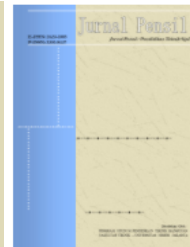


Available online at: <http://journal.unj.ac.id>

Jurnal
Pensil Pendidikan Teknik Sipil

Journal homepage: <http://journal.unj.ac.id/unj/index.php/jpensil/index>



ANALYSIS OF THE INFLUENCE OF ORDER VARIATION FACTORS ON THE COSTS AND TIME OF IMPLEMENTING CHANNEL DIVERCTION INFRASTRUCTURE CONSTRUCTION PROJECTS IN RESIDENTIAL AREAS

Ghazji Ghossan Hindami^{1*}, Agus Suroso², Mawardi Amin³

^{1,2,3} Magister Teknik Sipil, Fakultas Teknik, Universitas Mercu Buana Jakarta

Jalan Meruya Selatan, Kembangan, Jakarta Barat, DKI Jakarta, 11650, Indonesia

*gghindami@gmail.com, agus.suroso66@gmail.com, mawardi@mercubuana.ac.id

Abstract

Tangerang is a big city in Indonesia. The housing sector rocketing in this region. Changes in development often occur because problems arise and have an impact on costs and time. Researchers focused on finding the cause of the work diverting residential channels being hampered. For this reason, changes were made to the sheetpile design and changes to the infrastructure mobilization method to meet the contract time. The research uses the SEM PLS method to determine the factors causing order variations. In addition, the data processing application was used to determine the effect of order variations on time and cost performance. The respondents were 60 owners and consultants. Based on the results of the cost performance analysis, additional work arising from order variations reached 10,516,305,346 IDR and reduced work due to order variations reached 6,628,461,533 IDR or around 12.96% of the initial contract price and the results of time performance analysis for time losses that occurred due to order variations on the project showed an additional time of 5 months or 125%.

Keywords: Variation Orders, Time Performance, Cost Performance, Infrastructure, Housing

P-ISSN: [2301-8437](#)

E-ISSN: [2623-1085](#)

ARTICLE HISTORY

Accepted:
5 Maret 2024

Revision:
18 April 2024

Published:
29 Mei 2024

ARTICLE DOI:

[10.21009/jpensil.v13i2.43872](https://doi.org/10.21009/jpensil.v13i2.43872)



Jurnal Pensil :
Pendidikan Teknik
Sipil is licensed under a

[Creative Commons
Attribution-ShareAlike
4.0 International License](#)

(CC BY-SA 4.0).

Introduction

According to Malik (2010), understanding own project inform that the project has a final product (output) in the form of goods or services obtained from the results of a number of transformations source power (input). Transformation process input become output is carried out over the term time certain (limited) with cost and established quality by letter employment agreement. According to Santosa (2009), a project is defined as a series of activities unique things that are interrelated to achieve a certain result and are carried out in a certain period of time too. Construction Project Management is a science and concept for carry out and complete a construction project so that the work is on time, at the right cost and at the right quality (Mahyuddin, 2023).

According to National Standardization Agency (“National Standardization Agency. Procedures for Planning Residential Environments in Urban Areas Frick, Heinz. 1984. Simple House. Yogyakarta: Kanisius Publishers.” 2004) housing is a group a house that functions as a residential environment, equipped with facilities and infrastructure. Housing is part of settlements, both in urban areas and rural areas (*Law of the Republic of Indonesia Number 1 of 2011 Concerning Housing and Settlement Areas.*, 2011).

According to the American Institute of Architect (AIA) Variation Order is a written request signed by the architect, contractor, and owner made after the contract is issued, which has the authority to change scope of work or making adjustments to the contract value and time completion of work. Another meaning of variation order is an official document signed by the owner and contractor to provide compensation to contractor against changes, additional work, delays, or other consequences other than the collective agreement written in the contract (Barrie & Paulson, 1976).

A variation order will change the original work because changes to improve the original work during a construction project are unavoidable (Yadeta, 2010). Variation orders will be made for a reason and the frequency of changes to work instructions during the construction phase will likely result in significant changes to the original works contract, which will have a negative impact on all parties involved in the sector (Mohammad et al., 2022). Variation Orders is often a reason for construction projects exceeding projects budget and delays it is a global problem (Alhadithi et al., 2021). These variations often cause disputes and dissatisfaction between the parties involved Variation orders cannot be avoided in construction projects, change problems will disrupt cost and time performance because they will increase (Mohammad & Hamzah, 2019). in a construction project. Therefore, controlling VO in a construction project is very important (Memon et al., 2014). This variation order must be recorded so that they are aware that they must pay attention to the clauses relating to the contract, because misinterpretation causes disputes (Hardjomuljadi, 2016). Variation orders on construction are an important part issued to accommodate changes in the value of contract documents (Syal & Bora, 2016). Inconsistencies variations orders have significant implications for project success which can result in work not being completed on time or even trigger cost overruns (Tuloli et al., 2021).

The impact of cost overruns is the loss of a profit margin due to incomplete construction of a construction project (Wen et al., 2022). Tangerang is one of the big cities that is developing in Indonesia. Along with the development of the city, one sector that is increasingly developing is the housing sector. Housing growth does not only occur in a few sub-districts, but in almost all sub-districts in Tangerang City. Most city residents choose to live in housing. Housing development projects are urgently needed because of the availability of high quality and affordable accommodation to meet the housing needs of the population at any time (Mohammad et al., 2022).

This research is located in the Tangerang area on this project consisting of housing developments as many as 734 units House And 14 shophouse units. Researchers focus to work channel diversion infrastructure on the project housing where the initial contract value This work is 16,150,000,000 IDR over time implementation 18 weeks as well as wide channel 8 meters and

long 427 meter channel there is variation order on items Sheet pile work becomes secondary pile, DPT and gabion.

The objectives of this research include: to obtain and analyze the dominant factors that cause variation orders to occur in construction project performance in channel diversion infrastructure projects in residential areas, analyze the influence of these variables on performance values in channel diversion infrastructure projects, analyze the magnitude of the influence of variation orders on cost and value performance values time performance, analyzing the results of previous research with current research and as a source of knowledge and useful for further research.

That happen exists a problem where the unit developer cannot be built houses in the plot area as well there is a position for an electrical substation for flow supply electricity several house units in areas housing area the due to planning beginning which not good so that will be a problem for handover to customers so it will impact to implementation of project activities construction and influence on costs and implementation time and will reduce interest in developers so this research needs to be carried out. Feasibility studies are very important in determining whether or not a construction is worth building, how impact on the environment, away from facilities general (Rani, 2016). The construction of housing projects by private parties, especially due to their small size and scope, has not received sufficient attention from professional researchers around the world (Koushki et al., 2005).

This research "Analysis of the Influence of Order Variation Factors on the Cost and Time of Implementation of Channel Diversion Infrastructure Construction Projects in Residential Areas" is research made as a reference recommendation for project performance in this case, especially residential construction projects for channel diversion infrastructure carried out by private parties. From previous research, the author tries to complete the analysis of different case studies, namely discussing the factors causing variation orders, especially in residential channel diversion infrastructure projects. factors that influence project performance on costs and time which might be a solution or minimize risks on the next project.



Figure 1. Overview of the channel diversion

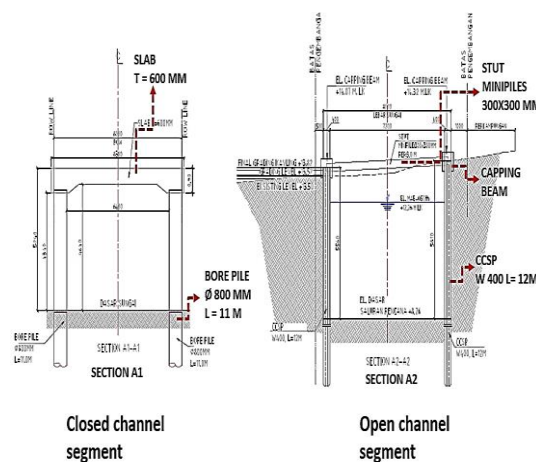


Figure 2. Initial design drawing

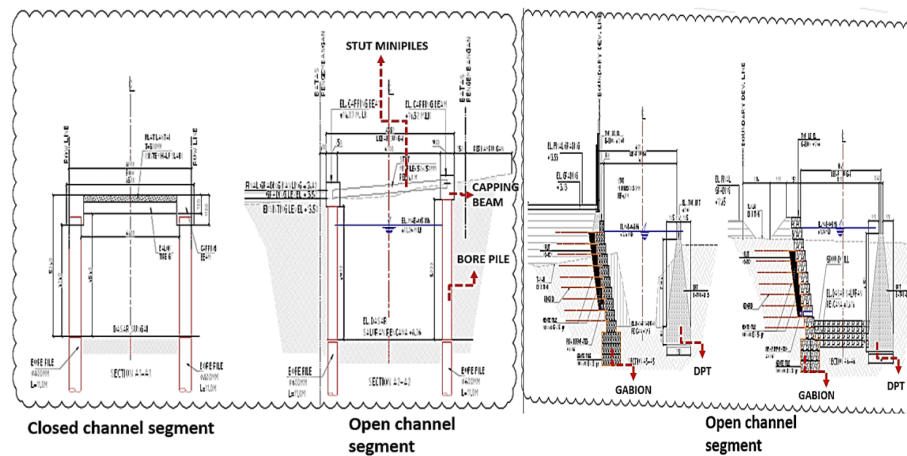


Figure 3. Image of design changes

Research Methodology

Research using a survey method was carried out to find out what factors just which be the cause variation order and how influence to performance project costs and construction implementation time on infrastructure projects channel switching on housing area. The questionnaire distributed to previous respondents via process expert opinion first.

Factors which this causes the variation order for the survey method to be formulated as 2 (two) mutual variables influence that is the dependent variable is the variable that is influenced, namely project performance and the independent variable (independent variable) as variable that affect variation orders namely contract document factors, planning And design factors, owner involvement factors, condition environmental or external factors, contractors factors and resources factors.

Variable values will be measured by using techniques Likert scale measurements that is in form factor of sequence occurrence variations that influential on performance project, on scale measurements (Albtoosh, et al., 2017):

1. Not one
2. Very seldom
3. Seldom
4. Often
5. Very often

The survey data that has been obtained will then be processed using the SEM PLS method to determine what factors are dominant in order variations in channel diversion work in residential areas. Furthermore, stages in this research, namely gather data tabulation which is obtained from respondents that is factors the cause variation order on the project diversion channel in residential areas that affect cost and time performance. Results from data then analyzed with use SEM PLS 3.3.3. To determine change cost and time which happen in analysis by using Microsoft Excel with calculations as follows:

$$\text{Cost Consequences (\%)} = \frac{\text{value due to variation order}}{\text{initial contract value}} \times 100\%$$

$$\text{time effect} = \frac{\text{time changes due to variation orders}}{\text{initial contract time value}} \times 100\%$$

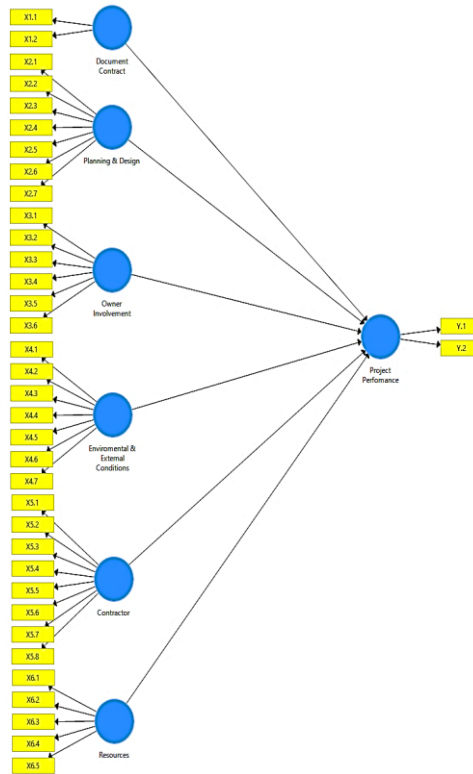


Figure 4. Research model

Research Results and Discussion

Based on literature which has been grouped together according to topic the discussion that will be researched is regarding aspects of factors that cause variation order on project performance, the researcher found a research gap based on the results of the research theme previously. This research gap is an analytical study carried out on research on channel diversion infrastructure work, especially in housing projects. Case studies of channel diversions in residential areas are very rarely found in housing project areas so this research needs to be carried out so that in future projects the same thing does not happen which will have an impact on costs and implementation time, especially in housing development projects. The results of expert validation that have been carried out on indicator questionnaires for factors that cause sequence variations in diversion project channels in residential areas that will be used in this research. The number of questionnaires available is 37 variable indicators that have passed expert validation for 42 research indicators except for indicators X1.2, X1.4, X1.5, X6.5, X6.6. Data related to the characteristics of the respondents about related parties can be seen in figure 5, education background can be seen in figure 6, and work experience can be seen in figure 7.

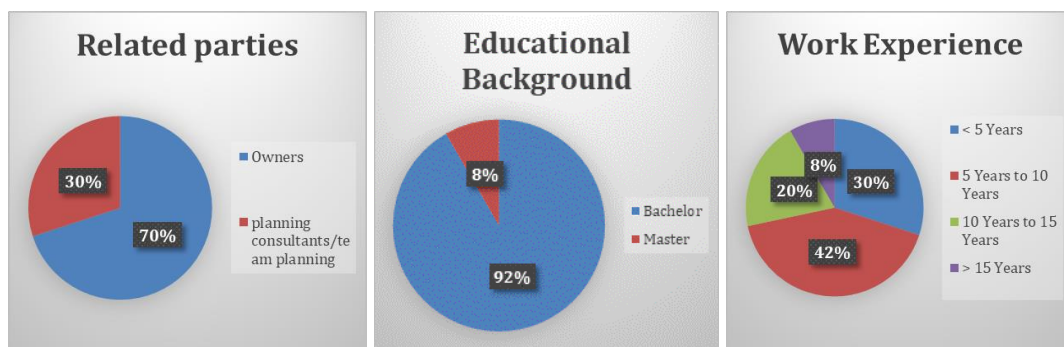


Figure 5. Characteristic of respondents

Construct Validity Test

This have two value criteria which will evaluated that is loading factor value and mark average variance extracted factor (AVE). Entire indicator for every variable has mark loading factors above 0.7. With thus, the indicators of each measuring variable study this has categorized as valid.

Table 1. Average Variance Extracted (AVE) factor

No	Indicators	Average Variance Extracted (AVE)
1	Contract documents (X1)	0.754
2	Planning and design (X2)	0.551
3	Owner Involvement (X3)	0.690
4	Environmental or external conditions (X4)	0.664
5	Contractors (X5)	0.663
6	Resources (X6)	0.770

Entire indicator for each variable has mark AVE above 0.5. Thus, indicators each this research variable has categorized as valid according to Hamid & Anwar (2019).

Discriminant Validity Test

On this stage there is two value criteria will evaluated namely the cross loading value and mark correlation between constructs latent. Variable document contract, owner involvement, conditions environment and external, planning and design, contractors, and resources have mark correlation between variables latent more small from the root value square AVE, so it can be interpreted that construct is categorized as valid according to Hamid & Anwar (2019).

Table 2. Correlation between latent constructs

	X1	X3	Y	X4	X5	X2	X6
X1	1,000	0.06	-0.09	0.017	0.1	0.01	0.02
X3	0.06	1,000	-0.16	-0.13	-0.2	-0.1	-0
Y	-0.1	-0.2	1,000	0.645	0.33	0.7	-0.2
X4	0	-0.1	0.65	1,000	0.21	0.33	-0.1
X5	0.1	-0.2	0.33	0.213	1,000	0.4	-0
X2	0.01	-0.1	0.7	0.327	0.4	1,000	0.01
X6	0.02	-0	-0.18	-0.13	-0	0.01	1,000
	AVE			AVE Square Root			
X1	0.754			X1	0.868		
X3	0.69			X3	0.83		
Y	0.77			Y	0.877		
X4	0.689			X4	0.83		
X5	0.664			X5	0.814		
X2	0.571			X2	0.755		
X6	0.663			X6	0.814		

Reliability Test

On SEM PLS stage test construct reliability done with look at the composite value reliability. Results all mark composite reliability is above 0.70 then it can be concluded that the document contracts, owner involvement, performance project, conditions environment or external, contractor, planning and design and resources have reliability which good or reliable category (Hamid & Anwar, 2019).

Table 3. Reliability test

	Composite Reliability
Contract documents	0.858
Owner involvement	0.93
Project performance	0.87
Environmental or external conditions	0.939
Contractor	0.94
Planning and design	0.896
Resources	0.907

Inner Model

Model structural, based mark path coefficient, see how much big influence between variables latent with bootstrapping calculations. Results from mark R2 can concluded that the project performance earned an R Square value as big as 0.708 or 70.8%, meaning variable which influence namely Documents Contract (X1), Planning and Design (X2), Involvement Owner (X3), Condition Environment or External (X4), Contractor (X5), and Resources (X6) in strong moderate category.

Table 4. R square

	R square	R square adjusted
Project Performance	0.708	0.675

Table 5. Path coefficients

No.		Original Sample (O)	T statistics (O or STDEV)	P Values
1	Contract document (X1) → project performance	-0.104	1.355	0.088
2	Planning & design (X2) → project performance	0.54	5.91	0
3	Owner involvement (X3) → project performance	-0.038	0.485	0.314
4	Environmental & external conditions (X4) → project performance	0.445	4.212	0
5	Contractor (X5) → project performance	0.025	0.356	0.361
6	Resources (X6) → project performance	-0.124	1.126	0.13

Results significant to project performance greatly influential to indicator Y1.1 that is influence on project cost performance is 32.145 with influencing variables significant, namely planning And design on dominant indicators X2.7 namely changes to planning drawings with mark amounting to 14.282 And environmental or external condition variables in the dominant indicator X4.1, namely the item reducing or postponing the construction part regarding the problem environment with value of 29.931.

Document contract influential negative and not significant to project performance, therefore that in job change (variation order) factors because the existence of document variables the contract does not affect performance projects and variation orders. This supports previous research by Aliyudin & Susetyo (2023) and Hansen et al., (2020) which stated that contract documents do not influence the factors causing variation orders. That variation orders can occur in the contract document factor, namely because they do not explain in detail and in detail

regarding the contract for the work so that there is a difference between the contract document and the drawing document.

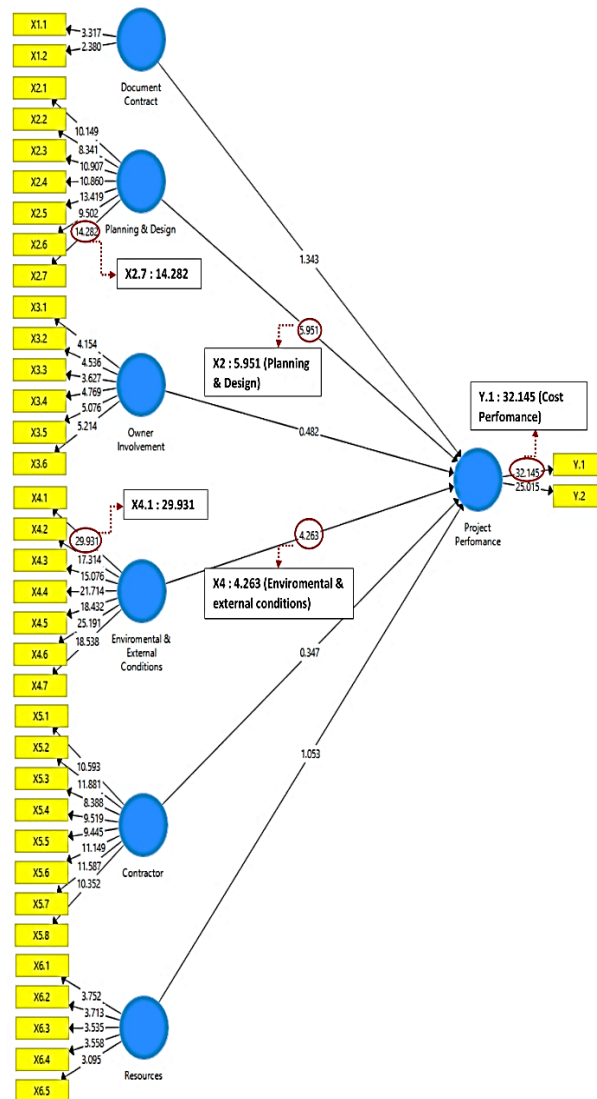


Figure 6. Bootstrapping results

Planning and design positive influence and significant on project performance, because it's in a job change (variation order) factor the cause is planning and design variable direct effect to performance project and variations order. This supports research Prasetya & Prasetia (2022), Hansen et al., (2020), Viswanath & Kumar (2017), Alzara (2022), Arain & Pheng (2006), Enshassi et al., (2010), Nurmala & Hardjomuljadi (2015), Palilati et al., (2022), Murtopo et al.,(2022) which states that the factors causing variation orders to occur are planning and design due to lack of detailed planning and not in accordance with field conditions and a feasibility study has not been carried out to minimize design changes which could result in changes in time and additional costs.

Involvement owner negative influence And No significant to performance project, because in change work (variation order), owner involvement variable does not affect performance projects and variation orders. This is contrary to research Putri & Waty (2021), Septian & Herzanita (2021), Widhiawati Ida Ayu Rai, Anak Agung Wiranata (2016), Elshaikh & Mahmoud (2020), M.karim et al., (2020), Mohammad et al.,(2017) which states that the owner involvement factor or owner

factor (owner) causes variation orders to occur due to requests or policies from the owner both in determining material specifications, environmental conditions, schedules and the owner's inability.

Condition environment or external influence is positive and significant to performance project, therefore in change of work (variation order) factor the cause is because environmental conditions or external variable direct influence to project performance and variation order. This supports research from Putri & Waty (2021), Widhiawati Ida Ayu Rai, Anak Agung Wiranata (2016), Muluk et al., (2018), Kustiah et al., (2022), Maulana (2016) which states that environmental conditions or external factors cause order variations to occur. due to problematic factors related to land acquisition in the project area, socio-cultural conditions of the community around the project, as well as third party interference.

Contractors have positive and negative influences significant to project performance, therefore in job changes (variation order), there are no contractor variables affect performance project and variation order. This supports research Muluk et al., (2018), Riswandi et al., (2021), and Mohammed, et al. (2017). However, the results of the research conducted are that there is poor project planning and scheduling by contractors

Resource has negative influence and not significant to performance project, therefore it's on a job change (variation order) the causal factor is due to variables resource has no direct influence on project performance and variation order. This supports research Septian & Herzanita (2021) which states that resource factors do not influence the occurrence of order variation.

Based on the results of project data processing then:

Table 6. Proportion of variation orders

Job Description	Initial Contract (IDR)	Added Work (IDR)	Less Work (IDR)	Variation Order (IDR)
River Stone & Grading	1,497,432,425	2,360,577,598		863,145,173
Closed Channel Segment	7,051,531,920	7,166,016,389		114,484,469
Open Channel Segment	6,628,461,533	989,711,359	6,628,461,533	989,711,359
Total Before VAT	15,177,424,878	10,516,305,346	6,628,461,533	1,967,341,001

Change cost which occurred due to order variations of 12.96% against price contract early so in category No Good. For work items with changes additional costs which big as well as change less cost which happen on items segment work channel open due to changes drawing of the initial design using a sheet pile changed into borepile, DPT and gabion. Time implementation project diversion channels under the contract are 18 week, from date February 14 2022 until July 14, 2022. But inside there was a delay in implementation, in because: (1) Existence items work which in design by planning consultants & planning team no in accordance with the actual conditions existing in the field; (2) During 2 Sunday project stopped by residents local, because it exists technical problems in implementing sheetpile work; and (3) Existence change design by a planning consultant so takes time to can be realize it in the field for 2 weeks. For the final completion time is agreed upon between party owner And the contractor to complete the extension time during 5 months until November 11 2022 or 125% so in the unfavorable category.

Conclusion

Based on results analysis smart PLS then the variable is obtained reason variation order most dominant and influences performance project is a planning variable and design with changes to planning drawings. Results analysis influence variable on performance project on study this is for variables influential negative and doesn't affect it to project performance as well factor variation occurs orders is a contract document, engagement owner and resources while influential variables

positive and affect performance project and the factors in which variation orders occur are planning and design, conditions environment and external as well contractor.

Analysis results cost performance for the amount of cost as a result variation order on additional work total of 10,516,305,346 IDR and for less total work amounting to 6,628,461,533 IDR around 12.96% of the initial contract price for the work so that in category not good. Results analysis performance time for that amount of time resulted there is a variation order on the project work that happens exists extension time for 5 months or 125% so it is in the poor category.

References

- Alhadithi, W., I. Naji, H., & N. Zehawi, R. (2021). Identifying the Key Causes and Impacts of Variation Orders in Iraqi Construction Projects. *Diyala Journal of Engineering Sciences*, 14(2), 18–27. <https://doi.org/10.24237/djes.2021.14202>
- Alzara, M. (2022). Exploring the Impacts of Change Orders on Performance of Construction Projects in Saudi Arabia. *Advances in Civil Engineering*, 2022. <https://doi.org/10.1155/2022/5775926>
- Arain, F. M., & Pheng, L. S. (2006). Developers' views of potential causes of variation orders for institutional buildings in Singapore. *Architectural Science Review*, 49(1), 59–74. <https://doi.org/10.3763/asre.2006.4908>
- Barrie, D. S., & Boyd C. Paulson Jr., M. A. (1976). Professional Construction Management third edition. Mc Graw-Hill. <https://doi.org/10.1061/JCCEAZ.0000620>
- Dwi Septian, R., & Herzanita, A. (2021). Analysis of the Impact of Variation Orders on Project Budget Plans. *Jurnal Artesis*, 1(2), 167–176.
- Elshaikh, E., & Mahmoud, S. (2020). Variation Orders in Building Projects in Khartoum State-Sudan: The Causes and the Impact on Projects Performance. *April*, 191–198. <https://doi.org/10.29117/cic.2020.0026>
- Eltahir Abu Elgassim Mohammed , Salma Yahia Mohammed, A. S. H. (2017). Factors causing variation orders in building projects in khartoum state- sudan. *International Journal of Engineering Research*, 6(11), 117–129.
- Enshassi, A., Arain, F., & Al-Raee, S. (2010). Causes of variation orders in construction projects in the Gaza Strip. *Journal of Civil Engineering and Management*, 16(4), 540–551. <https://doi.org/10.3846/jcem.2010.60>
- Hafnidar A, R. (2023). Construction Project Management 2023. In *Yayasan Kita Menulis* (Issue August).
- Hamzah, Z., & Mohammad, N. (2019). A Review of Causes of Variation Order in the Construction of Terrace Housing Projects in Malaysia. *MATEC Web of Conferences*, 03013.
- Hansen, S., Rostiyanti, S. F., & Rifat, A. (2020). Causes, Effects, and Mitigations Framework of Contract Change Orders: Lessons Learned from GBK Aquatic Stadium Project. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, 12(1), 1–8. [https://doi.org/10.1061/\(asce\)la.1943-4170.0000341](https://doi.org/10.1061/(asce)la.1943-4170.0000341)
- Hardjomuljadi, S. (2016). Variation Order, The Causal Or The Resolver Of Claims And Disputes In The Construction Projects. 11(14).
- Isfandina, & Susetyo, B. (2023). Analysis of Variation Order Factors on Construction Project Performance in Airport Transportation Projects. *Rekayasa Sipil*, 12(1), 59–67.

- Ja'far A. Aldibat Albtoosh*, A. tarmazi haron *University. (2017). Variation Orders Causes in Construction Buildings Projects in Jordan. *Global Journal of Engineering Science and Research Management*, 4(9), 42–48.
- Koushki, P. A., Al-Rashid, K., & Kartam, N. (2005). Delays and cost increases in the construction of private residential projects in Kuwait. *Construction Management and Economics*, 23(3), 285–294. <https://doi.org/10.1080/0144619042000326710>
- Kustiah, H., Hardjomuljadi, S., & Amin, M. (2022). Influence Factors of Variation Orders on Road and Bridge Construction to Reduce Construction Claims. *Konstruksia*, 13(2), 81. <https://doi.org/10.24853/jk.13.2.81-92>
- Law of the Republic of Indonesia Number 1 of 2011 concerning Housing and Settlement Areas*. (Vol. 16, Issue 22). (2011).
- Mahyuddin. (2023). Construction Project Management 2023. In *Yayasan Kita Menulis* (Issue August).
- Malik, A. (2010). *Introduction to the Construction Services Business*.
- Martanti, A. Y. (2019). Analysis of Factors Causing Contract Change Orders and Their Effect on Contractor Performance in Government Construction. *Rekayasa Sipil*, 7(1), 32. <https://doi.org/10.22441/jrs.2018.v07.i1.03>
- Maulana, A. (2016). Factors causing the Contract Change Order (CCO) to occur and their influence on the construction implementation of the Bendung Project. *Jurnal Infrastruktur*, 2(2), 40–51.
- Memon, A. H., Rahman, I. A., & Hasan, M. F. A. (2014). Significant causes and effects of variation orders in construction projects. *Research Journal of Applied Sciences, Engineering and Technology*, 7(21), 4494–4502. <https://doi.org/10.19026/rjaset.7.826>
- M.karim, K. H., Ali, N., & Majeed, B. (2020). The Causes of Variation Orders and Their Effects on Cost and Time of Projects in Sulaimani Governorate. *Kurdistan Journal of Applied Research*, 5(1), 218–235. <https://doi.org/10.24017/science.2020.1.16>
- Mohammad, N., Che-Ani, A. I., & Rakmat, R. A. O. K. (2017). Causes and effects of variation orders in the construction of terrace housing projects: A case study in the State of Selangor, Malaysia. *International Journal of Supply Chain Management*, 6(1), 226–232.
- Mohammad, N., Hamzah, Z., & Mokhtar, N. A. (2022). Control of Variation Orders in the Construction of Residential Projects in Malaysia. *Planning Malaysia*, 20(2), 14–21. <https://doi.org/10.21837/pm.v20i21.1088>
- Muluk, M., Misriani, M., Atmaja, J., Ali, S., & Monica, M. (2018). Identify the Factors Causing Change Orders on Road Construction Projects in West Sumatra. *Jurnal Ilmiah Rekayasa Sipil*, 15(2), 77–87. <https://doi.org/10.30630/jirs.15.2.126>
- Murtopo, A., Nugroho, A., & Budihardjo, M. A. (2022). Contract Change Order (CCO) Study on the Tidar University Integrated Laboratory Construction Project. *Reviews In Civil Engineering*, Vol. 6 No., 46–52.
- National Standardization Agency. Procedures for planning residential environments in urban areas Frick, Heinz. 1984. Simple House. Yogyakarta: Kanisius Publishers. (2004). In *Sni 03-1733-2004*.
- Nurmala, A., & Hardjomuljadi, S. (2016). Causes and Impact of Variation Orders (VO) on Construction Project Implementation. *Jurnal Konstruksia*, Volume 6 N(2), 63–77.

- Palilati, M. P., Hadi, A. K., & Musa, R. (2022). Analysis of Factors Causing Variation Orders on Education Building Projects in Gorontalo Province. *Jurnal Konstruksi: Teknik, Infrastruktur Dan Sains*, 01(06), 30–41.
- Prasetya, H., & Prasetya, I. (2022). Analysis of the Causes of Change Order in Housing Project Implementation in Banjarmasin (Case Study on Citra Land Housing). *International Journal of Innovative Science and Research Technology*, 7(6), 694–701.
- Putri, I. R. H., & Waty, M. (2021). Causes of Change Orders in Water Building Construction Projects in the DKI Jakarta Region. *JMTS: Jurnal Mitra Teknik Sipil*, 4(1), 249. <https://doi.org/10.24912/jmts.v0i0.10289>
- Hamid, R. S., & Suhardi M Anwar, S. M. (2019). Structural Equation Modeling (SEM) Variant Based. Digital Library. <http://digilib.stiem.ac.id:8080/xmlui/handle/123456789/626>
- Riswandi, Susetyo, B., & Bintoro, B. (2021). Internal Factors Cause Change Order in High-rise Building Projects, Case Study: Hotel Projects in Malang. *International Journal of Research and Review (Ijrrjournal.Com)*, 8(January), 1.
- Santosa, B. (2009). Project Management Concept & Implementation. *Journal of Chemical Information and Modeling*, 53(9).
- Syal, M., & Bora, M. (2016). Change Order Clauses in Standard Contract Documents. *Practice Periodical on Structural Design and Construction*, 21(2), 1–6. [https://doi.org/10.1061/\(asce\)sc.1943-5576.0000281](https://doi.org/10.1061/(asce)sc.1943-5576.0000281)
- Tuloli, M. Y., Utiahman, A., & Palilati, M. P. (2021). Analysis of causes and impact of variation order in the education building project in Gorontalo Province. *IOP Conference Series: Materials Science and Engineering*, 1098(2), 022065. <https://doi.org/10.1088/1757-899x/1098/2/022065>
- Viswanath, V. K., & Kumar, S. K. (2017). *An Analysis of Variation and Change Orders in Real Estate Projects*. 10(8), 295–306.
- Wen, L. S., Zainal, R., Hilmi, M., Rahman, I. A., & Noh, H. M. (2022). Cost Overruns in Housing Projects. *Research in Management of Technology and Business*, 3(1), 664–675.
- Widhiawati Ida Ayu Rai, Anak Agung Wiranata, I. P. Y. W. (2016). Factors Causing Change Orders in Building Construction Projects. *Jurnal Ilmiah Teknik Sipil a Scientific Journal of Civil Engineering*, 1–7.
- Yadeta, A. (2010). Impact of Variation Orders on Public. *26th Annual ARCOM Conference, September*, 101–110. <https://doi.org/10.5923/j.ijcem.20160503.03>

Appendix

Research variables and indicators

Variable	Factors that cause Variation Orders in Channel Diversion Projects in Residential Areas
X1	Contract Document Factors
X1.1	Contract which not enough complete (Septian & Herzani, 2021)
X1.2	Contract which not enough firm (Septian & Herzanita, 2021)
X1.3	Lack of understanding contractor in examining drawings and contract documents (Martanti, 2019)
X1.4	Chapter about variation orders no poured-on construction contracts in a way clear (Martanti, 2019)

Variable	Factors that cause Variation Orders in Channel Diversion Projects in Residential Areas
X1.5	Document contract no details (Hansel et al., 2020)
X2	Planning and Design Factors
X2.1	Error in image planning (Putri & Waty, 2021)
X2.2	Error in design (Putri & Waty, 2021)
X2.3	Error in volume measurement (Putri & Waty, 2021)
X2.4	Planning which is incomplete (Putri & Waty, 2021)
X2.5	Delay in design approval (Putri & Waty, 2021)
X2.6	Incompatibility between design drawing with field conditions (Putri & Waty, 2021)
X2.7	Changes to planning drawings (Putri & Waty, 2021)
X3	Owner Involvement Factor
X3.1	Not enough control (Putri & Waty, 2021)
X3.2	Inability owner (Putri & Waty, 2021)
X3.3	Things which owner not yet determined (Putri & Waty, 2021)
X3.4	Policy regulation from the owner schedule delays from owner (Putri & Waty, 2021)
X3.5	Failure of the owner to provide sites, tools, and material (Putri & Waty, 2021)
X3.6	Delay work by request owner (Putri & Waty, 2021)
X4	Environmental or External Condition Factors
X4.1	Reduce or delay construction section connection environmental problems (Putri & Waty, 2021)
X4.2	Consideration field security (Septian & Herzanita, 2021)
X4.3	Addition facility for residents (Putri & Waty, 2021)
X4.4	Lack of information about conditions field or project environment (Septian & Herzanita, 2021)
X4.5	Request official or local residents CSR (Corporate Social Responsibility) (Putri & Waty, 2021)
X4.6	Condition social culture communities around the project (Rai & Wiranata, 2016)
X4.7	Problem liberation land (Muluk et al., 2018)
X5	Contractor Factors
X5.1	Coordination which no adequate between contractor (Riswandi et al., 2021)
X5.2	Handling progress project which is incorrect by contractor (Riswandi et al., 2021)
X5.3	Control quality which ineffective by the contractor (Riswandi et al., 2021)
X5.4	Performance contractor which ugly (Septian & Herzanita, 2021)
X5.5	Performance subcontractor which ugly (Septian & Herzanita, 2021)
X5.6	Lack of team work internal contractor implementation work (Muluk et al., 2018)
X5.7	Lack of communication between implementers field with a consultant supervisor or planner (Muluk et al., 2018)
X5.8	It happened lateness because of work which be repeated (Muluk et al., 2018)
X6	Resource Factors
X6.1	The low skill workers (Septian & Herzanita, 2021)
X6.2	Lack of experience workers (Septian & Herzanita, 2021)
X6.3	Lack of knowledge workers (Septian & Herzanita, 2021)
X6.4	Lack of QA or QC (Septian & Herzanita, 2021)
X6.5	Amount work overtime too much (Septian & Herzanita, 2021)
X6.6	Dispute labourer (Septian & Herzanita, 2021)
X6.7	Failure supplying power expert work (Septian & Herzanita, 2021)
Y	Factors Against Project Performance
Y1	Variation Orders have an influence on cost performance
Y2	Variation Order has an influence on time performance

Loading factor

No		X1	X3	Y	X4	X5	X2	X6
1	X1.1	0.97						
2	X1.2	0.76						
3	X2.1						0.72	
4	X2.2						0.71	
5	X2.3						0.72	
6	X2.4						0.72	
7	X2.5						0.76	
8	X2.6						0.75	
9	X2.7						0.83	
10	X3.1		0.82					
11	X3.2		0.81					
12	X3.3		0.73					
13	X3.4		0.84					
14	X3.5		0.87					
15	X3.6		0.9					
16	X4.1				0.87			
17	X4.2				0.8			
18	X4.3				0.8			
19	X4.4				0.85			
20	X4.5				0.8			
21	X4.6				0.87			
22	X4.7				0.82			
23	X5.1					0.78		
24	X5.2					0.81		
25	X5.3					0.77		
26	X5.4					0.79		
27	X5.5					0.82		
28	X5.6					0.84		
29	X5.7					0.86		
30	X5.8					0.84		
31	X6.1							0.85
32	X6.2							0.89
33	X6.3							0.79
34	X6.4							0.8
35	X6.5							0.73
36	Y.1			0.88				
37	Y.2			0.87				

Cross loading

No		X1	X3	Y	X4	X5	X2	X6
1	X1.1	0.97	-0.01	-0.1	-0.01	0.08	0.01	0.03
2	X1.2	0.76	0.21	-0.04	0.08	0.12	0.03	-0.01
3	X2.1	-0.17	0.1	0.49	0.21	0.06	0.72	-0.01
4	X2.2	0.05	-0.08	0.42	0.15	0.19	0.71	0.04
5	X2.3	-0.05	-0.02	0.42	0.23	0.13	0.72	-0.04
6	X2.4	0.13	-0.26	0.48	0.34	0.18	0.72	-0.02
7	X2.5	-0.04	-0.29	0.58	0.27	0.42	0.76	0.07
8	X2.6	0.06	-0.07	0.54	0.16	0.43	0.75	0.01
9	X2.7	0.08	0.02	0.63	0.32	0.53	0.83	-0
10	X3.1	-0.14	0.82	-0.15	-0.15	-0.13	-0.17	-0.04

No		X1	X3	Y	X4	X5	X2	X6
11	X3.2	0.14	0.81	-0.13	-0.15	-0.19	-0.08	0.02
12	X3.3	0.27	0.73	-0.04	0.06	-0.03	0.02	0.06
13	X3.4	0.04	0.84	-0.14	-0.12	-0.17	-0.05	-0.02
14	X3.5	0.03	0.87	-0.12	-0.08	-0.15	-0.12	-0.07
15	X3.6	0.1	0.9	-0.17	-0.09	-0.08	-0.11	-0.05
16	X4.1	0.04	-0.13	0.61	0.87	0.16	0.32	-0.1
17	X4.2	0.01	-0.05	0.63	0.8	0.19	0.45	-0.06
18	X4.3	0.05	-0.15	0.47	0.8	0.19	0.28	-0.05
19	X4.4	0.03	-0.05	0.54	0.85	0.17	0.28	-0.15
20	X4.5	0.08	-0.17	0.48	0.8	0.25	0.26	-0.05
21	X4.6	0.01	-0.13	0.5	0.87	0.12	0.12	-0.09
22	X4.7	-0.12	-0.1	0.47	0.82	0.16	0.12	-0.24
23	X5.1	0.19	-0.11	0.23	0.21	0.78	0.36	-0.05
24	X5.2	0.18	-0.06	0.24	0.21	0.81	0.27	-0.04
25	X5.3	-0.02	-0.18	0.29	0.16	0.77	0.38	0.32
26	X5.4	-0.02	-0.21	0.27	0.2	0.79	0.27	-0.11
27	X5.5	0.21	-0.04	0.27	0.23	0.82	0.29	-0.17
28	X5.6	-0.02	-0.26	0.37	0.11	0.84	0.44	0.12
29	X5.7	0.09	-0.02	0.25	0.15	0.86	0.34	-0.06
30	X5.8	0.13	-0.07	0.18	0.16	0.84	0.19	-0.16
31	X6.1	-0.07	-0.11	-0.09	-0.12	-0.07	0.07	0.85
32	X6.2	0.1	0.03	-0.18	-0.06	0.03	-0.05	0.89
33	X6.3	-0.01	-0.14	-0.06	-0.01	-0.02	-0.02	0.79
34	X6.4	-0.06	-0.03	-0.08	-0.1	0.04	0.12	0.8
35	X6.5	-0.01	-0.11	0.06	0.15	0.03	0.06	0.73
36	Y1.1	-0.14	-0.1	0.88	0.6	0.34	0.59	-0.18
37	Y1.2	-0.02	-0.19	0.87	0.53	0.24	0.64	-0.13