Volume 2, No. 12 December 2023 (0000-0000)
p-ISSN 2980-4868 | e-ISSN 2980-4841
https://ajesh.ph/index.php/gp

ANALYSIS OF CONTRACT CHANGE ORDER (CCO) COSTS IN BUILDING CONSTRUCTION PROJECTS

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ABSTRACT
In every project implementation, one of the things that often occurs is change orders, namely changes to work that occur after the contract is signed by the work owner and implementing contractor. Most change orders occur due to the desire to change the design or related to budget adjustments by the work owner. The change order proposed by the contractor was due to differences between the design plan and the bill of quantities, the design lacked detail, the design did not suit field conditions, changes in implementation methods because the design was difficult to carry out, and difficulties in mobilizing materials according to technical specifications. Change orders that are not handled properly can potentially cause additional costs, additional time and decreased contractor performance. To minimize change orders, change order correlation analysis can be carried out using original data, with the parameters change order ratio (COR), change order ratio in addition (CORA) and change order ratio in subtraction (CORS). The data used in this study uses six original change order contract data on building construction projects which have initial contract data and cost data after the change order occurs. The results of COR, CORA, and CORS calculations are analyzed and described according to project conditions This study produced three conclusions, the average Index Change Order Ratio (COR) for the six research study object projects was 26%. This means that the 6 study object projects experienced a proportion change of 26% from the original contract value. The average Change Order Ratio in Addition (CORA) index for the six research study object projects is 16%. This means that of the 6 study object projects experiencing change orders, 16% were due to additional work from the original contract value. The average Change Order Ratio in Subtraction (CORS) index for the six research study object projects is 10%. This means that of the 6 research study object projects that experienced change orders, 10% were due to the work being less than the original contract value.
Keywords: change order, contract, building construction project.
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INTRODUCTION

A construction project is understood as a combination of various resources such as people, materials, equipment and costs that are collected in a temporary organizational framework to achieve certain goals and objectives. Construction projects are classified as complex work, because they have unique, dynamic characteristics, full of risks and uncertainties because they relate to costs, time, quality, policies and resources. Construction projects are unique because there are never exactly the same series of activities, only similar projects. This means that no project is identical or exactly the same, each project will have a

different character. Construction projects also require organizations to bring together a variety of different resources, both of different character, quality and purpose, so that construction projects tend to be risky. Efforts to realize a construction project will involve three parties who have a dominant role, namely the project owner (owner) or principal (employer/client/bowher), consultant and implementer (contractor). Large construction project work will go through a series of quite complicated stages, starting with design activities by planning consultants, followed by the implementation stage by implementing contractors, and supervised by supervisory consultants or construction management. A planning consultant is an individual or a business entity who has abilities in various scientific disciplines in their respective fields who act both as advisors and/or planners (in this case the field of structures and construction), in accordance with the wishes and needs of the owner and can also act as supervisors in its implementation. The people or bodies that finance, plan and carry out project activities are called development implementing elements. Each of these elements has duties, obligations, responsibilities and authority according to their respective positions. In carrying out activities to realize a project, each party, according to their position, interacts with each other according to the established working relationship(Wulfram I, 2005). The project provider or task provider or service user is the person or entity who owns the project and provides work or orders work to be provided to the service provider and who pays the costs of the work. Service users can be individuals/bodies/institutions/government or private agencies. Parties/agencies called consultants can be divided into two, namely planning consultants and supervisory consultants. Planning consultants can be separated into several types according to their specialization, namely consultants who handle the architectural field, civil field, mechanical and electrical field, and so on. These various types of fields generally become one unit and are called planning consultants, namely people/agencies who make complete building plans in the fields of architecture, civil engineering and other fields that are closely linked to forming a building system. Planning consultants can be individuals/individuals with legal entities/legal entities engaged in the field of building work planning(Wulfram I, 2005). The task of the planning consultant is to make a complete plan consisting of plan drawings, work plans and work implementation conditions, structure calculations and cost budget plans. Planning consultants must also be active in providing suggestions and considerations to service users and contractors regarding work implementation. The planning consultant is obliged to provide answers and explanations to the contractor regarding matters that are unclear in the plan drawings, work plans and requirements. Planning consultants are also required to attend project management coordination meetings. So that project work runs according to the design plan, k services are neededsupervising consultant, namely a person or business entity appointed by the service user to assist in managing the implementation of development work, in particular supervising the progress of the work from the beginning to the end of the project work, guided by the contract documents. Apart from planning consultants and supervisory consultants, there are implementing contractors, namely people or business entities who accept work and carry out the implementation of the work according to the costs that have been determined based on the plan drawings and regulations and conditions that have been determined. The contractor can be an individual company with a legal entity or a legal entity engaged in building construction.

Good planning will produce a detailed engineering design (DED)/detailed plan

drawing that is clear, easy to understand, complete, accommodates all the wishes of the work owner, and is in accordance with field conditions. Ideal planning involves considering the selection of materials in detail, selecting estimates for work implementation methods, selecting work equipment and being able to estimate the duration of time needed to complete a construction project from the initial stage to the handover of the work. However, a construction project is a complex activity, involving a lot of resources, requiring the right project management organization so that they can work together to realize an ideal construction project in terms of costs, quality and time. This makes construction project activities classified as high-risk activities. Risk and uncertainty can be a factor in the failure of a construction project to achieve its stated objectives (Ibbs and Seth (2009). In general, risk is associated with the possibility (probability) of events that are not expected (Soeharto, 1995). Risk is the possibility of something occurring. /events in the process of business activities, which can have a negative impact on the achievement of predetermined business targets, there are seven risk events that often arise in construction projects, one of which is the procurement of work plus or minus (Change Order; CO) Asiyanto (2005). Change Order is The impact of the high risk of uncertainty, work added to or deleted from the original scope of contract work which changes the entire contract value or work completion time (Jaydeep et al. 2015) reveals that in every construction project changes often occur which can be called CO. That it is very rare In a construction project, no changes occur until the project is completed, however, a large number of CO processes in a project are not recommended because they are more detrimental to the project itself (Nunnaly, 1993). Factors that cause CO can arise from various sources, namely project owners, consultants, contractors, subcontractors, natural factors, social factors, policies and others. Changes in work or CO to construction costs cause an increase of between 10-15% of the contract value (Fleming et al., 1990). Service users have a big role in job changes because service users do not give planning consultants enough time to design construction projects (Ndihokubwoyo and Haupt, 2009). Of the 54 projects studied, changes in work or construction project CO can cause productivity levels to decrease (Ibbs, 1997). CCO has such a large impact that it has a cumulative and disruptive influence (O'Brien, 1991). If the consequences of the CCO impact are not compensated, it can reduce work performance.CCO can influence or impact project implementation performance both in terms of cost, quality and time. CCO will influence the project which has an impact on project costs, project completion time, and the quality of the results. Unplanned changes that occur in construction projects can cause additional work beyond what was expected, which will result in additional costs and time (Chen and Hsu, 2007). Other research results show that 95% and 100% of road and rail projects, respectively, have a maximum cost overrun of 50%. The main causes of cost overruns were found to be scope changes, delays during construction, unreasonable estimates, project cost adjustments, and no practical use of earned value management systems. Research by Sulistio & Waty (2008) shows that the percentage of change orders occurring in 28.26% of projects in East Kalimantan in excavation and embankment work on road pavement projects. Research by Waty & Sulistio (2020) states that the effects of change orders from calculating change orders for road projects in Banten are: delaying the project completion date, cost overruns, resulting in claims and disputes, affecting work performance and morale, and most contractors incur additional costs.(Putra et al., 2020). Based on the party causing CCO, the factors that influence CCO can be grouped into 4 parts,

namely the work owner, the consultant (planner and supervisor), the implementing contractor and external parties. Problems from the work owner's side can consist of (1) Delays from the owner in approving drawings, contract designs and clarifications (Owner Performance), (2) Changes in the scope of work or additions to the volume of work, (3) Changes in work that has been completed (rework), (4) Acceleration of work implementation, (5) Temporary cessation of work, and changes to specifications and designs/materials. Problems from the consultant's side can be in the form of (1) Mismatches between drawings and field conditions, (2) Changes in volume due to planning calculation errors, (3) Defects in design and specifications due to errors and incomplete designs or changes in design, (4) Differences between specifications, drawings and BOQ in planning, (5) Detailed drawings and specifications are not clear. Problems from the implementing contractor's side can be in the form of (1) Late delivery of materials, (2) Delays in supplying labor, (3) Subcontractor's performance is not good, (4) Errors in work implementation, (5) Work accidents, (6) Delays in work implementation (reschedule), (7) Changes in work methods. Problems from external parties consist of (1) Weather or natural events beyond predictions, (2) Changes in government policy, (3) Third party intervention, and (4) Monetary conditions. In this research, the researcher wants to focus on research to measure the value of change order ratio (COR), change order in addition (CORA) and change order in subtraction (CORS) in case study projects.

The research objects chosen to identify the change order ratio (COR) value were six real data in the form of project contract addendums implemented in the 2017 - 2022 period which were analyzed from archival data sources from companies providing supervisory consulting services from Surabaya. The six project data show that there is quite a significant influence on contract change orders, both in terms of the causes of change orders, as well as the impact of change orders, namely delays in contract time and additional project contract value. Of the six project addendum documents studied, five of them required additional budget and one project was completed with a balanced budget. Of the six projects studied, four required additional time to complete the work, and two other projects were completed on time. This shows that change orders have a significant impact on project completion, especially in terms of time and cost. The amount of change order cost margin can be measured using several calculation analyzes namely COR, CORA, CORS(Edwin & Waty, 2020). Change Order of Ratio (COR) is an index used to measure the total cost variance of projects experiencing change orders. This COR value is the value of changes that occur in projects that experience change orders. Change Order ratio in Addition (CORA) is an index used to measure the ratio of the total added budget for projects experiencing change orders. Change Order Ratio in Substraction (CORS) is an index used to measure the ratio of the total shortage achieved on projects where change orders are carried out.

Based on the background and problem formulation above, the objectives of this research are as follows:

1. Measuring the change order ratio (COR) value in six case study projects.
2. Measuring the value of change order in addition (CORA) in six case study projects.
3. Measuring the value of change orders in subtraction (CORS) in six case study projects.

RESEARCH METHODS

Data Collection Procedures

Data collection is a process of collecting research data which is then processed and formulated, processed so that it can provide answers to hypotheses.

The data collection method that will be used is a descriptive method, namely by describing contract change orders that occur on construction projects, including the causes and impacts resulting from the implementation of contract change orders. The data collected consists of primary data sourced from PT. Dira Bina Nusa Group, in the form of work supervision documents subject to change orders.

Secondary data is data obtained from the results of literature studies, such as books, references, journals and other research related to this research topic. Secondary data collected in this research includes:

a. Literature related to the parties involved in project activities consisting of work owners, planning consultants, supervisory consultants, and implementing contractors.
b. Literature related to contract change orders.
c. Contract change order addendum document.
d. Monthly Physical Work Progress Report.
e. Cost Budget Plan for projects that use change order contracts.
f. Attachment to contract documents consisting of Detailed Engineering Design (DED) drawings, Cost Budget Plan (RAB), Work Plan and Requirements (RKS)

Data collection in this research focused on secondary data in the form of detailed engineering design drawings, cost budget plans, and technical specifications obtained from planning consultants. Secondary data in the form of contract change orders was obtained from contractors. Secondary data, minutes of change meetings, were obtained from supervisory consultants.

Data analysis technique

The analysis used in this research is quantitative analysis in the form of numbers to use analysis, and the data obtained is numerical based on the variables which are cause and effect.

Analysis of the causes of contract change orders is by using a descriptive method which explains contract change orders that occur on construction projects, including the causes and impacts resulting from the implementation of contract change orders, as well as the role of stakeholders in controlling contract change orders.

The variable factors causing change orders along with the indicators used in this research are as follows.

There are several calculation analyzes that can be used to measure change orders that occur, namely COR, CORA, CORS, FCO and PCO(Edwin & Waty, 2020):

***Change Order Ratio* (COR)**

This index measures the total cost variance of projects where change orders occur.

COR = (the sum of the added and minus values for the project for which the change order was made divided by the original contract price) x 100% ……..(2.1)
This COR value is the value of changes in projects that experience change orders.

Change Order Ratio in Addition (CORA)

This index measures the ratio of total additions to projects experiencing change orders.

CORA = (the amount of added value from projects undergoing change orders divided by the original contract price) x 100%..... (2.2)

Change Order Ratio in Substraction (CORS)

This index measures the ratio of the total deficiencies achieved in projects where change orders are carried out.

CORS = (the sum of the value of work less than the project for which the change order is made divided by the original contract price) x100%..... .....(2.3)

Three indicators for calculating change order cost margins, namely COR, CORA, and CORS. FCO is to measure the frequency of

change orders, while PCO is to measure and calculate the causes of change orders.

RESULTS AND DISCUSSION

Analysis and Calculation of COR, CORA, and CORS

Change Order Ratio (COR) calculation is a calculation carried out by comparing the change order value to the initial contract value. This index measures the total cost variance of projects where change orders occur. Based on analysis of calculations using COR, it shows that on average there is a change order value of 26% for the six project objects studied. The results of the CORA calculation analysis also show an average figure of 16% for change orders caused by additional work. The results of the CORS calculation analysis show an average figure of 10% for change orders caused by lack of work. Below are presented the results of the analysis of COR, CORA and CORS calculations on six research object projects:

Table 1. Results of COR, CORA, CORS Calculation Analysis for Case Study Projects

No	Nama	Kontrak (Rp.)	Addendum (Rp)	Tambah (Rp.)	Kurang (Rp)	Jumlah Tambah+Kurang	COR (%)	CORA (%)	CORS (%)
1	Proyek 1	14.177.840.000,00	15.237.276.000,00	3.238.641.215,41	2.400.310.997,49	5.638.952.212,90	0,40	0,23	0,17
2	Proyek 2	6.761.600.000,00	7.379.200.000,00	2.213.946.000,00	1.596.346.000,00	3.810.292.000,00	0,56	0,33	0,24
3	Proyek 3	1.029.185.559,90	1.063.376.676,05	45.658.882,97	13.806.029,19	59.464.912,17	0,06	0,04	0,01
4	Proyek 4	1.944.514.000,00	1.944.514.000,00	122.762.982,41	109.871.686,98	232.634.669,39	0,12	0,06	0,06
5	Proyek 5	3.841.210.000,00	4.224.434.000,00	752.714.000,00	369.471.000,00	1.122.185.000,00	0,29	0,20	0,10
6	Proyek 6	2.933.447.200,00	3.185.715.805,97	332.399.795,21	80.131.189,24	412.530.984,44	0,14	0,11	0,03
						RATA -RATA	0,26	0,16	0,10

Source: Recapitulation/Researcher Process, 2023

Based on the change order ratio (COR) calculation analysis, it can be seen that the largest change order incident occurred in project two, with a total change value of 56%, next project one change orders were 40%, followed by project five at 29%. In fourth place there is project six with a COR value of 14%, in fifth place project 4 is 12%, and finally the project that experienced the fewest change order incidents is project three with a value of 6%.

Table 2. Results of Case Study Project Total Change Rating Analysis Results

No	Nama	Kontrak (Rp.)	Addendum (Rp)	Tambah (Rp.)	Kurang (Rp)	Jumlah Tambah+Kurang	COR (%)
1	Proyek 2	6.761.600.000,00	7.379.200.000,00	2.213.946.000,00	1.596.346.000,00	3.810.292.000,00	0,56
2	Proyek 1	14.177.840.000,00	15.237.276.000,00	3.238.641.215,41	2.400.310.997,49	5.638.952.212,90	0,40
3	Proyek 5	3.841.210.000,00	4.224.434.000,00	752.714.000,00	369.471.000,00	1.122.185.000,00	0,29
4	Proyek 6	2.933.447.200,00	3.185.715.805,97	332.399.795,21	80.131.189,24	412.530.984,44	0,14
5	Proyek 4	1.944.514.000,00	1.944.514.000,00	122.762.982,41	109.871.686,98	232.634.669,39	0,12
6	Proyek 3	1.029.185.559,90	1.063.376.676,05	45.658.882,97	13.806.029,19	59.464.912,17	0,06

Source: Recapitulation/Researcher Process, 2023

The research findings noted five dominant work items contributing to change orders in each building work case study studied. In project case study one, masonry and concrete work items practically dominated the occurrence of change orders with a change

percentage of 539%. This is due to differences in the volume of the bill of quantities and plan drawings received by the implementing contractor during the auction and implementation in the field, resulting in a lack of volume as a result of adjusting the drawings to real conditions in the field.

In project case study 2, the roof covering and facade work items made from ACP material were the largest contributor to change orders with a figure of 212.90%. This is because the roof covering material without a frame was not available according to the contract specifications at the time of implementation, so the process of redesigning the roof covering, originally using roof material without a frame, changed to a roof covering design using a frame. The next change is related to the procedure for calculating the volume of concrete which causes a change in the back up volume of concrete which causes a reduction in the ACP work on the building facade, this can be considered to reduce the architectural quality of the building. Because the appearance of the building that should be beautified with ACP becomes a plain appearance with paint finishing.

In project case study 3, the work item for installing the building's main power cable from the main panel was the largest contributor with a figure of 120%. This is because the layout of the power cable placement route from the main building to the main panel is not the same because it is blocked by the existing ground water tank and existing septic tank, so changes to the cable route must be made. This causes the length of the main power cable to increase. The planning design drawings are not accurate, so they do not detect the existence of existing ground water tanks and existing septic tanks that are still functional.

In project case study 4, the floor raising work item was the largest contributor to change orders, namely 150%. This is due to a request to increase the height of the planned canteen floor elevation on the paving road on the east side as well as a request for design changes from the work owner.

In project case study 5, the procurement and installation of lighting work items was the largest contributor to change orders of 100%. This is possible because the lighting work item has not been listed in the bill of quantities received by the implementing contractor at the time of the auction. Likewise, the volume of building demolition materials has increased significantly compared to the bill of quantities. Meanwhile, in dirty water installation work there are additional work items that were not identified well in the planning process. In frame work, there are also many discrepancies between the plan drawings, bill of quantities and existing field conditions, this is a serious problem considering that the work carried out is rehabilitation, including replacing wooden frames with aluminum.

In project case study 6, the external drainage work item around the building was the largest contributor to change orders with a figure of 65.80%. This is possible because the DED landscape image does not match the factual conditions on the ground so adjustments need to be made. In full, the work items contributing to the change order ratio in the six case study projects are presented in table 3 as follows:

Table 3. Results of Case Study Project Total Change Rating Analysis Results

No	Nama		Jenis Pekerjaan	Persentase Perubahan	Keterangan
1	Proyek 1	1	Pasangan & beton praktis	539,00	Volume kurang, penyesuaian gambar dengan BoQ
		2	Peralatan Fire Alarm	283,10	Penggantian peralatan utama, terkait dengan sistem
		3	Penutup atap	275,90	Penggantian material penutup atap
		4	Beton GWT dan rumah pompa	221,80	Volume kurang, penyesuaian gambar dengan BoQ
		5	Kusen, pintu dan jendela	148,60	Penggantian tipe kusen, pintu, jendela
2	Proyek 2	1	Penutup atap & fasade ACP	212,90	Volume kurang, perubahan tampilan fasade finishing ACP
		2	Papan nama/identitas bangunan	120,09	Volume kurang, perubahan tampilan desain
		3	Dinding partisi	94,00	Perubahan desain, menyesuaikan gambar dan HSPK setempat
		4	Kusen dan aksesoris	78,00	Perubahan desain, menyesuaikan gambar dan HSPK setempat
		5	Finishing lantai & dinding	77,00	Volume kurang, perubahan tampilan desain
3	Proyek 3	1	Pasang Kabel dari panel induk NYY 4x10 mm	120,00	Volume kurang, pemasangan mengikuti kondisi lapangan
		2	Pasang finishing batu alam	116,60	Volume kurang, gambar tidak sesuai dengan BoQ
		3	Coating batu alam	105,00	Volume kurang, gambar tidak sesuai dengan BoQ
		4	Galian Tanah Cadas/Rabat/Aspal	7,16	Volume kurang, gambar tidak sesuai kondisi lapangan
		5	Pengangkutan Bekas Galian Keluar Lokasi	7,16	Volume kurang, gambar tidak sesuai kondisi lapangan

Source: Recapitulation/Researcher Process, 2023

Table 4. Case Study Project Total Change Rating Analysis Results (continued)

No	Nama		Jenis Pekerjaan	Persentase Perubahan	Keterangan
4	Proyek 4	1	Urugan peninggian lantai	150,00	Volume kurang, gambar tidak sesuai kondisi lapangan
		2	Finishing lantai	125,20	Volume kurang, gambar tidak sesuai kondisi lapangan
		3	Pondasi	100,00	Volume kurang, gambar tidak sesuai kondisi lapangan
		4	Rabatan lantai kerja	100,00	Volume kurang, gambar tidak sesuai kondisi lapangan
		5	Atap	100,00	Item pekerjaan dobel, salah satu harus dihapus
5	Proyek 5	1	Lampu	100,00	Item belum ada di BoQ
		2	Sanitair	100,00	Volume kurang, gambar beda dengan BoQ
		3	Bongkaran bangunan eksisting	100,00	Volume kurang, gambar tidak sesuai kondisi lapangan
		4	Instalasi air kotor	83,00	Volume kurang, perubahan layout gambar karena kondisi lapangan
		5	Kusen	80,00	Gambar denah kusen, detail kusen, kondisi lapangan berbeda
6	Proyek 6	1	Drainase luar di sekeliling bangunan	65,80	Gambar tidak sesuai layout
		2	Lansekap	57,04	Volume kurang
		3	Ground tank dan rumah pompa	47,39	Volume kurang
		4	Pekerjaan struktur dan rumah pompa	37,17	Volume kurang
		5	Pekerjaan utilitas di luar bangunan	33,94	Volume kurang

Source: Recapitulation/Researcher Process, 2023

Description of the causes of job changes that led to contract change orders in six research study object projects:

- Job Owner.
  The work owner can submit a change order taking into account changes in budget conditions, related to future development plans for the area where the building is located, improving the quality of the work, and the final results of the work being different from the work owner's expectations at the time of planning.
- Planning consultant

The planning consultant can provide considerations to approve or reject the proposed changes based on technical considerations. One of the causes of design changes in terms of planning factors is that the planned materials are no longer available (discontinued), there are conditions that were not predicted at the time of planning, such as the construction of foundations from old buildings, the condition of the building site plans that have changed and are not the same as the conditions at the time of planning. , land structures that are different from planners' assumptions, as well as changes in government policy regulations.

- Supervising consultants
  Supervising consultants can provide chronological identification reports and documentation of factors causing change orders, as well as help collect field data to assist planners in determining technical justification and alternative solutions related to proposed changes submitted with technical or administrative (contract) considerations.
- Implementing Contractor
  require approval from the parties.

The implementing contractor can propose a change order if there is a design plan that is different from field conditions, a volume that is different from field conditions, a volume that is different from the design plan, material specifications are discontinued/difficult to find on the market, design plans and design details do not support each other so it is necessary drawings of proposed changes and changes to implementation methods due to field conditions are made.

The results of research findings on six case study projects note that change orders affect costs and time and ultimately reduce implementation performance. Of the six case study projects, five of them experienced additional costs of varying amounts, from the lowest 103.32% to the highest 109.98%. Likewise, in terms of time, change orders that occurred in six case study projects resulted in the need for additional time for four case study projects. This additional time is used for recalculations, method adjustments, and change order administration processes that

Table 5. Results of Analysis of Change Orders and Their Effects on Six Case Study Projects

No	Nama	Kontrak	Addendum	Tambahan Anggaran		Keterangan	Tambahan Waktu
		(Rp.)	(Rp)	(Rp)	(%)		
1	Proyek 1	14.177.840.000,00	15.237.276.000,00	1.059.436.000,00	107,47	Tambah anggaran	Tambah Waktu
2	Proyek 2	6.761.600.000,00	7.379.200.000,00	617.600.000,00	109,13	Tambah anggaran	Tidak Ada
3	Proyek 3	1.029.185.559,90	1.063.376.676,05	34.191.116,14	103,32	Tambah anggaran	Tidak Ada
4	Proyek 4	1.944.514.000,00	1.944.514.000,00	-	100,00	Balance Budget	Tambah Waktu
5	Proyek 5	3.841.210.000,00	4.224.434.000,00	383.224.000,00	109,98	Tambah anggaran	Tambah Waktu
6	Proyek 6	2.933.447.200,00	3.185.715.805,97	252.268.605,97	108,60	Tambah anggaran	Tambah Waktu

Source: Recapitulation/Researcher Process, 2023

Results

Based on the analysis and recapitulation of the contract change order documents for the six projects used as research objects, the following facts can be found:

1. There is change order work or more or less on six research object projects.
2. There are additional costs for five research object projects and one balance budget for six projects used as research objects.

3. There is additional time for four research object projects and two case study projects that still complete the work according to the contract time.
4. *Change orders*which occurred in the six research study object projects was predominantly caused by [1] the volume of work listed on the BoQ being less or not in accordance with the detailed design drawings, [2] the less volume being caused by the volume of the BoQ and drawings not being in accordance with field conditions so that the drawings and the volume of work must be adjusted, [3] the work items have not been listed in the BoQ, [4] the design drawing is incomplete so it requires interpretation and detailing, [5] there is a request for design changes from the owner, [6] there is a request for material changes from the owner, [7] the layout of the plan design does not suit field conditions.
5. *Change orders*in the six case study projects initiated by [1] the work owner and implementing contractor. The proposed change order submitted by the work owner is due to [1] Changes in Engineering Design Details due to changes in the owner's wishes in the midst of work implementation and [2] Adjustments to the available budget.

The proposed change order submitted by the implementing contractor was due to [1] Differences in the Detail Engineering Design drawings with factual field conditions, [2] Differences in volume calculations between the Detail Engineering Design drawings and the Bill of Quantity bid by the implementing contractor at the time of the auction, [3] There were materials discontinuous or difficult to find on the market, [4] Suggestions for improving the quality of steel door work, [5] Differences in volume calculation procedures for concrete work which causes change orders..

CONCLUSION

COR index value

Index *Change Order Ratio (COR)*the average for the six research study object projects is 26%. This means that the 6 study object projects experienced a proportion change of 26% from the original contract value.

CORA index value

Index *Change Order Ratio in Addition (CORA)*the average for the six research study object projects is 16%. This means that of the 6 study object projects experiencing change orders, 16% were due to additional work from the original contract value.

CORS index value

Index *Change Order Ratio in Subtraction (CORS)*the average for six research study object projects is 10%. This means that of the 6 research study object projects that experienced change orders, 10% were due to the work being less than the original contract value

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