

# The Critical Factors of Project Management in Sudanese Construction Projects

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**Abstract:** *The Sudanese construction sector is characterized by many small and large projects and high labor intensity, and accounted for 3.2% of the Sudanese country's GDP. The basic problems facing the Sudanese construction projects are the factors that affect on construction project performance. The objectives include identifying the factors affecting the performance of Sudanese construction projects, and to determine the critical factors. The literature review has been done to gather the information about the causes and their factors that affect on the performance of construction projects from the previous researches. The research methodology was conducted to gather the data by questionnaire which was examined to be reliable and valid according to statistical tests. The (34) factors were identified as factors affect on construction projects and the (10) factors were the critical factors which may lead to poor performance of Sudanese construction projects. This study has some conclusions such as the instrument for measuring the critical factors on the performance is reliable and valid, so the project management stage performance is 64.2%.*

**Key words:** *Critical Factors, Sudanese Construction Industry, Critical Causes, Performance.*

## I. INTRODUCTION

The Sudanese construction sector is characterized by many small and large projects and high labor intensity; it is also highly dependent on public regulations and public investments. The Sudanese construction industry also has a number of factories and material suppliers that provide building materials and specialist fittings. The scope of Sudanese construction industry is very wide, includes residential construction, building construction of commercial, irrigation, roads, tunnels, transportation, facility building, and heavy engineering construction refer to infrastructure construction and industrial construction. The construction sector is an important to the Sudan economy; the construction sector accounted for 3.2% of the country's GDP in 2009 and grew by about 10% in 2010 in nominal terms, according to the Central Bank of Sudan [1].

### A. Stages of Project Life Cycle

The construction project passes through several stages of its project life cycle such as: The Project Management stage (in this study) consists of planning and execution stages so; the pre-construction (planning) stage is the key to good project planning to anticipate potential problems before they become actual problems. And the execution stage begins with pre-construction meeting that essentially establishes the ground rules for working. In this stage the monitoring and control are the responsibility for comparing actual with planned performance and control denotes.

## II. LITERATURE REVIEW

In this study, The Project Management Process consists of planning and execution, so the planning processes performed to establish the total scope of the effort, define and refine the objectives, and develop the course of action required to attain those objectives. The planning processes develop the project management plan and the project documents that will be used to carry out the project.

### A. Project Planning Stage

In general, the owner may engage a construction manager to provide professional construction management services and to provide advice to the owner including cost, schedule, safety, the construction process and other considerations and to ensures the requirements of the construction contract [2,3].

It is important, the key elements of the recruitment and selection contractor may include clarity of nature vacancy to be filled, job description, personnel selection criteria, interview preparation, Responsibility Assignment Matrix (RAM), financial standing, technical ability, management capability, quality, safety, senior management and experience, tenure with firm, division of responsibilities, and Current projects/backlog [4,5]. Moreover, the turnover which is represented as the degree of individuals to quit the membership of a social system, detracts from the ability of companies and sites. The cost of turnover to organizations can be high [6,7]. There are several factors affecting on turnover such as Job Satisfaction and Organizational commitment.

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While the review of scope of work sets the parameters and constructability review for the construction project and identifies the work to be done, the scope describes the building layout, site of work, site work, number of rooms, number of floors, types of materials, dimensions, special equipment, storage requirements, WBS, and so on [8].

So, Contract Review is to ensure that the company understands customers' needs and has the capacity and capability to meet those needs [9]. The researcher noticed the most problems in Sudanese construction project associated with a project contract that should not specify the scope, requirements, detailed specifications, and this may lead to disputes between the contract parties.

In general, the site layout planning is often done manually by marking up a site drawing to show different overlapping laydown areas [10]. The jobsite layout plan includes the following: jobsite space allocation, jobsite access, material handling, worker transportation, temporary facilities, jobsite security, and signage and barricades [2]. Moreover, Material handling plan often causes many cases of ineffective construction project, much more time, money, and materials goes to waste. Logistic planning is also used from a material flow perspective depending on critical activities that constrain the material handling, storing method, providing internal and external transport plans, placements suggestion, and production sequences [11,12].

For efficient work performance, the process of sequencing which have identified all the activities that need to be performed on construction project can be done by engineering program [8]. So, Schedule development is the process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule [13]. Scheduling helps manager and it seems to him like a compass and can be presented as Network diagrams.

In this stage, the budget estimation which is important for forecasting and predicting cost and expenditures of a project and to produce a budget [14]. Some tools and techniques for forecasting the budget should be known such as expert judgment, analogous estimating, parametric estimating, bottom-up estimating, three-Point estimates, reserve analysis, and cost of quality (COQ), etc [15].

The hidden Buy-out stage is the transitional time between the preconstruction and the construction stages of a project. During buyout, a purchase orders and subcontracts are issued. This time may help to lock-in materials price and price escalation of it, and being able to communicate well with all parties. The goal of buyout is to assemble the best team possible to deliver a project [16,2,17].

### *B. Project Execution Stage*

In this stage, all managerial aspects should control the whole construction project. A Material management is a scientific technique, concerned with Planning, Organizing & Control of flow of materials, from their initial purchase to destination. It has some benefits to sure right price,

high turnover, low procurement and storage cost, continuity in supply, consistency in quality, good supplier relation, development of personnel, and good information system. [18]. The most aspects of the physical storage of goods can be categories as following: accommodation, labeling, location, preservation, handling methods and equipment, optimum quantity, health and safety, security, and records and information systems [19].

In general, safety on the job site is an important aspect of the overall safety in construction, due to most hazardous in the field. The safety responsibility on any construction project should be shared between all the parties involved in the project [20,8].

Every aspects of construction project performance must be monitored, tracked, and recorded to ensure that the project plays out according to planning stage, and has a reasonable chance of meeting the project goals for time, cost, and quality. Tracking the deviations will help to identify problem areas to choose the correct or prevent actions [19,8].

The on-site management of a construction project involves great amounts of paperwork, even for relatively small projects, the documentation must be done to ensure communicate directions, questions, answers, approvals, general information and other material to appropriate members of the project team [2].

The very important aspect of control is Communication which is critical to the success of construction project teams with better communication leading to more positive outcomes by using some communication means [21]. The most meetings bring people together weekly to share important information, allow debate, resolve problems, review progress and make on-the-spot collective decisions.

The point of view of the change must be controlled by change order which is contains a brief explanation of the nature of the change and whether it is initiated by the contractor or the owner and its relation with scope of project [3].

It is important the process of quality control primarily deal with issues relating to the requirement conformance to the plans and specs by using quality tools to insure consistency in quality [8].

Also cost control is used to predict the final outcome of a project based on up-to-date status. Cost control during various stages of a project deals with variances between budgeted, earned, and actual costs in each control category, and the cost control is based on the earned value concept [22,14].

Scheduling control is very important control technique which is to check that the project is being implemented as planned (monitoring) and acting to resolve problems (controlling) and comparing the actual schedule situation with the plan [13]. Scheduling control must be monitored by using some tools and techniques such as Performance Reviews, Adjusting Leads and Lags, Variance Analysis and Schedule Compression.

A total of causes and their factors that affect on construction projects are summarized according to literature review and the experience which related to

literature review as in Table I.

TABLE I  
TOTAL OF CAUSES AND THEIR FACTORS

Causes	Factors
Team selection and employee turnover	Responsibility assignment matrix(RAM)
	Organizational Commitment
Scope and contract review	WBS
	requirements and documented
	Constructability Review
Site layout planning	The jobsite layout plan
	materials waste
	storing method
Sequences and schedule development	Engineering program
	Durations
	resource requirements
	Network diagrams
Budget Preparation	Budget estimation tools
Buy- out	Communication with all parties
	lock-in materials price and its price escalation
Material Handling Plan	continuity in material supply
	Control of flow of materials
	good information system
	development of personnel
	Optimal quantity (EOQ)
Monitoring and Control	Tracking the deviations
	the correct or prevent actions
Documentation management and control	Apply & appropriate documentation
Effective Communication	communication means
	Weekly meeting
	Priority for risk meeting
Safety in construction site	Risk plans
Scope & change control	Change control
Quality control	The requirements conformance
	quality control tools
Scheduling control	Leads and Lags
	Performance Reviews
	Variance Analysis
	Schedule Compression

### III. RESEARCH METHOD

A research Strategy is to use both qualitative (Literature review) and quantitative (Questionnaire survey) methods. The qualitative method permits researchers to study selected issues in depth and detail, and produces a wealth of detailed information about a much smaller number of people and cases. The quantitative method gives a broad, generalizable set of

findings presented succinctly and parsimoniously [23]. So, the research strategies were adopted the literature review, and a questionnaire survey. The data used to test the research model were obtained from Literature review.

The greatest advantage of a questionnaire survey is its lower cost compared to other methods. A questionnaire survey can be used only when the objective of the study is clear and not complex [24]. In this study, the questionnaire survey was used to obtain information about critical factors and their effect on performance from a wide range of 100 Sudanese construction firms by their construction managers. The Likert scale approach (1-5) was used to scale responses in survey research ranging from "very disagree" to "high agree". A total of 70 usable responses were obtained. Detailed descriptive statistics relating to the respondents' characteristics are shown in Table II.

TABLE II  
THE RESPONDENTS' CHARACTERISTICS

	Description	frequency	Percentage
Experience (years)	Less than 5 years	18	26.7%
	5 to 10 years	21	30%
	11 to 15 years	15	21.4%
	15 years above	16	21.9%
Level of education	Graduate	28	40 %
	Post graduate	42	60%

### IV. DATA ANALYSIS

In this study, the measurement instrument should be reliable and valid. Thus, they should be evaluated for reliability and validity. The SPSS IBM 19 program was used in evaluation.

#### A. Reliability

Reliability refers to whether you get the same answer by using an instrument to measure something more than once [25]. The internal consistency method was used in evaluating the reliability of the survey instrument in this research. In Table III, the Cronbach's alpha is 0.946 and the instrument was judged to be reliable.

TABLE III  
THE RELIABILITY STATISTICS

Scale	Reliability Statistics	
	Cronbach's Alpha	No of Items
Project Management	0.946	34

#### B. Validity

Validity is defined as the extent to which any instrument measures what it is intended to measure. In this study, only content validity and construct validity were conducted in order to evaluate the measurement instruments.

1) Content Validity

Content validity depends on the extent to which an empirical measurement reflects a specific domain of content. It cannot be evaluated numerically. To ensure the content validity, the survey was established from the existing literature. Also, pretesting conducted with experts in the field of project management in construction. After the pretesting, these items were fitted the construction context of study.

2) Construct Validity

Construct validity measures the extent to which the items in a scale all measure the same construct and can be evaluated by the use of factor analysis which to find a way of condensing or summarizing the information [26,27]. The factor analysis in this context was exploratory and the Principal component analysis method. Only the factors having latent (eigenvalues) greater than 1 are considered significant; those with eigenvalues less than 1 are considered insignificant and are disregarded [26]. In the case of this scale, nine factors emerged according to the rule that the Eigenvalues are greater than 1 as in Table IV. After the rotated (varimax) factor was done, the Item 17 belonged to Factors 3 or 4 as it loaded very significantly on both factors. After its content was examined, it was decided that Item 17 (consistency in quality) should be deleted from this scale. So, the sum of questions has become 34 items, so the instrument was valid.

TABLE IV  
FACTOR ANALYSIS OF PROJECT MANAGEMENT

scales	Factor number	Eigen-value	% of variance
Project management	9	14.417	40.046
		3.257	9.046
		2.452	6.810
		2.392	6.644
		1.715	4.764
		1.387	3.853
		1.235	3.431
		1.113	3.091
		1.023	2.841

V. ANALYSIS AND DISCUSSION

The quantitative data generated from the questionnaire survey was analyzed using average index technique by SPSS program, and is displayed in Table V. The critical causes had values less than the scale average (3) as the following: Scheduling control with mean (2.61), Team selection and employee turnover with mean (2.68), Safety in construction site with mean (2.76), and Quality control with mean (2.78). With respect to those causes, the respondents haven't applied them correctly which may lead to the poor performance of these causes. The general mean of the scale "Project management" is (3.21) which is slightly greater than the mean average (3) which

TABLE V  
RESULT OF THE PROJECT MANAGEMENT SCALE

Causes	Factors	Factor Mean	Causes mean	Scale Average
Team selection and employee turnover	Responsibility assignment matrix(RAM)	2.63	2.68	3
	Organizational Commitment	2.72		
Scope and contract review	WBS	2.95	3.37	3
	requirements and documented	3.51		
	Constructability Review	3.65		
Site layout planning	The jobsite layout plan	3.54	3.37	3
	materials waste	3.32		
	storing method	3.27		
Sequences and schedule development	Engineering program	3.63	3.54	3
	Durations	3.74		
	resource requirements	3.63		
	Network diagrams	3.17		
Budget Preparation	Budget estimation tools	3.17	3.17	3
Buy- out	Communication with all parties	3.63	3.70	3
	lock-in materials price and its price escalation	3.78		
Material Handling management	continuity in material supply	3.55	3.35	3
	Control of flow of materials	3.40		
	good information system	3.27		
	development of personnel	2.32		

Causes	Factors	Factor Mean	Causes mean	Scale Average
	Optimal quantity (EOQ)	3.25		
Monitoring and Control	Tracking the deviations	3.48	3.45	3
	the correct or prevent actions	3.42		
Documentation management and control	Apply & appropriate documentation	3.46	3.46	3
Effective Communication	communication means	3.41	3.52	3
	Weekly meeting	3.87		
	Priority for risk meeting	3.28		
Safety in construction site	Risk plans	2.76	2.76	3
Scope & change control	Change control	3.23	3.23	3
Quality control	The requirements conformance	3.28	2.78	3
	quality control tools	2.27		
Scheduling control	Leads and Lags	2.42	2.61	3
	Performance Reviews	2.70		
	Variance Analysis	2.53		
	Schedule Compression	2.78		
Project management average		3.21		
Project management performance		3.21*100/5 = 64.2%		

indicates that the respondents have little improvement for Project management, and the most of firms didn't have proper planning and control execution very well, so the performance may almost be poor.

#### A. Critical Factors of Project Management

From the last analysis, the critical factors that affect on Sudanese construction project performance were listed according to the lower mean than the scale average (3) in Table VI.

TABLE VI  
CRITICAL FACTORS OF PROJECT MANAGEMENT SCALE

No	Description	Mean	Scale average
	Quality control tools	2.27	3
	Development of personnel	2.32	3
	Leads and Lags	2.42	3
	Variance Analysis	2.53	3
	Responsibility assignment matrix(RAM)	2.63	3
	Performance Reviews	2.70	3
	Organizational Commitment	2.72	3
	Risk plans	2.76	3
	Schedule Compression	2.78	3
	WBS	2.95	3

#### VI. CONCLUSIONS

A number of conclusions have been obtained from this research as following:

1. The instrument for measuring the critical factors on the performance is reliable and valid, and can be used by other researchers to test the effects of these factors on the performance.
2. The project management stage performance is 64.2%. So, the improvement is required for the project management stage.
3. There were four critical causes and ten critical factors which should be improved.

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APPENDIX

APPENDIX - 1: QUESTIONNAIRE ABOUT THE EFFECT OF CRITICAL FACTORS ON CONSTRUCTION PROJECTS PERFORMANCE IN SUDAN

No.	Factors	1	2	3	4	5
1	We use a Responsibility assignment matrix in all projects (RAM)					
2	Our company employees have absolute loyalty towards the company					
3	We use the work breakdown structure (WBS) in our projects as a tool for managing project.					
4	We identify and document all requirements of the client					
5	We review architectural designs, civil, mechanical, fire-fighting, etc.) and match them with bill of quantities and specifications before implementation (Constructability Review)					
6	We introduce site layout plan.					
7	We have a plan to reduce the materials wasted					
8	We use modern storage methods appropriate for each project					
9	We use project scheduling template such as(primavera, MS project, etc.)					
10	Our employees have a sufficient knowledge to determine the activities durations in the project					
11	All project resources required have been provided.					
12	We use critical path method(CPM)in the project control					
13	We estimate the costs of activities based on (WBS).					
14	The company has Communication plan between contract parties (client, consultant and contractor) prior implementation stage.					
15	We review the prices of materials and their escalation before the implementation stage					
16	We have a plan to supply the different sites of materials needed					
17	We have technical staff to control the material flow process according to site demand.					
18	We have good storage plan.					
19	We have a job training program.					
20	Always keep to the Optimal quantity (EOQ)of storage of materials used in site					
21	The project managers track deviations that may occur during execution & take actions.					
22	We apply preventive or corrective actions when deviations will occur.					
23	We document all processes and activities during the project life cycle.					
24	For good communication, we use the modern media such as (camera site, the Internet, and multimedia)					
25	In the weekly meeting, we discuss the project progress.					
26	The weekly meetings priority is to discuss the risks.					
27	We develop a risk management plan.					
28	WE use a specific forms with change order					
29	We conduct tests for each activity separately to make sure it conformed to the specifications					
30	We use the seven tools of quality control					
31	We use Leads and Lags to control and adjust schedule					
32	We use performance reviews to monitor and control schedule					
33	We use analysis of variance for adjusting schedule and cost.					
34	We use Schedule Compression when needed.					

\*Note: 1= Strongly disagree, 2= disagree, 3= Neutral, 4= agree, 5= strongly agree