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Diagnoses the Causes of Cost Deviation in Iraqi Construction Projects

Eman A. Mahde*, Nidal A. Jasim

Department of Civil Engineering, University of Diyala, 32001 Diyala, Iraq

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ABSTRACT

There are challenges with cost deviation and time overruns in every project in the building sector, whether they're residential projects, infrastructure projects, or anything else. The study aims to find the causes of cost deviation in a construction project. The researcher depends on Root Cause Techniques. These techniques are a good choice for diagnosing the root causes of cost deviation in a construction project. Many roots cause analysis tools have emerged from the literature as generic standards for identifying root causes such as the Fishbone diagram, Pareto diagram, and the 5-Why analysis. This study diagnosed nineteen causes of cost deviation in the selected project (Dar Al-Nahrain building), These causes are divided into three main groups (planning causes, designing causes, and execution causes). Pareto analysis showed that ten causes out of nineteen causes represent the most important causes of cost deviation. According to the Pareto chart above, the designing causes group (C2) and the planning cause group (C1) are responsible for 80% of the problem. As a result, by focusing on these two main causes, 80% of the project deviation of the problem would be solved in the construction projects. The results filtered by using the 5-Why analysis; this analysis concluded that the cost deviation in the project was due to insufficient information about the project is a root cause for planning causes group, while the owner requirements unclear is a root cause for designing causes group and finally, changes in orders are the root cause for execution causes group.

1. Introduction

The project will be successful if its technical objectives are combined with its budget and if it is not exceeded, so it is difficult to imagine the existence of a construction project that is conducted without deviation in its cost, these deviations are either in the design stage, planning stage and implementation stage due to different causes such as poor management, poor monitoring, and poor supervision. Therefore, the main problem in cost deviation is the use of traditional estimation methods or formulas for cost estimation. In Iraq, there are numerous problems that occur during the selection process for project criteria and their proper evaluation: [1]and [2]:

1. The lack of modern and advanced means of estimating the project cost.
2. The lack of an integrated database for the project
3. Not using engineering alternatives in the planning, design, and implementation stages, and as a result of what was mentioned above, in addition to many reasons related to unstable construction conditions.

Most construction projects include a distinct set of tasks that must be completed in order to produce a distinct product. New buildings and structures, additions, adjustments, conversions, expansions, reconstruction, renovations, significant replacements, and mechanical and electrical installations are all examples of

* Corresponding author.
E-mail address: affulla770@gmail.com
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construction projects. Controlling costs and timeliness is critical in the construction business to ensure that projects are finished on time and on a budget [3] .

Generally, the success of a construction project is judged by the project's capacity to meet the client's objectives for cost, schedule, safety, resource allocation, and quality. In (2001), Kagioglou, Cooper, and Aouad [4], confirm that a successful project is one that has met its technical objectives, stayed on schedule, and stayed within budgetary constraints. According to Rahman et al. (2012) support the idea that on-time and on-budget performance is the most important criterion for a project's success.

In (2010), Olawale and Sun [5], showing that the construction sector as a whole has been considered as having poor performance, which has resulted in an inability to achieve efficient cost performance. As a result, most construction projects confront significant cost variance.

In (2013), Ameh, Soyingbe, and Odusami [6], explain that the history of the construction business worldwide is littered with projects that were finished with large cost overruns.

In (2016), Faiq and Reem [2], studied the condition of cost management in Iraqi highway construction projects. The survey involved examining and analyzing the reality of cost planning and control, as well as determining the causes of construction cost deviations. Causes of cost deviation were examined and collected through personal interviews and questionnaires with site engineers, as well as a review of existing research.

In Iraq, the construction sector encountered a number of challenges and issues that prevented project management approaches from being used in construction projects. In this study, the author attempted to employ a variety of novel methods for identifying problems and impediments in building projects before making ideas for a simple application for one of the project management approaches [7].

Because the scheduling of critical decisions can have a major impact on costs, it's important to identify elements that influence overall project costs early on. Based on an analysis of data from several projects, this report reveals major cost-influencing aspects. This study's database contained information on project characteristics, building parameters, dimensions, and expenses across numerous stages of the project life cycle, from programming through activation [8].

In (2020), Mustafa, and Sedqi [9], explain that many highway projects suffer from corruption factors in the contractor selection phase, many tools techniques were used for the root cause analysis techniques like Fishbone, Pareto chart, and 5-Why to diagnosis the project cost deviation.

Based on a survey of the literature and some discussions with project managers, the research problems are stated as follows:

- There is a deficiency in documenting previous project cost records, as well as a lack of data on construction project management.
- Because the currently available techniques are poor and suffer from several limitations such as being traditional, old, slow, and uncertain, there is a weakness in the assessment of the cost of construction projects. Aside from the need for contemporary, efficient cost estimating techniques, which have various advantages such as being modern, fast, accurate, flexible, and simple to use, there is also a demand for modern, efficient cost estimating approaches. As a result, as a modern method in the construction business, root cause analysis methodologies must be used to assure successful management.
- Despite the need for service construction projects in the present decade, the projects are being granted to project managers who have insufficient information to perform these projects.

Significant research described as follows:

- The cost deviation for construction projects is highlighted in this study and find the correct ways to reduce this deviation.
- It provides a real understanding of the problems experienced by project managers and planners to overcome and eliminate these obstacles while using the cost

management approach for construction projects.

The study was restricted to the following parameters:

- Time limitations: data collection began in 2020.
- Spatial limits: This research focused on the Dar Al-Nahrain printing project in the Republic of Iraq.
- To achieve the study's objective, research use a three-step methodology:
- Review of the literature
- Questionnaire and personal interviews with engineers of construction projects with specific specializations, as described in reference [2]
- Statistical Analysis

Finally, the aims of this paper are to determine and diagnose the causes of cost deviation in construction projects through various groups (planning causes, designing reasons, and execution causes), calculate the relative importance of each cause, and finding out realistic solutions that reduce cost deviation the project.

2. Methodology

In this study, the researcher used statistical analysis and identified the most affecting factors on cost deviation of the project construction.

The first part of the questionnaire related to the personal information of the respondents about his scientific and expertise and the institution in which he works. Then, open questionnaires are defined as free-form survey questions that allow a respondent to answer in open text format such that they can answer based on their complete knowledge and understanding [10].

In the work sector, a questionnaire was distributed to specialized engineers and engineering experts in a construction project. level of percentage 100 percent is shown in Figure (1).

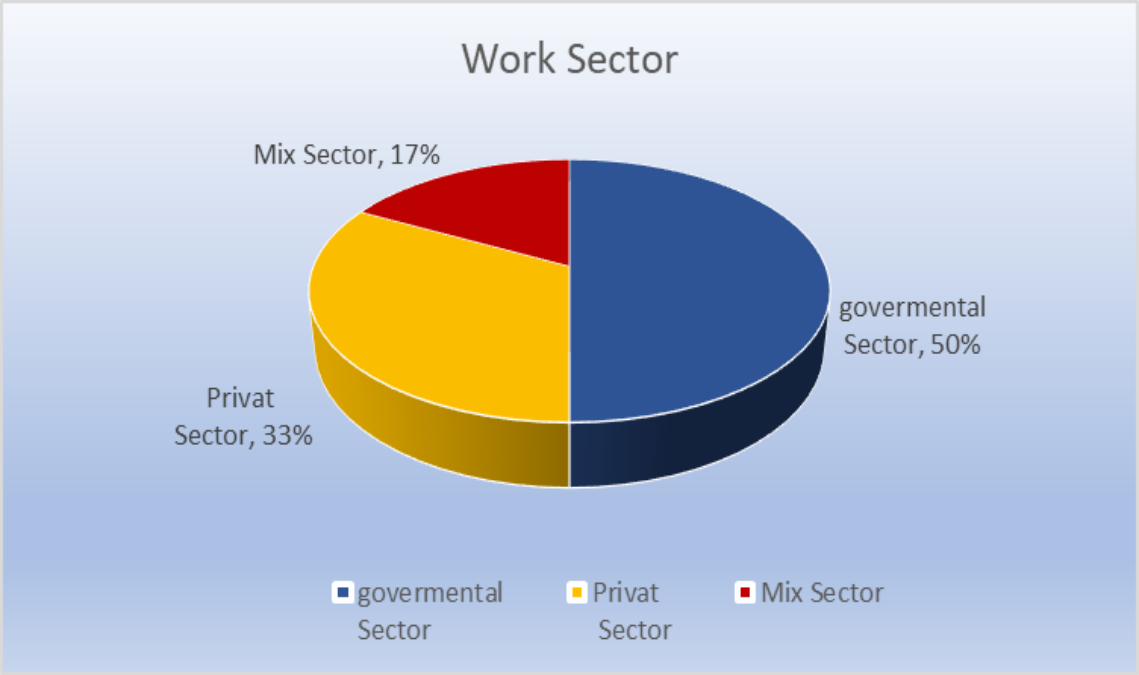

Figure 1. Work sector

The distribution of the research sample administrative level of Percentages 100 percent (50 total number) is shown in Figure (2).

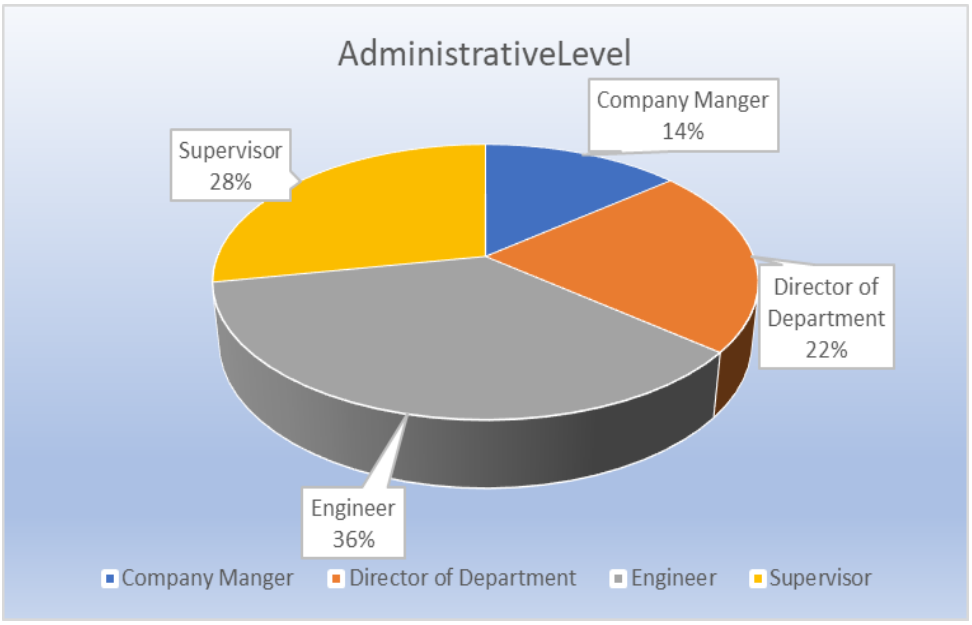

Figure 2. Administrative level

Figure (3) shown years of experience and the distribution of the research sample's experience percentage (50 total number).

Figure 3. Years of experience

The researcher follows up the same procedure by Al- Zwainy and Neran [11],and Nidal [12]who they diagnosed the causes of projects deviation by selecting a number of factors that had been identified through previous studies and the sources that have been found, and accordingly, these interviews were conducted for the purpose of taking the opinion of experts to know the extent of the importance of each factor on the construction project. Finally, a list of factors that affect the cost of the project was prepared. The methodology can be summarized in Figure (4).

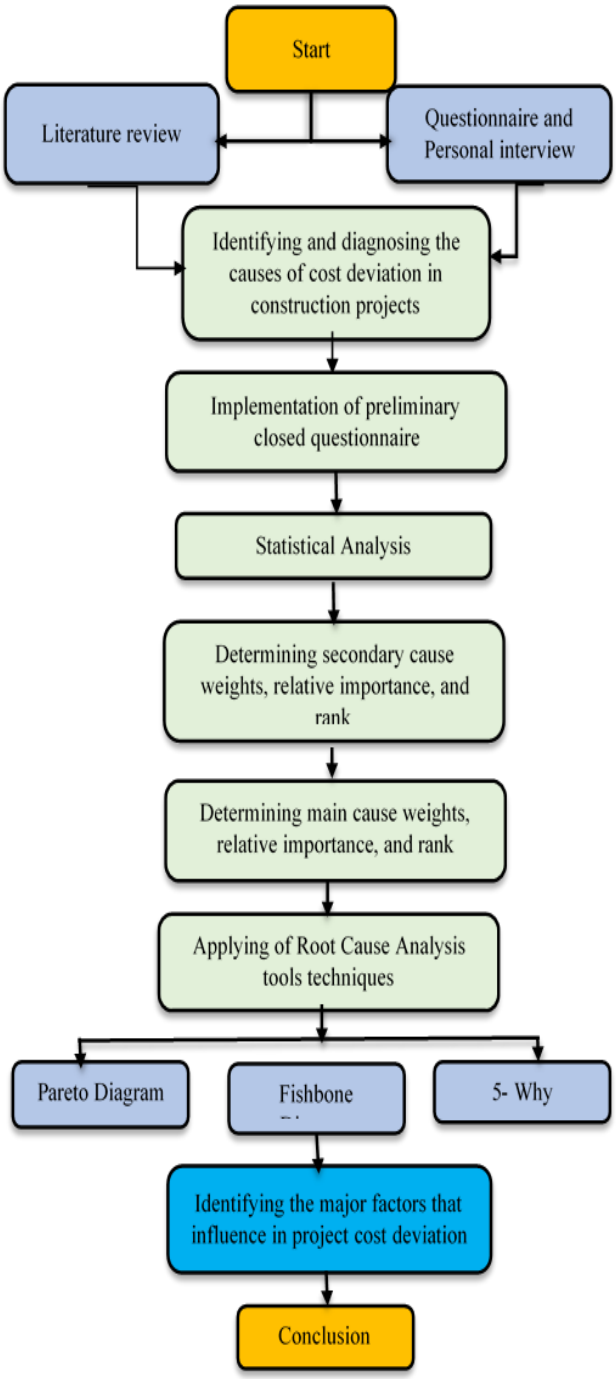

Figure 4. Research methodology

The second part of the questionnaire consists of nineteen causes, from this part, the researcher has identified the most influential factors on the selected project (Dar Al-Nahrain building) in Iraq, as shown in Table (1) and by using statistical analysis techniques, compute the weight of secondary causes, relative important index (RI %) and Rank.

After that, the reasons for the cost deviation were divided into three groups, which are in the planning, design, and implementation stage.

3. Concept of root cause analysis

The Root Cause Analysis (RCA) is a method that is used to a dress a problem or non-conformance, in order to get the "root cause" for the problem [13]. RCA is a popular technology and is often used to help people answer the why

question. RCA seeks to identify the origin of the problem by using a specific set of related steps in order to find the main cause of the problem. The works of this technique can be summarized as shown in Figure (5). This technology has the potential to be applicable not only to engineering but also to other disciplines [14]; [15]. This method can be used to resolve problems when the "root cause" of the issue cannot be reached. RCA is used to eliminate or mitigate the cause of the problem and prevent it from repeating. RCA is simply a collection of well-known techniques that can be used to produce a structured, quantitative, and documented approach to defining, understanding, and resolving the fundamental causes of project cost deviation [14]. Root cause analysis is more than just a phrase; it is a formal and well-structured methodology that is used as part of a total quality management approach [16].

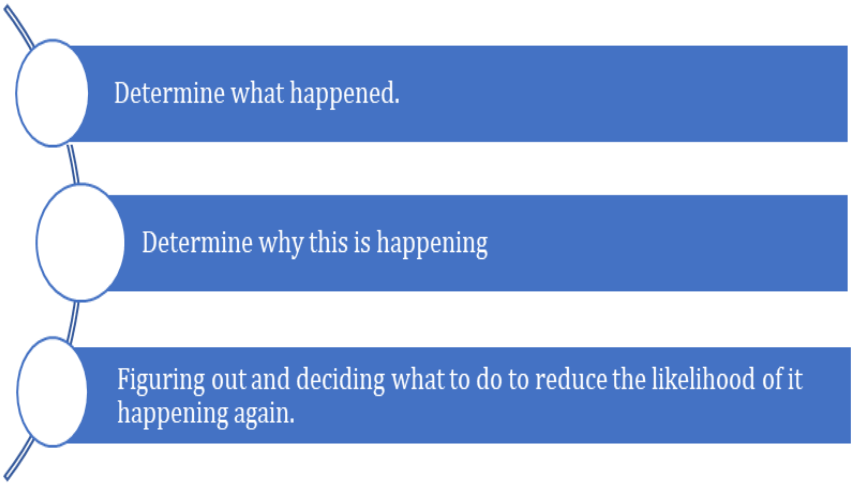

Figure 5. Workflow of RCA

4. Techniques of root cause analysis

Numerous tools are available for RCA techniques. Pareto Analysis, Causal Tree, Brainstorming, Nominal Group Technique, and 5-Why Analysis are all examples of creative thinking. The researcher will concentrate on Fishbone Diagrams, Pareto Diagrams and 5-Whys technique in this study. The study included investigating, evaluating, controlling costs, and determining the causes that lead to cost deviation [17].

4.1 Fishbone diagram

Diagrams are known as Ishikawa diagrams, cause-and-effect analysis, or fishbone diagrams because the final diagram resembles a fish's skeleton [14]. The cause-and-effect diagram provides a structured approach to searching for possible causes of a problem. This tool is often used after performing a Pareto analysis or brainstorming to arrange the resulting ideas [17]. This type of graph is used to identify all the causes that contribute to the occurrence of the problem and thus find solutions

4.2 Pareto diagram

Pareto analysis is used to focus on the most important problems, the Pareto concept that appeared in the 9th century by the Italian economist scientist, Philfredo Barreto, which shows that a small number of factors causing the problem represent a large proportion of the total cases (such as complaints, defects, and problems), that is, the classification of cases according to the degree of importance and focus on solving the most important problem and leaving the less importance [18].

4.3 5- Why technique

It is one of many brainstorming approaches that involves continually asking "why" five times to assist find the fundamental cause of a problem. When a problem is repeatedly questioned, a new solution appears each time, which is linked to the root cause. However, the

question of why can be continued until an acceptable solution is found. The number five is chosen at random. The theory goes that if you question "why" five times, you'll eventually find the core cause [19].

5. Diagnose the causes of cost deviation in construction project by using root causes

In order for the researcher to obtain the root causes that lead to cost deviation in construction projects, a survey analysis approach was used to determine the weight of each cause and these reasons are important in root cause analysis.

In this study, the researcher relied on a literature review, questionnaire, and personal interviews with experts. Causes of the cost deviation in Dar Al- Nahrain building project under different groups had been deduced (planning causes, designing causes, and execution causes) as it is shown in Table 1. below:

Table 1: Main and secondary causes of cost and schedule deviation

Main causes	Symbol	Secondary causes	Symbol
Planning reasons	C1	Inflation or changes in the cost of raw material.	C11
		Deficiencies in general contractor's organization	C12
		Poor contract administration	C13
		Insufficient information about the project	C14
		The implementation method is not appropriate with the project type	C15
		The contracting type's incompatibility with the project type	C16
Designing causes	C2	Owner requirements unclear	C21
		Design changes	C22
		Mistakes in design documents	C23
		Unrealistic tender cost estimation	C24
Execution causes	C3	Site incidents and delays due to lack of safety measures	C31
		Changes in orders	C32
		failure to agree and conflict management	C33
		Issues of imported materials and restrictions	C34
		The late delivery of materials and equipment	C35
		Frequent breakdowns of construction equipment	C36
		Lack in general employment	C37
		Lack of skilled labor	C38
		Project environment conditions	C39

5.1 Secondary planning causes analysis

The researcher found that the planning reasons (C1) consist of (6) causes which are arranged in Table 1. and Table 2. with mentioning the weights (note: the weights represent the results of the field survey) in addition to the relative importance and arrangement of each factor within the planning group. Figure (6) and Figure (7) show the Fishbone diagram and Pareto diagram for planning causes.

Table 2: Weights, relative important and Rank for secondary planning causes

Main Causes	Secondary Causes	Weight of secondary causes	Relative important index RI (%)	Rank
Planning reasons	C11	63.66	12.95	5
	C12	55.45	10.1	6
C1	C13	81.55	20.78	2
	C14	86.98	22.71	1
	C15	70.77	15.88	4
	C16	74.67	17.58	3
∑		433.08	100	

We note from the Pareto chart, that the most influential reason is insufficient information about the project (C14), Poor contract administration (C13), the contracting type's incompatibility with the project type (C16), and the implementation method is not appropriate with the project type (C15). These causes are responsible for (70%) of the deviation of the cost of the project so that we must be focus is on the percentage (70%) to solve the problems related to planning reasons.

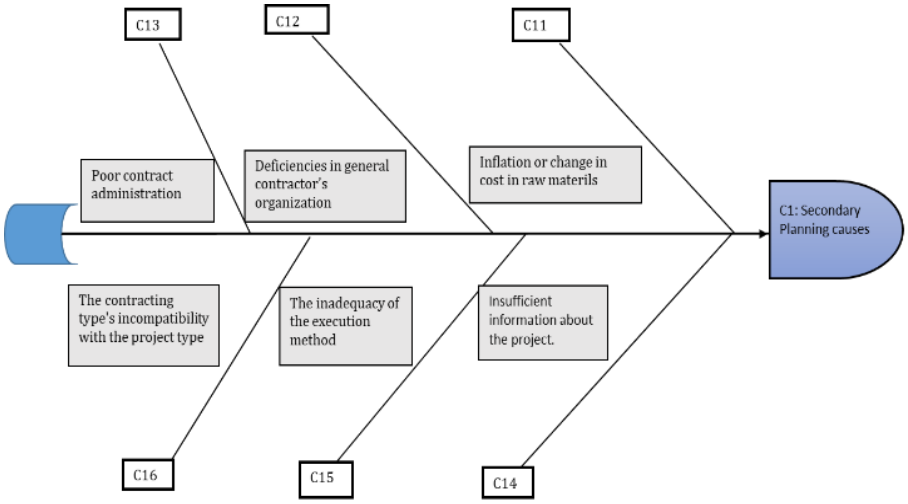

Figure 6. Fishbone diagram for secondary planning causes

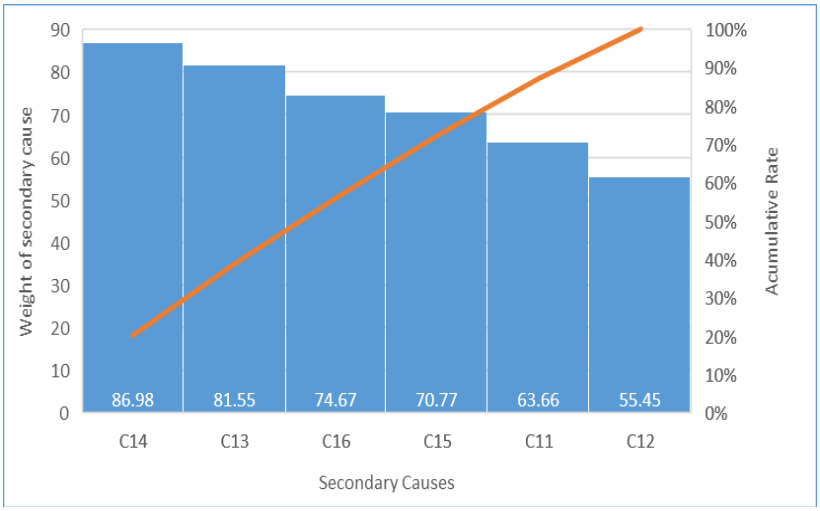

Figure 7. Pareto chart for secondary planning causes

5.2 Secondary designing causes analysis

The design group (C2) consists of 4 causes arranged in Table 1 and Table 3 showing the weights and relative importance and the arrangement of each factor in the design group. Figure (8) shows the Fishbone diagram and Figure (9) shows the Pareto Chart.

Table 3: Weights, relative important and rank for secondary designing causes

Main Causes	Secondary Causes	Weight of secondary causes	Relative important index RI (%)	Ranking
Designing reasons	C21	66.34	15.67	4
	C22	80.34	27.3	2
C2	C23	85.75	36.48	1
	C24	76.65	20.55	3
∑		309.08	100	

The researcher concluded from the Pareto diagram the mistakes in design documents (C23), design changes (C22), and unrealistic tender cost estimation (C24) are responsible for (68%) of the deviation of the project cost. so that, focusing on these problems (68%) will lead to solving the problem of cost deviation in the project.

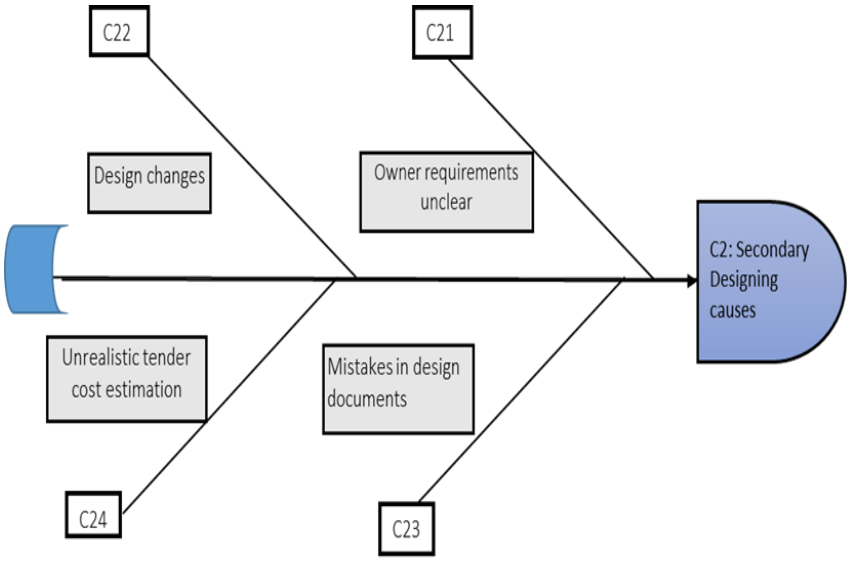

Figure 8. Fishbone diagram for secondary designing causes

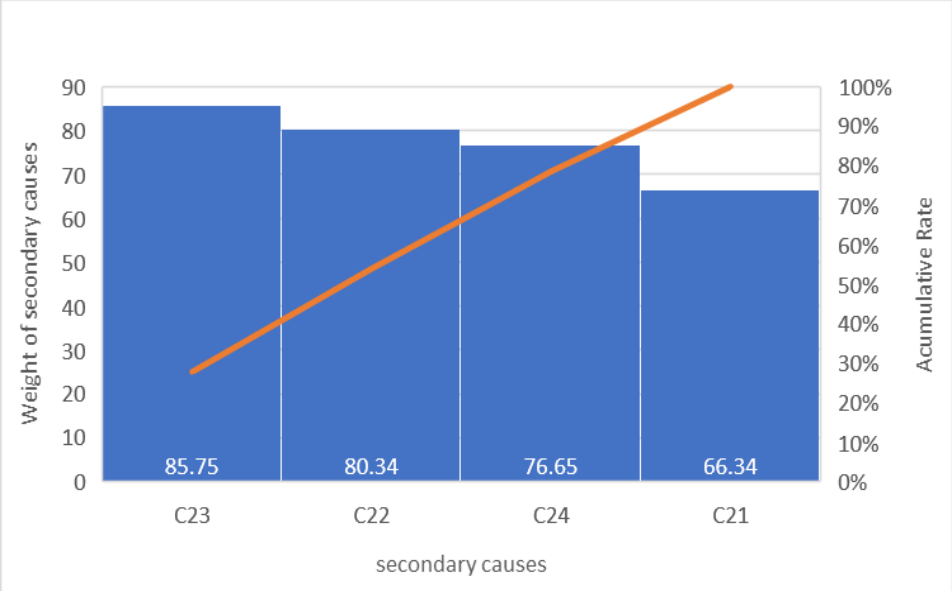

Figure 9. Pareto chart for secondary designing causes

5.3 Secondary execution causes analysis

The group of reasons for implementation (C3) consists of (11) reasons referred to in Table 1. and Table 4. showing the weights for each reason and their arrangement within the implementation group. Figure (10) shows the Fishbone diagram and the Figure (11) shows the Pareto Chart to analyze the group of reasons for execution.

Table 4: Weights, relative important and rank for secondary execution causes

Main Causes	Secondary causes	Weight of secondary causes	Relative important index RI (%)	Ranking
Execution reasons	C31	70.12	10.78	5
	C32	75.79	12.33	4
	C33	86.75	16.56	2
C3	C34	88.56	18.55	1
	C35	68.55	9.5	6
	C36	78.45	14.54	3
	C37	55.88	5.23	8
	C38	65.55	8.23	7
	C39	48.23	4.28	9
∑		637.88	100	

The researcher observed through the Pareto chart that the most influential reason is issues of imported materials and restrictions (C34), failure to agree and conflict management (C33) frequent breakdowns of construction equipment (C36), Changes in orders (C32), Finally, site incidents and delays due to lack of safety measures (C31)which constitute a percentage (68%) responsible for the deviation of the cost of the project, so that we must focus is on the percentage (68%) to solve the problems related to execution causes.

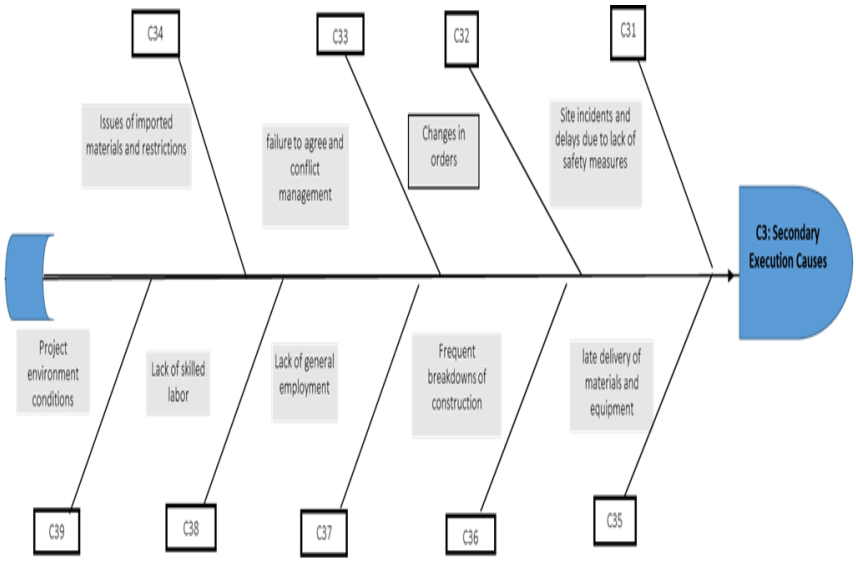

Figure 10. Fishbone diagram for secondary execution causes

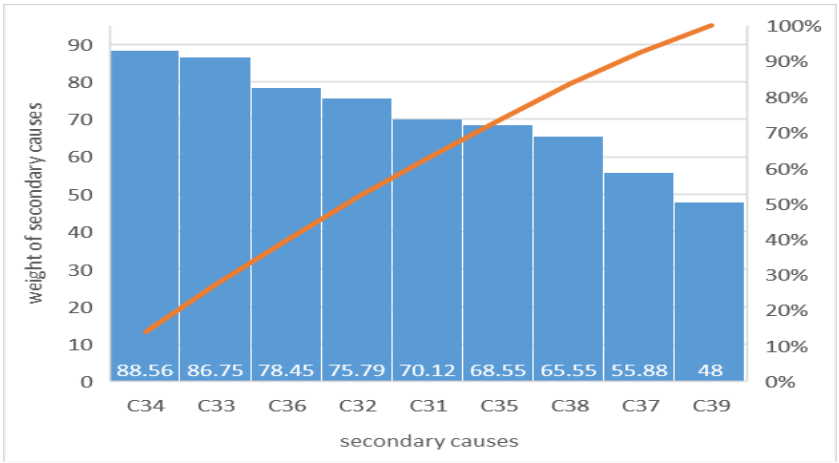

Figure 11. Pareto chart for secondary execution causes

5.4 Analysis of main causes

As explained previously, the main causes of cost deviation have been divided into three groups in projects (C1, C2, and C3) with secondary causes in each group. Table 5. Shows each of the average weights, relative importance and ranking for main causes. From Table 5., we note that the highest average weight is the group of design causes, followed by the group of planning causes, and finally the group of execution causes. Figures (12) and (13) show the fishbone diagram and Pareto chart for main group's analysis, respectively.

Table 5: Weights, relative importance and rank for Main causes

Main causes groups	Secondary causes	Average weights of main causes	RI%	Rank
	C11			
Planning Causes	C12			
C1	C13	72.18	35.66	2
	C14			
	C15			
	C16			
Designing Causes	C21			
C2	C22	77.27	40.22	1
	C23			
	C24			
Execution Causes	C31			
	C32			
C3	C33			
	C34	66.47	24.12	3
	C35			
	C36			
	C37			
	C38			
	C39			
		215.92	100	

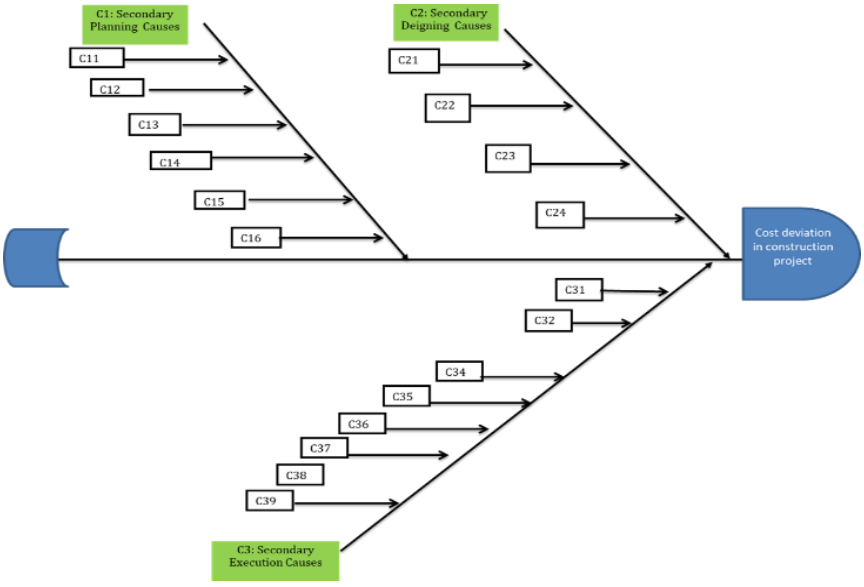

Figure 12. Fishbone diagram for cost deviation causes

According to the Pareto chart above, the designing causes group (C2) and the planning causes group (C1) are responsible for 80% of the problem. As a result, by focusing on these two main causes, 80% of the project deviation problem would be solved in the construction projects as shown in Figure (12).

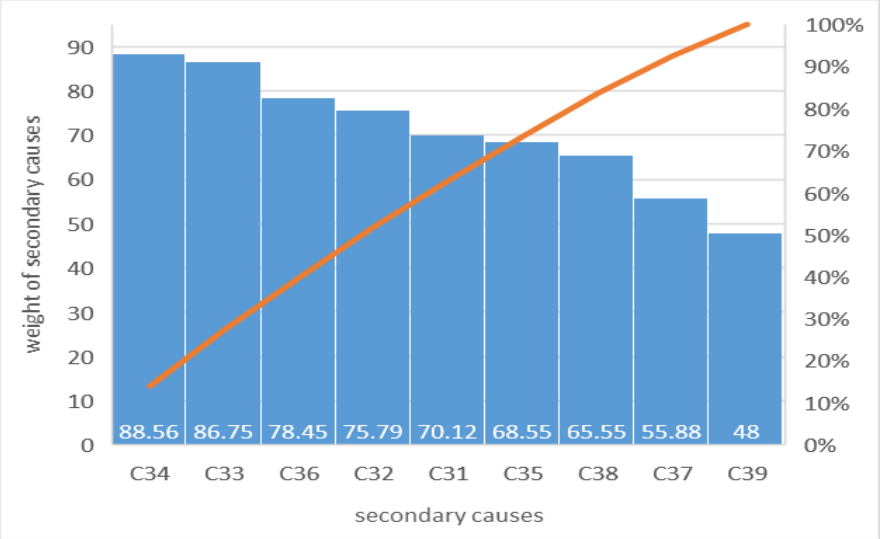

Figure 12. Pareto chart for cost deviation in construction project

6. Using the 5-Why technique

This technique is one of the simplest tools and easy to complete without statistical analysis. The researcher used the 5-Why technique to find the root causes of cost deviation in construction projects and problem-solving [20]. The number five is chosen at random. The theory goes that if you ask "why" five times, you'll eventually find the root cause. The 5 Why method is often used during the analysis phase in coordination with other analysis tools such as the Cause-and-Effect Diagram but can be used as a stand-alone tool. Sometimes we can get to the main cause of a problem by means of "3 or 4 Whys" .5 Why is it more effective when the answers are from people who have practical experience in the problem that is being addressed by repeating the question "why" (5), enabling us to reach the root cause of the problem. Figure (13) shown the technique of 5- Whys.

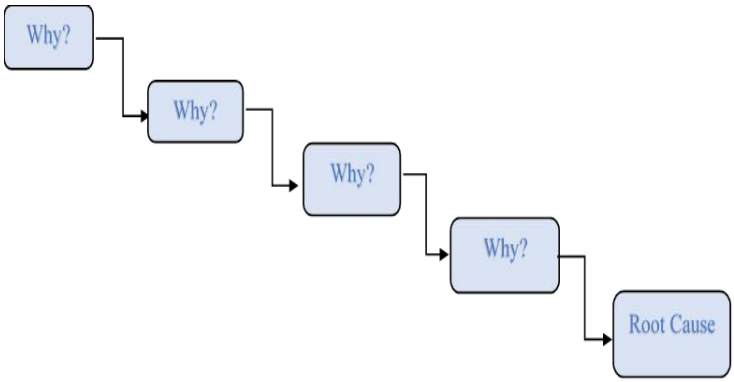

Figure 13. Technique of 5- whys

6.1 Analysis of "5 Whys" for secondary planning causes

Figure (14) shown "5 Whys" analysis for planning causes group. So, we found the root cause for cost and time deviation in this group among secondary planning reasons according to "5 Whys" analysis is the insufficient information about the project.

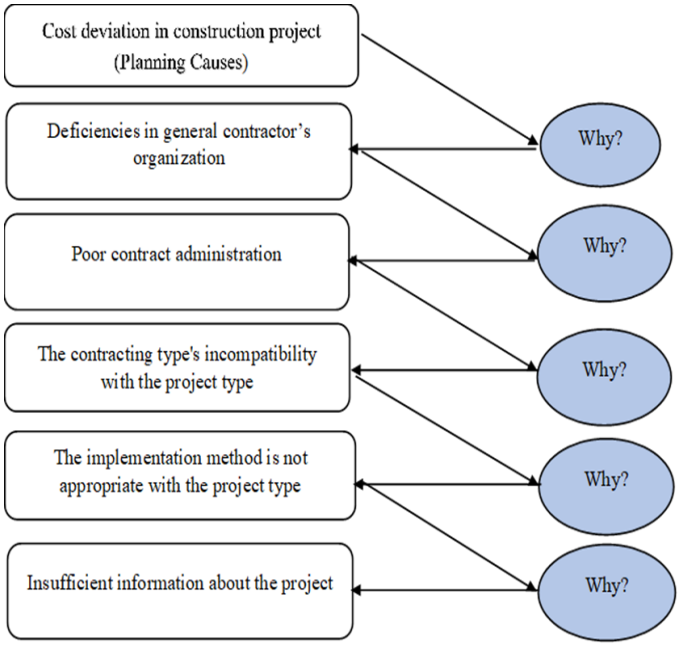

Figure 14. 5- Whys analysis for secondary planning causes

6.2 Analysis of "5 Whys" for secondary designing causes

With reference to what has been mentioned previously, Figure (15) showed the analysis of "4 causes" for designing causes. Therefore, we found the root cause of the deviation in this group among the causes of secondary designing causes according to the "5 Whys" analysis is the unclear owner requirements.

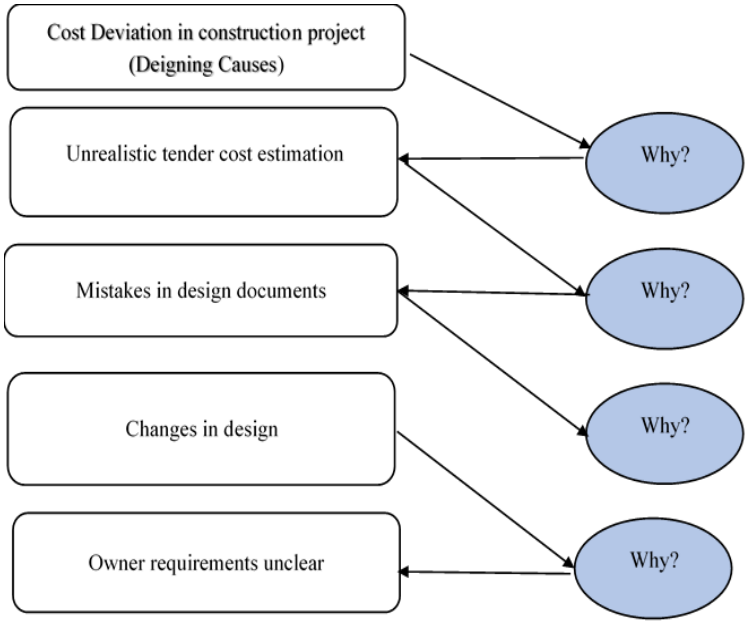

Figure 15. 5- Whys analysis for secondary designing causes

6.2 Analysis of "5 Whys" for secondary execution causes

Figure (16) showed the analysis of "5 whys" for execution causes. Therefore, we found the root cause of deviation in this group among the causes of secondary execution according to the "5 Whys" analysis is changes in orders.

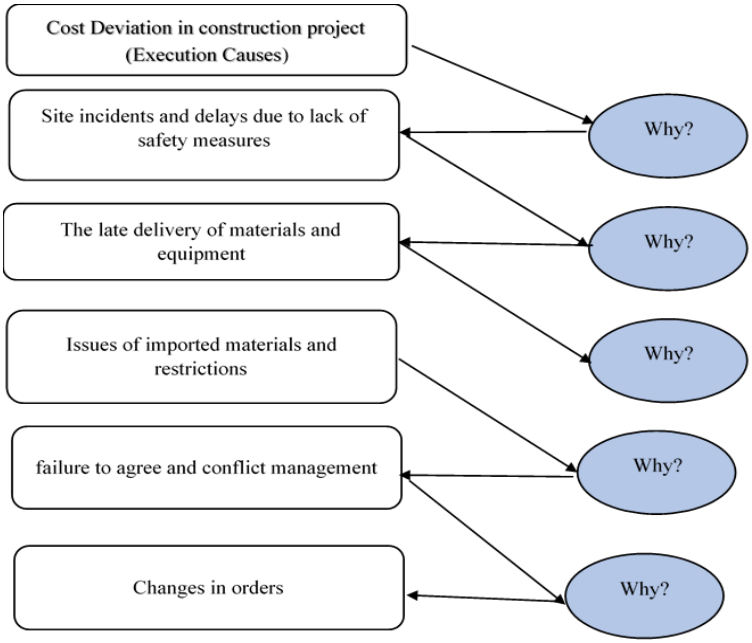

Figure 16. 5- Whys Analysis for secondary execution causes

Finally, for all secondary (planning, designing, and execution) groups, a 5-Why analysis was performed on the obtained results from the 5-Why analysis. This process is depicted in detail in Figure (17). According to the final 5-Why analysis, the root cause of the deviation in construction projects is "Owner requirements unclear".

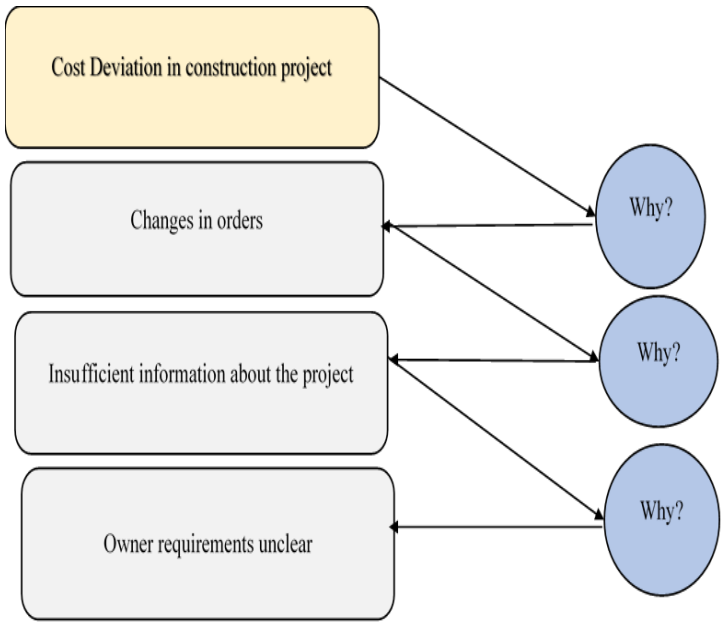

Figure 17. The analysis result of the "5 Whys" for main deviation in project

7. Conclusions

1- The root cause identification technique has been used in this study. The goal of this study is to determine the causes of cost deviation in selected case study (Dar Al-nahrain building), across various groups, such as the planning, design, and execution group. The identification of the root cause of project-related problems is a necessary stage toward cost control and improvement. The researcher used the Fishbone diagram (FD), Pareto diagram (PD), and the 5-Why

analysis to diagnose these causes in Iraqi construction projects

2- The study results were defined and diagnosed in general nineteen causes in project under the planning with six causes, designing with four causes and execution groups with nine causes; however, Pareto's analysis showed that only ten of the causes were the most important. The major causes concentrated in the designing and planning group.

3- The results filtered by using the 5-Why analysis; this analysis concluded that the cost deviation in the project was due to insufficient information about the project is root cause for planning causes group, while owner requirements unclear is root cause for designing causes group and finally, changes in orders are root cause for execution causes group.

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