. Mistake of plan assumptions                                                              |
| X1.1.17    | Changes in scope                                                                                   | 1. Efficiency budget                                                                       |
|            |                                                                                                   | 2. Failure of land acquisition                                                              |
|            |                                                                                                   | 3. Error assuming plan                                                                      |
| X1.1.18    | Increase in volume                                                                                 | 1. There are countless structural components                                                |
|            |                                                                                                   | 2. There are regulatory standards that are not applied                                       |
|            |                                                                                                   | 3. There is no role model for similar projects                                              |
| X1.1.19    | Estimated excess                                                                                   | 1. Design drawings are too general                                                          |
|            |                                                                                                   | 2. The tender period is too short                                                           |
|            |                                                                                                   | 3. There is no role model for similar projects                                              |
| X1.1.20    | Lack of information about the state of the field                                                   | 1. Field survey data taken is too random                                                     |
|            |                                                                                                   | 2. There is no explanation when aanwijzing                                                  |
|            |                                                                                                   | 3. Mistake of plan assumptions                                                              |
| X1.1.21    | Lack of anticipation of sudden circumstances                                                       | 1. Budget efficiency                                                                       |
|            |                                                                                                   | 2. Minimum risk budget                                                                      |
|            |                                                                                                   | 3. Mistake of plan assumptions                                                              |
| No  | Factors that cause Variation Order | Causes of Variation Order |
|-----|-----------------------------------|----------------------------|
| X1.1.22 | Late in approving drawings, contract design & clarification | 1. Lack of managerial leadership skills related to the cost  
2. Unclear communication lines |
| X1.2 | Underground Conditions |  |
| X1.2.1 | Incomplete field investigation | 1. Budget efficiency  
2. Data from field surveys taken are too random  
3. Mistake of plan assumptions |
| X1.2.2 | Additional requirements for underground repairs | 1. There are regulations that are not applied when planning  
2. Field survey data taken is too random during planning  
3. Mistake of plan assumptions |
| X1.2.3 | Improved underground investigation | 1. There are regulatory standards that are not applied when planning  
2. Field survey data taken is too random during planning  
3. Mistake of plan assumptions |
| X1.2.4 | Different underground conditions | 1. Lack of reserve for risk costs  
2. Field survey data taken is too random during planning  
3. Mistake of plan assumptions |
| X1.2.5 | Underground seepage after excavation | 1. Lack of reserve for risk costs  
2. Investigation of land taken is too random during planning  
3. Mistake of plan assumptions |
| X1.2.6 | Poor / accurate investigation | 1. Budget efficiency  
2. Failure of land acquisition  
3. Mistake of plan assumptions |
| X1.3 | Security considerations |  |
| X1.3.1 | Field security considerations | 1. Making a safety fence / boundary in response to community complaints during implementation  
2. Making barricades due to pressure on environmental conditions to secure imported project material  
3. The recruitment of security officers from local residents due to environmental pressure |
| X1.3.2 | Consideration of field protection | 1. The cost of a special security convoy by the officer concerned when shipping material / equipment  
2. Maintenance during construction by officers / related agencies due to misuse of the project area |
| No | Factors that cause Variation Order | Causes of Variation Order |
|----|-----------------------------------|---------------------------|
|    |                                   | for illegal parking, illegal street vendors, wild terminals |
|    |                                   | 3. Material / tool is closed with additional special cover |
| X1.3.3 | Additional security facilities | 1. Additional security personnel due to surrounding conditions |
|    |                                   | 2. Adding CCTV installations |
|    |                                   | 3. Alarm installation |
| X1.4 | Natural Events | |
| X1.4.1 | Landslide | 1. There is no calculation of slope stability around the project area |
|    |           | 2. Lack of documentation before, during and after the event, making it difficult to claim as a natural disaster |
|    |           | 3. Mistake of plan assumptions |
| X1.4.2 | Flood | 1. No calculation of flood discharge around the project area |
|    |        | 2. Lack of documentation before, during and after the event, making it difficult to claim as a natural disaster |
|    |        | 3. Mistake of plan assumptions |
| X1.4.3 | Land subsidence | 1. There is no calculation of settlement around the project area |
|    |          | 2. Lack of documentation before, during and after the event, making it difficult to claim as a natural disaster |
|    |          | 3. Mistake of plan assumptions |
| X1.4.4 | Bad weather | 1. There is no complete weather data around the project area |
|    |            | 2. Lack of documentation before, during and after the event, making it difficult to claim as a natural disaster |
|    |            | 3. Mistake of plan assumptions |
| X2  | Administrative Aspect | |
| X2.1 | Changes to Work Regulations | |
| X2.1.1 | Improving fire regulations | 1. Management change |
|    |                             | 2. Changing firewall material |
|    |                             | 3. There are regulatory standards that are not applied |
Table 1. List of Variation Order factors and causes variable that influence to the cost

| No   | Factors that cause Variation Order                        | Causes of Variation Order                                                                 |
|------|-----------------------------------------------------------|-------------------------------------------------------------------------------------------|
|      | X2.1.2 Improvement of city planning regulations           | 1. Management change                                                                      |
|      |                                                            | 2. Material changes                                                                        |
|      |                                                            | 3. There are regulatory standards that are not applied                                      |
|      | X2.1.3 Improvement of construction waste management regulations | 1. Material changes                                                                        |
|      |                                                            | 2. There is a non-applied regulation standard                                              |
|      | X2.1.4 Improvement of environmental protection regulations | 1. Management change                                                                      |
|      |                                                            | 2. Material changes                                                                        |
|      |                                                            | 3. There are regulatory standards that are not applied                                      |
|      | X2.1.5 Contract conflicts and disputes                    | 1. Disputes occur due to interpretation of a problem that is different between parties project owner and contractor |
|      |                                                            | 2. Lack of ability                                                                         |
|      |                                                            | Management in understanding contracts                                                     |
|      |                                                            | 3. Project complexity                                                                     |
|      | X2.1.6 Poor information flow                             | 1. No communication SOP was made in the project                                           |
|      |                                                            | 2. Don't use IT                                                                           |
|      |                                                            | 3. The project is in the remote area                                                      |
|      | X2.2 Regulations from those authorized to make decisions  | 1. There is no role model for similar projects                                            |
|      | X2.2.1 Initial placement of newly built facilities        | 2. There is no price reference                                                             |
|      |                                                            | 3. Mistake of plan assumptions                                                             |
|      | X2.2.2 Domination of the authority of superiors           | 1. There is additional space / facility                                                    |
|      |                                                            | 2. There is a specification change                                                         |
|      |                                                            | 3. Changes in plan assumptions                                                             |
|      | X2.2.3 Legal / government changes                         | 1. There is additional space / facility                                                    |
|      |                                                            | 2. There is a specification change                                                         |
|      |                                                            | 3. Changes in plan assumptions                                                             |
|      | X2.2.4 Change of commitment from government               | 1. Budget efficiency                                                                      |
|      |                                                            | 2. Failure of land acquisition                                                             |
|      |                                                            | 3. Contract delay                                                                         |
|      | X2.2.5 Delays during construction                         | 1. Budget efficiency                                                                      |
|      |                                                            | 2. Failure of land acquisition                                                             |
|      |                                                            | 3. Mistake of plan assumptions                                                             |
|      | X2.2.6 The intervention of the highest authority holder   | 1. Budget efficiency                                                                      |
|      |                                                            | 2. Failure of land acquisition                                                             |
|      |                                                            | 3. Mistake of plan assumptions                                                             |
| No      | Factors that cause Variation Order | Causes of Variation Order                                                                 |
|---------|------------------------------------|------------------------------------------------------------------------------------------|
| X2.2.7  | Requirements of urban planning agencies | 1. Budget efficiency  
                                                     2. Failure of land acquisition  
                                                     3. Mistake of plan assumptions |
| X2.2.8  | Contract price increase             | 1. High inflation occurs  
                                                     2. Better fuel prices  
                                                     3. Decreasing rupiah exchange rate |
| X2.2.9  | Adjustment of project costs         | 1. High inflation occurs  
                                                     2. Rising fuel prices  
                                                     3. Decreasing rupiah exchange rate |
| X2.2.10 | Interventions with third parties    | 1. There is additional space / facility  
                                                     2. There is a specification change  
                                                     3. Changes in plan assumptions |
| X2.3    | Change in ownership & testing commissioning |                                                                                   |
| X2.3.1  | Additional needs for functional and care | 1. Acceleration of handover to owner  
                                                     2. Dispute about responsibility  
                                                     3. Mistake of plan assumptions |
| X2.3.2  | The need for home users             | 1. Acceleration of handover to owner  
                                                     2. Dispute about responsibility  
                                                     3. Mistake of plan assumptions |
| X2.3.3  | Design modifications for related agents | 1. The existence of government intervention  
                                                     2. Failure of land acquisition  
                                                     3. Mistake of plan assumptions |
| X2.3.4  | Coordination with the utility system | 1. Utility exposed to heavy equipment  
                                                     2. Utility cannot be moved, so design changes occur  
                                                     3. Mistake of plan assumptions |
| X2.4    | Request for the surrounding environment |                                                                                   |
| X2.4.1  | Additional facilities for the population environment | 1. Government intervention  
                                                     2. Failure of land acquisition  
                                                     3. Mistake of plan assumptions |
| X2.4.2  | Reducing / stopping parts of construction in connection with environmental problems | 1. Budget efficiency  
                                                     2. Failure of land acquisition  
                                                     3. Mistake of plan assumptions |
| X2.4.3  | Special request from the city council | 1. There is additional space / facility  
                                                     2. There is a specification change  
                                                     3. Changes in plan assumptions |
Table 1. List of Variation Order factors and causes variable that influence to the cost

| No     | Factors that cause Variation Order                                                                 | Causes of Variation Order                                                                                   |
|--------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| X2.4.4 | Third party actions are beyond the control of the project owner or contractor                    | 1. There is additional space / facility<br>2. There is a specification change<br>3. Changes in plan assumptions |
| X2.5   | Management causes                                                                                |                                                                                                             |
| X2.5.1 | Poor owner performance                                                                           | 1. The management team is inexperienced<br>2. The management team handles several projects<br>3. Complexity of the problem |
| X2.5.2 | Poor contractor performance                                                                      | 1. The management team is inexperienced<br>2. The management team handles several projects<br>3. Complexity of problems |
| X2.5.3 | Wrong consideration at site                                                                       | 1. The management team is inexperienced<br>2. Lack of project supporting data<br>3. Mistake of plan assumptions |
| X2.5.4 | Too tight schedule                                                                                | 1. The management team is inexperienced<br>2. The management team handles several projects<br>3. Complexity of problems |
| X2.5.5 | Lack of control                                                                                  | 1. Lack of personnel<br>2. The management team handles several projects<br>3. Complexity of problems |
| X2.5.6 | Lack of team work                                                                                | 1. The management team is inexperienced<br>2. The management team handles several projects<br>3. Absence of internal routine meetings |
| X2.5.7 | Late access to the field                                                                          | 1. No communication SOP was made in the project<br>2. Don't use IT<br>3. The project is in the remote area |
| X2.5.8 | Sudden schedule changes                                                                          | 1. Third party intervention that has high authority<br>2. Government pressure<br>3. Mistake of plan assumptions |
| X2.5.9 | Another unexpected factor                                                                         | 1. If a new policy arises<br>2. The publication of new regulations<br>3. Political shock, including force majeure conditions |
| X3     | Aspects of Resources                                                                             |                                                                                                             |
| X3.1   | Material                                                                                         |                                                                                                             |
| X3.1.1 | Materials that are not available on the market                                                   | 1. Custom manufacturing<br>2. Special transportation<br>3. Mistake of plan assumptions                         |
| X3.1.2 | Late delivery of material                                                                        | 1. There is no periodic material progress information<br>2. There is no previous role model                   |
Table 1. List of Variation Order factors and causes variable that influence to the cost

| No   | Factors that cause Variation Order                                                                 | Causes of Variation Order                                                                 |
|------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
|      | 3. Frequent design changes occur                                                                   |                                                                                          |
| X3.1.3 | The sent specifications do not match                                                               | 1. There is no Factory Visit                                                              |
|      |                                                                                                    | 2. There is no periodic checking                                                           |
|      |                                                                                                    | 3. Mistake of plan assumptions                                                             |
| X3.2 | Wage                                                                                               |                                                                                          |
| X3.2.1 | Lack of knowledge of workers                                                                      | 1. Rework occurs because work is done on the basis of previous habits                      |
|      |                                                                                                    | 2. Rework occurs because the worker is not provided with training                          |
|      |                                                                                                    | 3. Rework occurs because the Supervisor does not provide an approved method                |
| X3.2.2 | Lack of worker experience                                                                         | 1. Rework occurs because work is done on the basis of previous habits                      |
|      |                                                                                                    | 2. Rework occurs because the worker is not provided with training                          |
|      |                                                                                                    | 3. Rework occurs because the Supervisor does not provide an approved method                |
| X3.2.3 | The amount of overtime work is too much                                                             | 1. Acceleration due to third parties                                                       |
|      |                                                                                                    | 2. Less effective work methods                                                             |
|      |                                                                                                    | 3. Mistake of plan assumptions                                                             |
| X3.3 | Tool                                                                                               |                                                                                          |
| X3.3.1 | Inadequate equipment                                                                               | 1. Work slows down, overhead increases                                                     |
|      |                                                                                                    | 2. Work slows down, subject to claims from third parties who will continue work            |
|      |                                                                                                    | 3. Work slowed, fuel increased                                                             |
| X3.3.2 | Loss of productivity                                                                              | 1. Work slows down, overhead increases                                                     |
|      |                                                                                                    | 2. Work slows down, subject to claims from third parties who will continue work            |
|      |                                                                                                    | 3. Jobs slow down, fuel increases                                                          |
| X3.3.3 | Delay in access or equipment supplied by the project owner                                         | 1. Work slows down, overhead increases                                                     |
|      |                                                                                                    | 2. Claimed by third parties / Sub cons that will continue the work                          |
|      |                                                                                                    | 3. Due to the domino effect of project delays                                              |
| X3.4 | Subcont                                                                                           |                                                                                          |
| X3.4.1 | Work is not appropriate Procedure                                                                  | 1. Rework occurs because work is done on the basis of previous habits                      |
|      |                                                                                                    | 2. Rework occurs because it does not know the work order                                   |
|      |                                                                                                    | 3. Rework occurs because the Supervisor does not provide Approved method                   |
Table 1. List of Variation Order factors and causes variable that influence to the cost

| No. | Factors that cause Variation Order | Causes of Variation Order |
|-----|-----------------------------------|---------------------------|
| X3.4.2 | The schedule of the subcontractor is late | 1. Work slows down, overhead increases |
| | | 2. Claimed by third parties / Sub cons that will continue the work |
| | | 3. Due to the domino effect of project delays |
| X3.4.3 | Poor subcontractor performance | 1. Work slows down, overhead increases |
| | | 2. Claimed by third parties / Sub contractors that will continue the work |
| X3.4.4 | Poor third party performance | 1. Work slows down, overhead increases |
| | | 2. Claimed by third parties / Sub contractors that will continue the work |
| | | 3. Due to the domino effect of project delays |
| X3.4.5 | Error in the execution of work | 1. Rework occurs because work is done on the basis of previous habits |
| | | 2. Claimed by third parties / Sub contractors that will continue the work |
| | | 3. Due to the domino effect of project delays |

4.2 Analyzing of survey results

In this survey, 32 respondents were successfully obtained from different project, with experience ranging from 3 years. Analysis with the AHP method is carried out to analyse the survey results with the aim to get the most significant Variation Order factors and causes influencing the cost. The steps of analysis carried out are as follows:

4.2.1 Normalization of sub criteria impact / influence level:

Table 2. Normalization of sub criteria impact

| Liker Scale | 1 | 2 | 3 | 4 | 5 | Total |
|-------------|---|---|---|---|---|-------|
| 1           | 1 | 1/2 | 1/3 | 1/4 | 1/5 | 2,2833 |
| 2           | 2 | 1 | 1/2 | 1/3 | 1/4 | 4,0833 |
| 3           | 3 | 2 | 1 | 1/2 | 1/3 | 6,8333 |
| 4           | 4 | 3 | 2 | 1 | 1/2 | 10,5000 |
| 5           | 5 | 4 | 3 | 2 | 1 | 15,0000 |
| Total       | 15,0000 | 10,5000 | 6,8333 | 4,0833 | 2,2833 | 38,7000 |
Table 3. Level of influence

| Liker Scale | 1  | 2  | 3  | 4  | 5  | ∑  | ∑/n  |
|-------------|----|----|----|----|----|-----|------|
| 1           | 0.0667 | 0.0476 | 0.0488 | 0.0612 | 0.0876 | 0.3119 | 0.0624 | 14.99 |
| 2           | 0.1333 | 0.0952 | 0.0732 | 0.0816 | 0.1095 | 0.4929 | 0.0986 | 23.68 |
| 3           | 0.2000 | 0.1905 | 0.1463 | 0.1224 | 0.1460 | 0.8053 | 0.1611 | 38.69 |
| 4           | 0.2667 | 0.2857 | 0.2927 | 0.2449 | 0.2190 | 1.3089 | 0.2618 | 62.90 |
| 5           | 0.3333 | 0.3810 | 0.4390 | 0.4898 | 0.4380 | 2.0811 | 0.1611 | 100.00 |
| Total       | 1   | 1   | 1   | 1   | 1  | 5   |    |     |

4.2.2 AHP Analysis

In table 4, table 5 and table 6, the AHP calculation is shown to get the significance level of all factors (in the following table we only show the top 10 factors that have the strongest significance).

Table 4. AHP analysis (top 10 result) for most significance factors and causes of Variation orders that affect costs based on construction aspect

| No | Variable                                                                 | n | level of influence | significance |
|----|--------------------------------------------------------------------------|---|-------------------|--------------|
|    |                                                                          |   | 1         | 2          | 3          | 4          | 5          |              |
|    |                                                                          |   | 15,0      | 23,7       | 38,7       | 62,9       | 100        |              |
| 1  | Increase in volume (There are countless structural components)           | 32| -         | 3          | 7          | 22         | -          | 3,6          | 13,8        | 68.8        | 86.1 |
| 2  | Contracts that are incomplete (Mistake of plan assumptions)              | 32| -         | 1          | 1          | 9          | 21         | -            | 0.7         | 1.2         | 65.6        | 85.3 |
| 3  | Design changes (Failure of land acquisition)                             | 32| -         | 2          | 3          | 6          | 21         | -            | 1.5         | 3,6         | 65.3        | 82.5 |
| 4  | Errors and planning and design (There are countless structural components) | 32| 1         | 2          | 10         | 19         | 0.5        | -            | 2.4         | 19,7        | 59,4        | 81.9 |
| 5  | Poor / accurate investigation (Failure of land acquisition)              | 32| -         | 2          | 5          | 6          | 19         | -            | 1.5         | 6           | 11,8        | 59,4        | 78.7 |
| 6  | Lack of information about the state of the field (Field survey data taken is too random) | 32| -         | 1          | 6          | 7          | 18         | -            | 0.7         | 7,3         | 13,8        | 56.3        | 78     |
| 7  | Errors and omissions in determining volume estimates (Design drawings are too general) | 32| 1         | -          | 6          | 8          | 17         | 0.5          | -           | 7,3         | 15,7        | 53.1        | 76.6 |
Table 4. AHP analysis (top 10 result) for most significance factors and causes of Variation orders that affect costs based on construction aspect

| No | Variable                                                                 | n  | level of influence | significance |
|----|--------------------------------------------------------------------------|----|-------------------|--------------|
|    |                                                                          |    | 1 2 3 4 5         | 1 2 3 4 5    |              |
|    |                                                                          |    | 1 23, 7 38, 9 100 | 15, 0 21, 6 46, 9 | 75, 8       |
| 8  | Contracts that are less strict (Explanation of an ambiguous article)     | 32 | - - 6 11 15       | - - 7,3 21, 6 | 46, 9 75, 8 |
| 9  | Improved underground investigation (Mistake of plan assumptions)         | 32 | - 2 4 11 15       | - 1,5 4,8 21, 6 | 46, 9 74, 8 |
| 10 | Changes to work methods (The initial work method is not productive)      | 32 | 1 5 1 11 14       | 0,5 3,7 1,2 21, 6 | 43, 8 70, 7 |

Table 5. AHP analysis (top 10 result) for most significance factors and causes of Variation orders that affect costs based on administration aspect

| No | Variable                                                                 | n  | level of influence | significance |
|----|--------------------------------------------------------------------------|----|-------------------|--------------|
|    |                                                                          |    | 1 2 3 4 5         | 1 2 3 4 5    |              |
|    |                                                                          |    | 1 23, 7 38, 9 100 | 15, 0 24, 7 4,8 62, 9 | 75, 8 |
| 1  | Adjustment of project costs (Decreasing rupiah exchange rate)             | 32 | - - 2 6 24       | - - 2,4 11,8 75 89,2 |
| 2  | Contract price increase (High inflation occurs)                          | 32 | - 1 2 5 24       | - 0,7 2,4 9,8 75 88 |
| 3  | Change of commitment from government (Contract delay)                    | 32 | - 1 4 7 20       | - 0,7 4,8 13,8 62,5 81,8 |
| 4  | Interventions with third parties (There is a specification change)       | 32 | - - 5 9 18       | - - 6 15,7 59,4 81,1 |
| 5  | Legal / government changes (There is a specification change)             | 32 | - - 4 10 18      | - - 4,8 19,7 56,3 80,7 |
| 6  | Requirements of urban planning agencies (Failure of land acquisition)    | 32 | - - 3 12 17      | - - 3,7 23,6 53,1 80,3 |
| 7  | Contract conflicts and disputes (Project complexity)                     | 32 | 1 1 3 9 18       | 0,5 0,7 3,6 15,7 59,4 79,9 |
| 8  | Change of commitment from                                                | 32 | 1 1 4 9 18       | 0,7 4,8 17,7 56,3 79,5 |
### Table 5. AHP analysis (top 10 result) for most significance factors and causes of Variation orders that affect costs based on administration aspect

| No | Variable                                                                 | n  | level of influence | significance |
|----|---------------------------------------------------------------------------|----|--------------------|--------------|
|    |                                                                          |    | 1  2  3  4  5  15,0 23,7 38,7 62,9 100 |              |
| 1  | government (Failure of land acquisition)                                 | 32 | -    7  7  18 - -  8,5  13,8  56,3 | 78,5         |
| 2  | Special request from the city council (There is a specification change)  | 32 | -    6  8  18 - -  7,3  17,7  53,1 | 78,1         |
| 3  | Delays during construction (Failure of land acquisition)                 | 32 | -    6  8  18 - -  7,3  17,7  53,1 | 78,1         |

### Table 6. AHP analysis (top 10 result) for most significance factors and causes of Variation orders that affect costs based on resource aspect

| No | Variable                                                                 | n  | level of influence | significance |
|----|---------------------------------------------------------------------------|----|--------------------|--------------|
|    |                                                                          |    | 1  2  3  4  5  15,0 23,7 38,7 62,9 100 |              |
| 1  | Materials that are not available on the market (Special transportation)   | 32 | -    4  7  21 - -  4,8  13,8  65,6 | 84,2         |
| 2  | Work is not appropriate procedure (Rework occurs because work is done on the basis of previous habits) | 32 | 2    1  11 18 0,9 -  1,2  21,6  56,3 | 80           |
| 3  | Inadequate equipment (Work slows down, overhead increases)                | 32 | 0    1  4 10 17 -  0,7  4,8  19,7  53,1 | 78,4         |
| 4  | Late delivery of material (Frequent design changes occur)                | 32 | -    6  9  17 - -  7,2  17,7  53,1 | 78,1         |
| 5  | Poor subcontractor performance (Claimed by third parties / Sub contractors that will continue the work) | 32 | 2    2  12 16 0,9 -  2,4  23,6  50 | 76,9         |
| 6  | The amount of overtime work is too much (Acceleration due to third parties) | 32 | 1    2  4  7 18 0,5  1,5  4,8  13,8  56,3 | 76,8         |
Table 6. AHP analysis (top 10 result) for most significance factors and causes of Variation orders that affect costs based on resource aspect

| No | Variable                                                                 | n   | 1  | 2  | 3  | 4  | 5  | 15,0 | 23,7 | 38,7 | 62,9 | 100 | Significance |
|----|---------------------------------------------------------------------------|-----|----|----|----|----|----|------|------|------|------|-----|-------------|
| 7  | The schedule of the subcontractor is late (Claimed by third parties / Sub contractors that will continue the work) | 32  | 1  | 1  | 2  | 13 | 15 | 0.5  | 0.7  | 2.4  | 25.6 | 46.9 | 76.1         |
| 8  | Delay in access or equipment supplied by the project owner (Due to the domino effect of project delays) that will continue the work) | 32  | -  | 1  | 4  | 12 | 15 | -    | 0.7  | 4.8  | 23.6 | 46.9 | 76       |
| 9  | Poor third party performance (Claimed by third parties / Sub contractors that will continue the work) | 32  | 2  | -  | 6  | 9  | 8  | 1.2  | -    | 9.3  | 22.6 | 32.0 | 65.1         |
| 10 | Error in the execution of work (Claimed by third parties / Sub contractors that will continue the work) | 32  | 2  | 1  | 5  | 8  | 8  | 1.3  | 0.9  | 8.1  | 20.9 | 33.3 | 64.6         |

4.3 Results of Analysis

After analysing the AHP method, the 10 main factors and causes of Variation Order to cost and also are validated by expert of MRT project are as follows:

Table 7. Most influence Variation Order cause and factor to cost based on construction aspect

| No | Variable                                                                 | Significance |
|----|---------------------------------------------------------------------------|--------------|
| 1  | Increase in volume (There are countless structural components)             | 86.1         |
| 2  | Contracts that are incomplete (Mistake of plan assumptions)                | 85.3         |
| 3  | Design changes (Failure of land acquisition)                               | 82.5         |
| 4  | Errors and planning and design (There are countless structural components) | 81.9         |
| 5  | Poor / accurate investigation (Failure of land acquisition)               | 78.7         |
| 6  | Lack of information about the state of the field (Field survey data taken is too random) | 78           |
| 7  | Errors and omissions in determining volume estimates (Design drawings are too general) | 76.6         |
| 8  | Contracts that are less strict (Explanation of an ambiguous article)       | 75.8         |
Table 7. Most influence Variation Order cause and factor to cost based on construction aspect

| No | Variable                                                                 | Significance |
|----|--------------------------------------------------------------------------|--------------|
| 9  | Improved underground investigation (Mistake of plan assumptions)         | 74.8         |
| 10 | Changes to work methods (The initial work method is not productive)     | 70.7         |

Table 8. Most influence Variation Order cause and factor to cost based on administration aspect

| No | Variable                                                                 | Significance |
|----|--------------------------------------------------------------------------|--------------|
| 1  | Adjustment of project costs (Decreasing rupiah exchange rate)             | 89.2         |
| 2  | Contract price increase (High inflation occurs)                          | 88           |
| 3  | Change of commitment from government (Contract delay)                    | 81.8         |
| 4  | Interventions with third parties (There is a specification change)       | 81.1         |
| 5  | Legal / government changes (There is a specification change)             | 80.7         |
| 6  | Requirements of urban planning agencies (Failure of land acquisition)    | 80.3         |
| 7  | Contract conflicts and disputes (Project complexity)                     | 79.9         |
| 8  | Change of commitment from government (Failure of land acquisition)       | 79.5         |
| 9  | Special request from the city council (There is a specification change)  | 78.5         |
| 10 | Delays during construction (Failure of land acquisition)                 | 78.1         |

Table 9. Most influence Variation Order cause and factor to cost based on resource aspect

| No | Variable                                                                 | Significance |
|----|--------------------------------------------------------------------------|--------------|
| 1  | Materials that are not available on the market (Special transportation)  | 84.2         |
| 2  | Work is not appropriate procedure (Rework occurs because work is done on the basis of previous habits) | 80           |
| 3  | Inadequate equipment (Work slows down, overhead increases)               | 78.4         |
| 4  | Late delivery of material (Frequent design changes occur)               | 78.1         |
| 5  | Poor subcontractor performance (Claimed by third parties / Sub contractors that will continue the work) | 76.9         |
| 6  | The amount of overtime work is too much (Acceleration due to third parties) | 76.8         |
| 7  | The schedule of the subcontractor is late (Claimed by third parties / Sub contractors that will continue the work) | 76.1         |
| 8  | Delay in access or equipment supplied by the project owner (Due to the domino effect of project delays) | 76           |
| 9  | Poor third party performance (Claimed by third parties / Sub contractors that will continue the work) | 65.1         |
| 10 | Error in the execution of work (Claimed by third parties / Sub contractors that will continue the work) | 64.6         |

Of the most influential factors, a survey was conducted for employees at several project to see the most influence Variation Order cause and factor to cost. From the results of the questionnaire which is distributed to 32 employees with 3-15 years’ experience, 50% employees from MRT project and the rest
came from other project get the following data. After that the results are validated by expert validation from MRT project team.

5. Implication of finding

Based on the data from the analysis of the main factors and causes of Variation Order influencing cost of the project that provide at table 7, 8 and table 9. We can identify factors and causes of Variation Orders that cause significant costs. There are 10 main factors and causes of Variation orders from construction aspect, administration aspect and resource aspect that affect costs can be done as a preventive solution for the next MRT project. This greatly affects the performance of the project related to profit achievement targets...

6. Conclusion

From the literature that has been studied, there are 244 variables related to factors and cause of Variation Order that affect the achievement of project profits. After a survey of 32 respondents from projects, it was obtained the results of 10 main factors (each) that affected the cost/ performance of project (project profit). There are 10 main factors and causes of Variation orders from construction aspect, administration aspect and resource aspect that affect costs can be done as a preventive solution for the next MRT project.

The MRT project phase 1 as the first time the project was built in Indonesia is expected to be a learning process for further MRT projects. Through this research can be done to prevent the existence of Variation Orders that can harm project owners and project implementers. So it is necessary to do research on methods such as what should be done by the company so that the steps that have been taken so far can run more effectively to get a good project performance in the form of profit target achievement.

Reference

[1] S. and Y. Nataanael, Belajar Otodidak SPSS, Jakarta: PT. Gramedia, 2014.

[2] A. Maulana, “Faktor Penyebab Terjadinya Contract Change Order dan Pengaruhnya Terhadap Pelaksanaan Proyek Konstruksi Pembangunan Bendung,” Jurnal Infrastruktur, 2016.

[3] A. Nurmala and S. Hardjomuljadi, “Penyebab dan Dampak Variation Order (VO) Pada Pelaksanaan Proyek Konstruksi,” Jurnal Konstruksia Volume 6, 2015.

[4] S. A. Gumolili and J. B.F. SOMPIE, “Analisa Faktor-Faktor Penyebab Change Order dan Pengaruhnya Terhadap Kinerja Waktu Pelaksanaan Proyek Konstruksi di Lingkungan Pemerintah Provinsi Sulawesi Utara,” Jurnal Ilmiah MEDIA ENGINEERING Vol.2, No.4, pp. 247-256, 2012.

[5] A. Sailendra, Langkah-Langkah Praktis Membuat SOP, Yogyakarta: Cetakan Pertama. Trans Idea Publishing, 2015.
[6] Moekijat, Administrasi Perkantoran, Bandung: Mandar Maju, 2008.

[7] T. Atmoko, Standar Operasional Prosedur(SOP) dan Akuntabilitas Kinerja Instansi Pemerintah, Jakarta: Skripsi Unpad, 2012.

[8] I. Insani, Pengembangan Kapasitas Sumber Daya Manusia Daerah Dalam Rangka Peningkatan Transparansi dan Akuntabilitas Pengelolaan Keuangan Daerah, 2010.