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ASSESSMENT OF FACTORS CAUSING CHANGE ORDERS IN CONSTRUCTION PROJECTS IN RWANDA

CASE STUDY: CONSTRUCTION OF MURUNDA, RUHANGO AND RUSEBEYA HANDCRAFT CENTERS

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ABSTRACT

This research assessed factors causing change orders in building construction in Rwanda, case study of the construction of Murunda, Ruhango and Rusebeya handcraft centers. This research aimed to find out the factors causing building change orders from the Clients, Consultants and contractors and external. The list of factors causing building change orders was subjected to a questionnaire survey and interviews, for the identification of the most important causes of change orders. The field survey included 30 respondents made up of 18 on contractor's side, 9 on consultant team and 3 on side of clients. Importance of each cause was calculated on the basis of the Relative Importance Index and the level of agreement between these contracting parties was tested using Kendall coefficient of concordance. The major causes of building change orders found by this research are: Owner's financial problem, Inadequate project objectives, Change of plans or scope by owner, Replacement of materials or procedures; Errors and omissions in design, Conflicts between contract documents, Value engineering, Inadequate working drawing details; Lack of contractor's involvement in design, Contractor's financial difficulties and Contractor's lack of required data, and Contractor's desired profitability. The results showed that, there is an influence from the clients, Consultants and Contractors in occurrence of building change orders. It was revealed that there was strong correlation (0.798) between contractors and Owners, and 0.777 between Owners and consultant. It was revealed that there was strong correlation (0.916) between contractors and Consultants, and a weak correlation of 0.549 between contractors and clients.

INTRODUCTION

1.1. BACKGROUND

Change orders in construction projects are very common and they usually come from different sources, by various causes, at any stage of a project, and may have considerable negative impacts on items such as costs and schedule delays. Therefore, it is in the design stage where the requirements of the client are identified and the constructive aspects and the standards of quality are defined through procedures, drawings and technical specifications (Motawaet al, 2007). Currently in Rwanda, the work within the design stage is split into several temporary sequences, and it is delivered to different specialists for its execution. In building projects, first the owner selects the architects who prepare the architectural designs and specifications, and then the structural design and other specialty designs are developed. Generally, the construction stage is the responsibility of a contractor selected by the owner.

One of the major problems facing the construction project is issue of Change orders during the construction phase (Ibb, 2001). These changes are inevitable in any construction project. The problem could become worse when there is a series of Change orders, when the programme is affected and when the time spent by the contractor's head office staff becomes totally disproportionate to the value of the contract.

There are many reasons why Change orders occur. They may be due to extra work caused by subsurface conditions, errors in contract documents, additional quantities of works or materials, reduction of work, or lack of proper communication between the parties (Ssegawa, 2002). Needs of the owner may change in the course of design or construction, market conditions may impose changes to the parameters of the project, and technological developments may alter the design and the choice of the engineer. The architects review of the design may bring about changes to improve or optimize the design and hence the operation of the project. All these factors and many others necessitate changes that are costly and generally unwelcomed by all parties.

1.2. PROBLEM STATEMENT

Rwanda has seen a significant rise in infrastructure developments in the recent past, especially in the fields of construction industry. However, many construction projects have failed to achieve project success due to change orders. The fact is that change orders are unwanted, but inevitable is reality in any construction project. The construction process can be influenced by changing variables and unpredictable factors that could result from different sources (Mokhtar et al, 2000). More than a third of clients are dissatisfied with contractors' performance in keeping to the quoted price and to time, resolving defects, and delivering a final product of the required quality (Sun et al.,2004). Therefore, the effort of managing change orders has imposed a huge burden on project management and it is a nightmare for construction projects since they are causing ethical problems and disputes. To date, there is a serious lack of understanding about the causes of the design changes because there have definitive studies reporting in quantitative terms.

1.3. OBJECTIVES OF STUDY

1.3.1. Main Objective

The main objective of this research was to assess factors causing Change orders in construction projects in Rwanda.

1.3.2. Specific Objectives

The specific objectives of this study were:

1. To measure the possible Client's factors causing change orders in Rwandan construction projects;
2. To identify and measure the Consultants related factors causing change orders in Rwandan construction projects;
3. To measure the Contractors 'related factors causing change orders in Rwandan construction projects;
4. To measure the possibles external factors causing change orders in construction in construction projects in Rwanda.

1.4. Research questions

1. What are the possible Client's factors causing change orders in construction projects in Rwanda?
2. What are the Consultant related factors causing change orders in construction projects in Rwanda?
3. What are the Contractors' related factors causing change orders in construction projects in Rwanda?
4. What are the external factors causing change orders in construction projects in Rwanda?

LITERATURE REVIEW

2.1.Introduction to construction changes

Changes are generally inevitable in most construction project (William et al., 2001). Owner needs may change during design or construction phases due to market desire and business conditions or technological developments. These changes may alter the project variables like design and specifications. Design revisions may lead to design improvements or optimizations and accordingly effect project executions. Furthermore, errors and omissions in design documents or construction defects may impose a change. All of these factors and more others necessitate changes which are cost and time consuming and normally un-welcomed by all parties.

2.1.1. Definition of change in construction industry

Sun and Meng [6] declared that "in construction projects, a change refers to an alteration to design, building work, project program or other project aspects caused by modifications to preexisting conditions, assumptions or requirements".

Hanna et al. (2004) stated that "Change is defined as any event that results in a modification of the original scope, execution time, or cost of work". Any additions, deletions, or other revision to project goals and scope are considered to be changes, whether they increase or decrease the project cost, schedule or quality. Change can be the responsibility of any project involved party including the owner, contractor and consultant or a third party. Frequently, uncertainties, changing environment, insufficient and untimely communication, poor integration, and growing complexity of the project provoke the risk of change.

2.1.2. Constructive change claims theory

Constructive Change theory allows the contractor to be paid for changes to the manner, method, or scope of work, even where there is no formal Change Order. Recovery may be allowed under other contract

adjustment clauses when there is some action or inaction by the owner or owner's agent that amounts to an order or directive to the contractor. The theory has been well established in federal contract forums, and has gained acceptance in most other jurisdictions, under custom and standard form construction industry contracts.

The primary causes of Change orders are owner-initiated changes and designer's errors and omissions (Issac and Navon, 2008). The impact of changes to a construction project needs to be evaluated case by case in order to assist with the decision making process. Though some changes may bring in "benefits" to the stakeholders especially to the owner in the long run, most changes, if not managed properly, will result in "negative" impacts, most likely resulting in time and cost overruns. In general, upper-stream changes have larger impacts. Lu and Issa (2005) believe that most frequent and most costly changes are often related to design, such as Change orders and design errors.

2.2. CRITICAL REVIEW

Through a literature review on factors causing change orders, it can be considered that there are numerous studies on "causative factors of change orders in construction" and few investigations on level of occurrence of these factors. The reason behind this issue is the large and vast extent of change orders which include a great diversity of factors trigger changes in construction. The vast diversity and scope of "Change Causes" makes the process of classification of them more complicated. Therefore, there is a great lack of comprehensive study on measure the level of occurrence of factors causing change orders. On the other hand the existing investigations on classifications are not general and usually have been conducted based on a specific project or country and could not be implemented in other projects or locations.

RESEARCH METHODOLOGY

2.1.Qualitative Methods

A qualitative approach is generally linked to inductive research, as a bottom-up approach in which new hypotheses and theory are generated from data collected. So, in this approach the researcher assumes the constructivist perspective to knowledge (Creswell, 2003). However, the qualitative approach is another methodological approach that is 'subjective' in nature (Naoum, 2007). Fellows and Liu (2008) explain that in this approach the research topic is examined in an attempt to boost understanding of the topic and to elicit interrelated data to generate/modify theories. Qualitative methods, try to recognize the basis for things that happen by looking at the meaning and the connotation to individual characteristic to social phenomena (Fellows and Liu, 2008). This study used an exploratory interview to investigate and assess the factors causing change orders in the Rwandan construction industry.

2.2.Quantitative Methods

Quantitative research is generally associated with deductive research, which is a top-down approach in which the hypothesis and theory would be examined by data. In this approach, researchers principally adopt a positivist perspective of knowledge development (Creswell, 2003). So, according to Noaum (1998) this is a methodological approach that is 'objective' in nature. Consequently, researchers who pursue quantitative approaches are likely to apply 'scientific methods', so that their research results in specific findings, in addition to propositions and hypotheses (Fellows and Liu, 2008).

2.3. TARGET POPULATION

The target population of this research was the public sector clients and private clients, the consulting firms and the contractors working in Rwandan construction industry. The motive behind studying these parties was to cover the all involved parties in the design stage, and project implementation stage of the project as they are only the involved parties in change order process, and also to discover their related factors causing Change Orders. Furthermore, the targeted population is the engineers involved in the design stage, such as architects, structural engineers, quantity surveyors, project managers, design managers and client representatives for construction building projects.

The case study of this research was the construction of Murunda, Ruhango and Rusebeya handcraft centers. This research concerned as the target population whom constitute the entire project team, 3 client representatives, 18 persons on contractor's side, and 9 persons on consultant's side.

DATA ANALYSIS AND DISCUSSIONS

4.1. FACTORS CAUSING CHANGE ORDERS IN CONSTRUCTION

Objectives of this study were to measure the Clients' Consultant, and Contractors 'possible causes of change orders in construction project. In order to achieve these objectives, the study set out to determine what the most important factors causing change orders are and to compare the clients', consultants,' and contractors' perspective on the factors contributing to change orders.

4.1.1. The Most Clients related Factors Causing Change Orders in Construction

The respondents were asked to rate each potential cause based on his/her professional judgment and using the following scale, Least contributing = 1; Low contributing = 2; Contributing = 3; High contributing = 4; highly contributing= 5. As illustrated in Table 4-1, it was possible to rank the causes of change orders by way of the Relative Importance Index (RII).

Owner's related factors of change order	**Overall**		**Client**		**Consultant**		**Contractor**	
	RII	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**
Owner's financial problems	0.967	1	0.933	1	0.956	1	0.978	1
Inadequate project objectives	0.920	2	0.867	2	0.822	4	0.978	1
Change of plans or scope by owner	0.767	3	0.867	2	0.889	2	0.689	3
Replacement of materials or procedures	0.747	4	0.533	4	0.956	1	0.678	4
Changes in specifications by owner	0.727	5	0.667	3	0.644	6	0.589	6

The five most important Clients's related causes of change orders in construction projects in Rwanda were found to be: 1) Owner's financial problem RII= 0.967, 2) Inadequate project objectives RII=0.920, 3) Change of plans or scope by owner RII=0.767, 4) Replacement of materials or procedures RII=0.747, 5) Changes in specifications by owner RII=0.727.

4.1.2. Test of Level of Agreement on Clients 'Factors Causing Change Orders

To test the level of agreement between the client, consultant and contractor, the Kendall's coefficient of concordance was used and the results were as shown in Table 4-2. It was revealed that there was strong correlation (0.798) between contractors and Owners, and 0.777 between Owners and consultant.

- **Kendall's Coefficient of Correlation for Clients' related factors of Change Order**

Correlation					
			Owners	**Consultants**	**Contractors**
Kendall's tau_b	Owners	Correlation coefficient N	1.000 5	.777** 9	.798** 16
	Consultants	Correlation coefficient N	.777** 5	1.000 9	.703** 16
	Contractors	Correlation coefficient N	.798** 5	.703** 9	1.000 16
**.Correlation is significant at the 0.01 level (2-tailed)					

This finding on strong correlation of the views of the Clients, consultants and those of the contractors regarding Owner's causes of change orders in construction projects in Rwanda is baffling given the often perceived adversarial relationship between the three parties in any given construction project. This could be interpreted to mean that the client does not fully appreciate the factors that give rise to change in his project, hence his immense contribution to the occurrence of change orders.

4.1.3. Most Consultant related causes of Change Order

The respondents were asked to rate each potential consultants related causes of change orders based on his/her professional judgment and using the following scale, Least contributing = 1; Low contributing = 2; Contributing = 3; High contributing = 4; highly contributing= 5.

Consultant related causes of Change Order	**Overall**		**Client**		**Consultant**		**Contractor**	
	RII	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**
Change in design by consultant	0.973	1	0.933	1	0.956	2	0.989	1
Errors and omissions in design	0.947	2	0.733	4	0.956	2	0.978	2
Conflicts between contract documents	0.927	3	0.667	5	0.933	3	0.967	3
Value engineering	0.913	4	0.867	2	0.778	8	0.989	1
Inadequate working drawing details	0.887	5	0.8	3	0.978	1	0.856	6

project (Arain, et al., 2004). Thorough reviewing of design details would assist in minimizing change orders.

4.1.4. Test of Level of Agreement on Consultants' Factors Causing Change Orders

To test the level of agreement between the client, consultant and contractor, the Kendall's coefficient of concordance was used and the results were as shown in Table 4-4. It was revealed that there was strong correlation (0.916) between contractors and Consultants, and a weak correlation of 0.549 between contractors and clients.

Kendall's Coefficient of Correlation for Consultant related causes of Change Order

Correlation					
			Client	**Consultant**	**Contractor**
Kendall's tau_b	Client	Correlation coefficient N	1.000 5	.756** 9	.549** 16
	Consultant	Correlation coefficient N	.756** 5	1.000 9	.916** 16
	Contractor	Correlation coefficient N	.549** 5	.916** 9	1.000 16
******.Correlation is significant at the 0.01 level (2-tailed)					

This finding on strong correlation of the views of the Owners, consultants and those of the contractors regarding Owner's causes of change orders in construction projects in Rwanda is baffling given the often perceived adversarial relationship between the three parties in any given construction project. This could be interpreted to mean that the Consultants do not fully appreciate the factors that give rise to change in his project, hence his immense contribution to the occurrence of change orders.

4.1.5. Most Contractor's related causes of Change Orders in construction

The five most important Contractor's related causes of change orders in construction projects in Rwanda were found to be: 1) Lack of contractor's involvement in design RII= 0.973, 2) Contractor's financial difficulties and Contractor's lack of required data RII= 0.933, 3) Contractor's desired profitability RII= 0.927, 4) Fast track construction RII= 0.913, 5) Poor procurement process and Differing site conditions RII= 0.907.

Contractor's related causes of Change Order	**Overall**		**Client**		**Consultant**		**Contractor**	
	RII	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**
Lack of contractor's involvement in design	0.973	1	0.933	1	0.978	1	0.978	3
Contractor's financial difficulties	0.933	2	0.8	4	0.911	2	0.967	4
Contractor's lack of required data	0.933	2	0.733	5	0.911	2	0.978	3
Contractor's desired profitability	0.927	3	0.667	6	0.911	2	0.978	3
Fast track construction	0.913	4	0.667	6	0.867	4	0.978	3
Poor procurement process	0.907	5	0.533	7	0.867	4	0.989	1
Differing site conditions	0.907	5	0.533	7	0.867	4	0.989	1

4.1.6. Test of Level of Agreement on Contractor's Factors Causing Change Orders

To test the level of agreement between the client, consultant and contractor, the Kendall's coefficient of concordance was used and the results were as shown in Table 4-6. It was revealed that there was strong correlation (0.832) between contractors and Consultants, and a weak correlation of 0.618 between Owners and consultants.

Kendall's Coefficient of Correlation for Contractor's related causes of Change Order

Correlation					
			Owners	**Consultants**	**Contractors**
Kendall's tau_b	Owners	Correlation coefficient	1.000	.618**	.696**
		N	5	9	16
	Consultants	Correlation coefficient	.618**	1.000	.832**
		N	5	9	16
	Contractors	Correlation coefficient	.696**	.832**	1.000
		N	5	9	16
******.Correlation is significant at the 0.01 level (2-tailed)					

This finding on strong correlation of the views of the Owners, consultants and those of the contractors regarding Consultants' causes of change orders in construction projects in Rwanda is baffling given the often perceived adversarial relationship between the three parties in any given construction project. This could be interpreted to mean that the contractors do not fully appreciate the factors that give rise to change in project, hence his immense contribution to the occurrence of change orders.

4.1.7. External Factors causing Change Order

In addition to the Clients, Consultants, and Contractors related factors causing change orders in the construction projects, this research outlined as well the external factors contributing to the change orders. The findings of these factors were illustrated under the table 4.7 below:

External Factors causing Change Order	**Overall**		**Clients**		**Consultants**		**Contractors**	
	RII	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**
Change in economic conditions	0.893	1	0.733	2	0.822	3	0.922	1
Weather condition	0.807	2	0.867	1	0.889	1	0.756	2
Safety consideration	0.767	3	0.533	4	0.778	4	0.744	3
Unforeseen problems	0.687	4	0.533	4	0.844	2	0.633	5
Socio-cultural factors	0.66	5	0.667	3	0.6	5	0.689	4
Change in government regulations	0.52	6	0.4	5	0.556	6	0.522	6

4.1.8. Test of Level of Agreement on External Factors Causing Change Orders

To test the level of agreement between the client, consultant and contractor, the Kendall's coefficient of concordance was used and the results were as shown in Table 4-8. It was revealed that there was strong correlation (0.772) between contractors and Clients, and a weak correlation of 0.528 between Owners and consultants.

Correlation					
			Client	**Consultant**	**Contractor**
Kendall's tau_b	Client	Correlation coefficient N	1.000 5	.528** 9	.772** 16
	Consultant	Correlation coefficient N	.528** 5	1.000 9	.607** 16
	Contractor	Correlation coefficient N	.772** 5	.607** 9	1.000 16
******.Correlation is significant at the 0.01 level (2-tailed)					

This finding on strong correlation of the views of the Clients and Contractors regarding External causes of change orders in construction projects in Rwanda is baffling given the often perceived adversarial relationship between the three parties in any given construction project. This could be interpreted to mean that the consultant do not fully appreciate the factors that give rise to change in project due to external influence.

CONCLUSION AND RECOMMENDATION

5.1. INTRODUCTION

This chapter presents the summary of the research work undertaken, and on the basis of the study findings draws conclusions about the study's objectives, and makes recommendations as an outgrowth of the study. Additionally, it discusses the implication (s) of the findings for policy in the Rwandan construction industry and concludes by suggesting area (s) for further research.

5.2. SUMMARY OF THE FINDINGS

5.2.1. Clients 'related Factors causing change orders in construction project

The first objective of this study was to measure the possible causes of change orders in construction projects in Rwanda.

The respondents were requested to rank the eight factors that contribute to change orders using the five point Likert scales of 5- extremely contributing through to 1- Least contributing according to their experience. The Likert scale was computed into a relative importance index (RII). Using the RII, it was possible to isolate five most important factors causing change orders in construction projects.

The study findings indicated the five most important factors causing change orders in construction projects are: 1) Owner's financial problem, 2) Inadequate project objectives, 3) Change of plans or scope by owner, 4) Replacement of materials or procedures, 5) Changes in specifications by owner.

The Kendall coefficient of concordance was applied to compare the perception of the three contracting parties namely; client, consultant and contractor on the factors causing change orders in construction projects in Rwanda. The findings of the study show that there is a strong correlation of 0.798 between the Clients and the contractors. However, a weak correlation of 0.703 was reported between the Consultants and Contractors.

5.2.2. Consultants related factors causing change orders in construction projects

The respondents were requested to rank the five out of nineteen most factors that contribute to change orders using the five point Likert scale of 5- extremely contributing through to 1- Least contributing according to their experience. The Likert scale was computed into a relative importance index (RII).

The study findings indicated the five most important factors causing change orders in construction projects are: 1) Change in design by consultant, 2) Errors and omissions in design, 3) Conflicts between contract documents, 4) Value engineering, 5) Inadequate working drawing details.

The Kendall coefficient of concordance was applied to compare the perception of the three contracting parties namely; client, consultant and contractor on the factors causing change orders in construction projects in Rwanda. The findings of the study show that there is a strong correlation of 0.916 between the consultants and the contractors. However, a weak correlation of 0.549 was reported between the Clients and Contractors.

5.2.3. Contractors related factors causing change orders in construction projects

Nineteen factors contributing to change orders were extracted from literature review, and the respondents were requested to rank these factors according to the level of contribution to change orders. Using the five point Likert scale of 5- extremely contributing through to 1- Least contributing according to their experience, The Likert scale was computed into a relative importance index (RII). Using the RII, it was possible to isolate five most important factors causing change orders in construction projects.

The study findings indicated the five most important factors causing change orders in construction projects are: 1) Lack of contractor's involvement in design, 2) Contractor's financial difficulties and Contractor's lack of required data, 3) Contractor's desired profitability, 4) Fast track construction, 5) Poor procurement process and Differing site conditions.

The Kendall coefficient of concordance was applied to compare the perception of the three contracting parties namely; client, consultant and contractor on the factors causing change orders in construction projects in Rwanda. The findings of the study show that there is a strong correlation of 0.832 between the Clients and the contractors. However, a weak correlation of 0.618 was reported between the Clients and Consultants.

5.3.4. External factors causing change orders

Six external factors causing change orders were elaborated from literature review, and the respondents were requested to rank these factors according to the level of severity in causing change orders. Therefore, five point Likert scale of 5- extremely contributing through to 1- Least contributing according to their experience, The Likert scale was computed into a relative importance index (RII). Using the RII, it was possible to isolate five most important factors causing change orders in construction projects.

The study findings indicated the five most important factors causing change orders in construction projects are: 1) Change in economic conditions, 2) Weather conditions, 3) Safety consideration, 4) Unforeseen problems, 5) Change in government regulations.

However, Kendall coefficient of concordance was applied to compare the perception of the three contracting parties namely; client, consultant and contractor on the factors causing change orders in construction

projects in Rwanda. The findings of the study show that there is a strong correlation of 0.772 between the Clients and the contractors. However, a weak correlation of 0.528 was reported between the Clients and Consultants.

5.3. CONCLUSION

In conclusion, three projects were taken under this research as case study. Firstly, all the contracting parties of the construction projects namely Clients, Consultants, and Contractors were requested to rank the Clients related factors caused the design change of the undertaken projects. These following factors were recorded as the most Owners causative factors of the change orders: 1) Owner's financial problem, 2) Inadequate project objectives, 3) Change of plans or scope by owner, 4) Replacement of materials or procedures, 5) Changes in specifications by owner.

Secondly, Clients, Consultants and Contractors were requested to rank the Consultants related factors caused change orders on the construction projects under the case study. The respondents reported that the following factors are the most important factors caused change orders: 1) Change in design by consultant, 2) Errors and omissions in design, 3) Conflicts between contract documents, 4) Value engineering, and 5) Inadequate working drawing details.

Thirdly, the respondents were as well requested to rank the contractors related factors caused change orders for the construction Murunda, Ruhango and Rusebeya handcraft centers. The most important Contractors related factors causing change orders are: 1) Lack of contractor's involvement in design, 2) Contractor's financial difficulties and Contractor's lack of required data, 3) Contractor's desired profitability, 4) Fast track construction, 5) Poor procurement process and Differing site conditions. Lastly, external causative factors of change orders were noted as follow: 1) Change in economic conditions, 2) Weather conditions, 3) Safety consideration, 4) Unforeseen problems, and 5) Change in government regulations.

In addition, the respondents were requested to rank the consequences accruing from change orders based on their severity. The records from survey are: 1) Loss of productivity, 2) Delay in project execution, 3) Additional project budget, 4) Waste of materials, 5) Delay in payment and 6) Disputes among projects teams.

5.4. RECOMMENDATIONS

A) Recommendations for Owners

In order to reduce change orders and their accruing consequences, Clients are recommended to do the following:

- Get involved in the design at an early stage to make sure it meets all requirements.
- Stop the work in the project if it doesn't meet the scope to avoid large cost overruns.
- Hire experienced consultants, contractors, and construction managers to avoid work repetition.
- Meet with the contractor regularly to avoid any deviations from the agreed upon work scope.

B) Recommendations for Consultants

In order to reduce change orders, consultants are recommended to do the following:

- Understand the owner's scope of work thoroughly to avoid design changes.
- Use updated lists of materials to avoid erroneous material specifications.
- Avoid miscommunications between the design team members (Architects, MEP, Structural engineers) to reduce change orders.

C) Recommendations for Contractors

In order to reduce change orders, contractors are recommended to do the following:

- Follow the owner's instructions and scope of work as much as possible.
- Be up to date with all government regulations.
- Hire experienced workers, engineers, Architects, Quantity Surveyors and construction managers to avoid work repetition.
- Stop using change orders as a way to make more profit from the project.
- Avoid increasing working hours and overtime to complete the work.
- Check the project site before starting the project to estimate the work correctly and to avoid future change orders.

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