Comparative Study on Change Orders in Building Projects

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Abstract This research aimed to contribute to the small but growing empirical literatures and studies on Change Orders in building construction industry in selected cities in the National Capital Region (NCR), Philippines. Using descriptive/survey research method specifically expert sampling method, key informant interviews, actual site observations and desk reviews of project documents (e.g., contract documents, plans and specifications, etc.), this study investigated and compared the causes and effects of Change Orders in public and private building construction projects and formulated recommendations and guidelines in order to address the problems brought about by Change Orders. Moreover, the existing change order management control practices being implemented by the contractors, consultants, and clients in response to the issuance of construction Change Orders were also identified and investigated. Based on the results of the study, it was found out that the major causes of Change Orders in building construction projects in the Philippines were related to change of plans and scope by the owner, adjustment of schedule, unpredictable weather conditions, unforeseen site conditions, change of schedule by the owner, long waiting time for approval of construction drawings, complexity of construction projects and external factors which are beyond the control of the contractors, consultants, and clients. Consequently, Change Orders have resulted to project time extension and delay in project completion, increase in the overall cost of the project, changes in the cash flow and loss of earnings, additional payments to the contractor, and increased time and material related charges. Generally, the management control practices being undertaken by both the public and private sector in dealing with Change Orders were as follows: (i) all changes in the design documents were checked, reviewed, and justified by the designers and consultants; (ii) coordination and cooperation

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among the contractors, consultants, and clients were encouraged; (iii) project personnel take proactive measures to promptly settle, authorize, and execute Change Orders in construction projects; (iv) involvement of knowledgeable persons or representatives during the change order negotiation and approval (v) a written approval of both parties should be made with clear scope of change before executing the requested changes or variations; and (vi) the use of various techniques in order to track cost of changes.

Keywords Building construction · Change Orders · Causes and effects
Management and control practices · Public sector · Private sector
Variation · Project risk

1 Introduction

Nowadays, one of the most important problems in the construction industry is change or variation in plans and specifications [22]. According to Rodriguez [19], the change occurs in every building construction project and the magnitude of which varies considerably from project to project. Alnuaimi et al. [3] cited that developing countries like the Philippines have experienced more Change Orders brought about by the needs of the owner in the course of the design or construction as compared to those projects in the developed countries. Changes in construction projects are primarily due to three main causes as follows: design errors and omissions, change in field conditions, and owner-initiated changes.

Change Order is defined by Clare [5] as a "written agreement between the owner, contractor and architect on the specific change in the work and any adjustment in the contract or the contract time". It is being issued by both parties to correct or modify the original design or scope of work. The corrections or modifications are carried out for many reasons like for instance: the changes in scope made by the client; and the result of change requests made by the consultant due to design errors or new findings during the courses of implementation. Change Orders are inevitable in most construction projects and may result to big number of claims, disputes and may eventually lead to legal battles if not been resolved immediately using the formalized change management process according to Rodriguez [19] and Aneesa et al. [4].

In the Philippines, Change Order is classified as one form of a Variation Order. Presidential Decree 1594 (PD 1594) [18] defines Variation Order as a document being issued in order to cover any change in plans and specifications, increase or decrease in quantities, deleted items and introduction of new work items that are not in the original contract. A Variation Order may either be in the form of a Change Order, Extra Work Order, or a Supplemental Agreement. Change Order, according to this decree, is issued in order to cover any increase or decrease in quantities of original work items in the contract. Extra Work Order, on the other hand, is issued to cover the introduction of new work items. Finally, Supplemental Agreement is

issued if the aggregate amount of Change Orders and extra work orders exceeds 25% of the escalated contract price. And among these three, Change Order is encountered the most due to a number of changes in the plans as well as in the project design and specifications.

According to the Philippine Daily Inquirer 2015 report, the construction industry was identified as one of the sectors that contributed significantly to the country's robust economy. However, the efficiency of construction projects are greatly affected by the magnitude and frequency of the Change Orders that are being filed during construction. Given the limited funding available for building projects, it is therefore imperative that these projects shall be undertaken in the most efficient way to properly and effectively manage these construction Change Orders. Numerous studies and articles by Aneesa et al. [4], Alnuaimi et al. [3], Rodriguez [19], and Ibbs [9] have written articles on Change Order and change management in the field of construction industry and have reported that improving the administrative process of Change Orders is beneficial in terms of reducing the cost and risk for all the project participants and it encourages more trustful relationship between the contractor and the client.

Based on the foregoing, there is a need for the study and better understanding on the impact of Change Orders, particularly their causes and effects in construction projects. Given the above, this study aimed to investigate the prevailing causes and effects of construction Change Orders. Moreover, this study also aimed to look into the management practices being implemented in order to minimize or mitigate the effects of these inevitable Change Orders in the construction industry. Thus, recommending alternative courses of action and guidelines that would be of help to construction professionals, engineers, and architects in efficiently and effectively managing Change Orders in their respective projects.

2 Literature Review

Change Order is inevitable in every construction project. It is defined as a written agreement between the owner, consultant, and contractor on any modification to the original scope of the construction contract. Change Orders are classified into three: (a) in terms of the initiator of changes [1, 14]; (b) in terms of the net effect on the scope of the project [1, 21]; and (c) in terms of the procedures used in introducing them [6, 17]. Alnuaimi et al. [3] and Ijaola & Iyagba [11] found out that the most important factors causing these Change Orders were related to the owner's instruction for additional works and modification to design and non-availability of construction manuals and procedures. Agreeing with this finding, Ibn-homaid et al. [10] also concluded that change of the project scope due to owner's requirements as the most frequent and important cause of Change Orders followed by inadequate field investigation.

Various studies [3, 4, 11] revealed that the most important effects of Change Orders are delays in the project schedule, claims and disputes, and cost overruns. Osman et al. [17] and Ibn-homaid et al. [10] further explained that aside from these identified effects, interruption of continuous work, additional payment to the contractor and increase in overhead expenses are also being experienced due to occurrence of Change Orders. Even though Change Orders cause a lot of problems, several empirical researches show that only few people believe that no one is benefitting from them. In the study of Alnuaimi et al. [3], they identified that the contractor is the party benefitting the most from Change Orders followed by consultants and then clients.

Ijaola and Iyagba [11] identified that the most important remedy for Change Orders is having a specialized quantity surveyor and project manager in large construction projects. Alnuaimi et al. [3], on the other hand, concluded that the most important remedy is the review of registration and technical capability of the consultants. Even though these research findings differ in description, they mean the same idea that these suggested remedies were consultant-related and these show how consultants could prevent changes during construction.

For Egan et al. [6], there are no generic standards related to change order management process because of the uniqueness of each project. However, Hwang and Low [8] and Molly [15] identified relevant steps in managing Change Orders which include: (1) identify the change, (2) evaluate the change, (3) document the change, and (4) resolve/implement changes. Motawa et al. [16] further explained that inconsistent management of the change process can result in many disruptive effects, contract disputes and project failure.

3 Research Objectives

The objectives of this study were as follows:

1. To identify the prevailing causes and effects of construction Change Orders in public and private building projects.
2. To identify the existing management control practices being implemented by the contractors, consultants, and clients to address construction Change Orders in public and private building projects.
3. To determine the significant differences in the perception with regards to the causes and effects of Change Orders (a) between public and private sectors, and (b) among clients, consultants, and contractors.
4. To recommend alternative courses of actions and/or guidelines in order to minimize/mitigate the issues and problems related to construction Change Orders.

4 Conceptual Framework

To attain the objectives of the study, this research has been conceptualized to determine the major causes and effects of building construction Change Order together with the existing management control practices in the selected construction firm in the Philippines. Figure 1 presents the Conceptual Framework.

As shown in Fig. 1, the inputs of this study consist of the prevailing causes and effects of construction Change Orders in the construction projects and the existing management control practices implemented by the contractors, consultants, and clients. These inputs were subjected to statistical treatment of data and served as the basis for the in-depth analysis of the research findings, conclusions, and recommendations.

The process portion of this study constitutes the conduct of an evidence-based empirical research process using researcher-made questionnaire, desk review or documentary analysis for secondary data; conduct of key informant interviews and analysis of the research findings. The output of this study is a management model based on the findings of the study that would serve as guidelines or model by the contractors, consultants, construction industry professionals, and owners in controlling or minimizing the effects of construction Change Orders.

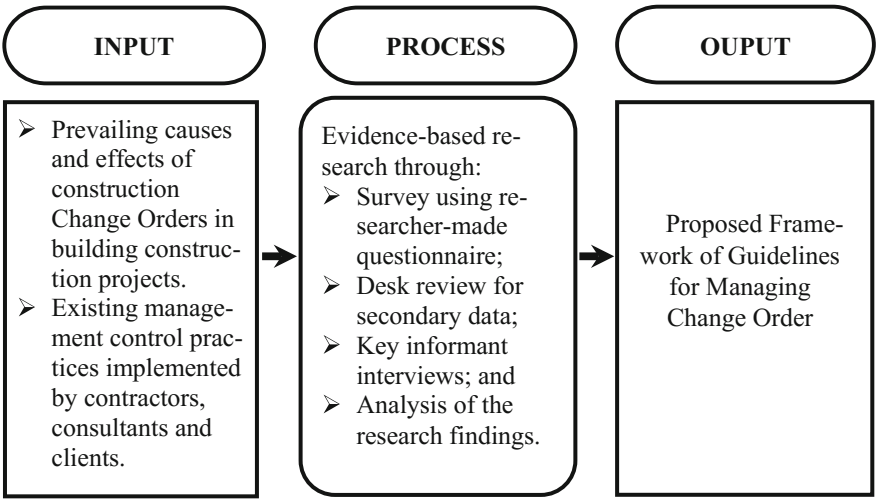

Fig. 1 Conceptual framework of the study

5 Significance of the Study

The findings of the study will prove beneficial to the following:

1. Philippine Building Construction Industry. This research will provide valuable information to the building construction industry in the Philippines with regard to the current situation and status of Change Order management in the country. This study will also serve as a basis for developing recommendations and guidelines for minimizing Change Order as well as possible recommendations on how to manage, control, and minimize the problems related to Change Orders which can have major impacts in the overall project performance.
2. Clients, Consultants, and Contractors. It is hoped that the research findings and suggested remedies will be helpful to various project stakeholders particularly the clients, consultants, and contractors. The results of this study will provide recommendations and alternative courses of action or Change Order guidelines that would help them to minimize and or mitigate the issues and problems related to Change Order.
3. Project Planners, Engineers, and Decision Makers. This study will also help these industry professionals in planning effectively prior to starting a project and even during the design phase in order to minimize and control changes and change effects. The results and findings will be used by project managers in making decisions and necessary actions to minimize various problems brought about by Change Orders.

6 Scope and Delimitations of the Study

This study covered the analysis of main causes, potential effects, and management control practices in the building construction Change Orders in selected cities and municipalities in the NCR based on the specific research questions indicated in the statement of the problem. The unit of analysis was based solely on the perceptions or opinions of the respondents, namely, Contractor, Consultant, and Owner or Client coming from different companies. The first limitation was related to the data used for building construction projects which were limited to only seven (7) selected cities and municipalities of the NCR and was not able to cover the entire cities and municipalities of the NCR due to the difficulty in the retrieval of questionnaires. Hence, the statistical strength of the total sample was relatively moderate, especially when Change Orders were examined by the type of building construction projects. The moderate statistical strength was likely attributable to the relatively small sample size among group of respondents in the analyses since more data would be needed to confirm the research findings. Nevertheless, the perceptions and opinions gathered and generated from the three groups of respondents in a way represented the entire population of the study.

7 Methodology

7.1 Research Design

This study employed descriptive or survey research method. According to Fraenkel and Wallen [7] a descriptive survey involves asking the same set of questions prepared in written questionnaire of a large number of individuals and could be administered to the target samples either by mail, by telephone, or in person. Moreover, a survey research was used to obtain data from the population (or a sample) to determine the current status with respect to variables or subject under investigation which in this study is to identify the primary causes and effects of Change Orders [7, p. 12].

7.2 Research Locale

This research was conducted in the National Capital Region specifically in Metro Manila. Aside from accessibility, the NCR is also the ideal location for this study because of its diverse or different kinds of building construction projects implemented. It is also one of the best places/locations where one can find the biggest and the most complicated building construction projects in the Philippines. Thus, lots of Change Orders have been encountered from the owners according to some professional engineers. Moreover, it is also a site for many building construction companies; consultancy and engineering design companies, as well as owners whose projects are located and extended to different regions and provinces across the country.

7.3 Sample and Sampling Techniques

The data used in the study were gathered from Consultants, Clients/Owners, and Contractors coming from the different building construction firms in NCR prime cities such as Manila, Mandaluyong City, Pasig City, Pasay City, Quezon City, Las Piñas, and Taguig City using purposive sampling. Purposive Sampling was utilized in this study in order to choose the specific or group of experts within the population of the construction company.

Specifically, this research utilized the expert sampling method because this study requires assessment or getting opinions of experts (i.e., contractors, engineers, architects, consultants, project managers, clients/owners) which requires a relatively high level of knowledge and expertise in the field of building construction industry and experts who are heavily involved in managing and/or addressing Change Orders in their respective companies.

Table 1 Distribution of respondents

Respondents	Public	Private	Total	%
Contractors	34	34	68	68.00
Clients	16	7	23	23.00
Consultants	0	9	9	9.00
Total	50	50	100	100.00

In this study, a total of one hundred (100) respondents were surveyed (50 each from both the public and private sectors). Table 1 presents the distribution of respondents from both public and private sector, as follows:

As shown in Table 1, a total of thirty four (34) respondents represents the Contractors in the private sector and the other thirty four (34) Contractors represents the public sector. Sixteen (16) respondents were Clients/Owners in the public sector and seven (7) respondents came from Clients/Owners in the private sector. The remaining nine (9) respondents came from the Consultants in the private sector. It is interesting to note that in the public sector, the Clients/owners also act as the project Consultants; hence, there were no consultant respondents for the public sector. Majority of these respondents were male with less than 30 years working experience in both public and private building construction projects in NCR.

7.4 Data Gathering Instruments

To gather data and answer the research questions indicated in this research, a questionnaire was developed tailor-fit for this study to assess the perceptions of clients, consultants, and contractors on the causes and effects of Change Orders. This questionnaire was composed of four (4) parts. Part I contained the demographic profile of the respondents such as experience, profession, and specialty of their projects. Part II, III, and IV pertains to the survey questions relative to the causes, effects, and management control practices of Change Orders in building construction projects in the Philippines.

7.5 Data Gathering Process

Before distributing the questionnaires to the target respondents, a dry run or pilot test was administered to selected engineers and architects in building construction industry. The objectives of the pilot test were to determine the reliability and validity of the specific questions and to determine whether it was easy to accomplish or not. After the pilot testing, the validated questionnaires were administered to the selected sample respondents, namely, Consultants, Clients/Owners, and Contractor of both public and private sector. To ensure a high retrieval rate,

the researcher personally handed and administered the questionnaires with a cover letter explaining the purpose and importance of the study.

Aside from the questionnaire, the researcher also conducted key informant interviews (KIIs) to the selected respondents in order to obtain firsthand information about the background and history of the project as well as to gain some insights about the building construction projects. In addition, the researcher also conducted actual site observations to gain more insights on how other companies responded to Change Orders. The valuable piece of information derived from the interviews were used as evidence-based information which greatly helped the researcher in terms of analyzing and interpreting the findings on the actual causes of Change Orders in the building construction projects in the Philippines. Moreover, project documents were also collected particularly those pertaining to the commercial and contractual aspect of the project of the selected construction companies and were utilized during the desk review of secondary data to substantiate the research findings.

The data collected from the administered questionnaires were tallied, classified, categorized, and analyzed according to the research objectives. These gathered data were analyzed and interpreted using different statistical analysis methods, utilizing Statistical Program for Social Science (SPSS) software version 19 for this purpose. Interpretations were arbitrarily assigned for the purpose of interpreting the findings, as follows:

Lowest score	Highest score	Interpretation
4.21	5.00	Very often
3.61	4.20	Often
2.41	3.60	Sometimes
1.81	2.40	Seldom
1.00	1.80	Never

7.6 Statistical Treatment of Data

In order to answer the research questions, the researchers floated the questionnaires to the target respondents. The data collected from the administered questionnaires were tallied, classified, categorized, and analyzed according to the research objectives. The descriptive statistics used in this study were as follows:

Percentage. This was utilized in the study for computation of the percentage for numerical analysis and for comparing magnitudes. This was applied "to determine the ratio of frequencies of responses to the total number of respondents expressed in percentile" [13]. It was expressed by the following formula:

$$P = \frac{f}{N} \times 100\%, \tag{1}$$

where,

P percentage
f frequency of response
N total number of cases

Weighted Mean. The weighted mean was used in determining the mean scores per item in the specific causes and effects of Change Order. Specifically, it determined the mean value of the perception of respondents on certain items related to the research questions and was expressed by the following formula:

$$\overline{x} = \frac{\sum f_x}{N}, \tag{2}$$

where,

$\overline{x}$ computed value of the weighted mean
$\sum$ summation symbol
f frequency
x unit weight
N total number of respondents

One-way Analysis of Variance (ANOVA). The one-way ANOVA was used to determine the significant differences in terms of perceptions between the public and private group of respondents with regards to the causes and effects of Change Orders. The following is the formula for computing the one-way ANOVA:

$$F = \frac{\text{MST}}{\text{MSE}} \tag{3}$$

where

F ANOVA coefficient
MST Mean sum of squares due to treatment
MSE Mean sum of squares due to error

Formula for MST:

$$\text{MST} = \frac{\text{SST}}{p-1} \tag{4}$$

$$\text{SST} = \sum n(x - \overline{x})^2, \tag{5}$$

where

SST Sum of squares due to treatment
p Total number of population
n Total number of samples

Formula for MSE

$$\mathrm{MSE} = \frac{\mathrm{SSE}}{N - p} \tag{6}$$

$$\mathrm{SSE} = \sum (n - 1)S^2, \tag{7}$$

where

SSE Sum of squares due to error
S Standard deviation of the samples
N Total number of observations.

8 Research Findings and Results

8.1 Causes of Change Orders

Table 2 presents the results of the comparative survey research findings with regard to the causes of Change Orders between the selected public and private construction projects in NCR. As shown in the table, the top five (5) most common causes of Change Orders in the public sector were related to change of plans and scope by the owner (M = 3.39, SD = 1.04); followed by change in the project design (M = 3.22, SD = 0.94); unpredictable weather conditions (M = 3.17, SD = 1.15); unforeseen site conditions (M = 3.17, SD = 0.99), and change of schedule by the owner (M = 3.11, SD = 1.18).

Compared to the public sector, the same major causes of Change Orders were also reported by the private sector respondents and these includes: change in the design (M = 4.25, SD = 0.89), followed by change of plans change and scope by the owner (M = 3.93, SD = 1.12), the change of schedule by the owner (M = 3.61, SD = 1.13), except however for the two identified causes which pertains to the long waiting time for approval of construction drawings (M = 3.57, SD = 0.92) and the complexity of project (M = 3.54, SD = 0.74).

Based on the results, the change of plans or scope of work by the owner is one of the most significant causes of Change Orders in building construction as reported by the public and private sector respondents. The same finding was also revealed in various literatures and studies (e.g., [20]) and in the documentary analyses conducted on Change Orders. This change in scope of work and plans is normally due to the expansion of the contracted work as a result of enhancements to the design or reduction because of budget considerations and value engineering.

Table 2 Comparison on the causes of Change Orders in the public and private building construction projects

Public sector					Private sector				
Causes	Mean	SD	Rank	Interpretation	Causes	Mean	SD	Rank	Interpretation
Change of plans and scope by the owner	3.39	1.04	1	Sometimes	Changes in the design	4.25	0.89	1	Very often
Changes in the design	3.22	0.94	2	Sometimes	Change of plans and scope by the owner	3.93	1.12	2	Often
Unpredictable weather conditions	3.17	1.15	3	Sometimes	Change of schedule by the owner	3.61	1.13	3	Often
Unforeseen site conditions	3.17	0.99	4	Sometimes	Long waiting time for approval of construction drawings	3.57	0.92	4	Sometimes
Change of schedule by the owner	3.11	1.18	5	Sometimes	Complexity of Project	3.54	0.74	5	Sometimes
Average	3.21	1.06		Sometimes	Average	3.78	0.96		Often

The next major cause of Change Order as identified by both public and private sectors has something to do with changes in the design. According to the key informant interviews (KIIs) and based on the experience of this researcher, changes in design happen in any building projects especially when a construction project commences before the design has been finalized. Changes in design may also happen when the design has been reviewed by the consultant who has a different opinion or perspective with that of the designer and recommended making some changes.

Based on the foregoing exposition, while these identified major causes of Change Order often happen in private sector building projects, however, these causes only happen sometimes or occasionally in the public sector as signified by their average mean of 3.21 and a standard deviation of 1.06. When validated with the respondents during the KIIs as to why the above-mentioned top major causes happen only sometimes in the public sector, one of the reasons cited was that unlike in private sector, Change Orders in public construction projects are only limited to 10% of the original project cost. And public sector building projects do not usually allow or encourage Change Orders because they believe that they will cause more delays in project schedule which is disadvantageous to the end-users.

It is also interesting to note that the top three (3) major causes of Change Orders as identified by both the public and private respondents were confirmed by the study of Alaryan et al. [2], Al-Dubaisi [1] which also reported that the change of plans by the owners/clients, problems related to project site, errors and omission in the design, change of project scope by owners/clients, and new government regulations were the major Causes of Change Order in construction projects in Kuwait and Saudi Arabia. While the former study was conducted in a different setting, however, it seems that regardless of the location, the same causes were observed with regards to the causes of Change Order.

8.2 Effects of Change Orders

As shown in Table 3, the respondents from the public sector identified the five major effects of Change Orders as follows: (1) time extension (M = 3.50, SD = 0.79), (2) delay in project completion (M = 3.44, SD = 0.92), (3) increase in the overall cost of the project (M = 3.44, SD = 0.83), (4) changes in the cash flow and (5) loss of earnings (M = 3.22, SD = 0.65). When compared to the private sector respondents, the same findings were also reported particularly on the top three effects of Change Orders particularly (1) time extension (M = 3.86, SD = 0.97), (2) delay in the project completion (M = 3.86, SD = 1.11), and increase in the overall cost of the project (M = 3.64, SD = 1.13). However, the remaining top two effects identified by the private sector respondents were different from that of the public sector responses, specifically on the issues related to additional payments to the Contractor (M = 3.75, SD = 1.17), and increased time- and material-related charges (M = 3.68, SD = 1.06). The standard deviation of 1.09 for the private sector respondents is still widely

Table 3 Comparison on the effects of Change Orders in the public and private building construction projects

Public sector					Private sector				
Effects	Mean	SD	Rank	Interpretation	Effects	Mean	SD	Rank	Interpretation
Time extension	3.50	0.79	1	Sometimes	Time extension	3.86	0.97	1	Often
Delay in project completion	3.44	0.92	2	Sometimes	Delay in project completion	3.86	1.11	2	Often
Increase in the overall cost of the project	3.28	0.83	3	Sometimes	Additional payments to the contractor	3.75	1.17	3	Often
Changes in the cash flow	3.22	0.65	4	Sometimes	Increased time and material related charges	3.68	1.06	4	Often
Loss of earnings	3.22	0.65	5	Sometimes	Increase in the overall cost of the project	3.64	1.13	5	Often
Average	3.33	0.77		Sometimes	Average	3.76	1.09		Often

dispersed and reflects that there is a wide variation of opinions among all the respondents involved.

In terms of the degree of occurrence, it is quite different since the identified five major effects of Change Orders are often or regularly happening in the private sector but are only happening sometimes or occasionally in the public sector according to the data. It was also observed that more Change Orders are being issued in private building projects due to the freedom of the owners/clients to initiate changes as stipulated in the contract unlike in public building projects wherein Change Orders are only limited up to 10% of the original project cost thus limiting the possible effects.

It can be deduced from the research findings that both public and private sector respondents rated time extension, delay in project completion, and increase in the overall project cost as three of the most significant effects of Change Orders. This indicates that they are mostly concerned on the additional days or months that may be incurred by the project due to delay in some of the construction activities brought about by these Change Orders. An increase in the overall cost was also expected since any delay or extension in the project duration would normally result to additional project costs. These findings were corroborated by the study of Al-Dubaisi [1], Osman et al. [17] and Ismail [12] which also reported that the five common effects of Change Orders were related to delay in completion schedule, increase in the project duration, increase in the project cost, increase in overhead expenses, and delays in payment.

8.3 Management Control Practices of Change Orders

As shown in Table 4, the top five (5) management and control of Change Orders identified by the respondents which happened frequently or "Often" in the public sector are: (1) changes in the design documents are checked and reviewed for justifications (M = 3.67, SD = 1.08); (2) encourage coordination and cooperation among the contractors, consultants, and clients (M = 3.61, SD = 0.85), (3) personnel involved in the building construction project take proactive measures to promptly settle, authorize, and execute Change Orders (M = 3.55, SD = 0.86); (4) Change Order is negotiated by knowledgeable persons (M = 3.50, SD = 0.92); and (5) changes are not made without appropriate written approval (M = 3.44, SD = 1.25). When compared to the top three management and control of Change Orders identified by the private sector respondents, the same findings were also revealed in the public sector except however for the remaining top two control mechanisms which pertains to the implementation of the policy of having a clear scope of the change (M = 4.00, SD = 0.94) and the use of various techniques (e.g., work breakdown structure) which are being implemented in order to track cost of any possible changes (M = 3.96, SD = 1.10).

Interestingly, almost all of the respondents from both public and private sectors agreed that changes in the contract documents need to undergo a thorough review and checking by authorized persons prior to their issuance and implementation at

Table 4 Comparison on the management control practices being implemented in the public and private building construction projects

Public sector					Private sector				
Management control practices	Mean	SD	Rank	Interpretation	Management control practices	Mean	SD	Rank	Interpretation
All changes to design documents are checked and reviewed for justifications	3.67	1.08	1	Often	All changes to design documents are checked and reviewed for justifications	4.21	0.83	1	Very often
Encourage team effort among all parties	3.61	0.85	2	Often	Change order is negotiated by knowledgeable persons	4.04	1.00	2	Often
Project personnel take proactive measures to promptly settle, authorize, and execute Change Orders on any project in your organization	3.56	0.86	3	Sometimes	Project personnel take proactive measures to promptly settle, authorize, and execute Change Orders on any project in your organization	4.04	1.00	3	Often
Change order is negotiated by knowledgeable persons	3.50	0.92	4	Sometimes	The scope of change is made clear	4.00	0.94	4	Often
Changes are not made without appropriate approval in writing	3.44	1.25	5	Sometimes	Work breakdown structure (WBS) or other techniques are used to track cost of changes	3.96	1.10	5	Often
Average	3.56	0.99		Sometimes	Average	4.05	0.98		Often

the project site. This management practice can eliminate a lot of problems such as errors and omissions in the design, unclear scope of work, and conflicts between contract documents, among others. This research finding was confirmed by the study of Al-Dubaisi [1] and Alaryan et al. [2] which also reported that reviewing and checking of design prior to change approval is one of the most important practices for managing and controlling Change Orders in various building construction projects in the different countries in the world. Moreover, the study also revealed that both public and private sector respondents perceived team effort and collaboration as the second most important change management and control practice. Finally, the data also revealed that public and private sector respondents both agreed that Change Orders must be reviewed, settled, and discussed by authorized and competent key personnel only. This management practice is very important in order to prevent errors in the design and decision blunders which can lead to further mistakes and more Change Orders. The same findings were also observed from various empirical findings conducted in different countries relative to management and control practices of Change Orders [2, 1, 10].

8.4 One-Way Analysis of Variance (ANOVA)

The researcher hypothesized that there is no significant difference between the public and private respondents' responses with regards to the causes of Change Orders in building construction projects in the Philippines. And in order to answer this question, Table 5 presents the results of the One-way ANOVA on the differences in perceptions between the public and private sectors respondents. A 0.05 level of confidence has been used to determine if there is indeed significant difference between public and private sector respondents' responses.

The results in Table 5 revealed that there were significant differences on the perceptions of both public and private sector respondents on the three identified factors causing Change Orders particularly project-related causes ($p = 0.025$), design-related causes ($p = 0.0005$), and contractor-related causes ($p = 0.033$). The significant differences in perceptions indicated that public and private sectors do not agree with each other that these are the major factors that cause Change Orders in building construction projects. However, they do agree that Change Orders are mostly caused by the client ($p = 0.116$) and other external factors ($p = 0.501$) such as unforeseen site conditions and force majeure among others.

From the foregoing exposition, it is safe to assume that the differences in perception between the respondents in public and private sectors on the three out of five factors which cause Change Orders was due to the differences in the setting and contract conditions that the two sectors are engaged with. While it is true that the private sector usually engaged in contracts which allow them to issue unlimited number of Change Orders, however public sector is usually engaged in various contracts which limit themselves to issue Change Orders up to 10% only of the original contract cost as stipulated in Republic Act 9184 (RA 9184). And because

Table 5 Differences in perceptions between the public and private sector respondents with regard to the causes of change order

Causes of Change Orders		Sum of squares	df	Mean square	*F*	Sig.
Project-related causes	Between groups	2.39	1.00	2.39	5.40	**0.025***
	Within groups	19.49	99.00	0.44		
	Total	21.88	100.00			
Client-related causes	Between groups	2.94	1.00	2.94	2.57	0.116
	Within groups	50.37	99.00	1.14		
	Total	53.30	100.00			
Design-related causes	Between groups	5.76	1.00	5.76	14.16	**0.0005***
	Within groups	17.90	99.00	0.41		
	Total	23.66	100.00			
Contractor-related causes	Between groups	3.21	1.00	3.21	4.86	**0.033***
	Within groups	29.04	99.00	0.66		
	Total	32.24	100.00			
External factors	Between groups	0.25	1.00	0.25	0.46	0.501
	Within groups	23.41	99.00	0.53		
	Total	23.66	100.00			

*Significant at 0.05 level of confidence

of this, the public sector is more cautious when it comes to creating changes to contract documents (Table 6).

The ANOVA revealed that there were no significant differences between the public and private sector with regards to the effects of the Changes Orders in the building construction projects in almost all of the top five reported effects of Change orders, except for risk-related effects which differ in their perceptions. But taken collectively, it is safe to assume that both public and private sector respondents have agreed that the most frequent effects of Change Orders are very much related to: time and schedule ($p = 0.061$); project cost ($p = 0.132$); productivity ($p = 0.118$); and other effects ($p = 0.623$) such as loss of morale, quality degradation, etc. The ANOVA results also revealed that the same effects are being experienced in every construction project. However, public and private sector respondents differs on how often risk-related effects ($p = 0.04$) such as accelerating the project, and site congestion are happening as a result of Change Orders.

Table 6 Differences in perceptions between the public and private sector respondents with regard to the effects of change order

Effects of Change Orders		Sum of squares	df	Mean square	*F*	Sig.
Time-related effects	Between groups	1.97	1.00	1.97	3.69	0.061
	Within groups	23.48	99.00	0.53		
	Total	25.45	100.00			
Cost-related effects	Between groups	1.47	1.00	1.47	2.36	0.132
	Within groups	27.51	99.00	0.63		
	Total	28.98	100.00			
Productivity-related effects	Between groups	1.55	1.00	1.55	2.55	0.118
	Within groups	26.71	99.00	0.61		
	Total	28.26	100.00			
Risk-related effects	Between groups	1.93	1.00	1.93	4.46	**0.040***
	Within groups	18.99	99.00	0.43		
	Total	20.92	100.00			
Other effects	Between groups	0.14	1.00	0.14	0.25	0.623
	Within groups	24.28	99.00	0.55		
	Total	24.41	100.00			

*Significant at 0.05 level of confidence

In this study, it was hypothesized that there were no significant differences between clients', consultants', and contractors' perceptions on the causes and effects of Change Orders. And in order to test this hypothesis, a one-way ANOVA test was done and is presented in Table 7.

The data revealed that there were no significant differences with regards to the factors related project-related causes ($p = 0.429$), design-related causes ($p = 0.722$), and external factors ($p = 0.266$) which have p-value greater than 0.05. These findings confirmed that indeed the clients, consultants, and contractors were in agreement with the identified factors causing Change Orders in the building construction projects in the Philippines. However, there were significant differences in perceptions with regards to the factors related to client ($p = 0.04$) and contractor ($p = 0.017$). Both have p-values less than 0.05, which indicated that there was a different view on these identified factors that causes Change Orders. Based on the foregoing exposition, clients, consultants, and contractors have differed in their

Table 7 Differences in perceptions between consultants, contractors, and clients/owners with regard to the causes of change order

Causes of Change Orders		Sum of squares	df	Mean square	*F*	Sig.
Project-related causes	Between groups	0.84	2.00	0.42	0.86	0.429
	Within groups	21.04	98.00	0.49		
	Total	21.88	100.00			
Client-related causes	Between groups	7.41	2.00	3.71	3.47	**0.040***
	Within groups	45.89	98.00	1.07		
	Total	53.30	100.00			
Design-related causes	Between groups	0.36	2.00	0.18	0.33	0.722
	Within groups	23.31	98.00	0.54		
	Total	23.66	100.00			
Contractor-related causes	Between groups	5.59	2.00	2.80	4.51	**0.017***
	Within groups	26.65	98.00	0.62		
	Total	32.24	100.00			
External factors	Between groups	1.41	2.00	0.71	1.37	0.266
	Within groups	22.24	98.00	0.52		
	Total	23.66	100.00			

*Significant at 0.05 level of confidence

perceptions as to who causes the Change Orders in both public and private building construction projects. Hence, to validate the above findings a Post Hoc analysis in ANOVA using Fisher's Least Significant Difference (LSD) was utilized in this study. LSD was used to compare the means and get the relationships between groups of respondents. Table 9 presents the results of the LSD.

As shown in Table 8, there were significant differences existed: (a) between contractors' and consultants' ($p = 0.043$) perceptions that causes of Change Order are client-related; and (b) between the contractor and client ($p = 0.007$) that the contractor is one of the major initiators of Change Orders. However, there were no significant differences with regards to the other causes of Change Orders. These findings indicate that there is a difference in the responses when identifying which party causes change order. Clients and their consultants deny that clients cause Change Orders as reflected by their low mean scores compared to that of the contractors which say otherwise. Furthermore, with regards to the contractor-related

Table 8 Differences in perceptions of consultants, contractors and clients/owners with regard to the causes of Change Orders (post hoc Analysis)

Causes of Change Orders (dependent variable)	(I) Type	(J) Type	Mean difference (I − J)	Std. error	95% confidence interval		Sig.
					Lower bound	Upper bound	
Project-related causes	Contractor	Consultant	−0.281	0.337	−0.960	0.399	0.410
		Client	−0.293	0.254	−0.806	0.220	0.256
	Consultant	Contractor	0.281	0.337	−0.399	0.960	0.410
		Client	−0.012	0.383	−0.785	0.760	0.974
	Client	Contractor	0.293	0.254	−0.220	0.806	0.256
		Consultant	0.012	0.383	−0.760	0.785	0.974
Client-related causes	Contractor	Consultant	1.039	0.498	0.035	2.043	**0.043***
		Client	0.739	0.376	−0.019	1.496	0.056
	Consultant	Contractor	−1.039	0.498	−2.043	−0.035	**0.043***
		Client	−0.300	0.566	−1.441	0.841	0.599
	Client	Contractor	−0.739	0.376	−1.496	0.019	0.056
		Consultant	0.300	0.566	−0.841	1.441	0.599
Design-related causes	Contractor	Consultant	0.215	0.355	−0.501	0.930	0.548
		Client	0.172	0.268	−0.368	0.712	0.524
	Consultant	Contractor	−0.215	0.355	−0.930	0.501	0.548
		Client	−0.043	0.403	−0.856	0.770	0.916
	Client	Contractor	−0.172	0.268	−0.712	0.368	0.524
		Consultant	0.043	0.403	−0.770	0.856	0.916
Contractor-related causes	Contractor	Consultant	−0.563	0.379	−1.328	0.202	0.145
		Client	−0.813	0.286	−1.391	−0.236	**0.007***
	Consultant	Contractor	0.563	0.379	−0.202	1.328	0.145
		Client	−0.250	0.431	−1.120	0.620	0.565
	Client	Contractor	0.813	0.286	0.236	1.391	**0.007***
		Consultant	0.250	0.431	−0.620	1.120	0.565
External factors	Contractor	Consultant	0.517	0.347	−0.182	1.216	0.143
		Client	−0.112	0.262	−0.639	0.416	0.672
	Consultant	Contractor	−0.517	0.347	−1.216	0.182	0.143
		Client	−0.629	0.394	−1.423	0.166	0.118
	Client	Contractor	0.112	0.262	−0.416	0.639	0.672
		Consultant	0.629	0.394	−0.166	1.423	0.118

*Significant at 0.05 level of confidence

causes, the same finding was observed between contractors and clients. During the KIIs, it was revealed that contractors and clients strongly disagree with each other. Clients said that contractors often cause Change Orders, whereas contractors say otherwise as revealed by their lower mean scores.

Based on these findings, it seemed that there is a blaming game as to who initiated or causes Change Orders in building construction projects. Clients placed more blame on the contractors than themselves and vice versa. And this disparity in their perceptions often leads to various claims, conflicts, and disputes.

The data presented in Table 9 revealed that there were no significant differences in the perceptions of respondents coming from consultants, contractors, and clients or owners with regards to the effects of Change Orders except however for other effects (e.g., poor professional relations, quality degradation, and loss of morale) which has a *p*-value of 0.045. They have different views as to how often these other effects particularly poor professional relations, quality degradation, and loss of morale happen in building construction projects. And this can be attributed due to varying conditions wherein one party may encounter these other effects, but the other party may not.

Table 9 Differences in perceptions between the consultants, contractors, and clients/owners with regard to the effects of change order

Effects of Change Orders		Sum of squares	df	Mean square	*F*	Sig.
Time-related effects	Between groups	0.36	2.00	0.18	0.31	0.734
	Within groups	25.09	98.00	0.58		
	Total	25.45	100.00			
Cost-related effects	Between groups	0.58	2.00	0.29	0.44	0.645
	Within groups	28.40	98.00	0.66		
	Total	28.98	100.00			
Productivity-related effects	Between groups	0.39	2.00	0.20	0.30	0.740
	Within groups	27.87	98.00	0.65		
	Total	28.26	100.00			
Risk-related effects	Between groups	0.38	2.00	0.19	0.40	0.672
	Within groups	20.54	98.00	0.48		
	Total	20.92	100.00			
Other effects	Between groups	3.29	2.00	1.64	3.35	**0.045***
	Within groups	21.12	98.00	0.49		
	Total	24.41	100.00			

*Significant at 0.05 level of confidence

In order to validate the above findings and further evaluate these differences among the three groups of respondents, a Post Hoc analysis in ANOVA using Fisher's Least Significant Difference (LSD) was utilized in this study. LSD was used to compare the means and get the relationships between groups of respondents. Table 10 presents the results of the LSD.

Table 10 Differences in perception of consultants, contractors and clients/owners with regard to the effects of Change Orders (post hoc Analysis)

Effects of Change Orders (dependent variable)	(I) Type	(J) Type	Mean difference (I − J)	Std. error	95% confidence interval		Sig.
					Lower bound	Upper bound	
Time-related effects	Contractor	Consultant	0.04	0.37	−0.70	0.79	0.91
		Client	−0.21	0.28	−0.77	0.35	0.46
	Consultant	Contractor	−0.04	0.37	−0.79	0.70	0.91
		Client	−0.25	0.42	−1.09	0.59	0.55
	Client	Contractor	0.21	0.28	−0.35	0.77	0.46
		Consultant	0.25	0.42	−0.59	1.09	0.55
Cost-related effects	Contractor	Consultant	0.11	0.39	−0.68	0.90	0.78
		Client	−0.24	0.30	−0.84	0.35	0.41
	Consultant	Contractor	−0.11	0.39	−0.90	0.68	0.78
		Client	−0.36	0.45	−1.25	0.54	0.43
	Client	Contractor	0.24	0.30	−0.35	0.84	0.41
		Consultant	0.36	0.45	−0.54	1.25	0.43
Productivity-related effects	Contractor	Consultant	0.21	0.39	−0.57	1.00	0.58
		Client	−0.13	0.29	−0.72	0.46	0.66
	Consultant	Contractor	−0.21	0.39	−1.00	0.57	0.58
		Client	−0.34	0.44	−1.23	0.55	0.44
	Client	Contractor	0.13	0.29	−0.46	0.72	0.66
		Consultant	0.34	0.44	−0.55	1.23	0.44
Risk-related effects	Contractor	Consultant	0.14	0.33	−0.53	0.81	0.67
		Client	−0.17	0.25	−0.68	0.33	0.49
	Consultant	Contractor	−0.14	0.33	−0.81	0.53	0.67
		Client	−0.32	0.38	−1.08	0.45	0.41
	Client	Contractor	0.17	0.25	−0.33	0.68	0.49
		Consultant	0.32	0.38	−0.45	1.08	0.41
Others effects	Contractor	Consultant	0.30	0.34	−0.38	0.98	0.38
		Client	−0.57	0.25	−1.08	−.05	**0.03***
	Consultant	Contractor	−0.30	0.34	−0.98	0.38	0.38
		Client	−0.87	0.38	−1.64	−0.09	**0.03***
	Client	Contractor	0.57	0.25	0.05	1.08	**0.03***
		Consultant	0.87	0.38	0.09	1.64	**0.03***

*Significant at 0.05 level of confidence

As shown in Table 10, the results of the ANOVA revealed that there were significant differences in the responses between the clients and contractors and also between clients and consultants on other effects (e.g., poor professional relations, quality degradation, loss of morale) as signified by the *p*-value of 0.03 which is less than the 0.05 level of confidence. This means that contractors and consultants are losing morale due to a number of Change Orders being issued at site. However, clients may not experience the same thing and may perceive the issuance of Change Orders as a good opportunity to enhance their construction project.

8.5 A Proposed Framework of Guidelines for Managing Change Orders

The researcher designed a research-validated framework or a set of guidelines which was based on the synthesis of several change process models reviewed in several literatures and on the actual site conditions of selected building construction projects in NCR. This framework was presented to construction professionals in selected building construction projects in NCR and was found to be reliable, acceptable, and can be recommended for proper implementation. This framework consists of procedures which were revised and improved continuously throughout the study especially after carrying out key informant interviews and analyzing the results of the survey. As shown in Fig. 2, this framework is composed of nine (9) stages or steps in managing Change Orders. This steps include: (1) Evaluate the Contract Documents; (2) Identify the Change; (3) Notify all the concerned parties; (4) Initiate and Propose; (5) Review and Evaluate the Change Order Request; (6) Approve the Change Order Request; (7) Implement or Execute the Change Order Request; (8) Settle Unresolved Change Orders and Claims; (9) Document the Change.

Thus, the following paper is hereby presented.

8.5.1 A Research-Validated Set of Guidelines for Managing Change Orders in Building Construction Projects in the Philippines

Implementing Guidelines for Managing Change Orders

Step 1. Evaluate the Contract Documents

- *Contractors, consultants, and clients should thoroughly review and understand contract requirements and provisions regarding conflicts and discrepancies in contract documents and any other risks before the project starts*
- *Contract documents should contain a change clause which would allow for changes to the scope of work and allows the contractor an equitable adjustment to the contract price or schedule as a result of a change.*

Step 2. Identify the Change

- *The second step in successful change order management is to identify the change, which can be defined as any anticipated or actual deviation from the scope, schedule, or price/budget/cost.*

Step 3. Notify All the Concerned Parties

- *The contractor should notify the owner through a Change Notice that a change has been spotted or had already happened.*
- *It is highly suggested that Change Notices reflecting the details of extra work to be performed shall be prepared and shall be submitted to the Client within seven (7) days to officialize the change.*

Step 4. Initiate & Propose

A. Client/Owner Initiates the CO Proposal

- *When a change order is initiated by the client/owner, the process should begin with a request for proposal (RFP).*
- *The RFP should present all the needed information so that the contractor can make a reasonable and realistic estimate of the costs and the time required in order to implement the change.*

B. Contractor Initiates the CO Proposal

- *When a change order is initiated by the contractor, the contractor should prepare a Change Order Request/Proposal, in a prescribed professional format, just after submitting the Change Notice.*
- *This request should contain a full description of the change and its corresponding production costs.*
- *Additionally, change requests should effectively use graphics and numbers to communicate the desired information to the intended audience. It should also establish a link or cause–effect relationship between the entitlement and the damages.*

Step 5. Review and Evaluate the Change Order Request

A. Contractor's representative reviews request and submits to Consultant

- *The Contractor should review first their change order request in order to check any errors and/or omissions in it before submitting to the Consultant*

B. Consultant reviews the CO request and recommends to the Client/Owner

- *The Consultant should check the rationality and validity of the Contractor's request and submit the request to the Client/Owner*

C. Client/Owner reviews merits of the proposed Change Order

- *The client should perform a detailed review and evaluation of the change documents in order to assess the rationality of the proposed change order and its possible impacts.*

- *The client should also evaluate the contractor's entitlement to recover additional costs or time by determining whether or not a change has occurred and if a remedy for the change exists in the contract documents.*

Step 6. Approve the Change Order Request

A. If Client denies Change Order request

- *If the Client does not find the CO request to be reasonable, it should be returned to the Contractor with denied authorization.*

B. If Client approves the Change Order request.

- *Consultant should request from Contractor quotations/price proposal of the change order.*
- *Contractor should estimate time and cost and submit signed Change Order proposal to the Consultant*
- *Consultant should review time/cost proposal and negotiate terms.*

a. *If the Consultant determines that the Contractor is entitled to recover costs and/or time associated with change, they should measure the effect of the change by calculating the additional costs and/or time extension required and compare and negotiate them to the impacts quantified in the contractor's change order request/proposal.*
b. *If Consultant and Contractor do not agree on the time and cost implications of the change, attempt to renegotiate the terms. Otherwise, if still disapproved, confer immediately with Legal/Contracts for assistance in securing reconsideration, arbitration or filing of a Claim*

Step 7. Implement/Execute the Change Order Request

A. Client/Owner signs Change Order

- *The client, should approve the Change Order preferably within fifteen (15) days from the receipt of the CO request, or as specified in relevant contract provisions.*
- *If the approval of Change Order was not obtained from the client within the specified time, the contractor may have the option to hold or stop the change order in process.*

B. Contractor begins Change Order work

- *The contractor should proceed with the execution of the change order works immediately right after the approval of the change order request/proposal to avoid further damages and delays.*
- *It is very important that change order work should begin after the client or client's representative issues a written authorization to proceed. Verbal authorization should be avoided.*

Step 8. Settle Unresolved Change Orders and Claims

- *All work items including all the issued Change Orders should be verified technically by the Client and/or Consultant whether those were completed correctly and satisfactorily.*
- *Moreover, all the remaining Change Orders and any other potential Change Orders should also be identified and resolved in a timely manner before the project close-out.*
- *Clients, consultants, and contractors should be proactive in settling all the claims and resolving all the issues and disputes regarding Change Orders in order to avoid unnecessary surprises in the future.*

Step 9. Document the Change

- *A complete documentation of the change should be created in order to provide the necessary data to prove and substantiate the occurrence of the changes.*
- *Appropriate supporting records and documents, including a written copy of the change directive, should also be maintained with the change order package.*
- *A checklist of documents and records that should be kept and maintained includes but may not be limited to: actual progress photos, project correspondences, minutes of meetings, original and revised construction drawings, construction contract and other legal documents.*

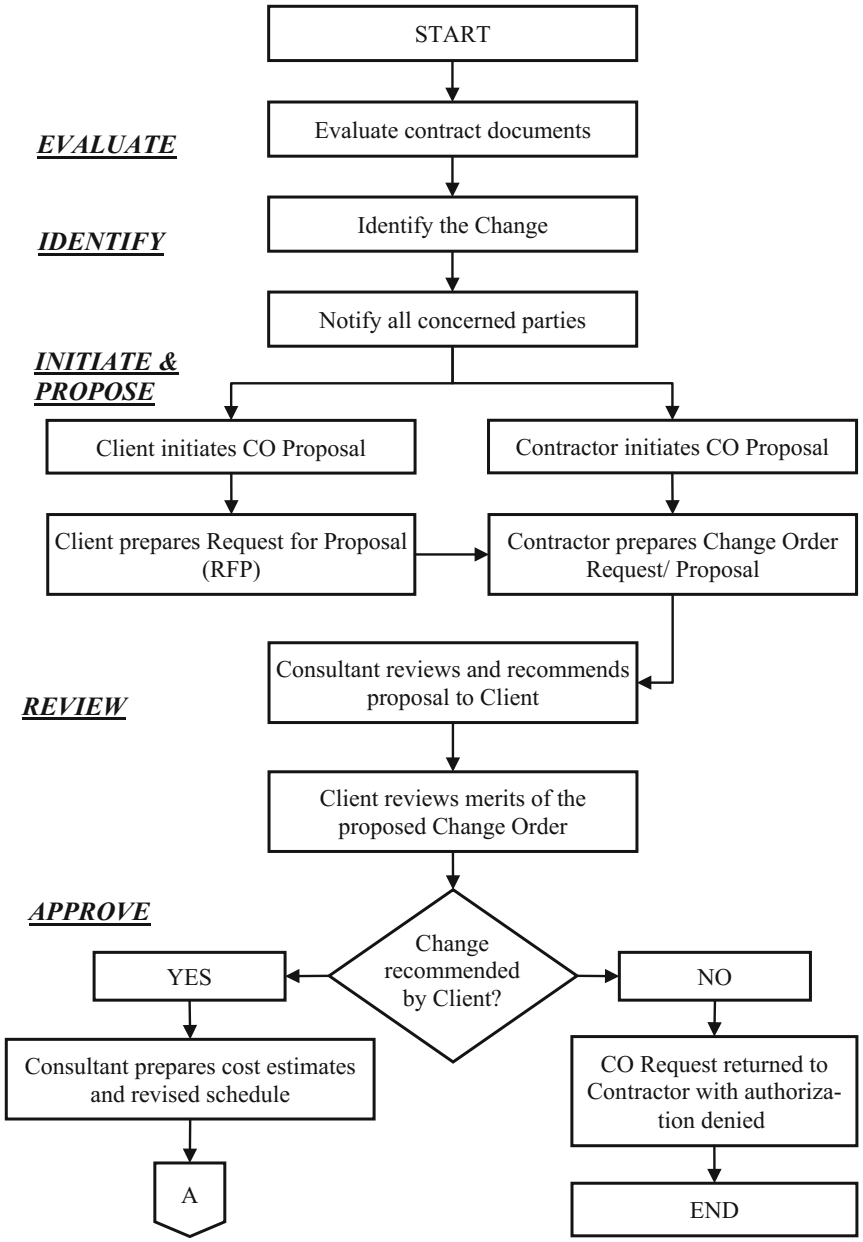

Fig. 2 Flow chart of procedures for managing change order

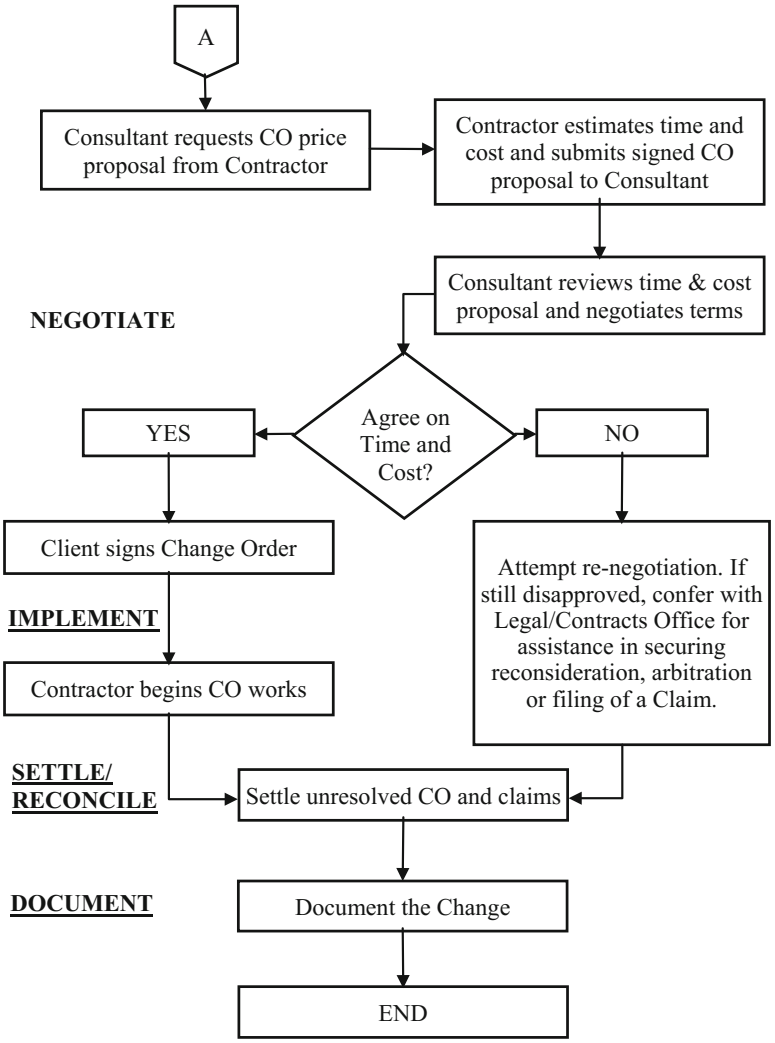

Fig. 2 (continued)

9 Conclusions

In the light of the foregoing findings, the following conclusions were drawn:

1. The common major causes of Change Orders in public and private building construction projects in the Philippines were related to clients' requests particularly changes in the plans and scope of work, changes in the design, and change in project schedule. The common major effects as reported by both the public and private respondents were related to project time extension, delay in project completion, and increase in the overall cost of the project.
2. The most common management control practices being undertaken by both public and private sector respondents were: (i) all changes in the design documents are checked and reviewed for justifications, (ii) project personnel take proactive measures to promptly settle, authorize, and execute Change Orders, and (iii) Change Order is negotiated by knowledgeable persons.
3. The results revealed that there were significant differences between the public and private sector respondents' responses on the causes of Change Orders particularly on project-related causes, design-related causes, and contractor-related causes. However, there were no significant differences between the public and private sector with regards to the effects of Changes Orders in building construction projects in the Philippines in almost all of the top five reported effects of Change orders, except for risk-related effects which differ in their perceptions.
4. There were significant differences on the respondents perception: (a) between contractor and consultant on the perception that Change Order are client-related causes; (b) between the contractor and client that the contractors are one of the major originators of Change Orders. However, there were no significant differences between clients, consultants, and contractors with regards to their perceptions on the major effects of Change Orders, except for the other effects of Change Orders such as poor professional relations and quality degradation.
5. The research-validated framework or set of guidelines that was developed in this study was found to be acceptable to the construction industry and can be used to minimize and or mitigate the issues and problems related to Change Orders in building construction projects.

10 Recommendations

In the light of the foregoing findings and conclusions, the following recommendations are offered:

1. To conduct thorough review and finalization of all designs, construction plans and specifications, scope of work and project schedule prior to the commencement of the project.

2. To conduct complete and meticulous site investigations such as soil surveys and geotechnical studies. Likewise, weather conditions should be recorded on a daily basis in order to support and justify claims for time extensions due to uncontrollable factors.
3. To require contractors to submit catch-up revised schedule to clients and consultants in order for them to adjust and recover from the effects of Change Orders in the overall project duration.
4. Clients, consultants, and contractors should discretely track the cost as well as schedule impacts in order to have a greater chance of recovery from cost overruns and underruns. This can be implemented by creating a unique cost code to capture the costs associated with the proposed change.
5. Inasmuch as three of the most common identified management practices being implemented to address Change Orders were related to checking and reviewing of design documents, proactively settling, authorizing and executing Change Orders, and proper negotiation by knowledgeable persons, it is recommended that these management practices be adopted in all public and private building construction projects.

References

1. Al-Dubaisi, A.H.: Change orders in construction projects in Saudi Arabia, Master's thesis. Available from Dissertations and Theses database (UMI No. 1399744) (2000)
2. Alaryan, A., Elshahat, A., Dawood, M.: Causes and effects of change orders on construction projects in Kuwait. Int. J. Eng. Res. Appl. **4**(7), 1–8 (2014)
3. Alnuaimi, A.S., Taha, R.A., Mohsin, M.Al, Al-harthi, A.S.: Causes, effects, benefits, and remedies of change orders on public construction projects in Oman. J Constr. Eng. Manage. **136**, 615–623 (2010)
4. Aneesa, M.M., Mohamed, H.E., Abdel, R.: Evaluation of change management efficiency of construction constractors. HBRC J. **9**, 77–85 (2013)
5. Clare, B.S.: Reviewing change orders 101. AACE Int. Trans., 1–5 (2008)
6. Egan, J.J., Seder, J.E., Anderson, D.L.: Practices in construction change order management. Cost Eng., 12–17 (April 2012)
7. Fraenkel, J., Wallen, N.: How to design and evaluate research in education, 8th edn. McGraw-Hill Education, New York (2007)
8. Hwang, B.G., Low, L.K.: Construction project change management in Singapore: status, importance and impact. Int. J. Project Manage. **30**(7), 817–826 (2012). https://doi.org/10.1016/j.ijproman.2011.11.001
9. Ibbs, C.: Change's impact on construction productivity. J. Constr. Eng. Manage. **123**(1), 89–97 (1997)
10. Ibn-homaid, N.T., Eldosouky, A.I., Al-ghamdi, M.A.: Change orders in Saudi linear construction projects. Emirates J. Eng. Res. **16**(1), 33–42 (2011)
11. Ijaola, I.A., Iyagba, R.O.: A comparative study of causes of change orders in public construction project in Nigeria and Oman. J. Emerg. Trends Econ. Manage. Sci. **3**(5), 495–501 (2012)
12. Ismail, A., Pourrostam, T., Soleymanzadeh, A., Ghouyounchizad, M.: Factors causing variation orders and their effects in Roadway construction projects. Res. J. Appl. Sci. Eng. Technol. **4**(23), 4969–4972 (2012)

13. Levin, J.A., Fox, J.A.: Elementary statistics in social research: essentials, 3rd edn. Northeastern University, Boston (1997)
14. Love, P.E., Holt, G.D., Shen, L.Y., Li, H., Irani, Z.: Using systems dynamics to better understand change and rework in construction project management systems. Int. J. Proj. Manag. **20**(6), 425–436 (2002)
15. Molly, K.K.: Six steps for successful change order management. Cost Eng. **49**(4), 12–20 (2007)
16. Motawa, I., Anumba, C., Lee, S., Peña-Mora, F.: An integrated system for change management in construction. Autom. Construc. **16**(3), 368–377 (2007)
17. Osman, Z., Omran, A., Foo, C.K.: The potential effects of variation orders in construction projects. J. Eng. Ann. Fac. Eng. Hunedoara **2**, 141–152 (2009)
18. Philippine Domestic Construction Board: A primer on PD no. 1594 and its implementing rules & regulations as amended. Philippine Domestic Construction Board, Makati, Metro Manila (1989)
19. Rodriguez, J.: Five (5) situations that might trigger a change order request. Retrieved from: http://construction.about.com/od/Claims-Management/a/Common-Causes-For-A-Change-Order.htm (2016)
20. Serag, E., Oloufa, A., Malone, L., Radwan, E.: Model for quantifying the impact of change orders on project cost for U.S. roadwork construction. J. Constr. Eng. Manage. **136**, 1015–1027 (2010)
21. Sun, M., Meng, X.: Taxonomy for change causes and effects in construction projects. Int. J. Project Manage. **27**(6), 560–572 (2009). https://doi.org/10.1016/j.ijproman.2008.10.005
22. Sundaram R.: Managing change order costs in construction projects: how owners can stay on top. Retrieved from https://www.fgould.com/americas/articles/managing-change-order-costs-construction-projects (2012)