

Profiling Contract Change Order Disputes: An Empirical Validation Study

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ABSTRACT

When assessing contract change order (CCO) disputes on-site, independent auditors have relied upon various techniques to identify the causes and effects of these disputes in order to produce audit reports. However, it has resulted in the various structures of dispute analysis and hence makes it difficult to understand by the parties involved. This paper aims to investigate the CCO disputes by implementing a framework developed specifically to analyse the causes, effects, and possible actions to mitigate the CCO disputes – the Causes, Effects & Mitigations (CEM) framework. A qualitative approach with two sequential strategies was adopted consisting of structured case analysis and expert interviews. Three audit reports related to the CCO disputes were analysed and used as case studies. The results of the case study analysis were then used to produce the CCO profiles that can assist parties to understand CCO disputes that occurred at the project level. Finally, expert interviews were conducted to investigate the effectiveness of this framework. This study contributes by investigating CCO disputes using the CEM framework. The dispute profiles produced are considered effective in providing a better understanding of CCO disputes at the project level.

KEYWORDS: CCO; CEM framework; construction audit; dispute profiles; validation.

INTRODUCTION

The construction industry has long been regarded as a high-risk and full of uncertainties industry. This leads to inevitable changes during the project execution. Any additions, deletions, or modifications to the project scope are considered contractual changes (Ibbs, Wong, & Kwak, 2001) and can occur throughout the project life cycle (Karimidorabati, Haas, & Gray, 2016). The emergence of these changes can alter the original conditions of the agreed contract which is known as the contract change orders (CCOs). As part of the change management process that occurs at the project level, these CCOs must be managed properly to prevent it from becoming a prolonged dispute that can affect the completion of the work.

Construction disputes have been identified as a major cause that leads to project failure, loss of money and time, and detrimental relationships among project parties involved (Cheung & Pang, 2013). These disputes can be instigated by interrelated factors and tend to be aggravated and lead to dispute resolution proceedings which are costly and time-consuming (Kumar Viswanathan et al., 2020). As CCOs can lead to construction disputes, several studies have been conducted to identify the causes and influence of CCOs in construction phases (Hansen, Rostiyanti, & Rif'at, 2020; Kökel, 2015; Padala, Maheswari, & Hirani, 2022). In an effort to resolve CCO disputes on-site, audits by an independent third party can be chosen as a cost-effective option in providing CCO dispute resolutions.

An audit is a mechanism to inspect various aspects of construction projects to ensure compliance of projects with the agreed contract (Hetami & Aransyah, 2020). In this study, the audits are carried out by analysing data related to the causes and effects of CCOs through various data collection techniques. The audits will provide recommendations related to CCO dispute resolution to both parties involved, namely the employer and the contractor. However, this study found limited academic and practical research that discusses the audit process of CCO disputes at the project level. A study that focuses on identifying the causes and effects of CCOs at the project level with a case study of a stadium project in Indonesia (Hansen et al., 2020). Their research succeeded in developing a simple yet applicable framework with a systematic approach to identify the CCO causes, effects, and mitigations called the CEM framework.

While past studies mainly focused on examining individual causal factors without revealing their interdependencies (Kumar Viswanathan et al., 2020), this study aims to profile CCO disputes by identifying their relationships based on the cause-effect-mitigation factors. To achieve that aim, this paper used a qualitative approach to investigate three case studies of CCO disputes utilizing the CEM framework. Next, the results of the framework analysis in the form of CCO dispute profiles were further validated by three expert practitioners who provided feedback regarding the effectiveness of the CEM framework in profiling CCO disputes. The use of this framework can facilitate a better understanding of CCO profiles in order to resolve related disputes.

The following section presents a key literature review of the CCOs and the developed CEM framework. It is followed by a methodology section that discusses two sequential techniques validating the framework. Next, the case study analysis is presented in the result section, while the CCO dispute profiles and expert validation are presented in detail in the discussion section. Finally, the conclusions section summarises the findings of this study while explaining the main contributions of this study.

LITERATURE REVIEW

Contract Change Orders

Changes are inevitable in construction projects. CCOs occur frequently due to many factors including omissions, design errors, the scope of work changes, etc. Many previous studies have focused on legal aspects such as CCO claims and disputes (Cox, 1997; Harrington et al., 2016; Kökel, 2015; Shalaby & Khalafallah, 2018). Other papers discussed various effects of CCO during project execution including effects on productivity (Jawad, Abdulkader, & Ali, 2009), costs (Jawad et al., 2009; Memon, Rahman, & Hasan, 2014), time (Karthick, Malathi, & Umarani, 2015; Khahro et al., 2017), and quality (Anees, Mohamed, & Abdel Razek, 2013).

If not managed properly, CCOs can become a source of major disputes between the parties involved. Disputes often lead to project failure, loss of time and money, and detrimental relationships among project parties involved (Cheung & Pang, 2013). Therefore, it is important for the parties in the construction projects to be able to manage CCOs properly. Hansen (2021) argued that managing CCO is a core competency required for construction contract professionals. The management of CCOs is closely related to analysis efforts to identify the causes and effects of CCOs. For instance, Memon et al. (2014) revealed the top five CCO causes, namely unavailability of equipment, poor workmanship, design complexity, schedule changes, and prompt decision impediments. Meanwhile, Anees et al. (2013) pointed out that poor coordination, design errors and omissions, value engineering, design changes, and

changes of plans by employers are the most crucial five concluding CCO causes in the Egyptian construction industry. Furthermore, Khahro et al. (2017) focused on examining the CCO effects on project duration. Meanwhile, the analysis conducted by Jawad et al. (2009) found that CCOs can result in cost overruns with a magnitude of 5-10% of the original contract value and time overrun <10% of the original contract duration.

In assessing CCO disputes, Hansen (2017) explained several considerations in examining CCOs that occur at the project level, namely: (1) whether CCOs are permitted in the contract, (2) whether the CCOs are included in the scope of work according to the contract documents, (3) whether the CCOs are in accordance with the conditions and procedures set forth in the contract, and (4) whether the CCO circumstances are carried out differently from the circumstances if the work is carried out in accordance with the original conditions of the contract. The assessment of CCO disputes requires not only technical expertise in estimating the magnitude of the CCO's impact but also the ability to act fairly and impartially when conducting an audit.

Construction Audits

Construction audits play a crucial role in managing construction projects (Hetami & Aransyah, 2020). It is a complex work (Wang, 2017) performed to examine the compliance of a construction project with the agreed contract. An independent external organization is hired to perform the audit. Sichombo et al. (2009) believe that the adoption of technical auditing should be done in the pre-contract and post-contract stages. While the pre-contract audits help to lower the construction cost by minimizing deviations such as miscalculations and corruption practices, the post-contract audits are performed to evaluate the difference between the contractual requirements and the completed works (Hetami & Aransyah, 2020; Zou, 2006). Furthermore, it can also be used as a mechanism to resolve a construction dispute by investigating the works.

There are two types of audit mechanisms as proposed by Gunduz and Önder (2013), namely internal and external audits. The internal audits aim to manage the risks in construction project practices and processes, while the external audits focus on the examination of the contractual requirements and the actual works by an independent party. Hetami and Aransyah (2020) believe that audits on project records including CCOs must be conducted comprehensively.

Despite the importance of construction audits, the review of the literature found that it has not been widely studied, especially regarding the use of audits as a dispute resolution mechanism at the project level. Wang (2017) analysed several problems existing in construction project audits including the lack of an audit management system, ignoring the audit management processes, and failure to identify the problems as well as formulate corresponding measures in time.

The Causes, Effects & Mitigations (CEM) Framework

In early 2020, a framework to better understand CCO practices was developed using a systematic approach with multiple sequences of qualitative techniques. This framework called the Causes, Effects, and Mitigations (CEM) framework can be used to identify the causes and effects of CCOs and provide recommended mitigations in order to minimize the effects of CCOs at the project level (Hansen et al., 2020). The development of this framework is based on a case study of a construction project in Indonesia, namely the GBK Aquatic Stadium project. A qualitative approach with multiple techniques was used including the study of literature, site visits, document examination, and expert interviews to develop the framework as illustrated in Figure 1. A similar approach was adopted by Thunberg (2016) to develop a construction supply chain planning framework.

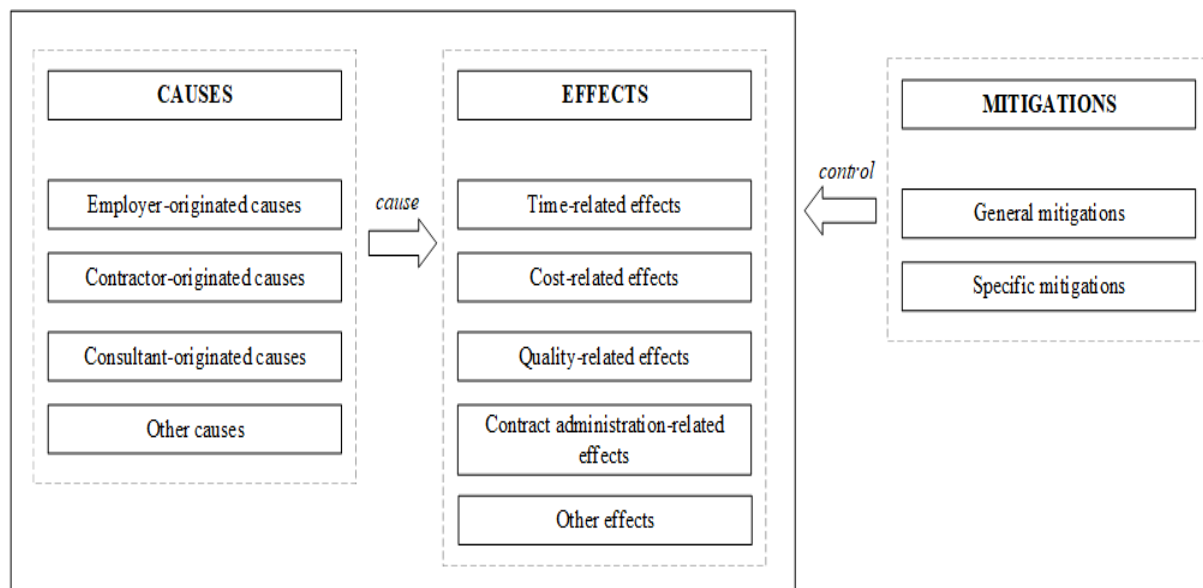


Figure 1: The CEM framework (source: Hansen et al. 2020)

As shown in Figure 1, the CEM framework consists of three major components of causes, effects, and mitigation actions. Each component has sub-components which are groupings of factors based on their types and similarities. For example, there are four sub-components of causes, namely (1) the causes of CCOs originated by the employer, (2) the causes of CCOs originated by contractors, (3) the causes of CCOs originated by consultants, and (4) CCOs that occur other than by three originations above. In the 'effects' component, there are five sub-components, namely (1) the CCO effects related to the time of work implementation, (2) the CCO effects related to the cost of carrying out the work, (3) the CCO effects related to the quality of work produced, (4) the CCO effects related to the contract administration process, and (5) CCO effects other than those mentioned previously. Finally, the mitigation component consists of two types of mitigations, namely (1) general mitigations that can be used to control more than one CCO originator/effect, and (2) specific mitigations which are specifically used in controlling one type of originator/effect.

The strength of this framework lies in its simplicity to identify major components in CCO practices. It represents a systematic model that can improve contract administration practices related to CCO management. The framework presents a logical grouping of CCO components as observed in construction projects thereby facilitating the understanding of all parties in analysing the causes and effects of CCOs and providing the required mitigations. Due to its simplicity, this framework can be easily applied to various project scopes and is applicable for use in other countries. On the other hand, the CEM framework was developed without validation. Hence, a framework validation through real case study implementations was carried out in this research to identify the CCO profiles of three construction projects in Indonesia.

METHODS

In brief, this study adopts a qualitative approach to implement and evaluate the effectiveness of the CEM framework. It uses a validation technique through two sequential strategies, namely case study analysis and expert interviews. Figure 2 illustrates the overall methodology adopted in this study.

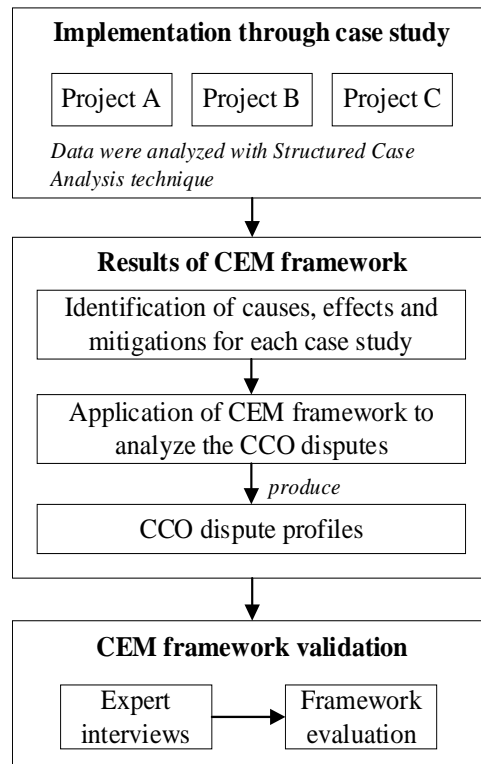


Figure 2: Validation methodology

Validation Method

Validation is a process to test the validity of a model or framework. This process can occur throughout a research project, adjusting to different purposes and research stages (Pedersen et al., 2000). Validation methods are chosen based on validation objectives, research constraints, and researchers' preferences (Ho, Fischer, & Kam, 2009).

Judging from the purpose of its validation, this study is at a research implementation stage that validates the CEM framework developed to investigate the causes and effects of CCOs in a construction project. Meanwhile, based on its research constraints, there are no constraints that can limit the feasibility of the validation in this study. This is because the CEM framework that will be implemented has been developed in a prior study to be able to handle complex real project data. Thus, this study applies an external validation using real project data to understand the phenomena of CCOs in construction projects.

Whereas researchers' preferences refer to choices regarding the validation parameters that will be applied by researchers. The choice of these parameters will affect the strength of evidence of power (Ho et al., 2009). To obtain validation results that provide the strongest evidence possible, there are three validation criteria applied in this study:

1. Real case study implementation. This study uses real project data to validate the CEM framework that has been developed previously. By using real project data, the research outcome provides stronger evidence compared to using simulated data.
2. An uncontrolled environment. Studies conducted in an uncontrolled environment provides better research outcome and stronger evidence than those conducted in a controlled environment.

3. Expert practitioner validation. In this study, the research outcome in the form of CCO dispute profiles was asked to an expert practitioner who provided feedback in order to validate the results. Thus, it provides strong evidence compared to validation by researchers only.

Structured Case Analysis

To confirm the usability of the CEM framework, three construction projects were used for case studies while considering accessibility to obtain information regarding CCO disputes. These three project case studies were obtained from one of the QS consulting companies in Jakarta which had received responsibility as an independent auditor in mediating CCO disputes in Indonesia. The documents used in this study are CCO analysis audit reports from three projects as mentioned in Table 1. To guarantee the fulfillment of the agreement on the consent form with the expert respondents, the research objects (namely company names, project names, parties involved, and expert names) are made non-identifiable.

Table 1: Summary of project case studies

	CASE 1	CASE 2	CASE 3
Project name	Project A	Project B	Project C
Project type	Hotel	Integrated Resort Park	Office Tower
Location	Yogyakarta	Sukabumi	Jakarta
Contract date	21 April 2016	27 July 2017	20 March 2007
Duration	8 months	5 months	10 months
Scope of work	Preliminaries, structural works, architectural works, MEP works	Infrastructure works	Preliminaries, structural works, architectural works, MEP works
Planned area	1,800 m ²	90,000 m ²	1,500 m ²

Furthermore, these three case studies were analysed using structured case analysis techniques as exemplified in previous research (Hansen, 2019). It is a systematic procedure that presents cases in a clear and structured format so as to facilitate the analysis of case studies conducted. In addition, a structured case analysis format will enable inherent iteration of the research process (Carroll & Swatman, 2000) so that it helps researchers to identify patterns and establish relationships between cases that are useful in interpreting qualitative research conclusions. In this study, cases are presented with four elements, namely case title, project description, case summary, and case findings. The findings were then presented in the form of CCO dispute profiles in the discussion section.

Expert Interviews

To obtain expert validation, the findings of this study were asked to three practitioners who were directly involved in the audit process of CCO disputes at the project level. The selection of expert respondents was based on the following criteria: (1) professional working in the construction industry, (2) has a construction-related educational background, (3) has a minimum of 10 years of working experience, (4) has a minimum middle management level position, and (5) has been involved in the audit process of CCO disputes. Table 2 presents the expert respondent profiles.

Meanwhile, the list of questions asked to the expert respondents includes five aspects to validate the effectiveness of the CEM framework, namely: (1) framework comprehensiveness, (2) framework applicability, (3) framework user-friendliness, (4) user recommendation, and (5) user's feedback. The interviews took place at the location determined by the expert

respondents and with the permission of the experts, the interviews were audio-recorded. Next, the audio records were transcribed in the form of interview transcripts to be analysed qualitatively. The interviews were conducted in Bahasa Indonesia.

Table 2: Summary of expert respondent profiles

	Expert 1	Expert 2	Expert 3
Affiliation	QS consultant	QS consultant	QS consultant
Educational background	Construction	Construction	Construction
Working experience	14 years	13 years	10 years
Job position	Project coordinator	Project coordinator	Senior QS
Involvement in audit process	Yes	Yes	Yes

ANALYSIS & RESULTS

Case Study 1: Project A (Yogyakarta Case)

Project Description

It is a hotel development project located in the city of Yogyakarta. The location of the building is very strategic because it is located in the south of Yogyakarta Square which is developing very rapidly into a tourist center, and has excellent access, in addition to the effective use of urban land in accordance with architectural and spatial development. It is designed in a modern classical architectural style and has a capacity of 61 rooms.

Case Summary

In accordance with the contract agreement that was signed jointly by the employer and contractor on 21 April 2016, it was agreed to build a hotel with a project value of IDR 30,687,000,000 with a duration of eight months. As the work progressed, CCO-related problems arose that prompted the employer to ask an independent party to audit and resolve the existing problems. The audit was carried out for three days by applying data collection methods in the project site (both data from employer and contractor), project work observation, work performance evaluation, and interviews.

Case Findings

1. The contract clauses between the two parties are ambiguous and biased.
2. There are two BQ documents with the same value but different details (volume and unit prices).
3. Lack of coordination between the contractor and the project supervisor results in miss management.
4. Poor project planning has resulted in employers' dissatisfaction with the work and led to CCO submission by the contractor.
5. Payments to contractors are not in accordance with the payment procedure stated in the contract.
6. There is no contractual condition explaining the method of measuring quantities and determining unit prices.
7. No down payment and performance bonds are given.
8. There is no contractual condition explaining the retention.
9. There is no document hierarchy.

Case Study 2: Project B (Sukabumi Case)

Project Description

This resort construction project is one of the best-integrated resort park projects located in Sukabumi, West Java. The project location is very strategic which is rapidly developing into a tourist center, and has very good access, in addition to the effective use of urban land in accordance with architectural and spatial development.

Case Summary

In accordance with the contract dated 27 July 2017, an integrated resort park has been agreed to IDR 3,148,000,000 and IDR 4,834,000,000 for infrastructure works with a duration of 5 months. During its execution, several problems arose which resulted in the project suspension, including the emergence of a work addendum submitted by the contractor, and a landslide that caused the collapse of the retaining wall that had been completed by the contractor. An independent auditor was appointed to mediate existing disputes. The methods used by auditors include data collection, observation, and interviews on the site.

Case Findings

1. The contract clauses between the two parties are ambiguous and biased.
2. Poor project planning has resulted in the employer's dissatisfaction with the work and led to CCO submission by the contractor.
3. Payments to contractors are not in accordance with the payment procedure stated in the contract.
4. No significant differences were found between the planned and actual work progress on site.
5. Reworks (costs for repairing the collapsed retaining wall and reinforcement of other retaining walls) were still incorrectly submitted as CCOs by the contractor.

Case Study 3: Project C (Jakarta Case)

Project Description

Situated in the Slipi area of Jakarta, this project is a commercial office tower construction project that carries the concept of modern architecture equipped with high technology to support existing business activities. Strategic location is one of the advantages of this project because it is easily accessible from various places in Jakarta. Architecturally, the tower design applies an asymmetrical principle with curved corners. It has 22 floors and is surrounded by various other facilities such as malls, gyms, residences, hospitals, and banking.

Case Summary

During its execution, this project was suspended due to several problems including (1) CCO problem due to lack of chemical anchor cuttings in Basement 3 to Basement 1, (2) CCO problem due to design changes for steel and concrete works in Basement 3 to Basement 1, (3) price differences in material supplied by the employer (i.e. concrete), (4) volume and unit price differences for steelwork, and (5) delays as a result of the above problems. To mediate these disputes, an independent auditor was appointed to provide solutions.

Case Findings

1. There is an absence of rebars for chemical anchors in the BQ.
2. Unclear contract drawings.
3. Ambiguous and unclear contract clauses including the material supplied by the employer.
4. There are differences regarding the price and volume of steel work.
5. Employer's instruction to postpone the work is the employer's responsibility and thus the contractor is entitled to an extension of time.

DISCUSSION

CCO Dispute Profiles

The developed CEM framework was used to map CCO disputes for each case study. Based on the findings in case study 1 (Project A), three types of CCO causes can be identified, namely employer-originated causes (with four causes), a contractor-originated cause, and a consultant-originated cause. These lead to three types of CCO effects, namely cost-related effects (with three effects), contract administration-related effects (with three effects), and other effects. Furthermore, mitigation actions can be grouped into two types, namely general mitigations (with five actions) and specific mitigations (with three actions). Figure 3 illustrates the CCO dispute profile for case study 1.

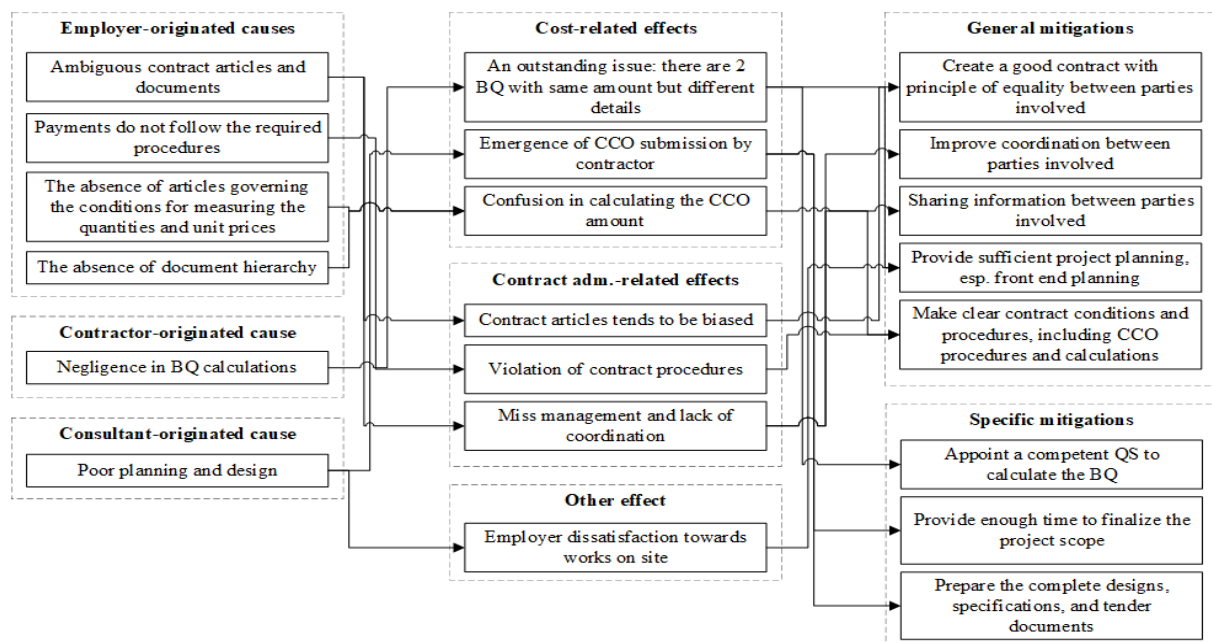


Figure 3: CCO dispute profile for case study 1

A similar process was applied to case study 2 (Project B) and case study 3 (Project C) and produced a mapping of CCO disputes as shown in Figure 4 and Figure 5. For case study 2, there are three types of causes namely employer-originated causes (with two causes), a contractor-originated cause, and a consultant-originated cause. While the effects are of three types, namely cost-related effects (with two effects), contract administration-related effects (with two effects), and other effects. Furthermore, mitigation actions consist of general mitigations (with three actions) and specific mitigations (with four actions).

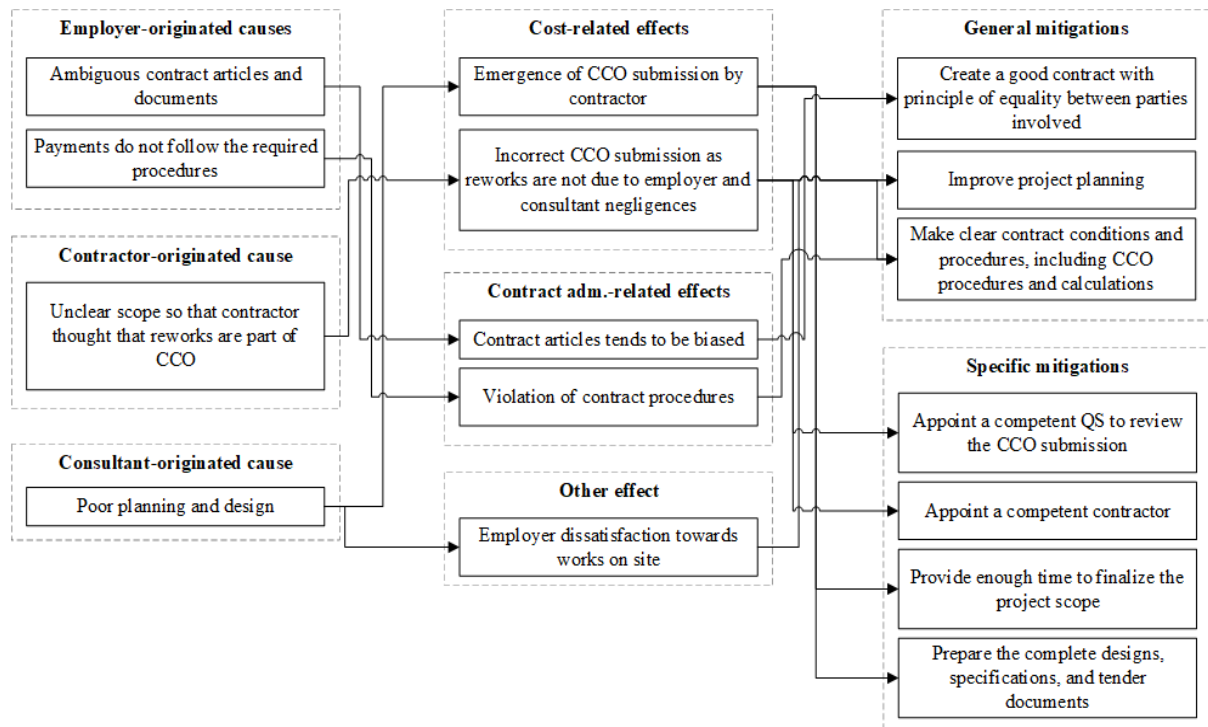


Figure 4: CCO dispute profile for case study 2

Whereas for case study 3 (Project C), only two types of CCOs were identified, namely employer-originated causes (with four causes) and consultant-originated causes (with two causes). The types of CCO effects identified include cost-related effects (with two effects), contract administration-related effects (with three effects), and a time-related effect. As the result, it produces three general mitigations and four specific mitigations.

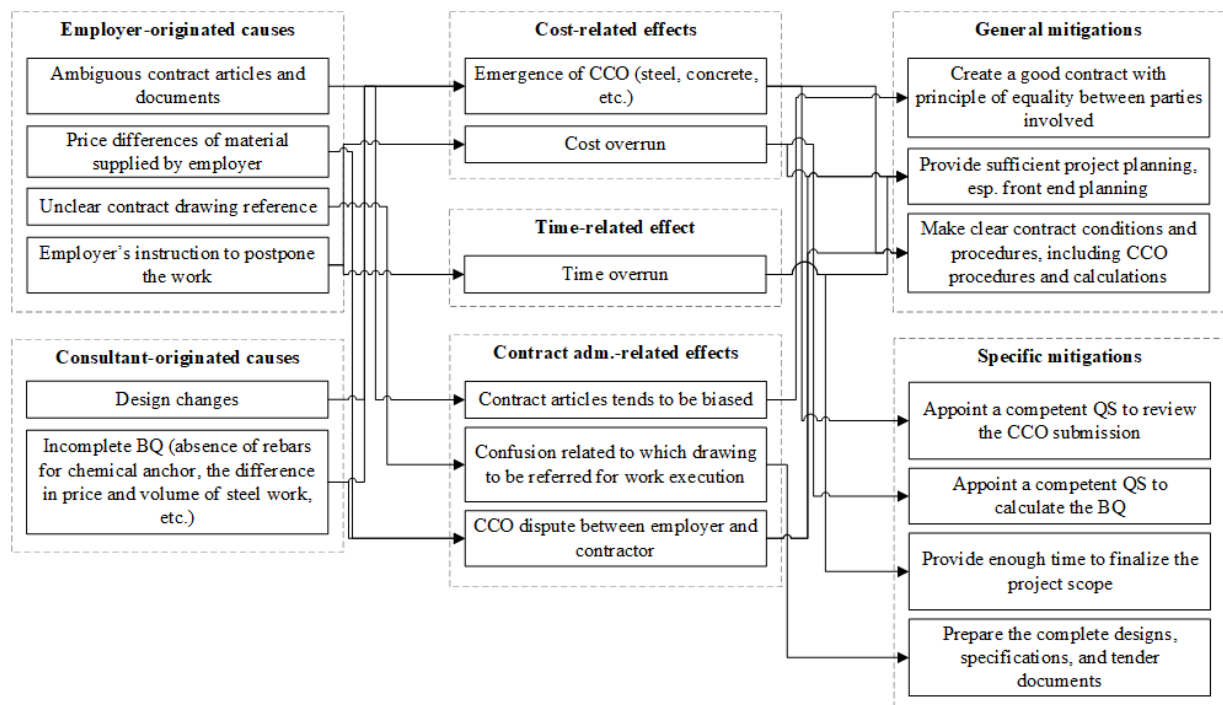


Figure 5: CCO dispute profile for case study 3

Based on the CCO dispute profiles from the three case studies above, it can be seen that the CCOs are commonly caused by the parties involved in the construction projects, namely the employer, the contractor, and the consultant. The construction contract document and its clauses have a major influence on the project's success (Hansen, 2021; William & Ashley, 1987). The three cases in this study have shown that the main causes of CCO disputes are ambiguous contract documents and poor planning and design. Chan, Nik-Bakht, and Han (2021) recognised ambiguity in contract documents as a potential cause of construction disputes. Peansupap and Cheang (2015) found poor planning as a cause of CCO, while Shamsudeen and Obaju (2016) have identified several effects of design errors including project failures, quality reduction, and conflicting specifications. On the other hand, there is one type of CCO cause in the CEM framework that is not identified in the three case studies above, namely 'other causes.' In this context, other causes refer to the CCO causes that cannot be attributed to the three parties involved. For instance, CCO due to a force majeure event or other neutral causes.

Whereas regarding CCO effects, the analysis of the three case studies above successfully identified four types of effects mentioned in the CEM framework, namely cost, time, contract administration, and other effects. Cost and time are two crucial aspects of construction projects and design changes may impact the project cost and schedule (Hansen et al., 2020; Shamsudeen & Obaju, 2016). Contract administration refers to the understanding and implementation of various contract activities which include managing contractual relationships, notifications, recording, and other activities related to contract execution (Hansen, 2021). Meanwhile, dissatisfaction of a contracting party is considered as the other effect not related to the four types of effects mentioned previously. On the other hand, there is one type of CCO effect from the CEM framework that was not identified in the three case studies, i.e. quality-related effects. It refers to the CCO effects that affect the quality of work output (Karthick et al., 2015; Khahro et al., 2017).

Finally, related to possible mitigations to minimize the effects of CCOs, the three case studies have succeeded in identifying two types of mitigation mentioned in the CEM framework, namely general and specific mitigations. In this context, general mitigations refer to actions that can control more than one CCO effect, while specific mitigations refer to actions that can control only one type of effect (Hansen et al., 2020). These three major components of causes, effects, and mitigations are mapped in a simple yet representative way in the form of CCO dispute profiles generated from the CEM framework. Next, expert interviews were conducted to further evaluate the effectiveness of this CEM framework in providing a better understanding of CCO disputes at the project level.

Expert Feedback and Validation

To evaluate the applicability and effectiveness of this framework, expert validation was employed in this study. Three practitioners who meet the criteria as expert respondents were selected and interviewed face-to-face. Questions asked to the experts include five aspects, namely comprehensiveness (Q1), applicability (Q2-Q4), user-friendliness (Q5-Q6), user recommendation (Q7-Q8), and user feedback (Q9). To facilitate understanding of the CEM framework validation, Table 3 presents the key responses of the experts.

Table 3: Interview analysis of framework validation

NO	QUESTIONS	RESPONSES
Q1	Do the three major components of this framework (causes, effects and mitigations) illustrate all the important considerations in CCO analysis?	<ul style="list-style-type: none"> The framework is quite complete describing the main components in CCO analysis (Expert 1). The CEM framework has illustrated the important considerations in CCO analysis (Expert 2 and 3).
Q2	Does this framework precisely meet the needs of the construction industry? / Is it important for us to have this framework?	<ul style="list-style-type: none"> It is very important to have this framework (Expert 1, 2 and 3). It can be used as lessons learned from past CCO cases as a guide for the future (Expert 1).
Q3	Is this framework applicable and efficient to implement?	<ul style="list-style-type: none"> It is effective and efficient (Expert 1, 2 and 3). It can be used especially related to mitigation actions that can be applied to subsequent projects (Expert 1).
Q4	Are the results (in the form of CCO profiles) of this framework useful for you in providing an overview of the potential and mitigation of CCO in the project?	<ul style="list-style-type: none"> It is very useful for construction industry (Expert 1, 2 and 3). In practice, we have to look at what are the causes, what are the consequences, and how do we deal with the risks going forward (Expert 1).
Q5	Is this framework easy to use?	<ul style="list-style-type: none"> It is very easy and applicative (Expert 1, 2 and 3).
Q6	Are the results of this framework (CCO profiles) easy to understand?	<ul style="list-style-type: none"> It is easy to understand, because it's not too complicated and the relationships between CCO causes, effects and mitigations can be clearly presented (Expert 1). It is very straightforward and easily-understood (Expert 2 and 3).
Q7	Do you recommend applying this framework to projects in your company?	<ul style="list-style-type: none"> For this framework, we will certainly implement it (Expert 1 and 3). We can use it to review the past projects as lessons learned as well (Expert 1). Yes, because it has been developed and describe clearly (Expert 2).
Q8	In your opinion, what are the strengths of this framework?	<ul style="list-style-type: none"> Its simplicity (Expert 1 and 3). Its applicability. It is important for our database related to projects that have already been completed and those that are on-going so that we can mitigate issues that arise. It is also useful in preparation for the next projects (Expert 1). The framework produces a CCO dispute profile (Expert 2).
Q9	Do you have suggestions for improving this framework?	<ul style="list-style-type: none"> It is good enough (Expert 1, 2 and 3).

Remarks from the experts' opinions are summarized as follows:

- (1) The CEM framework has been developed comprehensively by providing the main components of CCO analysis
- (2) The CEM framework is applicable and useful in assisting construction professionals to investigate the CCO disputes
- (3) The CEM framework is simple and user-friendly
- (4) The use of this framework is recommended to solve problems regarding CCO analysis

Research Implications

In the construction industry, the audit mechanism stands a vital role in managing construction projects (Hetami & Aransyah, 2020). Strict audit mechanisms should be developed to control and inspect construction processes (Gunduz & Önder, 2013; Le et al., 2014; Sichombo et al., 2009). Similarly, Wang (2017) suggests the establishment of an audit management system,

strengthening audit investigation and evidence collection, contract review, and establishment of a strict procedure for CCOs audit. This study focuses on CCO dispute audits at the project level. In fact, profiling CCO disputes is a complicated task because it involves many stakeholders, requires the collection of accurate data and evidence, and produces various interpretations. In addition, different auditors often initiate CCO dispute investigations from different starting points and present different audit report formats, making it difficult for uniform understanding.

This study utilizes the CEM framework that was introduced in previous studies to analyse CCO disputes that occurred in three different projects. Responses from experts indicate that the CEM framework is applicable when they are carrying out audits related to CCO disputes. They agree that this CEM framework has been developed comprehensively by considering important aspects of CCO analysis, namely the identification of causes, effects, and potential mitigation actions. In addition, experts also agree that this framework is a technical tool that can improve contract management practices related to CCO analysis and management. As an effective tool in identifying the cause, effect and recommended action of the CCO, it is useful for construction professionals, especially auditors who are tasked with profiling the CCO dispute.

The CEM framework is easy to use and the results are easy to understand. It provides standardised results in the form of CCO dispute profiles which can facilitate a uniform understanding for auditors and parties involved in CCO disputes, thus assisting the dispute resolution process. Hetami and Aransyah (2020) believe that comprehensive technical auditing must be performed to investigate the construction project documents, technical specifications, completed works, and CCOs. Furthermore, Wang (2017) argues that the audit mechanism provides a standardised supervision that is conducive to improving cost efficiency. Thus, the experts recommend this framework.

CONCLUSION

CCOs are common in construction projects due to many causes such as incorrect BQ estimates, inefficient project team coordination, and design errors. These changes can alter the scope of work which in turn has an impact on overall cost and timely completion. To facilitate the understanding of CCO disputes, the developed CEM framework can be utilized as a technical tool to map the CCO causes, effects, and mitigations at the project level.

This paper presents the findings of the CEM framework implementation on three CCO audit reports to describe CCO dispute profiles. This results in a standardised, efficient, and easily understood report. The scope of this study is limited to the construction CCO disputes observed in Indonesia. Furthermore, this study also serves as a validation of the CEM framework developed in a prior work. In general, an evidence-based validation process is crucial to provide a strong justification for a developed framework. Thus, this study contributes to establishing an evidence-based model which can be used in assessing CCO disputes by construction professionals.

While the construction industry is complex and involves many parties, disputes are inevitable especially related to CCOs. In order to minimise the changes that lead to CCO disputes in construction projects, a strict audit procedure is required to be applied at the early stage of the construction process. Therefore, construction practitioners can utilise the CEM framework at the early stage as a dispute prevention measurement tool in their projects. As for the limitation,

this study recognises the need for profiling CCO disputes which may occur during construction execution. Thus, further research can be done by implementing this CEM framework in ongoing projects rather than using past project audit reports so that it can identify the constraints on the implementation of this framework in real time at the project sites. It is also recommended that future studies be carried out using more holistic datasets.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this paper.

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