

Study of the Causes of Change Orders in Infrastructure Work Implementation and its Impact on Project Performance

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Article Information	ABSTRACT
Article History Received : April 25, 2025 Revised : May 08, 2025 Published : July 02, 2025 Keywords: <i>Change Order; Factors; Impact; Infrastructure</i>	Infrastructure work often undergoes changes during the construction phase to adapt to field conditions that differ from the initial planning. These changes may involve adding work volume, modifying technical specifications, or adjusting work schedules due to field conditions, policy changes, or other external factors. If not managed properly, these changes can lead to cost overruns, project delays, and even disputes among the parties involved. This research aims to identify the factors causing changes in orders and their impact on project performance. The method used is the distribution of questionnaires to involved contractors, followed by data analysis using the Relative Importance Index (RII) approach. The results show that there are 7 main factors, namely Planning and Design, Natural Factors, Owners, Construction, External Causes, Administration, and Policy Changes, with 40 indicators causing changes in orders in infrastructure projects. Additionally, it was found that changes in orders impact project performance in terms of cost, quality, and time, with 15 indicators representing those impacts. This finding makes an important contribution to project management practices, particularly in efforts to control changes in work during construction execution. The results of this research can serve as a basis for consideration in planning, monitoring, and decision-making to minimize the risks of work changes and improve overall project performance.

INTRODUCTION

Infrastructure work often requires work changes during the construction phase to adapt to actual site conditions that may differ from initial plans. In the project implementation process, obstacles often occur such as changes. (Yunisa and Puspasari 2024). Changes may include increasing work volume, changing technical specifications, or adjusting work schedules due to field conditions, policy changes, or other external factors. This change can certainly affect the budget, duration and quality of the project. If not managed well, this can cause cost overruns, project delays and even disputes between related parties. The occurrence of Change Orders on construction projects can have direct and indirect negative impacts, both for the contractor and the owner (Engineering and Sciej 2022). During the implementation of construction Change Orders can occur from the owner, contractor, and also due to field conditions that make it impossible to continue in the road construction project implementation process. (Muluk et al. 2018). The Bojonegoro District Government is committed to accelerating infrastructure development in order to improve accessibility, economy and community welfare. Currently construction work is developing rapidly and has various infrastructure projects such as roads, bridges, retaining walls,

drainage channels, irrigation channels, river banks and others. For example, road work shows that in 2023, 84.02% or around 878,983 km of roads will be in good condition, while in moderate condition it will be 17,059 km or 1.63%, then the lightly damaged condition will be 115,514 km or 11.04% and the heavily damaged condition will be 34,603 km or 3.31%, meaning there are still roads that need to be repaired and rebuilt by the District Government. Bojonegoro, meanwhile, for existing bridge data, there is a Good Condition of 1115 or 58.62%, then for moderate condition it is 433 or 22.77%, while for lightly damaged condition it is 322 or 16.93%, while for heavily damaged condition it is 29 or 1.52%, while for collapsed condition it is 3 or 0.16%. With the improvement program still in place, of course construction work will continue to be carried out on this work as well as other infrastructure work. Of course, apart from road and bridge work, there is still a lot of infrastructure work carried out by the Bojonegoro District Government, such as construction of retaining walls (TPT), drainage channel work, sanitation work, irrigation work and river bank work and many other works. Of course, the work carried out must maintain good quality in the right time and at an efficient cost. For this reason, it is important to carry out good planning so that during the implementation stage no changes occur. However, it is often found that changes will certainly disrupt project performance.

On government projects, change order instructions are frequently restricted to not adding to the total contract price. This means that if additional work is ordered, some work must be reduced in order to keep the total contract price fixed. This makes it difficult for the contractor or service provider to finance the project. (Martanti 2019). In implementing construction projects, additional or less work is often unavoidable due to adjustments to site needs, changes to specifications, or design revisions that occur after the initial contract has been agreed. This additional or reduced work, which is actually referred to as a variation order or change order, is a change to the project's scope, budget, and timeline that the contractor and project owner agree upon. Risk and uncertainty may contribute to a construction project's inability to meet its declared goals. (Harviyanti and Pasa 2022). Ineffective management of work plus or minus can lead to issues that affect the project's quality, budget, schedule, and relationships amongst the stakeholders. In addition to raising expenses, this affects the scope of the task, leading to more working hours and various scope implications that enable longer implementation durations. (Anitabella, Nugroho, and Sundari 2024).

A change order's effects are so intricate that they have a significant impact on how well a building project performs. (Sutra, Soekiman, and Hidayat 2022). According to Desai et al (2015) Changes in the volume of work through contract change mechanisms can result in project cost increases of around 10 – 15%. The quality of the project will be impacted by significant and extensive work modifications, such as the execution of construction work that deviates from or is not in line with the contract value and previously agreed-upon papers between the owner and contractor. (Murtopo, Nugroho, and Budihardjo 2023). Deeper study is thus required to determine the elements factor that lead to Change Orders and their effects on project performance. This will allow for future anticipation or mitigation in following work to prevent Change Orders from occurring and disrupting project performance.

RESEARCH METHODS

The type of research used in this study is quantitative research, which focuses on identifying the causal factors of change orders in the implementation of infrastructure work and their impact on project performance. The research was conducted on several service providers that have carried out infrastructure work in Bojonegoro Regency, such as road rehabilitation work, drainage systems, irrigation channels, retaining walls, sanitation, and so on. This study uses purposive sampling techniques, which are sampling methods based on certain criteria deemed relevant to the research objectives. The number of respondents sampled is 30 construction service providers who have ever carried out or are currently implementing infrastructure projects in Bojonegoro Regency. The criteria for selecting respondents include: Being a construction service company that has completed at least one infrastructure project in the last three years in the Bojonegoro area. Directly involved in the project implementation stage and Willing to provide information by filling out a questionnaire. Before being distributed to respondents, the

questionnaire is first validated through content validity testing by soliciting input from three experts in the field of construction management, including academics and project practitioners. To analyze the collected data, the Relative Importance Index (RII) method was used. This method is relevant because it allows researchers to measure the level of importance or relative influence of each factor causing change orders, based on respondents' perceptions. RII is very suitable for use in research aimed at creating rankings or priorities based on Likert scale assessments.

The formula used is as follows:

$$RII = \Sigma W / (A \times N) \dots \dots \dots (1)$$

ΣW = the total score from all respondents for one factor

A = the highest score on the Likert scale

N = total number of respondents

RESULTS AND DISCUSSION

The execution of the research method based on data analysis based on the collected data will be explained by the author in this chapter. This begins with the study design phase, which entails determining and gathering research tools, namely questionnaires. The data processing procedure is also covered in this chapter, including statistics from survey data and interviews on the reasons behind change orders in infrastructure work implementation and how they affect project performance. Questionnaires containing research variables that had been previously identified based on literature studies, the reasons behind change orders in the implementation of infrastructure work, and their effects on construction project performance were distributed as part of the data collection method. Subsequently, specialists validated the questionnaires before they were given to correspondents in order to collect data. Following validity and reliability testing of the collected data, the Relative Importance Index (RII) approach is used to analyze the data. The factors causing change orders used in this research are as follows:

Table 1. Factors causing Change Orders

No.	Factor	Indicator	Source
1	Planning And Design	a. Design changes by planning consultants	(Muluk et al., 2018)
2		b. Design Mistake	(Waty & Sulistio, 2020)
3		c. Perubahan scope pekerjaan pada tahap pelaksanaan konstruksi	(Simhanandi & Budiharjo, 2015)
4		d. Changes in the scope of work at the construction implementation stage	(Dewantoro, 2017)
5		e. Unclear Drawing details	(Muluk et al., 2018)
6		f. Errors and Omissions in determination of estimates	(Dikdik Moh. NS1, 2017)
7		g. Insufficient design specifications complete	(Putri & Waty, 2021)
8		h. Addition to the scope of work	(Putri & Waty, 2021)
9		i. Reduction of scope of work	(Putri & Waty, 2021)
10	Nature Factor	a. Unpredictable weather or univers events	(Putri & Waty, 2021)
11		b. Very bad weather	(Muluk et al., 2018)
12		c. flood occurred	(Muluk et al., 2018)
13		d. landslides occur	(Muluk et al., 2018)

14		e. land subsidence	(Muluk et al., 2018)
15	Owner	a. Project Schedule Changes	(Rohana et al., 2018)
16		b. Accelerated implementation time	(Muluk et al., 2018)
17		work due to owner's request	
17		c. there is a request for change	(Muluk et al., 2018)
18		quality by owner	
18		d. Unclear instructions on construction	(Gumolili et al., 2012)
19		implementation	
19		e. Change of policy from the owner	(Putri & Waty, 2021)
20		f. Additional construction costs outside the plan	(Indramanik, 2019)
21		g. changes to the technical specifications of the item work	(Muluk et al., 2018)
22	Construction	h. Delay in work implementation time due to owner's request	(Muluk et al., 2018)
23		i. Project owner request (owner) for optimization	(Martanti, 2019)
24		j. Design changes	(Prayudi, 2017)
25		a. The number of overtime hours worked	(Indramanik, 2019)
26		b. Delay in delivery of materials	(Indramanik, 2019)
27		c. Schedule changes caused by contractors	(Muluk et al., 2018)
28		d. Lack of supervision	(Putri & Waty, 2021)
29		e. Lack of knowledge and work experience	(Indramanik, 2019)
30		f. Disputes between stakeholders	(Simhanandi & Budiharjo, 2015)
31		g. Lack of cooperation between workers	(Indramanik, 2019)
32		h. Delay in approval from the owner/consultant in approving drawings, contract designs and clarifications	(Simhanandi & Budiharjo, 2015)
33		i. material delivery by the supplier does not comply with specifications	(Muluk et al., 2018)
34		Schedule delays due to repetitive work	(Muluk et al., 2018)
35		Lack of coordination	(Junius & Waty, 2020)
36	External Causes	a. Land acquisition problem factors	(Muluk et al., 2018)
37		b. Changes in monetary policy	(Gumolili et al., 2012)

38		c. Work delays due to certain reasons	(Widhiawati Ida Ayu, Anak Agung Wiranata, 2016)
39		d. interference from the government	(Muluk et al., 2018)
40	Administration	a. Errors/omissions in contract documentation	(Muh, 2018)
41		b. Contract documents are incomplete	(Hansen et al., 2020)
42		c. Unclear contract articles	(Martanti, 2019)
43		d. Contract terms and conditions unclear	(Hardjomuljadi, 2016)
44		e. Incomplete contract	(Putri & Waty, 2021)
45	Policy Changes	a. Instructions to contractors different from what specified in the contract documents	(Khalef et al., 2021)
46		b. There is a change order in drawings or specifications	(Khalef et al., 2021)
47		c. Work delays due to certain reasons	(Widhiawati Ida Ayu, Anak Agung Wiranata, 2016)
48		d. Change of project location	(Widhiawati Ida Ayu, Anak Agung Wiranata, 2016)
49		e. Delay in delivery permission, approval and decision	(Widhiawati Ida Ayu, Anak Agung Wiranata, 2016)

Meanwhile, the impacts caused by the change order are as follows:

Table 2. Impact Change Orders

No.	Impact	Indicator	Source
1.	Cost	a. Increase the contractor's budget	(Junius & Waty, 2022)
2.		b. Decrease in project profits	(Junius & Waty, 2022)
3.		c. Project costs ballooned	(Junius & Waty, 2022)
4.		d. increase overhead costs	(Junius & Waty, 2022)
5.		e. Changes in Contract Value	(Suseno et al., 2024)
6.	Quality	a. Causing rework or rework	(Suseno et al., 2024)
7.		b. Changing construction methods	(Suseno et al., 2024)

8.		c. The work methods used are ineffective	Suseno et al., 2024)
9.		d. Reduce contractor performance	Suseno et al., 2024)
10.		e. resulting in some products being produced being defective	(Beatrix & Wiguna, 2014)
11.		a. Causing material delays	(Waty & Sulistio 2022)
12.		b. Changing Daily Progress	(Suseno et al., 2024)
13.	Time	c. Increase project duration	(Junius & Waty (2022)
14.		d. Inhibits other work	(Junius & Waty (2022)
15.		e. Causing delays in procurement of work equipment.	Junius & Waty (2022)

Validity Test Result

The validity test is carried out by correlating each question with the total score, then comparing it with the r table value (Pearson Product-Moment Correlation Coefficient), with a level of significance value of 5%. This indicates that the tolerable error rate in this research is 5%. Thus, the confidence level figure in this study is 95%, while the Pearson r coefficient value for the number of respondents (N) = 30, is 0.361.

Based on the results of the validity test for the causes of change orders for 49 indicators, valid data was obtained for 40 indicators while 9 indicators were invalid. So, by carrying out the validity test, it was found that there were 40 indicators or 81.6%. It can be believed that each question item in this questionnaire can provide valid results, namely with the condition that r count > r table. Meanwhile, based on the results of the validity test of the impact of change orders on 15 indicators, valid data was obtained for 15 indicators so that it can be 100% confident that each question item in this questionnaire can provide valid results, namely provided that r count > r table.

Reliability Test Result

Reliability testing is an advanced stage in factor analysis after testing the validity of the variables that make up the factors formed. Reliability shows an understanding that an instrument is quite trustworthy and reliable, using Cornbach Alpha analysis. A questionnaire is considered reliable if the Cornbach Alpha coefficient is greater than or equal to 0.6 (Arikunto, 2010) while Sekaran (2006) states that a research instrument indicates adequate reliability if the Cronbach alpha coefficient is greater than or equal to 0.70.

Table 3. Factor Reliability Test Result

<i>Criteria</i>		
Reference Value	Cronbach's Alpha Value	Conclusion
0,7	0,908	Reliabel

By analyzing the calculations, a Cronbach's Alpha value of 0.908 was obtained, which means that the components causing the change order were declared reliable.

Meanwhile, the reliability test for the impact due to the Change Order is as follows:

Table 4. Impact Reliability Test Results

<i>Criteria</i>		
Reference Value	Cronbach's Alpha Value	Conclusion
0,7	0,726	Reliabel

By analyzing the calculations, a Cronbach's Alpha value of 0.726 is obtained, which means that the change order impact component is declared reliable. RII analysis is an analysis tool that allows relative quantitative analysis, where the higher the rating, the higher the influence exerted by the variable (Rusdiani, 2017). Ranking of factors that can cause change orders in the implementation of infrastructure work and their impact on construction project performance. By carrying out calculations like the formula above, the Relative Importance Index (RII) is calculated on influential factors that can cause change orders in the implementation of infrastructure work and their impact on construction project performance, so that from these calculations the most dominant variables are obtained.

Based on the results of the index calculation, it is found that the first planning factor that causes change orders is a mismatch between drawings and field conditions with a value of 0.847, then in second place there are design changes by consultants and incomplete design specifications with a value of 0.840 each. The index value is 0.813 and in the sixth order there are unclear image details and errors and omissions in determining estimates with a value of 0.807 respectively. Meanwhile, for natural factors, flooding is the first cause of change order with a value of 0.873, while in second place is the occurrence of landslides and land subsidence with a value of 0.867 each, while in third place is very bad weather with a value of 0.860 and in fourth place is erratic weather or natural events with a value of 0.853. Meanwhile, for the project owner factor, it shows that in the first place there is a change in the technical specifications of the work item with a value of 0.900, while in the second place there is a request for a change in quality by the owner and a request from the project owner for optimization as well as a change in design with a value of 0.873 each, while in third place is an unclear instruction to the construction implementer with a value of 0.867, while in fourth place there is a change in the project schedule and an acceleration of the work implementation time due to requests by the owner with a value of 0.853 respectively, while in fifth place there is an increase in construction costs. outside the plan with a value of 0.840 and in sixth place are policy changes from the owner and delays in work implementation due to the owner's request with an index value of 0.827 respectively. Meanwhile, the construction factor index value is in first place, namely the delivery of materials by suppliers not in accordance with specifications with a value of 0.913, while the second place is late approval from the owner or consultant in approving contract design drawings and clarifications with a value of 0.907, while the third place is lack of knowledge and work experience, then lack of cooperation between workers and lack of coordination with a value of 0.900 each, while in fourth place is the number of hours of overtime work and disputes between stakeholders with a value of 0.893 respectively. Fifth is schedule changes caused by contractors with a value of 0.887 and sixth is lack of supervision with a value of 0.873 and seventh is delays in material delivery with an index value of 0.847 and eighth or last is schedule delays due to work being repeated with a value of 0.840. Meanwhile, the first place in the external factors causing change orders is changes in monetary policy with a value of 0.907, then the second place is postponement of work for certain reasons with a value of 0.900, while in third place is the land acquisition problem factor with a value of 0.887 and the fourth place is interference from the government with a value of 0.773. Meanwhile, for the administration factor, the results showed that the first order was incomplete contract documents with a value of 0.927, while the second order was errors or omissions in the contract documentation with an index value of 0.907 and the third order was unclear contract terms and conditions with an index value of 0.887 and the fourth order was unclear contract articles and

incomplete contracts with an index value of 0.860 respectively. And for the policy change factor, the first order is Instructions to contractors that are different from what is specified in the contract documents with an index value of 0.913, while the second order is orders for changes in drawings or specifications and delays in granting permits, approvals and decisions with an index value of 0.887 respectively and the third order is delays in work for certain reasons with an index value of 0.880, while the fourth or last order is changes in project location with a value of 0.853.

Based on the results of the index calculation, it was found that the cause of the change order which had an impact on costs in the first order was increasing overhead costs with a value of 0.853, then in the second order was a decrease in project profits and a change in contract value with each index value of 0.847, while in the third order the project costs increased with an index value of 0.833 and the fourth or last order was increasing the contractor's budget with a value of 0.780. Meanwhile, the first cause of change orders that have an impact on quality is changing the construction method with a value of 0.873, then in the second place the work method used is ineffective and results in several products being produced being defective with an index value of 0.867, while in the third order it causes rework with an index value of 0.833 and the fourth or final order is reducing contractor performance with a value of 0.800. And the results of the index calculation for the causes of change orders that have an impact on time in the first order are changing the duration of the project with a value of 0.887, then in the second order it causes delays in the procurement of work equipment with an index value of 0.873, while in the third order it changes daily progress with an index value of 0.867 and the fourth order is hampering other work with an index value of 0.860 and the fifth or last order is causing material delays with an index value of 0.853.

CONCLUSION

After data analysis, it is known that there are 7 factors causing change orders in the implementation of infrastructure work in Bojonegoro District with 40 indicators. The most dominant factor causing change orders is the design planning factor with indicators of discrepancies between drawings and field conditions, then the natural factor is the occurrence of flooding, then the project owner factor is a request for quality changes by the owner, and the construction factor is the delivery of materials by the supplier which does not match the specifications, and external factors are changes in monetary policy, and for administrative factors caused by incomplete contract documents, and policy change factors are instructions to contractors that differ from what is specified in the contract documents.

The impact caused by change orders on infrastructure projects in Bojonegoro District is that there are 3 variables, namely Cost, Quality and Time with 15 indicators. The most dominant impact due to change orders on infrastructure projects in Bojonegoro District is for the cost variable, namely increasing overhead costs, then for the Quality variable, it is changing the construction method and for the time variable, it is changing the project duration. This finding can be utilized by project stakeholders such as project owners, planning consultants, and contractors to formulate mitigation steps and risk control strategies, from the planning phase to implementation, in order to minimize the occurrence of change orders and their impact on project success.

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