



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



**Sudan University of  
Science & Technology  
College of Graduate Studies**

**Factors Affecting the Performance of The  
Completed Construction Projects in the Sudan**

(Khartoum State as Case Study)

العوامل المؤثرة في أداء

مشاريع التشييد المكتملة في السودان

( ولاية الخرطوم كدراسة حالة )

A thesis Submitted in Partial Fulfillment of the Requirements for Degree  
Master of Science in Civil Engineering (Construction Management)

**Prepared by:**

**Walaa Abd El Kareem Satti**

**Supervised by:**

**Dr. Osama Mohammed Ahmed**

**2015**

## الآية

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

قال تعالى

﴿ اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ ﴾ 1 ﴿ خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ ﴾ 2 ﴿ اقْرَأْ وَرَبُّكَ  
الْأَكْرَمُ ﴾ 3 ﴿ الَّذِي عَلَّمَ بِالْقَلَمِ ﴾ 4 ﴿ عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ ﴾ 5

صدق الله العظيم

سورة العلق الآيات ( 1 - 5 )

## المستخلص باللغة العربي

صناعة التشييد من الصناعات المعقدة في طبيعتها لأنها تحتوي على عدد كبير من الشركاء مثل الملاك والمقاولين والاستشاريين وأصحاب المصلحة والمساهمين والمنظمين وغيرها. إن مشاريع البناء في السودان تعاني من العديد من المشاكل والقضايا المعقدة في الأداء مثل التكلفة والوقت والسلامة. الهدف من هذا البحث هو تحديد وتقييم العوامل الرئيسية التي تؤثر على أداء مشاريع التشييد في السودان.

واستعرضت الباحثة الأداء العملي لتحديد العوامل التي تؤثر على أداء المشاريع الإنشائية. وبالإضافة إلى ذلك، تم إضافة عوامل محلية أخرى على النحو الموصى به من قبل خبراء محليين. وذلك من خلال التي تتألف من 30 استبيان. وأجري الاستبيان وكان 63 العوامل التي تم تحديدها، تصنيفها إلى 10 مجموعات وتقييمها من قبل أصحاب العمل والاستشاريين والمقاولين. تم توزيع 120 استبيان على النحو التالي: 25 إلى الملاك، 35 للاستشاريين و 60 للمقاولين. وكانت أهم العوامل التي اتفق عليها الملاك والاستشاريين والمقاولين: معدل التأخير بسبب الإغلاق نقص المواد؛ توافر الموارد كما هو مخطط لها خلال مدة المشروع. المهارات القيادية لمدير المشروع؛ تصاعد أسعار المواد؛ توافر شخصيات من ذوي الخبرة العالية والمؤهلات. ونوعية المعدات والمواد الخام في المشروع.

تم تحديد درجة الاتفاق بين الأطراف بشأن ترتيب العوامل وفقا لمعامل [كندال] من التوافق. لالتكلفة والوقت والجودة، والإنتاجية، ورضا العملاء، والشعب، والابتكار والتعلم العوامل، وجميع الفئات معا، وهناك درجة كبيرة من الاتفاق بين الملاك والاستشاريين والمقاولين. من ناحية أخرى، للتوصل إلى اتفاق منظم والجمع بين الملاك والاستشاريين والمقاولين تم تحليل مؤشرات الأداء الرئيسية مثل الوقت والتكلفة، ورضا مالك المشروع وسلامة القوائم المرجعية من أجل معرفة المشاكل العملية الرئيسية لأداء المشاريع في السودان ومن ثم إلى صياغة توصيات لتحسين أداء المشاريع الإنشائية في السودان.

## **Abstract**

Construction industry has complexity in its nature because it contains large number of parties as clients, contractors, consultants, stakeholders, shareholders, regulators and others. Construction projects in the Sudan suffer from many problems and complex issues in performance such as cost, time and safety. The aim of this thesis is to identify and evaluate the main factors affecting the performance of construction projects in the Sudan.

Literature review about performance was reviewed to identify the factors affecting the performance of construction projects. In addition, other local factors have been added as recommended by local experts. Pilot study of the questionnaire was achieved by a scouting sample, which consisted of 30 questionnaires. A questionnaire survey was conducted and 63 factors were identified, categorized into 10 groups, evaluated and ranked from owners, consultants and constructors perspectives. 120 questionnaires were distributed as follows: 25 to owners, 35 to consultants and 60 to contractors. The most important factors agreed by the owners, consultants and contractors were: average delay because of closures and materials shortage; availability of resources as planned through project duration; leadership skills for project manager; escalation of material prices; availability of personals with high experience and qualification; and quality of equipments and raw materials in project.

The degree of agreement between parties regarding the ranking of factors was determined according to Kendall's Coefficient of Concordance. For Cost, Time, Quality, Productivity, Client Satisfaction, People, Innovation and learning factors, and all groups together, there is a significant degree of agreement among the owners, consultants and

contractors. On the other hand, for Regular and community agreement among the owners, consultants and contractors

The practices concerning with the Key Performance Indicators (KPIs) such as time, cost, project owner satisfaction and safety checklists were analyzed in order to know the main practical problems of projects performance in the Sudan and then to formulate recommendations to improve performance of construction projects in the Sudan. It was concluded that projects were delayed and the actual cost of projects was more than the estimated cost because of Sudan economic conditions. Overall project safety factors had been moderately implemented in construction organizations.

## CONTENTES

item	Description	Page
<b>1</b>	<b>CHAPTER ONE : INTRODUCTION</b>	<b>1</b>
1.1	Introduction	1
1.2	Research Objectives	3
1.3	Statement of the Problem	4
1.4	Research Important	4
1.5	Research Hypotheses	3
<b>2</b>	<b>CHAPTER TWO : LITERATURE REVIEW</b>	<b>7</b>
2.1	Definitions and Concepts	7
2.2	Information Technology and Construction Projects Performance	<b>8</b>
2.3	Factors Affecting Performance of Managers	<b>10</b>
2.4	Key Performance Indicators	<b>11</b>
2.5	Methodology for this research	<b>13</b>
2.6	Problem of Performance in Construction Industry	<b>8</b>
2.5.1	Concerning objective one	<b>13</b>
2.5.2	Concerning objective two	<b>14</b>
2.5.3	Concerning objective three	<b>15</b>
2.5.4	Concerning objective four	<b>15</b>
2.5.5	Concerning objective five	<b>16</b>
2.5.6	Concerning objective six	<b>16</b>
2.6	Summary	<b>16</b>
<b>3</b>	<b>CHAPTER THREE : METHODOLOGY</b>	<b>18</b>
3.1	Introduction	<b>18</b>
3.2	Pilot Study	<b>18</b>
3.2.1	Pilot study results	<b>18</b>
3.2.2	Validity test	<b>20</b>
3.2.2.1	Criterion-related validity test	<b>20</b>
3.2.2.2	Structure validity test	<b>21</b>
3.2.3	Reliability statistics	<b>21</b>
3.3	Questionnaire Distribution	<b>24</b>
3.4	Data Measurement	<b>26</b>
<b>4</b>	<b>CHAPTER FOUR : RESULTS AND ANALYSIS</b>	<b>28</b>
4.1	Part One: General Information	<b>29</b>

<b>4.2</b>	Part Two: Factors Affecting the Performance of Construction Projects	<b>32</b>
<b>4.2.1</b>	Group one: Cost factors	<b>47</b>
<b>4.2.2</b>	Group two: Time factors	<b>53</b>
<b>4.2.3</b>	Group three: Quality factors	<b>59</b>
<b>4.2.4</b>	Group four: Productivity factors	<b>64</b>
<b>4.2.5</b>	Group five: Client Satisfaction factors	<b>69</b>
<b>4.2.6</b>	Group six: Regular and Community Satisfaction factor	<b>73</b>
<b>4.2.7</b>	Group seven: People factors	<b>78</b>
<b>4.2.8</b>	Group eight: Health and safety factors	<b>81</b>
<b>4.2.9</b>	Group nine: Innovation and learning factors	<b>84</b>
<b>4.2.10</b>	Group ten: Environment factors	<b>88</b>
<b>4.3</b>	Degree of Agreement among the Owners ,Contractors and Consultants regarding Factors Affecting the Performance of construction projects	<b>91</b>
<b>4.4</b>	Means Differences of the Respondents Agreements Regarding the factors affecting the Performance of Construction Projects	<b>94</b>
<b>4.5</b>	Part Three: The Practices Concerning the Performance of construction Projects	<b>95</b>
<b>4.5.1</b>	Time management practice	<b>95</b>
<b>4.5.2</b>	Cost management practice	<b>101</b>
<b>4.5.3</b>	Owner satisfaction management practice	<b>106</b>
<b>4.5.4</b>	Safety management practice	<b>109</b>
<b>5</b>	<b>CHAPTER FIVE : CONCLUSION AND RECOMMENDATIONS</b>	<b>112</b>
<b>5.1</b>	Conclusion	<b>112</b>
<b>5.2</b>	Recommendation	<b>115</b>
<b>5.2.1</b>	Introduction	<b>115</b>
	Reference	<b>118</b>
	Appendix	<b>121</b>

# CHAPTER ONE

## 1. INTRODUCTION

### **1.1 Introduction:-**

In Sudan, efficient construction projects can provide a solid platform for reviving economy and for building a more balance and independent economy. they have had to work in every difficult physical, social, political, economic and institutional circumstance. Performance is related to many topics and factors such as time, cost, quality, client satisfaction; productivity and safety. Construction industry in the develop countries suffers from many problems and complex issues in performance.

There are many realistic reasons such as closures, amendment of drawings and amendment of the design. In addition, there are other different reasons affecting construction projects performance in the Sudan such as poor management and leadership; inappropriate participants; poor relations and coordination; absence of motivation, control, monitor or decision making systems; inadequate infrastructure, political problems; cultural problems and economic conditions.

While individual organizations have been measuring their performance for many years, there has been little consistency in the data, and the way it has been published. The performance can be measured by key indicators for evaluation. The purpose of Key performance indicators (KPIs) is that clients want their projects delivered: on time, on budget, free from defects, efficiently, right first time, safely, by profitable companies. So, Regular clients expect continuous improvement from their construction team to achieve year-on-year: reductions in project costs and time. In addition, the Key Performance Indicators (KPIs) can be used for benchmarking purposes, and will be a key component of any organization move towards achieving best practice. Clients, for instance,



assess the suitability of potential suppliers or contractors for a project, by asking them to provide information about how they response to a range of indicators. Some information will also be available through the industries benchmarking initiatives, so clients observe how potential suppliers compare with the rest of industry in a number of different areas. Construction supply chain companies will be able to benchmark their performance to enable them to identify strengths and weaknesses, and assess their ability to improve over time. The KPIs framework consists of seven main groups: time, cost, quality, client satisfaction, client changes, business Performance, health and safety (DETR, 2000).

In Sudan, there are many construction projects fail in performance. In addition, performance measurement systems are not effective or efficient to overcome this problem. Construction projects performance problem appears in many aspects in the sudan. There are many constructed projects fail in time performance, others fail in cost performance and others fail in other performance indicators. In 2006 there were many projects which finished with poor performance because of many evidential reasons such as: obstacles by client, non-availability of materials, road closure, amendment of the design and drawing, additional works, waiting the decision, handing over, variation order, amendments in Bill of Quantity (B.O.Q) and delay of receiving drawings (UNRWA, 2006). There are other indicators for problems of performance in Sudan such as project management, coordination between participants, monitoring, feedback and leadership skills. In addition, political, economic and cultural issues are three important indicators related to failures of projects' performance in the Sudan.

In this study, factors affecting the performance of construction projects in the Sudan will be analyzed. Performance indicators are used to

measure performance in construction projects. These indicators can then be used for benchmarking purposes, and will be a key component of any organization's move towards achieving best practice in order to overcome performance problem. However, this study aims at identify the factors and attributes affecting the performance of construction projects in the Sudan and to obtain main criteria and indicators to measure performance.

## **1.2 Research Objectives:-**

The aim of this research is to analyze the local factors affecting the performance of construction projects in the Sudan. The aim of this research can be broken down into the following objectives:-

1. To identify the factors affecting the performance of construction projects (Key performance indicators).
2. To determine owners, consultants and contractors perceptions towards the relative importance of the key performance indicators in develop countries construction projects in order to evaluate performance of construction projects in the Sudan.
3. To identify the most significant key performance indicators of construction projects in the Sudan.
4. To evaluate the degree of agreement/disagreement between owners contractors and consultants regarding the ranking of key performance, indicators.
5. To test the hypothesis to verify the association between the ranking of owners, contractors and consultants parties regarding key performance indicators.
6. To formulate recommendations to improve performance of construction projects in the Sudan.

### **1.3 Statement of the Problem:-**

It is shown from previous studies , there are many reasons and factors which attribute to such this problem. In Sudan, there are many construction projects fail in performance. In addition, performance measurement systems are not effective or efficient to overcome such this problem.

In Sudan, construction projects performance problem appears through different directions. There are many constructed projects fail in time performance, others fail in cost performance and others fail in other performance indicators. In 2006 there were many projects which finished with poor performance because of many evidential reasons such as: obstacles by client, non-availability of materials, roads closure, amendment of the design and drawing, additional works, waiting the decision, handing over, variation order, amendments in Bill of Quantity and delay of receiving drawings . In addition there are other indicators of performance in the Sudan such as (project managers, coordination between participants, monitoring, feedback and leadership skills. However, there are three important issues related to failures and problems of performance in the Sudan which are political, economic and cultural issues.

Therefore, this research will evaluate the factors affecting the performance of construction projects in the Sudan in order to assist owners, consultants and contractors to overcome performance problem and to improve performance of their construction projects. Hence, performance of any construction projects can be evaluated according to key performance indicators.

### **1.4 Research Important:**

Construction industry has complexity in its nature because it contains large number of parties as clients, contractors, consultants,

stakeholders, shareholders, regulators and others. Construction projects in the Sudan suffer from many problems and complex issues in performance because of many reasons and factors. This thesis is very important to identify and to evaluate the main factors affecting the performance of construction projects in the Sudan. The practices concerning with the KPIs such as time, cost, project owner satisfaction and safety checklists will be analyzed in order to know the main practical problems of projects performance in the develop countries and then to formulate recommendations to improve performance of construction projects in the Sudan.

Because of performance problem in the Sudan as shown previously and because previous studies in the develop countries about this topic do not deal with all aspects of construction project performance; this study is required and very important to be considered. In this study, it will be studied the factors affecting the performance of construction projects in Sudan. These factors can be said as key performance indicators (KPIs). These KPIs can be used to measure performance in construction projects and can then be used for benchmarking purposes. This will be a key component of any organization move towards achieving best practice in order to overcome performance problem in the Sudan.

### **1.5 Research Hypotheses:-**

the association between the ranking of owner, contractor and consultant parties regarding key performance indicators

The most important indicators which will be studied in this research are:

1. Cost
2. Time
3. Quality
4. Productivity
5. Client satisfaction

6. Regular and community satisfaction
7. People
8. Health and Safety
9. Innovation and learning
10. Environment

## CHAPTER TWO

### 2. LITERATURE REVIEW

#### 2.1 Definitions and Concepts

In order to define the KPIs throughout the lifetime of a project, five key stages have been identified as shown in Figure 2.1 :

be sure they have right processes and capabilities in place. The KPIs also all.

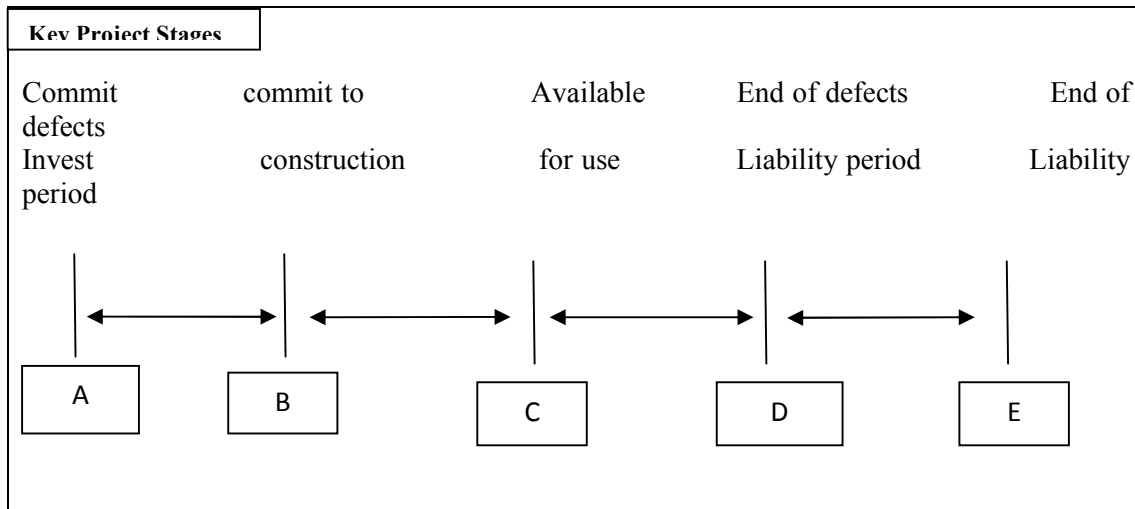
**A. Commit to Invest:** the point at which the client decides in principle to invest in a project, sets out the requirements in business terms and authorizes the project team to proceed with the conceptual design.

**B. Commit to Construct:** the point at which the client authorizes the project team to start the construction of the project.

**C. Available for Use:** the point at which the project is available for substantial occupancy or use. This may be in advance of the completion of the project.

**D. End of Defect Liability Period:** the point at which the period within the construction contract during which the contractor is obliged to rectify defects ends (often 12 months from point C).

**E. End of Lifetime of Project:** the point at which the period over which the project is employed in its original or near original purpose ends. As this is usually many years after the projects completion, this is a theoretical point over which concepts such as full life costs can be applied.



**Fig. 2.1. KPIs throughout the lifetime of a project (Source: DETR, 2000)**

According to previous studies, concepts and definitions, it can be said that the performance measurement is a process include factors as Key Performance Indicators(KPIs) such as time, cost, quality, client satisfaction; productivity and safety in order to enable measurement of current organizational project performance and to achieve significant performance improvements of future projects.

## **2.2 Information Technology and Construction Projects Performance**

Information technology technique is very important in the entire world. Information technology (IT) opens new visions in the businesses and industries performance of the world. The construction industry is considered as one of the industries using IT technique such as software management systems, database and communications. For many years, many processes, functions, operations were done difficulty because of absence of IT field. In addition, most of the work was done manually which lead to more cost, time and poor performance. Furthermore, IT usage in the construction industry leads to many changes, innovations and developing in many aspects which lead finally to good and strong

performance. There are many benefits and relations of using IT in the construction projects such as: greater use of IT correlates with better project performance, owners and contractors realize meaningful benefits, IT affects schedule compression beneficially, and overall project cost savings which lead to a success performance of project .

Nitithamyong et al (2004) remarked that information Technology (IT) is now routinely used in the construction industry as a tool to reduce some of the problems generated by fragmentation. The use of IT improves coordination and collaboration between firms participating in a construction project, leading to better communication practices and so good performance. Its benefits include an increase in the quality of documents and the speed of the work, better financial control and communications, and simpler and faster access to common data as well as a decrease in documentation errors.

Thomas (2002) proposed contractor Performance Appraisal and Reporting (PAR) system for reviewing contractor performance at an organizational level. Advancements in World Wide Web techniques provide enhanced capacities to collect compile and disseminate performance-related information to various construction stakeholders in a timely and cost-effective manner. Becerik (2004) stated that the rapid advances of web-based project management and collaboration technology offer new opportunities to improve existing construction project performance. Cheung et al (2004) obtained framework software to measure project performance based on project performance measurement system (PPMS). The system contains four stages which are data entry, database, reporting and action. This system has eight categories to measure performance which are people, cost, time, quality, safety and health, environment, client satisfaction, and communication. Goh (2005) remarked that information technology management leads to performance



improvement in the construction industries. For instance, in Singapore 2003, general administration, design, project management, site management were enhanced by using of IT. In addition, there were more advantages as quick working, good quality of work and fast access of information.

### **2.3 Factors Affecting Performance of Managers**

Ogunlana et al, (1996) recommended the need for focused effort by economy managers and construction industry associations to provide the infrastructure needed for efficient project management and performance. Dissanayaka and Kumaraswamy (1999) stated that the knowledge that would influence potential performance enables project managers to pay special attention to control performance more effectively. Chan and Kumaraswamy (2002) remarked that effective communication and fast information transfer between managers and participants help to accelerate the building construction process and performance. Kuprenas (2003) studied the impact of the use of a project management based organizational structure, project manager training, frequency of design meetings, and frequency of design reports on design phase cost performance. The process of a design team meeting frequency and the process of written reporting of design phase progress were found to be statistically significant in reducing design phase costs.

Navon (2005) stated that data are collected and used for construction managers as a basis to evaluate the project performance indicator's (PPI) actual value to compare it with the planned value and forecast its future value based on past performance. Pheng and Chuan (2006) identified the importance of the working environment variables for the performance of a project manager in the private and public sectors according to three main groups which are job condition, project characteristic and organizational related categories. The result revealed

that working hours, physical condition of project site, complexity of project, material and supplies, project size, duration of project and time availability were viewed differently in terms of importance by the contractors and consultants groups. Team relationship was ranked as the most important variable affecting the performance of a project manager. It is obtained that project managers experiences do not have much effect on how they perceive their working environment.

## **2.4 Key Performance Indicators**

Samson and Lema (2002) remarked that characteristics of emerging performance measurement indicators need analysis of both the organization and environment such as: nature of work, global competition, quality awards, organizational role, external demands and power of IT. The indicators should be able to identify causes of problems, address all possible performance drivers, and identify potential opportunities for improvement. Stewart and Mohamed (2003) emphasized the importance of a structured evaluation framework to evaluate the value IT adds to the process of project information management. The framework is in the form of a. Construct IT. with IT performance perspectives and indicators developed specifically for managing information on construction projects. Therefore, construction organizations should lay the foundations for an IT performance measurement and management culture, by actively seeking to quantify the value IT generates.

Cheung et al (2004) remarked seven main key indicators for performance which are: time, cost, quality, client satisfaction, client changes, business performance, and safety and health. Navon (2005) stated that a number of research efforts to fully automate project performance control of various project performance indicators have been carried out in recent years. These are also briefly described together with

the concept of measuring indirect parameters and converting them into the sought indicators. These are (1) labor and earthmoving productivity based on measuring the location of workers or earthmoving equipment at regular time intervals; (2) progress based on the above data; (3) a comprehensive control of construction materials starting by monitoring orders and purchasing up to the movement of the materials on site.

Pheng and Chuan (2006) stated that project performance can be determined by two common sets of indicators. The first set is related to the owner, users, stakeholders and the general public which are the groups of people who will look at project performance from the macro viewpoint. The second are the developer, a non-operator, and the contractor which are the groups of people who will look at project performance from the micro viewpoint. Jin et al (2006) studied the relationship-based factors that affect performance of general building projects in China. Thirteen performance metrics was used to measure the success level of construction projects. These factors were categorized into four groups namely cost, schedule, quality and relationship performance. It was recommended that foreign firms that have entered or are going to enter the Chinese construction industry should learn how to build cooperative and harmonious relationships with Chinese partners and finally achieve satisfactory project performance by paying sufficient attention to the aforementioned factors.

Ugwu and Haupt (2007) developed and validated key performance indicators (KPI) for sustainability appraisal using South Africa as a case study. It is used four main levels in a questionnaire to identify the relative importance of KPI. The main indicators were: economy, environment, society, resource utilization, health and safety and project management and administration. Luu et al (2007) provided nine key performance indicators (KPIs) which can be applied to measure project management

performance PMP and evaluate potential contractors as well as their capacity by requesting these indices.

Based on previous literature review and historical studies about performance of construction projects. Table 2.1 shows a summary of the main groups affecting the performance of construction projects (KPIs groups).

## **2.5 Methodology for This Research**

This research discusses the factors affecting performance within construction organizations in Sudan. The basic methodology which is considered to achieve the objectives of this research is as the following issues:

### **2.5.1 Concerning objective one: (To identify the factors affecting the performance of construction projects):**

Literature review about performance was reviewed (Okuwoga, 1998; Dissanayaka and Kumaraswamy, 1999; Reichelt and Lynies, 1999; Karim and Marosszeky, 1999; Brown and Adams, 2000; DETR (KPI Report), 2000; Lehtonen, 2001; Chan, 2001; Samson and Lema, 2002; Kuprenas, 2003; Cheung, 2004; Iyer and Jha, 2005; Navon, 2005; Love et al, 2005; Ugwa and Haupt, 2007) to identify the factors affecting the performance of construction projects. In addition, there are other local factors that have been added as recommended by local experts such as escalation of material prices, differentiation of coin prices, average delay because of closures and material shortage, neighbors and site condition problems, belonging to work and location of project.

63 factors affecting performance of construction projects are selected. These factors are grouped into 10 groups based on literature review. These groups can give a comprehensive summary of the main key performance indicators. The factors, which are considered in the questionnaire, are summarized and collected according to previous

studies and other factors are added as recommended by local experts as shown in Table 3.1.

**2.5.2 Concerning objective two (To determine owners, consultants and contractors perceptions of the relative importance of the key performance indicators in Sudan construction projects):**

A structured questionnaire survey approach is considered to study the impact of various attributes and factors affecting performance. In addition, the questionnaire can assist to study the attitude of owners, consultants and contractors towards the factors that affect on performance in the construction industry. The relative importance index method (RII) is used here to determine owners, consultants and contractors perceptions of the relative importance of the key performance indicators in Sudan construction projects. The relative importance index is computed as (Cheung et al, 2004; Iyer and Jha, 2005; Ugwu and Haupt, 2007):

$$RII = \frac{\sum W}{A \times N} \dots\dots\dots (1)$$

Where:

- W is the weight given to each factor by the respondents and ranges from 1 to 5
- A = the highest weight = 5
- N = the total number of respondents

**2.5.3 Concerning objective three (To identify the most significant key performance indicators of construction projects in the Sudan):**

The relative importance index method (RII) is also used to determine the most significant key performance indicators of construction projects in the in Sudan. The relative importance index is computed as shown previously (Cheung et al, 2004; Iyer and Jha, 2005; Ugwu and Haupt, 2007).

**2.5.4 Concerning objective four (To evaluate the degree of agreement/disagreement between owners, contractors and consultants regarding the ranking of key performance indicators):**

The degree of agreement between parties regarding the ranking of factors are determined according to Kendall's Coefficient of Concordance. The degree of agreement can be determined as the following equation (Moore et al, 2003; Frimpong et al, 2003):

$$W = \frac{(12U - 3m n^2 (n-1)^2)}{m^2 n (n-1)} \dots\dots\dots( 2)$$

Where

$$U = \sum(\sum R )$$

$$i=1$$

Moreover:

- n = number of factors;
- m = number of groups;
- j = the factors 1,2,..,n.

**2.5.5 Concerning objective five (To test the hypothesis to verify the association between the ranking of owner, contractor and consultant parties regarding key performance indicators):**

To test the hypothesis that there is no significant difference of opinion between the three parties regarding project performance factors, Kendall's Coefficient of Concordance is also used according to two hypothesizes. These hypothesizes are (Moore et al, 2003; Frimpong et al, 2003):

- Null Hypothesis: H0 : There is insignificant degree of agreement among the owners , contractors and consultants.
- Alternative Hypothesis: H1 : There is significant degree of agreement among the owners , contractors and consultants.

**2.5.6 Concerning objective six (To formulate recommendations to improve performance of construction projects in the Sudan):**

The practices concerning with the KPIs such as time, cost, project owner satisfaction and the safety checklists are analyzed in order to know the main practical problems of projects performance in in Sudan and then to formulate recommendations to improve performance of construction projects in the in Sudan.

**2.6 Summary**

According to previous studies, it can be said that the performance measurement is a performance such as, construction management, information technology, factors quality, client satisfaction; productivity and safety in order to enable measurement of current organizational project performance and to achieve significant performance improvements of future projects.

It was obtained that there were many fields and topics which are related to performance such as, construction management, information technology, factors affecting performance of managers, measurement of project performance, key performance indicator and benchmarking.

The key performance indicators are used to evaluate performance of construction projects. These indicators can then be used for benchmarking purposes, and will be as a key component of any organization to move towards achieving best practice and to overcome performance problem in Sudan. Based on previous studies and literature review, the most important indicators which will be studied in this research are: (Okuwoga, 1998; Dissanayaka and Kumaraswamy, 1999; Reichelt and Lynies, 1999; Karim and Marosszeky, 1999; Brown and Adams, 2000; DETR (KPI Report), 2000; Lehtonen, 2001; Chan, 2001; Samson and Lema, 2002; Kuprenas, 2003; Cheung, 2004; Iyer and Jha, 2005; Navon, 2005; Love et al, 2005; Ugwa and Haupt, 2007; Hovichit, 2007):

1. Cost
2. Time
3. Quality
4. Productivity
5. Client satisfaction
6. Regular and community satisfaction
7. People
8. Health and Safety
9. Innovation and learning
10. Environment



## **CHAPTER THREE**

### **3. METHODOLOGY**

#### **3.1 Introduction**

This research presents the main factors affecting the performance of construction projects in the Sudan. From literature review and past studies, it was obtained that there were different directions and methodologies used in order to achieve the required target, goals and objectives. Some of previous studies focused on factors affecting the performance of construction projects. Other studies concentrated on one or two directions such as cost, time or quality performance. Other studies focused on measurement of construction projects performance. Some of studies deal with different aspects related to performance such as information technology (IT).

The differentiation of directions and goals of topic as shown previously, required different methodologies. The main methodologies obtained from literature review were: questionnaire survey, interviewing, case studies and modeling. The following topics show summary of the main studies related to performance and their methodologies. Finally, it is shown methodology which is used in this research. Figure 3.1 shows summary of methodology used in this research.

#### **3.2 Pilot Study**

##### **3.2.1 Pilot study results**

Pilot study of the questionnaire is achieved by a scouting sample, which consisted of 30 questionnaires. These questionnaires were distributed to expert engineers such as projects managers, site engineers/office engineers and organizations managers. They have a strong practical experience in construction industries field. Their

sufficient experiences are a suitable indication for pilot study. The following items are summary of the main results obtained from pilot study:

1. Questionnaire should be started with a cover page.
2. The first part of questionnaire should be general information about the organization.
3. Owner category should be added as a respondent of questionnaire
4. Typical of project organization should be modified according to actual and practical projects constructed in the in Sudan such as building, roads and transportation, and water and sewage projects.
5. Some factors and sentences should be modified or represented with more details.
6. Some factors were repeated more than one time with the same meaning. So, it should be to eliminate these repeated factors.
7. Some factors and sentences should be modified in order to give more clear meaning and understanding.
8. Some local factors should be added as recommended by local experts which affect the performance of construction projects in the in Sudan.
9. There are some parts of questionnaire required to be regulated well.
10. Some factors should be rearranged in order to give more suitable and consistent meaning.
11. There are some questions which are not practical or realistic with respect to situations of construction projects in the Sudan. Such these questions should be removed or modified to realistic and practical situations of Sudan.
12. Some of factors related to consultant should be added.
13. The practices concerning with owner satisfaction factors .part three of questionnaire- are required to be represented with more clear meaning.

14. Some choices should be added in part three of questionnaire in order to achieve more accurate and suitable choice of respondents.

### **3.2.2 Validity test**

This section presents test of validity of questionnaire according to the pilot study. Validity refers to the degree to which an instrument measures what it is supposed to measure (Pilot and Hungler,1985). Validity has a number of different aspects and assessment approaches. Statistical validity is used to evaluate instrument validity, which include criterion-related validity and construct validity.

To insure the validity of the questionnaire, two statistical tests should be applied. The first test is Criterion-related validity test (Spearman test) which measure the correlation coefficient between each paragraph in one field and the whole field. The second test is structure validity test (Spearman test) that used to test the validity of the questionnaire structure by testing the validity of each field and the validity of the whole questionnaire. It measures the correlation coefficient between one filed and all the fields of the questionnaire that have the same level of similar scale.

#### **3.2.2.1 Criterion-related validity test**

To test criterion-related validity test, the correlation coefficient for each item of the group factors and the total of the field is achieved. The p-values (Sig.) are less than 0.01 for all results, so the correlation coefficients of each field are significant at  $\alpha = 0.01$ , so it can be said that the paragraphs of each field are consistent and valid to measure what it was set for. The results of criterion-related validity test can be obtained with more details and tables through appendix.

### 3.2.2.2 Structure validity test

It is assessed the fields structure validity by calculating the correlation coefficients of each field of the questionnaire and the whole of questionnaire.

Table (3.2) Correlation coefficient of each field and the whole of questionnaire

No	Field	Spearman Correlation Coefficient	P-Value (Sig.)
1	Cost factors	0.842	0.000**
2	Time factors	0.805	0.000**
3	Quality factors	0.713	0.000**
4	Productivity factors	0.773	0.000**
5	Client Satisfaction factors	0.684	0.000**
6	Regular and community satisfaction factors	0.771	0.000**
7	People factors	0.797	0.000**
8	Health and Safety factors	0.784	0.000**
9	Innovation and learning factors	0.727	0.000**
10	Environment factors	0.609	0.000**

\*\* Correlation is significant at the 0.01 level

Table 3.2 clarifies the correlation coefficient for each field and the whole questionnaire. The p-values (Sig.) are less than 0.01, so the correlation coefficients of all the fields are significant at  $\alpha = 0.01$ , so it can be said that the fields are valid to measured what it was set for to achieve the main aim of the study .

### 3.2.3 Reliability statistics

This section presents test of reliability of questionnaire according to the pilot study. The reliability of an instrument is the degree of consistency which measures the attribute; it is supposed to be measuring (Polit & Hunger,1985). The less variation an instrument produces in

repeated measurements of an attribute, the higher its reliability. Reliability can be equated with the stability, consistency, or dependability of a measuring tool. The test is repeated to the same sample of people on two occasions and then compares the scores obtained by computing a reliability coefficient (Polit & Hunger, 1985).

Chronbach's coefficient alpha (George and Mallery, 2003) is designed as a measure of internal consistency, that is, do all items within the instrument measure the same thing? Chronbach's alpha is used here to measure the reliability of the questionnaire between each field. The normal range of Chronbach's coefficient alpha value between 0.0 and + 1.0. The closer the Alpha is to 1, the greater the internal consistency of items in the instrument being assumed. The formula that determines alpha is fairly simple and makes use of the items (variables),  $k$ , in the scale and the average of the inter-item correlations,  $r$ :

$$\alpha = \frac{k r}{1 + (k-1) r} \dots\dots\dots (3)$$

As the number of items (variables) in the scale ( $k$ ) increases the value  $\alpha$  becomes large. Also, if the intercorrelation between items is large, the corresponding  $\alpha$  will also be large.

Since the alpha value is inflated by a large number of variables then there is no set interpretation as to what is an acceptable alpha value. A rule of thumb that applies to most situations is:

- 0.9 ≤ α ≤ 1.0 Excellent
- 0.8 ≤ α < 0.9 Good
- 0.7 ≤ α < 0.8 Acceptable
- 0.6 ≤ α < 0.7 Questionable
- 0.5 ≤ α < 0.6 Poor
- 0.0 ≤ α < 0.5 Unacceptable

The Chronbach.s coefficient alpha was calculated for each field of the questionnaire. The most identical values of alpha indicate that the mean and variances in the original scales do not differ much, and thus standardization does not make a great difference in alpha.

Table 3.3 shows the values of Chronbach's Alpha for each filed of the questionnaire and the entire questionnaire. For the fields, values of Chronbach's Alpha were in the range from 0.707 and 0.879. This range is considered high; the result ensures the reliability of each field of the questionnaire. Chronbach's Alpha equals 0.962 for the entire questionnaire which indicates an excellent reliability of the entire questionnaire. Thereby, it can be said that it is proved that the questionnaire is valid, reliable, and ready for distribution for the population sample.

**Table (3.3) Chronbach's Alpha for each filed of the questionnaire and all the**

**Questionnaire:-**

<b>No.</b>	<b>Field</b>	<b>Cronbach's Alpha</b>
1	Cost factors	0.869
2	Time factors	0.834
3	Quality factors	0.815
4	Productivity factors	0.757
5	Client Satisfaction factors	0.707
6	Regular and community satisfaction factors	0.840
7	People factors	0.879
8	Health and Safety factors	0.829
9	Innovation and learning factors	0.870
10	Environment factors	0.849
	<b>Total</b>	<b>0.962</b>

### 3.3 Questionnaire Distribution

The target groups in this study are owners, contractors and consultants. According to the Palestinian Contractors Union in Sudan, there are 120 contractor organizations. According to the Engineers' Association in Sudan, there are 41 consultant offices. Number of owners is determined as 25 owners in Sudan. Kish (1965) showed that the sample size can be calculated as following equation for 94% confidence level (Assaf et al 2001, Israel 2003, Moore et al, 2003):

$$n = n' / [1 + (n'/N)] \dots\dots\dots (4)$$

Where:

- N = total number of population
- n = sample size from finite population
- n' = sample size from infinite population =  $S^2/V^2$ ; where S<sup>2</sup> is the variance of the population elements and V is a standard error of sampling population. (Usually S = 0.5 and V = 0.06).

So, for 120 contractor organizations:

- $n = n' / [1 + (n'/N)]$
- $n' = S^2/V^2 = (0.5)^2 / (0.06)^2 = 69.44$
- N = 120
- $n = 69.44 / [1 + (69.44 / 120)] = 46$

This means that the questionnaire should be distributed to 46 contractor organizations in order to achieve 94% confidence level

So, for 41 consultant offices:

- $n = n' / [1 + (n' / N)]$
- $n' = S^2 / V^2 = (0.5)^2 / (0.06)^2 = 69.44$
- $N = 41$
- $n = 69.44 / [1 + (69.44 / 41)] = 25$

This means that the questionnaire should be distributed to 25 consultant offices in order to achieve 94% confidence level.

For owners, the number is determined as not large as there are 25 owners. So it is not required to determine sample size using previous Kish equation and it can be selected all of 25 owners.

According to previous results of sample sizes, 120 questionnaires were distributed as follows: 25 to owners, 35 to consultants and 60 to contractors.

These respondents are projects managers, site engineers and organizations managers, as they have a practical experience in construction industries field. Their sufficient experiences are a suitable indication to find out the perceptives of the relative importance of project performance indicators of the owner, consultant and contractor parties. Their experiences included many construction fields such as buildings, roads and transportations, and water and sewage projects. The following Table 3.4 shows summary for frequency of job title of the respondents for each group.



**Table (3.4) Frequency of Job title of the respondents**

<b>Job title of the respondent</b>	<b>Owner Frequency</b>	<b>Consultant Frequency</b>	<b>Contractor Frequency</b>
Project Manager	3	5	13
Site Engineer	7	10	6
Organization Manager	2	7	23

### **3.4 Data Measurement**

In order to be able to select the appropriate method of analysis, the level of measurement must be understood. For each type of measurement, there is/are an appropriate method/s that can be applied and not others. In this research, ordinal scales were used. Ordinal scale as shown in Table 3.5 is a ranking or a rating data that normally uses integers in ascending or descending order. The numbers assigned to the important (1,2,3,4,5) do not indicate that the interval between scales are equal, nor do they indicate absolute quantities. They are merely numerical labels. Based on Likert scale we have the following table 3.5 (Cheung et al, 2004; Iyer and Jha, 2005; Ugwu and Haupt, 2007):

**Table (3.5) Ordinal scale used for data measurement**

<b>Item</b>	<b>Very high important</b>	<b>High Important</b>	<b>Medium Important</b>	<b>Low Important</b>	<b>Very Low Important</b>
Scale	5	4	3	2	1

The relative importance index method (RII) is used here to determine owners, consultants and contractors perceptions of the relative importance of the key performance indicators in Sudan construction projects. The relative importance index is computed as (Cheung et al, 2004; Iyer and Jha, 2005; Ugwu and Haupt, 2007):

Where:

$$RII = \frac{\sum W}{A \times N} \dots\dots\dots (5)$$

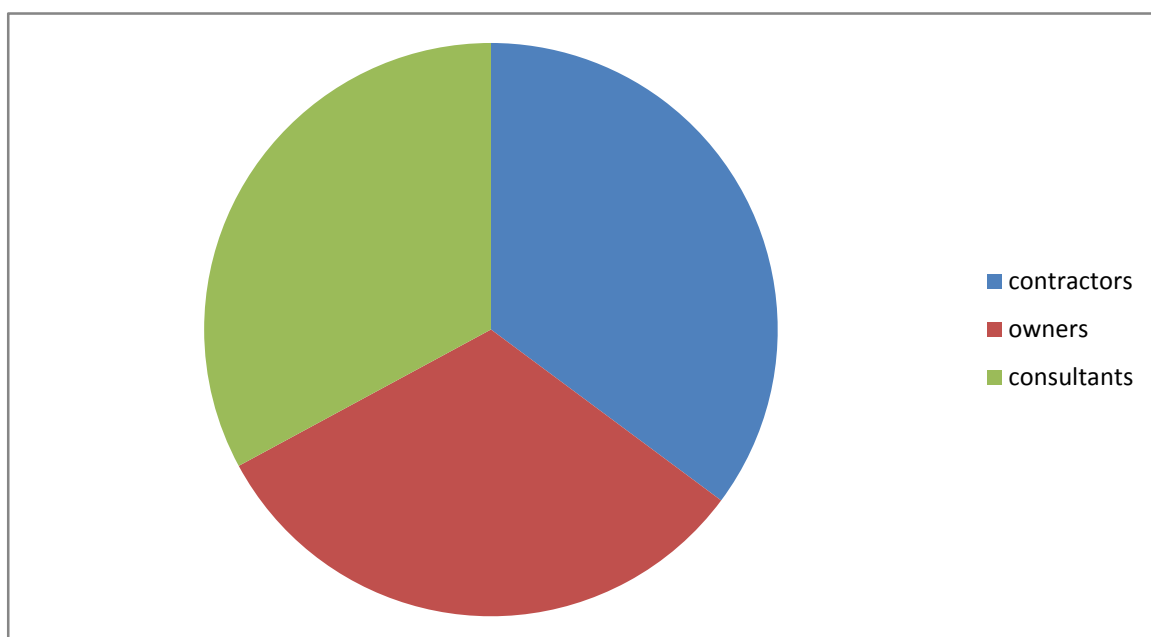
- W is the weight given to each factor by the respondents and ranges from 1 to 5
- A = the highest weight = 5
- N = the total number of respondents

## CHAPTER FOUR

### 4. PRESENTATION OF RESULTS AND ANALYSIS

Pilot study of the questionnaire is achieved by a scouting sample, which consisted of 30 questionnaires. These questionnaires were distributed to expert engineers such as projects managers, site engineers/office engineers and organizations managers. They have a strong practical experience in construction industries field. Their sufficient experiences are a suitable indication for pilot study. The following items are summary of the main results obtained from pilot study.

120 questionnaires were distributed as follows: 25 to owners, 35 to consultants and 60 to contractors. 88 questionnaires were received (73%) as follows: 17 (70%) from owners, 25 (72%) from consultants and 46 (77%) from contractors as respondents. These percentages are shown in Figure 3.2.



#### 4.1 Part One: General Information:

##### 1. Type of Organization:

Table 4.1 shows the frequency and percent of each type of organization:

**Table (4.1) Frequency and percent of each type of organization**

Type of Organization	Frequency	Percent%
Owner	17	19.32 %
Contractant	25	28.41 %
Contractor	46	52.27%
<b>Total</b>	<b>88</b>	<b>100.00 %</b>

##### 2. Typical of projects of organization:

Table 4.2 shows the percent of organizations projects types according to each type of target group:

**Table (4.2) Percent of organizations projects types**

Type of project	Owner	Consultant	Contractor
Buildings	34.9% (15)	35.6% (21)	41.3% (45)
Roads and transportation	30.2% (13)	28.8% (17)	27.5% (30)
Water and sewage	30.2% (13)	28.8% (17)	23.9% (26)
Others	4.7% (2)	6.8% (4)	7.3% (8)

##### 3. Company size :( number of employees):

Average number of employees in owners' organizations is 50 employees

Average number of employees in consultants' organizations is 12 employees

Average number of employees in contractors' organizations is 10 employees

##### 4. Job title of the respondent:

Table 4.3 shows the frequency and percent of job title of the respondent according to each type of target group:

**Table (4.3) Frequency and percent of job title of the respondent**

Job title of the respondent	Owner		Consultant		Contractor	
	Frequency	Percent %	Frequency	Percent %	Frequency	Percent %
Project Manager	3	17.6	5	20.0	13	28.3
Site Engineer	7	41.2	10	40.0		13.0
Organization Manager	2	11.8	7	28.0	6	50.0
Others	5	29.4	3	12.0	23	8.7
<b>Total</b>	<b>17</b>	<b>100.0</b>	<b>25</b>	<b>100.0</b>	<b>4</b>	<b>100.0</b>

**5. Years of experience of the respondent:**

Average number of experience years of the owners' respondents is 14 Years

Average number of experience years of the consultants' respondents is 13 Years

Average number of experience years of the contractors' respondents is 16 Years

**6. Number of projects executed in the last five years:**

Table 4.4 shows the frequency and percent of number of projects executed in the last five years according to each type of target group:

**Table (4.4) Frequency and percent of number of projects executed in the last five Years**

Number executed projects	Owner		Consultant		Contractor	
	Frequency	Percent%	Frequency	Percent%	Frequency	Percent%
1 to 10	2	11.8	7	28.0	25	54.3
11 to 20	5	29.4	4	16.0	11	23.9
21 to 30	2	11.8	3	12.0	3	6.5
More than 30	8	47.1	11	44.0	7	15.2
<b>Total</b>	<b>17</b>	<b>100.0</b>	<b>25</b>	<b>100.0</b>	<b>46</b>	<b>100.0</b>

**7. Value of projects executed in the last five years: (in million dollars)**

Table 4.5 shows the frequency and percent of value of projects executed in the last five years according to each type of target group:

**Table (4.5) Frequency and percent of value of projects executed in the last five years**

Value of executed projects	Owner		Consultant		Contractor	
	Frequency	Percent %	Frequency	Percent %	Frequency	Percent %
1 . less than 2 M	2	11.8	4	16.0	19	41.3
2 . less than 5 M	5	29.4	6	24.0	13	28.3
5 . less than 10 M	4	23.5	6	24.0	6	13.0
More than or equal 10 M	6	35.3	9	36.0	8	17.4
<b>Total</b>	<b>17</b>	<b>100.0</b>	<b>24</b>	<b>100.0</b>	<b>46</b>	<b>100.0</b>

## 4.2 Part Two: Factors Affecting the Performance of Construction Projects

The results of this part of study provide an indication of the relative importance index and rank of factors affecting the performance of construction projects in Sudan. The following Table 4.6 show summary of factors ranking according to each type of target group.

**Table (4.6) The relative importance index (RII) and rank of factors affecting the performance of construction projects in Sudan according to each category**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(1) Cost factors</b>						
Market share of organization	0.600	54	0.709	39	0.726	39
Liquidity of organization	0.729	31	0.842	5	0.839	10
Cash flow of project	0.812	14	0.800	11	0.848	9
Profit rate of project	0.694	38	0.776	14	0.739	38
Overhead percentage of project	0.647	48	0.687	49	0.662	47
Project design cost	0.500	63	0.688	43	0.582	63
Material and equipment cost	0.812	14	0.776	14	0.813	16
Project labor cost	0.741	27	0.744	22	0.739	37
Project overtime cost	0.588	58	0.600	59	0.617	<b>55</b>
Motivation cost	0.600	54	0.584	61	0.609	58
Cost of rework	0.588	58	0.672	51	0.587	62
Cost of variation orders	0.565	62	0.688	43	0.662	46
Waste rate of materials	0.650	46	0.624	57	0.639	51
Regular project budget update	0.638	50	0.742	24	0.743	35
Cost control system	0.725	33	0.728	28	0.765	32
Escalation of material prices	0.847	5	0.832	7	0.889	4
Differentiation of coins prices	0.788	18	0.808	9	0.874	5

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(2) Time factors</b>						
Site preparation time	0.682	42	0.664	53	0.596	61
Planned time for project construction	0.753	26	0.760	18	0.765	30
Percentage of orders delivered late	0.694	40	0.768	17	0.774	29
Time needed to implement variation orders	0.706	35	0.704	40	0.693	43
Time needed to rectify defects	0.659	44	0.672	51	0.639	50
Average delay in claim approval	0.650	46	0.728	28	0.765	30
Average delay in payment from owner to contractor	0.824	11	0.776	14	0.839	11
Availability of resources as planned through project duration	0.871	3	0.858	2	0.904	3
Average delay because of closures and materials shortage	0.941	1	0.896	1	0.943	1
<b>(3) Quality factors</b>						
Conformance to specification	0.882	2	0.808	9	0.822	13
Availability of personals with high experience and qualification	0.859	4	0.848	3	0.865	6
Quality of equipments and raw materials in project	0.835	9	0.840	6	0.861	7
Participation of managerial levels with decision making	0.812	14	0.784	13	0.800	21
Quality assessment system in organization	0.706	35	0.712	35	0.743	34
Quality training/meeting	0.659	45	0.728	28	0.674	44
<b>(4) Productivity factors`</b>						
Project complexity	0.729	31	0.712	35	0.761	33
Number of new projects / year	0.600	54	0.688	43	0.630	53
Management-labor relationship	0.776	22	0.688	43	0.796	22
Absenteeism rate through project	0.776	20	0.688	43	0.743	36
Sequencing of work according to schedule	0.800	17	0.816	8	0.804	20
<b>(5) Client Satisfaction factors</b>						
Information coordination between owner	0.729	29	0.792	12	0.809	19



and project parties						
Leadership skills for project manager	0.835	7	0.848	3	0.904	2
Speed and reliability of service to owner	0.718	34	0.744	22	0.822	13
Number of disputes between owner and project parties	0.753	24	0.728	28	0.720	40
Number of reworks	0.635	51	0.712	35	0.627	54
<b>(6) Regular and community satisfaction factors</b>						
Cost of compliance to regulators requirements	0.600	54	0.648	55	0.604	59
Number of non compliance to regulation	0.635	51	0.624	57	0.614	59
Quality and availability of regulator documentation	0.647	49	0.736	25	0.653	48
Neighbors and site conditions problems	0.788	18	0.712	0.707	0.707	
<b>(7) People factors</b>						
Employee attitudes in project	0.682	41	0.728	28	0.795	23
Recruitment and competence development between employees	0.753	24	0.688	43	0.809	17
Employees motivation	0.765	23	0.736	42	0.791	24
Belonging to work	0.835	9	0.704	25	0.849	8
<b>(8) Health and Safety factors</b>						
Application of Health and safety factors in organization	0.700	37	0.728	28	0.787	25
Easiness to reach to the site (location of project)	0.694	38	0.704	40	0.774	28
Reportable accidents rate in project	0.729	29	0.680	50	0.600	60
Assurance rate of project	0.671	43	0.632	56	0.635	52
<b>(9) Innovation and learning factors</b>						
Learning from own experience and past history	0.847	5	0.752	20	0.818	15
Learning from best practice and experience of others	0.824	12	0.760	18	0.822	12
Training the human resources in the skills demanded by the project	0.835	7	0.720	34	0.787	26
Work group	0.776	20	0.736	25	0.787	27
Review of failures and solve them	0.824	12	0.752	20	0.809	17
<b>(10) Environment factors</b>						

Air quality	0.588	58	0.592	60	0.671	45
Noise level	0.565	61	0.512	63	0.613	57
Wastes around the site	0.635	51	0.584	61	0.649	49
Climate condition in the site	0.729	28	0.656	54	0.707	41

The most important factors agreed by the owners, consultants and contractors as the main factors affecting the performance of construction projects in the Sudan were: escalation of material prices; availability of resources as planned through project duration; average delay because of closures and materials shortage; availability of personals with high experience and qualification; quality of equipments and raw materials in project; and leadership skills for project manager. This can be explained and shown by Table 4.7.

**Table (4.7) the following factors are among the top significant factors affecting the performance of construction projects in Sudan for all parties**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
Escalation of material prices	0.847	5	0.832	7	0.889	4
Availability of resources as planned through project duration	0.871	3	0.858	2	0.904	3
Average delay because of closures and materials shortage	0.941	1	0.896	1	0.943	1
Availability of personals with high experience and qualification	0.859	4	0.848	3	0.865	6
Quality of equipments and raw materials in project	0.835	9	0.840	6	0.861	7
Leadership skills for project manager	0.835	7	0.848	3	0.904	2

According to owners, consultants and contractors; it was obtained that the average delay because of closures and materials shortage was the most important performance factor as it has the first rank among all factors with relative index (RII) = 0.941 for owners, 0.896 for consultants and 0.943 for contractors. This agreement between all target groups is traced to the difficult political situation from which Sudan suffers. Construction projects in Sudan is suffering from a number of problems because of closures and materials shortage. These problems can be considered as an obstacle for time performance of projects. All owners, consultants and contractors feel with such this sensitive problem in their projects.

Availability of resources as planned through project duration has been ranked by the owners respondents in the third position with RII equal 0.871. It has been ranked by the consultants respondents in the second position with RII equal 0.858 and has been ranked by the contractors respondents in the third position with RII equal 0.904. This factor can be considered as an important for three parties and it has a similar rank for all parties as it affects directly on project performance such as time.

Availability of personals with high experience and qualification has been ranked by the owners respondents in the fourth position with RII equal 0.859. It has been ranked by the consultants respondents in the third position with RII equal 0.848 and has been ranked by the contractors respondents in the sixth position with RII equal 0.865. This factor is more important for consultants than for others. Availability of personals with high experience and qualification lead to better performance of quality, time, cost, productivity and safety of projects.

Escalation of material prices has been ranked by the owners respondents in the fifth position with RII equal 0.847.

Quality of equipments and raw materials in project has been ranked by the owners respondents in the ninth position with RII equal 0.835. It has been ranked by the consultants respondents in the sixth position with RII equal 0.840 and has been ranked by the contractors respondents in the seventh position with RII equal 0.861.

However, there are some factors which can be considered as more important for one party than for others as shown in the Table 4.6. This is because contractors are interested with operational and managerial factors such as productivity and material availability. Unlike contractors, however, the owners and consultants considered the client and technical factors to be more important than operational ones.

Table 4.8 shows summary of factors ranking according to all categories:

**Table (4.8) The relative importance index (RII) and rank of factors affecting the performance of construction projects in Sudan according to all categories**

Factors	All Response	
	RII	Rank
Average delay because of closures and materials shortage	0.930	1
Availability of resources as planned through project duration	0.885	2
Leadership skills for project manager	0.875	3
Escalation of material prices	0.864	4
Availability of personals with high experience and qualification	0.859	5
Quality of equipments and raw materials in project	0.850	6
Differentiation of coins prices	0.839	7
Conformance to specification	0.830	8
Cash flow of project	0.827	9
Liquidity of organization	0.818	10
Average delay in payment from owner to contractor	0.818	11
Belonging to work	0.814	12
Sequencing of work according to schedule	0.807	13
Learning from own experience and past history	0.805	14
Learning from best practice and experience of others	0.805	15
Material and equipment cost	0.802	16
Participation of managerial levels with decision making	0.798	17
Review of failures and solve them	0.795	18
Information coordination between owner and project parties	0.789	19
Speed and reliability of service to owner	0.780	20
Training the human resources in the skills demanded by the project	0.777	21
Work group	0.770	22
Recruitment and competence development between employees	0.763	23
Planned time for project construction	0.761	24

Management-labor relationship	0.761	24
Employees motivation	0.759	26
Percentage of orders delivered late	0.757	27
Application of Health and safety factors in organization	0.754	28
Employee attitudes in project	0.753	29
Cost control system	0.747	30
Profit rate of project	0.741	31
Project complexity	0.741	31
Project labor cost	0.741	33
Easiness to reach to the site (location of project)	0.739	34
Absenteeism rate through project	0.734	35
Average delay in claim approval	0.733	36
Number of disputes between owner and project parties	0.729	37
Quality assessment system in organization	0.727	38
Neighbors and site conditions problems	0.724	39
Regular project budget update	0.723	40
Time needed to implement variation orders	0.699	41
Climate condition in the site	0.697	42
Market share of organization	0.696	43
Quality training/meeting	0.686	44
Quality and availability of regulator documentation	0.676	45
Overhead percentage of project	0.666	46
Number of reworks	0.653	47
Time needed to rectify defects	0.652	48
Cost of variation orders	0.651	49
Reportable accidents rate in project	0.648	50
Number of new projects / year	0.641	51
Assurance rate of project	0.641	52
Waste rate of materials	0.637	53
Air quality	0.632	54
Site preparation time	0.632	55
Wastes around the site	0.628	56
Number of non compliance to regulation	0.621	57
Cost of compliance to regulators requirements	0.616	58
Cost of rework	0.611	59
Project overtime cost	0.607	60
Motivation cost	0.600	61
Project design cost	0.598	62
Noise level	0.575	63

The following table 4.9 shows the top ten significant factors affecting the performance of construction projects in Sudan.

**Table (4.9) the following factors are among the top ten significant factors affecting the performance of construction projects in Sudan according to all categories**

Factors	All Response	
	RII	Rank
Average delay because of closures and materials shortage	0.930	1
Availability of resources as planned through project duration	0.885	2
Leadership skills for project manager	0.875	3
Escalation of material prices	0.864	4
Availability of personals with high experience and qualification	0.859	5
Quality of equipments and raw materials in project	0.850	6
Differentiation of coins prices	0.839	7
Conformance to specification	0.830	8
Cash flow of project	0.827	9
Liquidity of organization	0.818	10

According to all response, average delay because of closures and materials shortage was the most important performance factor as it has the first rank among all factors with RII = 0.930. This importance is traced to the difficult political situation from which Gaza strip suffers. Construction projects in Sudan is suffering from complex problems because of closures and materials shortage. These problems can be considered as an obstacle for time performance of projects. All owners, consultants and contractors feel with such this sensitive problem in their projects. In 2006 there were many projects in Sudan which finished with poor time performance because of many reasons such as non-availability of materials and continuous closures (UNRWA, 2006). Construction projects in Sudan suffered from difficult political and economical situation which lead to poor performance of projects (World Bank, 2004).

Availability of resources as planned through project duration has been ranked by all response in the second position with RII equal 0.885. This factor is considered as an important for all parties as it affects directly on project performance such as time. If resources are not available as planned through project duration, the project will suffers from problem of time and cost performance. This result is in line with Iyer and Jha (2005) as availability of resources as planned through project duration is an important factor for all response in Indian construction projects. This is because resource availability as planned schedule can improve time performance of projects. Leadership skills for project manager has been ranked by all response in the third position with RII equal 0.875. If project manager has strong leadership skills, the project performance can be monitored, controlled and managed with high quality. This result is in line with Iyer and Jha (2005) as skills and quality of leadership affects strongly and directly on performance of construction project.

Escalation of material prices has been ranked by all response in the fourth position with RII equal 0.864. Escalation of material prices affects the cost performance of project. It was mentioned that there were many projects in the Sudan finished with poor cost performance because of escalation of material prices (UNRWA, 2006). Availability of personals with high experience and qualification has been ranked by all response in the fifth position with RII equal 0.859. Availability of personals with high experience and qualification lead to better performance of quality, time, cost, productivity and safety of projects. In Sudan, projects are awarded to the lowest bidder. Some of the lowest bidders may lack management skills and less attention is paid to contractor's plan, cost control, overall site management and resource allocation. Samson and Lema (2002), Cheung et al (2004) and Iyer and Jha (2005) are in agreement with our



result as this factor is very important because it affects strongly on quality performance of construction projects.

Quality of equipments and raw materials in project has been ranked by all response in the sixth position with RII equal 0.850. Quality control is one of the most important duties for the consultant in the site of construction project. This will lead to owner satisfaction and implementation of project according to specifications. In Sudan, most of available materials are with little variation in quality and produced by a limited number of producers. Cheung et al (2004) and Iyer and Jha (2005) are in agreement with our result as this factor affects the project performance and the degree of owners satisfaction.

Differentiation of coins prices has been ranked by all response in the seventh position with RII equal 0.839. This factor affects the liquidity, project budget and cost performance. Construction projects in Sudan suffered from differentiation of coins prices because of difficult political and economical situation (World Bank, 2004).

Conformance to specification has been ranked by all response in the eighth position with RII equal 0.830. This factor is an important for owner's satisfaction. The owner usually seeks to implement project according to specification. Iyer and Jha (2005) are in agreement with our result as this factor is significant for owners because this factor is strongly related to client satisfaction.

Cash flow of project has also been ranked by all response in the ninth position with RII equal 0.827. This is mainly because cash flow affects the project budget and project cost performance. This result is in agreement with Samson and Lema (2002) because cash flow can give an important evaluation for the cost performance at any stage of project.

Liquidity of organization has been ranked by all response in the tenth position with RII equal 0.818. Cost performance of any project depends mainly on liquidity of organization. This result is in line with Samson and Lema (2002) as liquidity of organization is very important for evaluation of project budget and cost performance.

### **Performance Categories**

Table 4.10 shows the ten categories which affect the performance of construction projects.

Cost group has been ranked by the owners respondents in the eighth position with RII equal 0.679. It has been ranked by the consultants respondents in the fifth position with RII equal 0.724 and has been ranked by the contractors respondents in the seventh position with RII equal 0.726. This group is more important for consultant than for others because liquidity of organization and project design cost affect the project cost performance and this is related to owner satisfaction. Cheung et al (2004) are in line with our result as cost group affects strongly the performance of construction projects and it can be one of the most important indicators to measure performance. Iyer and Jha (2005) are in agreement with our result as cost is considered as an important criteria for judgment of construction projects performance.

**Table (4.10) the relative importance index (RII) and rank of major groups affecting the performance of construction projects in Sudan**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
Cost	0.679	8	0.724	5	0.726	7
Time	0.753	4	0.757	3	0.769	5
Quality	0.792	2	0.787	1	0.794	3
Productivity	0.736	5	0.718	6	0.747	6
Client Satisfaction	0.734	6	0.765	2	0.779	4
Regular and community satisfaction	0.668	9	0.680	9	0.646	10
People	0.759	3	0.712	7	0.812	1
Health and Safety	0.698	7	0.686	8	0.699	8
Innovation and learning	0.821	1	0.744	4	0.804	2
Environment	0.629	10	0.629	10	0.660	9

Time group has been ranked by the owners respondents in the fourth position with RII equal 0.753. It has been ranked by the consultants respondents in the third position with RII equal 0.757 and has been ranked by the contractors respondents in the fifth position with RII equal 0.769. This group is also more important for consultant than for others because the consultant is concerned with planned time for project completion. Samson and Lema (2002) remarked that time performance is affected by schedule stability of construction projects. Cheung et al (2004) remarked that time group affects strongly the performance of construction projects and it can be one of the most important indicators to measure performance.

Quality group has been ranked by the owners respondents in the second position with RII equal 0.792. It has been ranked by the consultants respondents in the first position with RII equal 0.787 and has been ranked by the contractors respondents in the third position with RII

equal 0.794. This group is the most important one for consultants because consultants are interested with clients and technical factors.

Productivity group has been ranked by the owners respondents in the fifth position with RII equal 0.736. It has been ranked by the consultants respondents in the sixth position with RII equal 0.718 and has been ranked by the contractors respondents in the sixth position with RII equal 0.747. It is obtained that this factor has a similar importance for three parties as productivity affects the cost, time and quality performance of projects.

Client satisfaction group has been ranked by the owners respondents in the sixth position with RII equal 0.734. It has been ranked by the consultants respondents in the second position with RII equal 0.765 and has been ranked by the contractors respondents in the fourth position with RII equal 0.779. It is interesting to observe that client satisfaction group is more important for consultants than for contractors because consultants are usually interested with client factors. This is mainly due to financing issues and owner interference which are considered very important by consultants.

Regular and community satisfaction group has been ranked by the owners respondents in the ninth position with RII equal 0.668. It has been ranked by the consultants respondents in the ninth position with RII equal 0.680 and has been ranked by the contractors respondents in the tenth position with RII equal 0.646. This group is not important for three parties because it rarely affect the project performance because of political situation in the Sudan.

People group has been ranked by the owners respondents in the third position with RII equal 0.759. It has been ranked by the consultants respondents in the seventh position with RII equal 0.712 and has been ranked by the contractors respondents in the first position with RII equal

0.812. It is not surprising to observe that people group is the most important one for contractors because contractors remarked competence development between employees and belonging to work affect strongly on productivity, cost and time performance of contractors

Health and safety group has been ranked by the owners respondents in the seventh position with RII equal 0.698. It has been ranked by the consultants respondents in the eighth position with RII equal 0.686 and has been ranked by the contractors respondents in the eighth position with RII equal 0.699. It is obtained that this group is not important for three parties because safety is rarely considered or applied through implementation stage of construction projects in the Sudan

Innovation and learning group has been ranked by the owners respondents in the first position with RII equal 0.821. It has been ranked by the consultants respondents in the fourth position with RII equal 0.744 and has been ranked by the contractors respondents in the second position with RII equal 0.804. This group is the most important one for owners because owners remarked learning from experience and training the human resources with skills demanded by the project affect strongly the project performance

Environment group has been ranked by the owners respondents in the tenth position with RII equal 0.629. It has been ranked by the consultants respondents in the tenth position with RII equal 0.586 and has been ranked by the contractors respondents in the ninth position with RII equal 0.660. It is obtained that this group is not important for three parties because environmental factors such as air quality and noise level do not affect practically on the performance of projects in the Sudan.

The following is a brief discussion of the ranking of factors for each group

#### 4.2.1 Group one: Cost factors:

The relative importance index (RII) and rank of cost factors are summarized in Table

4.11:

**Table (4.11) RII and rank of cost factors**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(1) Cost factors</b>						
Market share of organization	0.600	12	0.709	10	0.726	10
Liquidity of organization	0.729	6	0.842	1	0.839	4
Cash flow of project	0.812	2	0.800	4	0.848	3
Profit rate of project	0.694	8	0.776	5	0.739	9
Overhead percentage of project	0.647	10	0.687	13	0.662	12
Project design cost	0.500	17	0.688	11	0.582	17
Material and equipment cost	0.812	2	0.776	5	0.813	5
Project labor cost	0.741	5	0.744	7	0.739	8
Project overtime cost	0.588	14	0.600	16	0.617	14
Motivation cost	0.600	12	0.584	17	0.609	15
Cost of rework	0.588	14	0.672	14	0.587	16
Cost of variation orders	0.565	16	0.688	11	0.662	11
Waste rate of materials	0.650	9	0.624	15	0.639	13
Regular project budget update	0.638	11	0.742	8	0.743	7
Cost control system	0.725	7	0.728	9	0.765	6
Escalation of material prices	0.847	1	0.832	2	0.889	1
Differentiation of coins prices	0.788	4	0.808	3	0.874	2

#### Owners view:

As expected, escalation of material prices has been ranked by the owners respondents in the first position with RII equal 0.847. It is worth noticing that this factor is the most important one for owners because continuous closures in the Sudan lead to rapid shortage of construction materials and escalation of construction material prices. This escalation of material prices affect the liquidity of owners' projects and cost

performance of their projects. It should be mentioned that construction projects in Sudan suffered from difficult political and economical situation which lead to poor performance of projects (World Bank, 2004).

Material and equipment cost has been ranked by the owners respondents in the second position with RII equal 0.812. This factor affects the owner's liquidity and project cost performance. This might be due to different location, economical and political situation.

Cash flow of project has also been ranked by the owners respondents in the second position with RII equal 0.812. This mainly because cash flow affects the project budget and project cost performance. This result is in agreement with Samson and Lema (2002) because cash flow can give an important evaluation for the cost performance at any stage of project.

Differentiation of coins prices has been ranked by the owners respondents in the fourth position with RII equal 0.788. This factor affects the owners' liquidity, project budget and cost performance. Construction projects in Sudan suffered from differentiation of coins prices because of difficult political and economical situation (World Bank, 2004).

Project labor cost has been ranked by the owners respondents in the fifth position with RII equal 0.741. This factor affects the cost performance of project because labor cost is one of the main components of project cost. This can be attributed to different location, regulations and laws.

#### **Consultants view:**

Liquidity of organization has been ranked by the consultants respondents in the first position with RII equal 0.842. Consultants considered this factor as the most important one because cost

performance of any project depends mainly on liquidity of organization. This is mainly due to different economical and political situation.

Escalation of material prices has been ranked by the consultants respondents in the second position RII equal 0.832. Continuous closures in the Sudan lead to rapid shortage of construction materials and escalation of construction material prices. This escalation of material prices affect the cost performance of projects which is related to client's representative. There were many projects in Sudan suffered from escalation of material prices because of borders' closures and difficult availability of materials.

Differentiation of coins prices has been ranked by the consultants respondents in the third position with RII equal 0.808. This factor is related to clients' representative factors such as owners' liquidity and project budget. Construction projects in Sudan suffered from differentiation of coins prices because of difficult political and economical situation (World Bank, 2004).

Cash flow of project has been ranked by the consultants respondents in the fourth position with RII equal 0.800. Cash flow can give an important evaluation for the cost performance at any stage of project Profit rate of project has been ranked by the consultants respondents in the fifth position with RII equal 0.776. Profit rate is an important indicator to evaluate cost performance of construction projects. Material and equipment cost has also been ranked by the consultant respondents in the fifth position with RII equal 0.776. Material and equipment cost is one of the main components of project budget affecting the performance of cost.



**Contractors view:**

Escalation of material prices has been ranked by the contractors respondents in the first position with RII equal 0.889. This factor is the most important one for contractors because continuous closures of roads in the Sudan lead to rapid shortage of construction materials and escalation of construction material prices. This escalation of material prices affect the liquidity of contractors and profit rate of their projects. Contractors in Sudan suffered from escalation of construction material prices because of borders' closures and difficult availability of materials

Differentiation of coins prices has been ranked by the contractors respondents in the second position with RII equal 0.874. Differentiation of coins prices affects the project's profit rate for contractors and the contractors' cost performance. Contractors suffered from differentiation of coins prices because of difficult political and economical situation (World Bank, 2004).

Cash flow of project has been ranked by the contractors respondents in the third position with RII equal 0.848. This result is not surprising as most of contracting firms in the Sudan have major problems in Cash flow. Cash flow can give an important evaluation for the contractors' cost performance at any stage of project. In addition, contractors can improve their cost performance based on continues cash flow review. This result is in line with Samson and Lema (2002) as cash flow is a significant factor for evaluation and measurement of construction contractors' performance.

Liquidity of organization has been ranked by the contractors respondents in the fourth position with RII equal 0.839. Cost performance of any construction project depends mainly on liquidity of organization. This result is in agreement with Samson and Lema (2002) as liquidity of organization is very important for evaluation of contractors' cost

performance. However, Ugwu and Haupt (2007) are not in agreement with our result as this factor is not important for contractors in South Africa. This might be due to different economical and political situation.

Material and equipment cost has been ranked by the contractors respondents in the fifth position with RII equal 0.813. This factor is considered as one of project cost components. Therefore, material and equipment cost affects the contractors' profit rate and hence their cost performance. This can be attributed to different economical and political situation.

**Comparison between owners, consultants and contractors:**

Comparison between owners, consultants and contractors for cost factors are

summarized in Table 4.12:

**Table (4.12) Comparison between owners, consultants and contractors for cost factors**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(1) Cost factors</b>						
Escalation of material prices	0.847	1	0.832	2	0.889	1
Differentiation of coins prices	0.788	4	0.808	3	0.874	2
Cash flow of project	0.812	2	0.800	4	0.848	3
Material and equipment cost	0.812	2	0.776	5	<b>0.813</b>	5
Liquidity of organization	0.729	6	0.842	1	0.839	4

Escalation of material prices has been ranked by the owners and contractors respondents in the first position. However, this factor has been ranked by the consultants respondents in the second position. It is observed that this factor is more important for owners and contractors

because escalation of material prices affects the liquidity of owners and the profit rate of contractors. Continuous closures of roads in the Sudan lead to rapid shortage of construction materials and escalation of construction material prices. Construction projects in Sudan suffered from escalation of construction material prices because of borders' closures and difficult availability of materials.

Differentiation of coins prices has been ranked by the owners respondents in the fourth position. It has been ranked by the consultants respondents in the third position and has been ranked by the contractors respondents in the second position. It is not surprising to find out differentiation of coins prices is more important for contractors than for others because this factor affects the contractors' profit rate and cost performance. In Sudan, contractors suffered from differentiation of coins prices because of difficult political and economical situation .

Cash flow of project has been ranked by the owners respondents in the second position. It has been ranked by the consultants respondents in the fourth position and has been ranked by the contractors respondents in the third position. Cash flow is more important for owners and contractors than for consultants because it can give an important evaluation for the owners' and the contractors' cost performance at any stage of project.

Material and equipment cost has been ranked by the owners respondents in the second position but it has been ranked by the consultants and the contractors respondents in the fifth position. It is remarked that this factor is more important for owners than for others. Material and equipment cost is one of project cost components which affect the owners' liquidity and project budget. This can be attributed to different economical and political situation.

Liquidity of organization has been ranked by the owners respondents in the sixth position. It has been ranked by the consultants respondents in the first position and has been ranked by the contractors respondents in the fourth position. Consultants considered this factor as the most important one because cost performance of any project depends mainly on liquidity of organization.. This might be due to different economical and political situation.

#### 4.2.2 Group two: Time factors:

The relative importance index (RII) and rank of time factors are summarized in Table4.13:

**Table (4.13) RII and rank of time factors**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(2) time factors</b>						
Site preparation time	0.682	7	0.664	9	0.596	9
Planned time for project construction	0.753	4	0.760	5	0.765	5
Percentage of orders delivered late	0.694	6	0.768	4	0.774	4
Time needed to implement variation orders	0.706	5	0.704	7	0.693	7
Time needed to rectify defects	0.659	8	0.672	8	0.639	8
Average delay in claim approval	0.650	9	0.728	6	0.765	5
Average delay in payment from owner to contractor	0.824	3	0.776	3	0.776	3
Availability of resources as planned through project duration	0.871	2	0.858	2	0.904	2
Average delay because of closures and materials shortage	0.941	1	0.896	1	0.943	1

**Owners view:**

Average delay because of closures and materials shortage has been ranked by the owner respondents in the first position with RII equal 0.941. This factor is the most important one for owners because construction projects in Sudan is suffering from time performance problems such as delay due to closures and materials shortage. Owners usually feel with this sensitive problem in their projects. Construction projects in Sudan suffered from time performance problem because of boarders' closures and difficult availability of materials .

Availability of resources as planned through project duration has been ranked by the owner respondents in the second position with RII equal 0.871. This factor affects directly and practically on project performance such as time. If resources are not available as planned through project duration, the project will suffer from problem of time and cost performance. This is because resource availability as planned schedule can improve time performance of projects.

Average delay in payment from owner to contractor has been ranked by the owner respondents in the third position with RII equal 0.824. Delay in payment from owner to contractor lead to delay of contractors' performance and cause problem in time performance. This may also lead to disputes and claims between owner and contractor of project. All of that will affect the overall performance of project which has been implemented

Planned time for project construction has been ranked by the owner respondents in the fourth position with RII equal 0.753. Planned time for project construction may not be suitable practically. If planned time is not suitable for implementation, the performance of project will suffers from delay and disputes between the owner and other parties of project. Owners usually want their projects to finish as early as possible

Time needed to implement variation orders has been ranked by the owner respondents in the fifth position with RII equal 0.706. Time needed to implement variation orders will affect the performance of basic schedule. Therefore, this will affect the time performance.. For example, estimated schedule will be changed and modified.

**Consultants view:**

Average delay because of closures and materials shortage has been ranked by the consultants respondents in the first position with RII equal 0.896. This factor is the most important one for consultants because construction projects in Sudan is suffering from time performance problems such as delay due to closures and materials shortage. Consultants usually feel with this sensitive problem in their projects. Construction projects in Sudan suffered from delay because of boarders' closures and difficult availability of materials .

Availability of resources as planned through project duration has been ranked by the consultants respondents in the second position with RII equal 0.858. This factor affects directly and practically on project performance such as time. If resources are not available as planned through project duration, the project will suffer from problem of time performance. This result is in agreement with Samson and Lema (2002) and Ugwu and Haupt (2007) as resource availability is an important factor for consultants because it affects the processes performance of construction projects.

Average delay in payment from owner to contractor has been ranked by the consultants respondents in the third position with RII equal 0.776. Delay in payment from owner to contractor lead to delay of project performance. This may also lead to disputes and claims between consultant and contractor of project. All of that will affect the overall performance of project which has been implemented. Percentage of

orders delivered late has been ranked by the consultants respondents in the fourth position with RII equal 0.768. When orders from consultant to contractor are delivered late, time performance of project will also be delayed. Then the schedule of project will be affected.

Planned time for project construction has been ranked by the consultants respondents in the fifth position with RII equal 0.760. Planned time for project construction may not be suitable practically. Therefore, the performance of project will suffer from delay and disputes between consultant and contractor. Cheung et al (2004) is in line with our result as this factor affects strongly on time performance.

**Contractors view:**

Average delay because of closures and materials shortage has been ranked by the contractors respondents in the first position with RII equal 0.943. This factor is the most important one for contractors because construction projects in Sudan is suffering from complex problems due to closures and materials shortage. These problems can be considered as an obstacle for time performance of projects and leads to project delay. Contractors usually feel with this sensitive problem in their projects in Sudan. Contractors in Sudan suffered from delay because of borders' closures and materials shortage .Availability of resources as planned through project duration has been ranked by the contractors respondents in the second position with RII equal 0.904. This factor affects directly and practically on contractors' performance through projects. If resources are not available for contractors as planned through project duration, the project will suffer from problem of time and cost performance. of contractors. result as availability of resources as planned through project duration is not important for contractors and it is rarely affects the contractors' time performance. This might be due to different location, political and economical situation.

Average delay in payment from owner to contractor has been ranked by the contractors respondents in the third position with RII equal 0.839. Delay in payment from owner to contractor lead to delay of contractors' performance and cause problem in time performance. This may also lead to disputes and claims between contractor and consultant of project. All of that will affect the overall performance of project that has been implemented.

Percentage of orders delivered late has been ranked by the contractors respondents in the fourth position with RII equal 0.774. When orders from consultant to contractor are delivered late, time performance of contractor will also be delayed. The contractor cannot implement any stage through project without having orders from project's consultant.

Planned time for project construction has been ranked by the contractors respondents in the fifth position with RII equal 0.765. Planned time for project construction may not be suitable practically. Therefore, the performance of project will suffer from delay and disputes between contractor and consultant.

**Comparison between owners, consultants and contractors:**

Comparison between owners, consultants and contractors for time factors are

summarized in Table 4.14:



**Table (4.14) Comparison between owners, consultants and contractors for time factors**

Factors	Owner		Consultant		Contractor	
	RII	Ran k	RII	Ran k	RII	Ran k
<b>(2) time factors</b>						
delay because of closures and materials shortage	0.94 1	1	0.89 6	1	0.94 3	1
Availability of resources as planned through project duration	0.87 1	2	0.85 8	2	0.90 4	2
Average delay in payment from owner to contractor	0.82 4	3	0.77 6	3	0.83 9	3
Percentage of orders delivered late	0.69 4	6	0.76 8	4	<b>0.77</b> <b>4</b>	4
Planned time for project construction	0.75 3	4	0.76 0	5	0.76 5	5

According to owners, consultants and contractors; the average delay because of closures and materials shortage was the most important performance factor as it has the first rank among all factors with RII = 0.941 for owners, 0.896 for consultants and 0.943 for contractors. This agreement between all target groups is traced to the difficult political situation from which Sudan suffers. Construction projects in Sudan is suffering from complex problems because of closures and materials shortage. These problems can be considered as an obstacle for time performance of projects. All owners, consultants and contractors feel with this sensitive problem in their projects. Contractors in the Sudan suffered from delay because of boarders' closures and materials shortage.

Availability of resources as planned through project duration has been ranked by the owners respondents in the third position. It has been ranked by the consultants respondents in the second position and has been ranked by the contractors respondents in the third position. This factor

can be considered as an important for three parties and has a similar rank for all of them. This factor is related to closures and it affects directly on project performance such as time. If resources are not available as planned through project duration, the project will suffer from problem of time performance

Average delay in payment from owner to contractor has been ranked by the owners, consultants and contractors respondents in the third position. This agreement between parties is traced to disputes which will happen between project's parties when the payment from owner is delayed. This will affect the performance of project specially time criteria

Percentage of orders delivered late has been ranked by the owners respondents in the sixth position and has been ranked by the consultants and contractors respondents in the fourth position. This factor has the same rank for contractors and consultants and it is more important for them because it is related to contractual relationships between them. The contractor cannot implement any stage through project without having orders from project's consultant.

Planned time for project construction has been ranked by the owners respondents in the fourth position and has been ranked by the consultants and contractors respondents in the fifth position. This factor is more important for owners as they usually want their projects to finish as early as possible.

#### **4.2.3 Group three: Quality factors:**

The relative importance index (RII) and rank of quality factors are summarized in

Table 4.15:

**Table (4.15) RII and rank of quality factors**

Factors	Owner		Consultant		Contractor	
	RII	Ran k	RII	Ran k	RII	Ran k
<b>(3) Quality factors</b>						
Conformance to specification	0.88 2	1	0.80 8	3	0.82 2	3
Availability of personals with high experience and qualification	0.85 9	2	0.84 8	1	0.86 5	1
Quality of equipments and raw materials in project	0.83 5	3	0.84 0	2	0.86 1	2
Participation of managerial levels with decision making	0.81 2	4	<b>0.78 4</b>	4	0.80 0	4
Quality assessment system in organization	0.70 6	5	0.71 2	6	0.74 3	5
Quality training/meeting	0.65 9	6	0.72 8	5	0.67 4	6

### **Owners view**

Conformance to specification has been ranked by the owners respondents in the first position with RII equal 0.882. This factor is the most important one for owners because this factor is an important to owner's satisfaction. The owner usually seeks to implement project according to specification .

Availability of personals with high experience and qualification has been ranked by the owners respondents in the second position with RII equal 0.859. Availability of personals with high experience and qualification in project lead to implementation of project with suitable cost, time and with professional quality which satisfy the owner.

Quality of equipments and raw materials in project has been ranked by the owners respondents in the third position with RII equal 0.835. The owners usually want materials used in their project with a good quality

and according to specification. In Sudan, most of available materials are with little variation in quality and produced by a limited number of producers. Participation of managerial levels with decision-making has been ranked by the owners respondents in the fourth position with RII equal 0.812. If managerial levels share with decision making, this will lead to better implementation of project and this will satisfy the owner with more degree

Quality assessment system in organization has been ranked by the owners respondents in the fifth position with RII equal 0.706. Quality assessment system in organization is rarely achieved or implemented through construction projects in the Sudan.

### **Consultants view**

Availability of personals with high experience and qualification has been ranked by the consultants respondents in the first position with RII equal 0.848. This factor is the most important one for consultants because availability of personals with high experience and qualification assist consultants to supervise the project with a good professionalism and also this assist them to satisfy the owner with a successful performance of project. This result is in agreement with Cheung et al (2004) and Iyer and Jha (2005) as this factor affects strongly on project performance because it affects strongly the degree of owners satisfaction which is one of the main responsibilities of consultants.

Quality of equipments and raw materials in project has been ranked by the consultants respondents in the second position with RII equal 0.840. Consultants usually want materials used in supervised project with a good quality and according to specification

Conformance to specification has been ranked by the consultants respondents in the third position with RII equal 0.808. This factor is an

important to client representative satisfaction because it is mainly related to owner satisfaction

Participation of managerial levels with decision-making has been ranked by the consultants respondents in the fourth position with RII equal 0.784. If managerial levels share with decision making, this will lead to better performance of project and this will satisfy the client representative with more degree.

Quality training/meeting has been ranked by the consultants respondents in the fifth position with RII equal 0.728. Quality training/meeting is rarely achieved or implemented in construction projects in the Sudan. However,

### **Contractors view**

Availability of personals with high experience and qualification has been ranked by the contractors respondents in the first position with RII equal 0.865. This factor is the most important one for contractors because availability of personals with high experience and qualification assist contractors to implement their projects with a successful and suitable performance. In Sudan, the majority of site managers are civil engineers with good work experience but little training or education in management.

Quality of equipments and raw materials in project has been ranked by the contractors respondents in the second position with RII equal 0.861. Contractors must implement their projects according to required and agreed quality because owners and consultants usually want materials used in supervised project according to specification and agreement.

Conformance to specification has been ranked by the contractors respondents in the third position with RII equal 0.822. This factor is significant for contractors as it is relate to consultants and owners satisfaction.

Participation of managerial levels with decision-making has been ranked by the contractors respondents in the fourth position with RII equal 0.800. If managerial levels share with decision making, this will lead to better performance of project and this will satisfy both of consultant and owner with more degree.

Quality assessment system in organization has been ranked by the contractors respondents in the fifth position with RII equal 0.743. Quality assessment system in organization is rarely achieved or implemented for contractors in the Sudan.

**Comparison between owners, consultants and contractors:**

Comparison between owners, consultants and contractors for quality factors are

summarized in Table 4.16:

**Table (4.16) Comparison between owners, consultants and contractors for quality Factors**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(3) Quality factors</b>						
Participation of managerial levels with decision-making	0.812	4	0.784	4	0.800	4
Availability of personals with high experience and qualification	0.859	2	0.848	1	0.865	1
Conformance to specification	0.882	1	0.808	3	0.822	3
Quality of equipments and raw materials in project	0.835	3	0.840	2	0.861	2

Participation of managerial levels with decision-making has been ranked by the owners, consultants and contractors respondents in the fourth position. This factor has the same rank for all parties because sharing of managerial levels with decision-making will lead to better implementation and performance of project and this will satisfy the three parties with more degree.

Availability of personals with high experience and qualification has been ranked by consultants and contractors respondents in the first position and has been ranked by owners respondents in the second position. However, this factor is very important for three parties because availability of personals with high experience and qualification assist them to implement their project with a professional and successful performance.

Conformance to specification has been ranked in the first position for owners but it has been ranked in the third position for both of consultants and contractors. This factor is more important for owners as it is significant and related to client satisfaction. The owners usually seek to implement their project according to required specifications.

Quality of equipments and raw materials in project has been ranked by the consultants and contractors respondents in the second position and has been ranked by the owner respondent in the third position. This factor is more important for consultant and contractor than for owner as they usually want materials used in project with a good quality and according to specification.

#### **4.2.4 Group four: Productivity factors:**

The relative importance index (RII) and rank of productivity factors are summarized

in Table 4.17:

**Table (4.17) RII and rank of productivity factors**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(4) Productivity factors</b>						
Project complexity	0.729	4	0.712	2	0.761	3
Number of new projects / year	0.600	5	0.688	3	0.630	5
Management-labor relationship	0.776	2	0.688	3	0.796	2
Absenteeism rate through project	0.776	2	0.688	3	0.743	4
Sequencing of work according to schedule	0.800	1	0.816	1	0.804	1

**Owners view:**

Sequencing of work according to schedule has been ranked by the owners respondents in the first position with RII equal 0.800. This factor is the most important one for owners because sequencing of work according to schedule assists the owner to deliver project according to scheduled time for project completion.

Absenteeism rate through project has been ranked by the owners respondents in the second position with RII equal 0.776. Absenteeism through project will affect the productivity performance of project. Therefore, the owner will suffer from delay of project.

Management-labor relationship has also been ranked by the owners respondents in the second position with RII equal 0.776. Management-labor relationship can assist for strong coordination and motivation between labor level and managerial level. This will assist for implementation of project with success productivity and good performance. All of that will satisfy the owner of project. This might be due to different location and culture



Project complexity has been ranked by the owners respondents in the fourth position with RII equal 0.729. Project complexity affect the degree of overall performance through projectNumber of new projects / year has been ranked by the owners respondents in the fifth position with RII equal 0.600. Number of new projects / year rarely affect practically on performance of projects. This is because experiences and skills depend on number of executed projects.

**Consultants view:**

Sequencing of work according to schedule has been ranked by the consultants respondents in the first position with RII equal 0.816. This factor is the most important one for consultant because sequencing of work according to schedule assists consultant to deliver project to the owner according to scheduled time for project completion.

Project complexity has been ranked by the consultants respondents in the second position with RII equal 0.712. Degree of project complexity is correlated with experiences required for supervision and skills needed to monitor and supervise performance of project.

Absenteeism rate through project has been ranked by the consultants respondents in the third position with RII equal 0.688. Absenteeism through project will affect the productivity and time performance of project.

Management-labor relationship has also been ranked by the consultants respondents in the third position with RII equal 0.688. Management-labor relationship can assist for strong coordination and motivation between contractor level and consultant level. This will lead to implement project with success supervision and so good performance of consultant.

Number of new projects / year has also been ranked by the consultants respondents in the third position with RII equal 0.688. Number of new projects / year affect the degree of experiences and skills learned from executed projects and that will affect the degree of consultant performance according to previous or current experiences.

**Contractors view:**

Sequencing of work according to schedule has been ranked by the contractors respondents in the first position with RII equal 0.804. This factor is the most important one for contractors because sequencing of work according to schedule assists contractors to implement project according to scheduled time for project completion. Therefore, the contractors will not suffer from time and cost performance problems..

Management-labor relationship has been ranked by the contractors respondents in the second position with RII equal 0.796. Management-labor relationship can assist for strong coordination and motivation between labor level and managerial level. This will lead to implement project with success productivity and suitable time performance of project.

Project complexity has been ranked by the contractors respondents in the third position with RII equal 0.761. Degree of project complexity is related with experiences required for implementation and skills needed to construct project. All of that affect on the degree of contractors performance.

Absenteeism rate through project has been ranked by the contractors respondents in the fourth position with RII equal 0.743. Absenteeism through project will affect the productivity. The contractor will suffer from time performance problem.

Number of new projects / year has been ranked by the contractors respondents in the fifth position with RII equal 0.630. Number of new projects / year rarely affect practically on construction contractors performance. This is because experiences and skills depend on number of executed projects.

**Comparison between owners, consultants and contractors:**

Comparison between owners, consultants and contractors for productivity factors are

summarized in Table 4.18:

**Table (4.18) Comparison between owners, consultants and contractors for productivity factors**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(4) Productivity factors</b>						
Sequencing of work according to schedule	0.800	1	0.816	1	0.804	1
Management-labor relationship	0.776	2	0.688	3	0.796	2
Number of new projects / year	0.600	5	0.688	3	0.630	5

Sequencing of work according to schedule has been ranked by owners, consultants and contractors in the first position. This factor is the most important one for three parties because sequencing of work according to schedule assists them to perform project according to scheduled time for project completion. Therefore, there is no delay or cost overruns.

Management-labor relationship has been ranked by owners and contractors respondents in the second position and has been ranked by consultants respondents in the third position. However, this factor is considered as an important for three parties as management-labor

relationship can assist them for strong coordination and motivation between labor level and managerial level. This will lead to implement project with success productivity and so good performance of project.

Number of new projects / year has been ranked by owners and contractors respondents in the fifth position and has been ranked by consultant respondents in the third position. This factor is considered more important for consultants. Owners and contractors considered that number of new projects / year rarely affect the performance of projects. Otherwise, consultants considered that number of new projects / year affect the degree of experiences and skills learned from executed projects and that will affect the degree of project performance based on previous or current experiences.

#### 4.2.5 Group five: Client Satisfaction factors:

The relative importance index (RII) and rank of client satisfaction factors are summarized in Table 4.19:

Table (4.19) RII and rank of client satisfaction factors

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(5) Client satisfaction factors</b>						
Information coordination between owner and project parties	0.729	3	0.792	3	0.809	3
Leadership skills for project manager	0.835	1	0.848	1	0.904	1
Speed and reliability of service to owner	0.718	4	0.744	3	0.822	2
Number of disputes between owner and project parties	0.753	2	0.728	4	0.720	4
Number of reworks	0.635	5	0.712	5	0.627	5

**Owners view:**

Leadership skills for project manager have been ranked by the owners respondents in the first position with RII equal 0.835. This factor is the most important one for owners because leadership skills for project manager affect the degree of project performance and client satisfaction.

Number of disputes between owner and project parties have been ranked by the owners respondents in the second position with RII equal 0.753. Disputes between owner and project parties will affect on relationship between them and also the degree of client satisfaction will be decreased. All of that can affect the performance of project.

Information coordination between owner and project parties has been ranked by the owners respondents in the third position with RII equal 0.729. Information coordination between owner and project parties will lead to strong relationship between them and the client will be more satisfied.

Speed and reliability of service to owner has been ranked by the owners respondents in the fourth position with RII equal 0.718. This factor increases the degree of satisfaction with respect to client.

Number of reworks has been ranked by the owners respondents in the fifth position with RII equal 0.635. This factor has an effect on client satisfaction and project performance.

**Consultants view:**

Leadership skills for project manager have been ranked by the consultants respondents in the first position with RII equal 0.848. This factor is the most important one for consultants because leadership skills for project manager assist consultants to supervise the project with strong and suitable performance. This will convenient and satisfy the client of project

Information coordination between owner and project parties has been ranked by the consultants respondents in the second position with RII equal 0.792. Information coordination between owner and project parties will lead to strong relationship between owner and consultant. Therefore, the client will be more satisfied

Speed and reliability of service to owner has been ranked by the consultants respondents in the third position with RII equal 0.744. Speed and reliability of service from consultant to owner affect the degree of satisfaction with respect to client.

Number of disputes between owner and project parties have been ranked by the consultants respondents in the fourth position with RII equal 0.728. Disputes between owner and consultant will affect on relationship between them and the degree of client satisfaction will be affected. All of that can affect the performance of project.

Number of reworks has been ranked by the consultants respondents in the fifth position with RII equal 0.712. This factor has an effect on client satisfaction and project performance.

#### **Contractors view:**

Leadership skills for project manager have been ranked by the contractors respondents in the first position with RII equal 0.904 for contractors. This factor is the most important one for contractors because leadership skills for project manager affect the construction contractors performance.

Speed and reliability of service to owner has been ranked by the contractors respondents in the second position with RII equal 0.822. Speed and reliability of service from contractor to client representative affect the degree of satisfaction with respect to client.

Information coordination between owner and project parties has been ranked by the contractors respondents in the third position with RII

equal 0.809 for contractors. contractors respondents in the third position with RII equal 0.809 for contractors. Information coordination between owner and project parties will lead to success construction contractors performance and strong relationship between project parties.

Number of disputes between owner and project parties have been ranked by the contractors respondents in the fourth position with RII equal 0.720. Disputes between contractors respondents in the fourth position with RII equal 0.720. Disputes between owner and contractor will affect the relationship between them and the degree of client satisfaction will be affected. All of that affects on performance of contractors.

Number of reworks has been ranked by the contractors respondents in the fifth position with RII equal 0.627. This factor has an effect on client satisfaction and contractors performance

**Comparison between owners, consultants and contractors:**

Comparison between owners, consultants and contractors for client satisfaction factors are summarized in Table 4.20:

**Table (4.20) Comparison between owners, consultants and contractors for client satisfaction factors:**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(5) Client satisfaction factors</b>						
Leadership skills for project manager	0.835	1	0.848	1	0.904	1
Number of reworks	0.635	5	0.712	5	0.627	5
Number of disputes between owner and project parties	0.753	2	0.728	4	0.720	4
Information coordination between owner and project parties	0.729	3	0.792	2	0.809	3

Leadership skills for project manager have been ranked by owners, consultants and contractors respondents in the first position. This factor is the most important one for three parties because leadership skills for project manager affect the degree of project performance and client satisfaction. Number of reworks has been ranked by owners, consultants and contractors respondents in the fifth position. This factor has the same rank for three parties because number of reworks affect the relationship between them.

Number of disputes between owner and project parties have been ranked by owners respondents in the second position and have been ranked by consultants and contractors respondents in the fourth position. This factor is more important for owners because disputes between owner and project parties will affect on relationship between them and the degree of client satisfaction will be affected. All of that affects the performance of project..

Information coordination between owner and project parties has been ranked by the owners and contractors respondents in the third position and has been ranked by the consultant respondents in the second position. This factor is more important for consultants because in formation coordination affects the client satisfaction. Consultants usually are related to client factors.

#### **4.2.6 Group six: Regular and Community Satisfaction factors:**

The relative importance index (RII) and rank of regular and community satisfaction

factors are summarized in Table 4.21:



**Table (4.21) RII and rank of regular and community satisfaction factors**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(6) Regular and community satisfaction factors</b>						
Cost of compliance to regulators requirements	0.600	4	0.648	3	0.604	4
Number of non compliance to regulation	0.635	3	0.624	4	0.614	3
Quality and availability of regulator documentation	0.647	2	0.736	1	0.653	2
Neighbors and site conditions problems	0.788	1	0.712	2	0.707	1

### **Owners view**

Neighbors and site conditions problems has been ranked by the owners respondents in the first position with RII equal 0.788. This factor is the most important one for owners because construction projects in Sudan usually suffer from this problem. This problem affects the time performance of project and causes disputes and delays.

Quality and availability of regulator documentation has been ranked by the owners respondents in the second position with RII equal 0.647. Quality and availability of regulator documentation affects the regular and community satisfaction. Project performance will also be affected.

Number of non-compliance to regulation has been ranked by the owners respondents in the third position with RII equal 0.635. The more increase of non compliance to regulation, the more dissatisfaction of regular and community for project. This will affect the project performance.

Cost of compliance to regulators requirements has been ranked by the owners respondents in the fourth position with RII equal 0.600. Cost of compliance to regulators requirements affects the cost performance of project.

**Consultants view:**

Quality and availability of regulator documentation has been ranked by the consultants respondents in the first position with RII equal 0.736. This factor is the most important one for consultants as quality and availability of regulator documentation affects the regular and community satisfaction. Project performance will also be affected.

Neighbors and site conditions problems has been ranked by the consultants respondents in the second position with RII equal 0.712. Construction projects in Sudan usually suffer from this problem. This problem affects the consultant performance of project and causes disputes and delays.

Cost of compliance to regulators requirements has been ranked by the consultants respondents in the third position with RII equal 0.648. Cost of compliance to regulators requirements affects the cost performance of project.

Number of non-compliance to regulation has been ranked by the consultants respondents in the fourth position with RII equal 0.624. The more increase of noncompliance to regulation, the more dissatisfaction of regular and community for project. This will affect the project performance.

**Contractors view:**

Neighbors and site conditions problems has been ranked by the contractors respondents in the first position with RII equal 0.707. Contractors considered this factor as the most important one because construction projects in Sudan usually suffer from this problem. This problem affects the performance of contractors and causes disputes and delay of project.

Quality and availability of regulator documentation has been ranked by the contractors respondents in the second position with RII equal 0.653. Quality and availability of regulator documentation affects the regular and community satisfaction. Project performance will also be affected.

Number of non-compliance to regulation has been ranked by the contractors respondents in the third position with RII equal 0.614. The more increase of noncompliance to regulation, the more dissatisfaction of regular and community for project. This will affect the project performance.

Cost of compliance to regulators requirements has been ranked by the contractors respondents in the fourth position with RII equal 0.604. Cost of compliance to regulators requirements affects the cost performance of project.

**Comparison between owners, consultants and contractors:**

Comparison between owners, consultants and contractors for regular and community satisfaction factors are summarized in Table 4.22:

**Table (4.22) Comparison between owners, consultants and contractors for regular and community satisfaction factors.**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(6) Regular and community satisfaction factors</b>						
Neighbors and site conditions problems	0.788	1	0.712	2	0.707	1
Quality and availability of regulator documentation	0.647	2	0.736	1	0.653	2

Neighbors and site conditions problems has been ranked by the owners and contractors respondents in the first position and has been ranked by the consultants respondents in the second position. This might be because of different location, environment and culture. Quality and availability of regulator documentation has been ranked by the consultants respondents in the first position and has been ranked by the owners and contractors respondents in the second position. Quality and availability of regulator documentation is more important for consultants because it affects the performance of consultants and community satisfaction.

It is obtained that there is a strong agreement between owners and contractors for ranking of all regular and community satisfaction factors because these factors are more related to contractors' performance and client satisfaction. Generally, it can be said that three parties have similar agreement for ranking of these factors.

#### 4.2.7 Group seven: People factors:

The relative importance index (RII) and rank of people factors are summarized in

Table (4.23) RII and rank of people factors

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(7) People factors</b>						
Employee attitudes in project	0.682	4	0.728	2	0.795	3
Recruitment and competence development between employees	0.753	3	0.688	4	0.809	2
Employees motivation	0.765	2	0.696	3	0.791	4
Belonging to work	0.835	1	0.736	1	0.849	1

#### Owners view

Belonging to work has been ranked by the owners respondents in the first position with RII equal 0.835. This factor is the most important one for owners because belonging to work usually improves productivity and performance of project.. Employees' motivation has been ranked by the owners respondents in the second position with RII equal 0.765. Employees' motivation leads to belonging to work and productivity will be improved. However,

Recruitment and competence development between employees has been ranked by the owners respondents in the third position with RII equal 0.753. Recruitment and competence development between employees improve performance of project and the client will be more satisfied.

Employee attitudes in project have been ranked by the owners respondents in the fourth position with RII equal 0.682. Employee attitudes affects the project performance and owner satisfaction.

### **Consultants view**

Belonging to work has been ranked by the consultants respondents in the first position with RII equal 0.736. This factor is the most important one for consultants because belonging to work usually improves consultant's performance.

Employee attitudes in project have been ranked by the consultants respondents in the second position with RII equal 0.728. Employee attitudes affects strongly on performance of project.

Employees' motivation has been ranked by the consultants respondents in the third position with RII equal 0.696. Employees' motivation leads to more belonging to work and performance of project will be improved.

Recruitment and competence development between employees has been ranked by the consultants respondents in the fourth position with RII equal 0.688. Recruitment and competence development between employees improve performance of consultants through projects and the client will be more satisfied.

### **Contractors view**

Belonging to work has been ranked by the contractors respondents in the first position with RII equal 0.849. This factor is the most important one for contractors because belonging to work usually improves contractor's productivity and performance of project

Recruitment and competence development between employees has been ranked by the contractors respondents in the second position with RII equal 0.809. Recruitment and competence development between employees improve productivity through project and performance will be enhanced.

Employee attitudes in project have been ranked by the contractors respondents in the third position with RII equal 0.795. Employee attitudes affects the contractors performance through project implementation.

Employees' motivation has been ranked by the contractors respondents in the fourth position with RII equal 0.791. Employees' motivation leads to belonging to work and will improve productivity, cost and time performance

**Comparison between owners, consultants and contractors:**

Comparison between owners, consultants and contractors for people factors are summarized in Table 4.24:

**Table (4.24) Comparison between owners, consultants and contractors for people Factors**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(7) People factors</b>						
Belonging to work	0.835	1	0.736	1	0.849	1
Employees' motivation	0.765	2	0.696	3	0.791	4

Belonging to work has been ranked by the owners, consultants and contractors respondents in the first position. This factor is the most important one for three parties because belonging to work usually improves productivity and performance of project

Employees' motivation has been ranked by the owners respondents in the second position. It has been ranked by the consultants respondents in the third position and that this factor is less important for contractors because it is rarely contractors has been ranked by the contractors respondents in the fourth position. It is remarked motivate employees in

Sudan. However, other factors are obtained that more important for one party than others as shown previously.

#### 4.2.8 Group eight: Health and safety factors:

The relative importance index (RII) and rank of health and safety factors are summarized in Table 4.25:

Table (4.25) RII and rank of health and safety factors

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(8) Health and safety factors</b>						
Application of Health and safety factors in organization	0.700	2	0.728	1	0.787	1
Easiness to reach to the site (location of project)	0.694	3	0.704	2	0.774	2
Reportable accidents rate in project	0.729	1	0.680	3	0.600	4
Assurance rate of project	0.671	4	0.632	4	0.635	3

#### Owners view

Reportable accidents rate in project has been ranked by the owners respondents in the first position with RII equal 0.729. Owners considered this factor as the most important one because reportable accidents rate usually affects the safety performance and the client satisfaction in construction projects.

Application of health and safety factors in organization has been ranked by the owners respondents in the second position with RII equal 0.700. Application of health and safety factors in construction projects will satisfy the owners

Easiness to reach to the site (location of project) has been ranked by the owners respondents in the third position with RII equal 0.694.



Easiness to reach to the site affects the degree of health and safety for project employees.

Assurance rate of project has been ranked by the owners respondents in the fourth position with RII equal 0.671. This factor affects the safety and cost performance of project.

### **Consultants view**

Application of health and safety factors in organization has been ranked by the consultants respondents in the first position with RII equal 0.728. This factor is the most important one for consultants because application of health and safety factors in construction projects will satisfy the owners.

Reportable accidents rate in project has been ranked by the consultants respondents in the third position with RII equal 0.680. Reportable accidents rate affects the safety performance of construction projects. Assurance rate of project has been ranked by the consultants respondents in the fourth position with RII equal 0.632. This factor affects the safety and cost performance of project.

### **Contractors view**

Application of health and safety factors in organization has been ranked by the contractors respondents in the first position with RII equal 0.787. This factor is the most important one for contractors because application of health and safety factors in construction projects will improve construction contractors' performance in project.

Easiness to reach to the site (location of project) has been ranked by the contractors respondents in the second position with RII equal 0.774. Easiness to reach to the site affects on the degree of health and safety for project employees.

Assurance rate of project has been ranked by the contractors respondents in the third position with RII equal 0.635. This factor affects the safety and cost performance of construction contractors projects

Reportable accidents rate in project has been ranked by the contractors respondents in the fourth position with RII equal 0.600. Reportable accidents rate affects the safety performance of construction projects. This will affect the overall of construction contractors performance.

**Comparison between owners, consultants and contractors:**

Comparison between owners, consultants and contractors for health and safety factors are summarized in Table 4.26:

**Table (4.26) Comparison between owners, consultants and contractors for health and safety factors**

Factors	Owner		Consultant		Contractor	
	RII	Ran k	RII	Ran k	RII	Ran k
<b>(8) Health and safety factors</b>						
Application of Health and safety factors in organization	0.70 0	2	0.72 8	1	0.78 7	1
Reportable accidents rate in project	0.69 4	3	0.70 4	2	0.77 4	2
Easiness to reach to the site (location of project)	0.72 9	1	0.68 0	3	0.60 0	4

Application of health and safety factors in organization has been ranked by the consultants and contractors respondents in first position but has been ranked by the owners respondents in the second position. However, this factor is very important for three parties because application of health and safety factors in construction projects will improve overall performance of construction project.

Reportable accidents rate in project has been ranked by the owners respondents in the first position. It has been ranked by the consultants respondents in the third position and has been ranked by the contractors respondents in the fourth position. Owners considered this factor as the most important one because reportable accidents rate usually affects the safety performance and the client satisfaction degree in construction projects.

Easiness to reach to the site (location of project) has been ranked by the owners respondents in the third position and has been ranked by the consultants and contractors respondent in the second position. This factor is more important for consultants and contractors because easiness to reach to the site is more related to them and affects the degree of safety for their employees.

#### **4.2.9 Group nine: Innovation and learning factors:**

The relative importance index (RII) and rank of innovation and learning factors are summarized in Table 4.27:

**Table (4.27) RII and rank of innovation and learning factors**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(9) Innovation and learning factors</b>						
Learning from own experience and past history	0.847	1	0.752	2	0.818	2
Learning from best practice and experience of others	0.824	3	0.760	1	0.822	1
Training the human resources in the skills demanded by the project	0.835	2	0.720	5	0.787	4
Work group	0.776	5	0.736	4	0.787	4
Review of failures and solve them	0.824	3	0.752	2	0.809	3

### **Owners view**

Learning from own experience and past history has been ranked by the owners respondents in the first position with RII equal 0.847. This factor is the most important one for owners because learning from own experience and past history can improve and develop performance of current and future projects.

Training the human resources in the skills demanded by the project has been ranked by the owners respondents in the second position with RII equal 0.835. Training the human resources in the skills demanded by the project assists employees to perform project successfully and with high professional degree. All of that will increase satisfaction of owner.

Learning from best practice and experience of others has been ranked by the owners respondents in the third position with RII equal 0.824. It can improve and develop performance of current and future projects. This is related to clients' satisfaction. Review of failures and solve them has also been ranked by the owners respondents in the third position with RII equal 0.824. This factor will enhance project performance and will satisfy the owner.

Work group has been ranked by the owners respondents in the fifth position with RII equal 0.776. Work group between owner and other parties lead to better performance of project. This result is in agreement with .

### **Consultants view**

Learning from best practice and experience of others has been ranked by the consultants respondents in the first position with RII equal 0.760. This factor is the most important one for consultants because it can improve and develop consultants performance of current and future projects.

Learning from own experience and past history has been ranked by the consultants respondents in the second position with RII equal 0.752. Learning from own experience and past history can improve and develop consultants performance of current and future projects. This is related to clients' satisfaction.

Review of failures and solve them has also been ranked by the consultants respondents in the second position with RII equal 0.752. This factor will enhance project performance and will satisfy the owner.

Work group has been ranked by the consultants respondents in the fourth position with RII equal 0.736. Work group between consultant and other parties lead to better performance of project.

Training the human resources in the skills demanded by the project has been ranked by the consultants respondents in the fifth position with RII equal 0.720. Consultants should train employees with different and improved skills in order to design and supervise different and complex types of projects.

### **Contractors view**

Learning from best practice and experience of others has been ranked by the contractors respondents in the first position with RII equal 0.822. contractors considered this factor as the most important one because it can improve and develop construction contractors' performance of current and future projects. This factor is strongly related to contractors' party.

Learning from own experience and past history has been ranked by the contractors respondents in the second position with RII equal 0.818. Learning from own experience and past history can improve and develop contractors performance of current and future projects. This factor is also strongly related to contractors' party. Review of failures and solve them has been ranked by the contractors respondents in the third position with

RII equal 0.809. Review of failures and solve them will enhance contractors performance and will satisfy the owner. Samson and Lema (2002) are in line with this result, as this factor will improve the contractors performance and will satisfy the owner of project.

Training the human resources in the skills demanded by the project has been ranked by the contractors respondents in the fourth position with RII equal 0.787. Contractors should train their employees with different and improved skills in order to implement different and complex types of projects

Work group has also been ranked by the contractors respondents in the fourth position with RII equal 0.787. Work group between contractor and other parties lead to better performance of project. This also will satisfy the owner.

**Comparison between owners, consultants and contractors:**

Comparison between owners, consultants and contractors for innovation and learning factors are summarized in Table 4.28:

**Table (4.28) Comparison between owners, consultants and contractors for innovation and learning factors**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(9) Innovation and learning factors</b>						
Learning from own experience and past history	0.847	1	0.752	2	0.818	2
Learning from best practice and experience of other	0.824	3	0.760	1	0.822	1
Training the human resources in the skills demanded by the project	0.835	2	0.720	5	0.787	

Learning from own experience and past history has been ranked by the owners respondents in the first position and has been ranked by the consultants and contractors respondents in the second position. This factor is more important for owners than for others. Owners can use their own experience and past history to improve and develop performance of their current and future projects.

Learning from best practice and experience of others has been ranked by the owners respondents in the third position and has been ranked by the consultants and contractors respondents in the first position. Contractors and consultants considered this factor as more important than owners did. This is because learning from best practice and experience of others can improve and develop consultants and contractors performance.

Training the human resources in the skills demanded by the project has been ranked by the owners respondents in the second position. It has been ranked by the consultants respondents in the fifth position and has been ranked by the contractors respondents in the fourth position. This factor is less important for contractors and consultants in Sudan as they seldom train their employees by required and professional skills.

#### **4.2.10 Group ten: Environment factors:**

The relative importance index (RII) and rank of environment factors are summarized in Table 4.29:

**Table (4.29) RII and rank of environment factors**

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(10) Environment factors</b>						
Air quality	0.588	3	0.592	2	0.671	2
Noise level	0.565	4	0.512	4	0.613	4
Wastes around the site	0.635	2	0.584	3	0.649	3
Climate condition in the site	0.729	1	0.656	1	0.707	1

**Owners view**

Climate condition in the site has been ranked by the owners respondents in the first position with RII equal 0.729. This factor is the most important one for owners because climate condition in the site affects the productivity and time performance of project. This result is not in line with Iyer and Jha (2005) as climate condition is not important for owners because of different location, weather and environment.

Wastes around the site have been ranked by the owners respondents in the second position with RII equal 0.635. Wastes around the site affect the health and safety of employees.

Air quality has been ranked by the owners respondents in the third position with RII equal 0.588. Air quality affects the health, safety and productivity performance. Noise level has been ranked by the owners respondents in the fourth position with RII equal 0.565. Noise level affects the productivity performance of project.

**Consultants view**

Climate condition in the site has been ranked by the consultants respondents in the first position with RII equal 0.656. Consultants considered this factor as the most important one because climate



condition in the site affects the productivity and time performance of project.

Air quality has been ranked by the consultants respondents in the second position with RII equal 0.592. Air quality affects the health, safety and productivity performance.

Wastes around the site have been ranked by the consultants respondents in the third position with RII equal 0.584. Wastes around the site affects the health and safety of employees

Noise level has been ranked by the consultants respondents in the fourth position with RII equal 0.512. Noise level affects the productivity performance of project.

### **Contactors view**

Climate condition in the site has been ranked by the contractors respondents in the first position with RII equal 0.707. Contractors considered this factor as the most important one because climate condition in the site affects the productivity and time performance of project.

Air quality has been ranked by the contractors respondents in the second position with RII equal 0.671. Air quality affects the health, safety and productivity performance of contractors.

Wastes around the site have been ranked by the contractors respondents in the third position with RII equal 0.649. Wastes around the site affects the health and safety of employees.

Noise level has been ranked by the contractors respondents in the fourth position with RII equal 0.613. Noise level affects the productivity performance of contractors.

### **Comparison between owners, consultants and contractors:**

Comparison between owners, consultants and contractors for environment factors are summarized in Table 4.30:

Table (4.30) Comparison between owners, consultants and contractors for environment factors

Factors	Owner		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
<b>(10) Environment factors</b>						
Climate condition in the site	0.729	1	0.656	1	0.707	1
Noise level	0.565	4	0.512	4	0.613	4

Climate condition in the site has been ranked by the owners, consultants and contractors respondents in the first position. This factor is the most important one for them because it affects the productivity and time performance of project.

Noise level has been ranked by the owners, consultants and contractors respondents in the fourth position. However, for all parties, noise level is less important than other environmental factors because it is rarely obtained in Sudan.

### **4.3 Degree of Agreement among the Owners, Contractors and Consultants Regarding Factors Affecting the Performance of Construction Projects**

To determine whether there is a significant degree of agreement among the three groups (Owners, Contractors and Consultants) Kendall's Coefficient of Concordance is used as a measure of agreement among raters. Each case is a judge or rater and each variable is an item or person

being judged. For each variable, the sum of ranks is computed. Kendall's  $W$ , ranges between zero (no agreement) and one (complete agreement).

To determine whether there is degree of agreement among the levels of each of the factors affecting the performance of construction projects for each owner, contractors and consultants, Kendall's Coefficient of Concordance says that the degree of agreement on a zero to one scale is (Moore et al, 2003; Frimpong et al, 2003):

$$W = \frac{12U - 3m^2(n-1)^2}{m^2 n (n-1)} \quad (1)$$

Where:

$$U = \sum_{i=1}^n (\sum R)^2$$

- $n$  = number of factors;
- $m$  = number of groups;
- $j$  = the factors 1,2,..,N.
- Null Hypothesis:  $H_0$  : There is insignificant degree of agreement among the Owners , Contractors and Consultants.
- Alternative Hypothesis:  $H_1$  : There is significant degree of agreement among the Owners , Contractors and Consultants

Table 4.31 shows the results of Kendall's Coefficient of Concordance for each group:

**Table (4.31) Kendall's Coefficient of Concordance**

<b>Field</b>	<b>W</b>	<b>Chi-Square</b>	<b>P-value</b>	<b>Decision</b>
Cost factors	0.457	119.277	0.012	Reject H0
Time factors	0.527	137.547	0.000	Reject H0
Quality factors	0.586	152.946	0.000	Reject H0
Productivity factors	0.468	122.148	0.008	Reject H0
Client Satisfaction factors	0.537	140.157	0.000	Reject H0
Regular and community satisfaction factors	0.274	71.514	0.885	Don't reject H0
People factors	0.484	126.324	0.004	Reject H0
Health and Safety factors	0.33	86.13	0.506	Don't reject H0
Innovation and learning factors	0.552	144.072	0.000	Reject H0
Environment factors	0.217	56.637	0.995	Don't reject H0
<b>ALL groups</b>	0.507	132.327	0.001	Reject H0

\* The agreement is significant at level of significant  $\alpha = 0.05$

For Cost, Time, Quality, Productivity, Client Satisfaction, People, Innovation and learning factors, and all groups together, the p-values (Sig.) are less than  $\alpha = 0.05$  ( $\alpha$  is the level of significance) the null hypothesis, H0, is rejected and the alternative hypothesis, H1, is accepted. Therefore, it can be said that there is a significant degree of agreement among the owners, contractors and consultants regarding factors affecting the performance of construction projects in the Sudan.

On the other hand, for regular and community satisfaction, Health and Safety, and Environment factors, the p-values (Sig.) are greater than  $\alpha = 0.05$  ( $\alpha$  is the level of significance) then we don't reject the null hypothesis, H0. Therefore, it can be said that there is insufficient

evidence to support the alternative hypothesis, H1. Hence, there is insignificant degree of agreement among the owners, contractors and consultants regarding factors affecting the performance of construction projects in the Sudan.

#### **4.4 Means Differences of the Respondents Agreements Regarding the Factors Affecting the Performance of Construction Projects**

The Kruskal-Wallis. (KW) test is a statistical test that is used to compare the ranks means differences in the point of view of the respondents (Owners , between two or more samples. This test is used in order to check out if there are any significant Contractors and Consultants) regarding the levels of each of the factors affecting the performance of construction projects. The KW results are shown in the following Table 4.32:

**Table (4.32) Kruskal- Wallis test for factors affecting the performance of construction Projects**

<b>Field</b>	<b>KW value</b>	<b>DF</b>	<b>P-value(Sig)</b>
Cost factors	2.141	2	0.343
Time factors	0.097	2	0.953
Quality factors	0.004	2	0.998
Productivity factors	0.302	2	0.860
Client Satisfaction factors	2.634	2	0.268
Regular and community satisfaction factors	1.006	2	0.605
People factors	4.456	2	0.108
Health and Safety factors	0.080	2	0.961
Innovation and learning factors	1.804	2	0.406
Environment factors	2.949	2	0.229
<b>ALL groups</b>	0.568	2	0.753

DF : Degrees of Freedom

As shown in previous table, all p-value (sig.) for each group is greater than  $\alpha = 0.05$  ( $\alpha$  is the level of significance), then there are no significant

differences between the organization types (Owners , Contractors and Consultants) regarding their respondent degree to all fields.

#### **4.5 Part Three: The Practices Concerning the Performance of Construction Projects:**

The target groups in this study are owners, consultants and contractors. 120 questionnaires were distributed as follows: 25 to owners, 35 to consultants and 60 to contractors. 88 questionnaires were received (73%) as follows: 17 (70%) from owners, 25 (72%) from consultants and 46 (77%) from contractors as respondents. This part of study discusses the practices concerning the performance of construction projects.

##### **4.5.1 Time management practice**

1. What kind of method do you use to represent the project planning and scheduling?

Table (4.33) Usage of planning method

<b>Item</b>	<b>Percent% (Frequency)</b>		
	<b>Owner</b>	<b>Consultant</b>	<b>Contractor</b>
Bar Chart method	56.25 (10)	41.67 (10)	53.49 (25)
Critical Path method	43.75 (7)	54.17 (14)	32.56 (15)
S-Curve method	-	4.17 (1)	11.63 (5)
Others	-	-	2.33 (1)
Total	100 (17)	100 (25)	100 (46)

Table 4.33 shows that Bar Chart method is the most important planning and scheduling method for owners and contractors because Bar Chart method can facilitate time performance control for each scheduled activity through project implementation. However, Critical Path Method (CPM) is the most important one for consultants because CPM can be used to determine critical activities of project. This will assist consultants

to evaluate overall time performance and to identify the effectiveness of critical path on completion date of project. S-Curve method is never used by owners and it is rarely used by consultants and contractors. This is because S-Curve method can compare only between actual time and estimated time at any stage through project implementation. It is difficult to control time performance for each scheduled activity and it is difficult to obtain critical path affecting overall time performance of project.

Chen (2007) remarked that in many situations, time of projects can be complicated and challenging to be managed. When the activity times in the project are deterministic and known, critical path method (CPM) has been demonstrated to be a useful tool in managing projects in an efficient manner to meet this challenge. Koo et al (2007) stated that construction planners face many scheduling challenges during the course of a project. Planners today rely on CPM-based scheduling tools to evaluate different sequencing alternatives for their feasibility and whether they will meet project deadlines.

2. How often your project team does formally meet for discussion of monitoring, updating and controlling the progress?

**Table (4.34) Frequency of meeting type of project team**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Daily	11.76 (2)	4.17 (1)	10.87 (5)
Weekly	70.59 (12)	87.50 (22)	80.43 (37)
Monthly	17.65 (3)	4.17 (1)	8.70 (4)
No	-	4.17 (1)	-

Table 4.34 shows that owners, consultants and contractors often meet weekly for discussion. Weekly meeting assist them for monitoring, updating and controlling the progress through project implementation. In addition, they can solve problems, evaluate current performance, and improve future works. Respondents are rarely meets daily or monthly. Daily meeting are required in the case of sensitive and very important works. Monthly meeting is not effective for monitoring or updating processes

3. How often do you coordinate your schedule with master schedule of the project owner?

**Table (4.35) Coordination frequency of current schedule with master schedule**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Daily	11.76 (2)	4.00 (1)	32.61 (15)
Weekly	47.06 (8)	72.00 (18)	30.43 (14)
Monthly	41.18 (7)	24.00 (6)	36.96 (17)
No	-	-	-

Table 4.35 shows that most of owners and consultants coordinate current schedule with master schedule of the project weekly. This weekly coordination can assist them to evaluate time performance of project comparing with base schedule. However, most of contractors coordinate current schedule with master schedule of the project monthly. In fact, contractors should do that weekly in order to have continuous monitoring, controlling and updating of time performance of project. Generally, monitoring and updating the progress depends up on project duration, type of works and degree of project complexity



4. How often do you require the sub-contractors or supplier to submit their detail activities schedule for you in advance to adjust your actual schedule?

**Table (4.36) Frequency of coordination with sub-contractors and supplier schedule**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Daily	6.25 (1)	12.00 (3)	28.26 (13)
Weekly	43.75 (7)	28.00 (7)	34.78 (16)
Monthly	43.75 (7)	52.00 (13)	32.61 (15)
No	11.76 (2)	8.00 (2)	4.35 (2)

Table 4.36 shows that most owners coordinate with sub-contractors and supplier schedule monthly or weekly. This depends up on the need of coordination and controlling processes. However, most consultants coordinate with sub-contractors and supplier schedule monthly. Most contractors coordinate with sub-contractors and supplier schedule weekly. This coordination depends mainly on project nature, type of work and duration of supplying and implementation.

5. How do you supply the incentive system to stimulate the construction time?

**Table (4.37) Usage of each incentive system**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Increase salary Daily	58.82 (10)	59.09 (15)	52.17 (24)
Bonus in position	-	9.09 (2)	15.22 (7)
Training	26.67 (4)	13.64 (3)	19.57 (9)
Others	20.00 (3)	18.18 (5)	13.04 (6)

Table 4.37 shows that most of owners, consultants and contractors use increase salary system in order to stimulate the construction time. This system will motivate employees and assist them to improve productivity and performance. This system is more important for employees than bonus in position or training systems because these systems are rarely affect on employees performance or their productivity. This is traced to cultural situation in the Sudan. Training is required according to nature of project and its duration. In addition, training is an important for improvement and development overall performance of organization. 6. Which software do you apply for planning and scheduling the progress the project?

**Table (4.38) Usage of each software for planning and scheduling**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Primavera	-	12.00 (3)	19.57 (9)
Microsoft project	88.24 (15)	88.00 (22)	50.00 (23)
Excel sheet	11.76 (2)	-	26.09 (12)
Others	-	-	4.35 (2)

Table 4.38 shows that Microsoft project is the most important, famous and easy program used by owners, consultants and contractors for planning and scheduling. This program enables them to schedule, monitor, update and control many criteria of project such as time, cost and resources. In addition, most organizations in the Sudan are familiar with this program to be used for planning and scheduling processes. It is observed that Primavera program is an advanced and a complex program compared with Microsoft project. Construction organizations in the Sudan are not familiar with Primavera to be used or applied. However, Excel program has a limitation in usage for planning and scheduling.

7. Did your company formally participate in the pre-project planning effort?

**Table (4.39) Company formally participation in the pre-project planning effort**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Yes, as the pre-project planner	75.00 (13)	12.00 (3)	23.91(11)
Yes, as the consultant	12.50 (2)	80.00 (20)	8.70 (4)
No	12.50 (2)	8.00 (2)	67.39 (31)

Table 4.39 shows that most owners participate in the pre-project planning effort as the pre-project planner. Most consultants participate in the pre-project planning effort as the consultant. However, Most contractors do not participate in the pre-project planning effort. Planning of construction projects is one of the main duties and responsibilities of consultants. Owners mainly need planning for budget and time estimation of projects. Some contractors participate in the planning for complex and large projects. This depend up on the nature and type of implemented works. Wang (2004) remarked that construction planning and efficient site utilization are of importance in the site management of building construction.

8. Did projects be delay because of Sudan political conditions?

**Table (4.40) Delay of projects because of Sudan political conditions**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Yes	88.24 (15)	88.00 (22)	76.09 (35)
No	-	-	2.17 (1)
Sometimes	11.76 (2)	12.00 (3)	21.74 (10)

Table 4.40 shows that most owners, consultants and contractors agree that projects were delay because of Sudan political conditions. Continuous closures in the Sudan lead to rapid shortage of construction

materials and delay of projects. This problems can be considered as an obstacle for contractors feel with such this sensitive problem time performance of construction projects. All owners, consultants and in their projects. In 2006 there were many projects in Sudan which finished with poor time performance because of many reasons such as non-availability of materials poor time performance because of many reasons such as non-availability of materials poor time performance because of many reasons such as non-availability of materials suffered from difficult political and economical situation which lead to poor performance of projects.

**4.5.2. Cost management practice:**

1. Do you have the cost schedule associated with the estimated time schedule?

**Table (4.41) Presence of cost schedule associated with the estimated time schedule**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Yes	68.75 (12)	64.00 (16)	58.70 (27)
No	6.25 (1)	4.00 (1)	17.39 (8)
Sometimes	25.00 (4)	32.00 (8)	23.91 (11)

Table 4.41 shows that construction organizations often use cost schedule associated with the estimated time schedule. This association assist organizations to evaluate performance of cost and time together at any stage through project implementation. That will assist construction organizations to know if project is ahead or behind of schedule and if it is over or under estimated cost

2. Do you apply the actual value and earned value concept in controlling cost for the project?

**Table (4.42) Applying the actual value and earned value concept in controlling cost**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Yes	58.82 (10)	58.33 (15)	54.55 (25)
No	23.53 (4)	12.50 (3)	27.27 (13)
Sometimes	17.65 (3)	29.17 (7)	18.18 (8)

Table 4.42 shows that most of owners, consultants and contractors apply the actual value and earned value concept in controlling cost for the project. Earned value concept provides a system for evaluating the performance of the project through integrating cost, schedule, and work. This will assist for evaluation cost and time performance of projects. For example, at any stage of project, if earned value is more than actual value, the cost performance will be good.

3. Do you have a cost engineer who is only responsible for dealing with cost control?

**Table (4.43) Having a cost engineer who is only responsible for dealing with cost Control**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Yes	11.76 (2)	28.00 (7)	30.43 (14)
No	76.47 (13)	60.00 (15)	43.48 (20)
Sometimes	11.76 (2)	12.00 (3)	26.09 (12)

Table 4.43 shows that most of owners, consultants and contractors do not have a cost engineer who is only responsible for dealing with cost control. This is because most construction firms in the Sudan are small size nature. Hence, their needs to cost engineer is much lower than large companies.. Those processes include the rework cycle, feedback loops

creating changes in productivity and quality, and effects between work phases.

4. Do you give right and authority for line managers to manage the actual expenses?

**Table (4.44) Giving right and authority for line managers to manage the actual Expenses**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Yes	41.18 (7)	29.17 (7)	43.48 (20)
No	23.53 (4)	41.67 (11)	32.61 (15)
Sometimes	35.29 (6)	29.17 (7)	

Table 4.44 shows that most owners and contractors give right and authority for line managers to manage the actual expenses. However, most of consultants do not give right and authority for line managers to manage the actual expenses. Giving right and authority for line managers to manage the actual expenses depends mainly on the nature and size of works.

5. Do you apply any software to plan, monitor, and control cost?

**Table (4.45) Applying any software to plan, monitor, and control cost**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Yes	47.06 (8)	50.00 (13)	45.65 (21)
No	23.53 (4)	33.33 (8)	28.26 (13)
Sometimes	29.41 (5)	16.67 (4)	26.09 (12)

Table 4.45 shows that most owners, consultants and contractors use software program in order to facilitate planning, monitoring and controlling cost. The most programs used in construction organization in order to control and monitor cost are : Excel, Ms project and Al Aseel programs. Most organizations are familiar with these software programs because they are easy to be used and have different facilities and

functions to control the cost. For instance, in Singapore 2003, general administration, design, project management, cost control, site management were enhanced by using of IT. In addition, there were more advantages as quick working and good quality of work.

6. Do you apply the following records to estimate the construction cost for the project?

**Table (4.46) Applying the following records to estimate the construction cost for the Project**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Historical cost data	45.8 (8)	40.5 (10)	37.1 (17)
Current quotation for labor, material and equipment cost	54.2 (9)	56.8 (14)	59.7 (28)
Others	-	2.7 (1)	3.2 (1)

Table 4.46 shows that most owners, consultants and contractors use current quotation for labor, material and equipment cost to estimate the construction cost for the project. This method is more accurate for cost estimation than others because it depend on current situation. However, historical data is interested to be used for owners, consultants and contractors as an experience can assist for quick evaluation and estimation.

7. Did the project be delay by late payment from the owner?

**Table (4.47) Delay of project by late payment from the owner**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Yes	35.29 (6)	32.00 (8)	28.26 (13)
No	29.41 (5)	12.00 (3)	15.22 (7)
Sometimes	35.29 (6)	56.00 (14)	56.52 (26)

Table 4.47 shows that most consultants and contractors stated that the project was sometimes delay by late payment from the owner. In the Sudan, contractors usually suffer from this problem. Delay in payment from owner to contractor lead to delay of contractors' performance and cause problem in time performance. This may also lead to disputes and claims between owner and contractor of project. All of that will affect the overall performance of project which has been implemented.

8. Did the actual cost of projects be more than the estimated cost because of Sudan political conditions?

**Table (4.48) The percent if actual cost of projects was more than the estimated cost because of Sudan political conditions**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Yes	76.47 (13)	80.00 (20)	82.61 (38)
No	-	4.00 (1)	2.17 (1)
Sometimes	23.53 (4)	16.00 (4)	15.22 (7)

Table 4.48 shows that most owners, consultants and contractors agree that actual cost of projects was more than the estimated cost because of Sudan political conditions. Continuous closures in the Sudan lead to rapid shortage of construction materials and escalation of construction material prices. This escalation of material prices affect the liquidity and cost performance of projects. It should be mentioned that construction projects in Sudan suffered from difficult political and economical situation which lead to poor performance of projects (World Bank, 2004). In 2006 there were many projects in Sudan finished with poor performance because of many reasons such as non-availability of materials and continuous closures (UNRWA, 2006).



### 4.5.3. Owner satisfaction management practice:

#### 1. Product (project)

Table (4.49) Owner satisfaction degree for consultants and contractors projects

How satisfied are the owners with the finished product of projects executed by your company?	Percent% (Frequency)		
	Low satisfied	medium satisfied	high satisfied
Consultant	-	- 20 (5)	80 (20)
Contractor	4.5 (2)	25 (12)	70.5 (32)

Table 4.49 shows that owners are medium satisfied with 20 % of consultants projects and high satisfied with 80 % of consultants projects in the Sudan. However, owners are low satisfied with 4.5 % of contractors projects, medium satisfied with 25% of contractors projects and high satisfied with 70.5 % of contractors projects. Generally, it is obtained that most of consultants and contractors projects are high satisfied by the owners in the Sudan. In addition, some contractors and consultants projects are medium satisfied by the owner because of many reasons such as: poor quality, non conformance to specification, problems in cost and time performance, weak coordination or relationship between projects participants, occurrence of accidents through implementation stage, claims and disputes.

#### 2. Organization

**Table (4.50) Owner satisfaction degree for each of consultants and contractors companies' services**

How satisfied are the owner with the services of your company ?	Percent (%)					
	Low satisfied		medium satisfied		high satisfied	
	Consultant	Contractor	Consultant	Contractor	Consultant	Contractor
Overall performance	-	-	20	35.56	80	64.44
Ability to keep to price quoted	-	17.39	48	43.48	52	39.13
Ability to keep to time	8.33	19.57	33.33	30.43	58.33	50.00
Ability to keep to quality	-	2.22	12	20.00	88	77.78
Resolution of any defects	4.00	2.17	28.00	39.13	68.00	58.70
Trust/Overall confidence in your ability	-	-	24.00	23.91	76.00	76.09

Table 4.50 shows that the overall performance of the most of consultants and contractors projects is high satisfied by the owners as 80 % of consultants projects are high satisfied and 64.44 % of contractors projects are high satisfied by the owners.

On the other hand, most of consultants projects are high satisfied to owners with respect to availability to keep to cost. Most of contractors projects are medium satisfied to owners with respect to availability to keep to cost. Most of consultants and contractors projects are high satisfied to owners with respect to availability to keep to time, availability to keep to quality, resolution of any defects and overall confidence in ability.

Owner satisfaction mainly depends up on information coordination between owner and project parties, leadership skills for project manager, speed and reliability of service to owner, number of disputes between owner and project parties and number of reworks.

## 2. Defects

**Table (4.51) Defects impact degree on the owner at the time of handover**

What was the impact of defects on the owner at the time of handover?	few defects with low impact on the owner	Some defects with some impact on the owner	many defects with high impact on the owner
Consultant	87.50 %	12.50 %	-
Contractor	77.27 %	22.73 %	-

Table 4.51 shows that 87.50% of consultants projects and 77.27 % of contractors projects have few defects with low impact on the owner satisfaction. However, 12.50% of consultants projects and 22.73 % of contractors projects have some defects with some impact on the owner satisfaction. Generally, consultants and contractors projects usually have few defects with low impact on the owner satisfaction. This is traced to many factors such as information coordination between owner and

project parties, leadership skills for project manager, speed and reliability of service to owner

#### 4.5.4 Safety management practice:

1. To what extent has an overall project safety factors been implemented?

**Table (4.52) Implementation frequency of safety factors**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
Not at all	6.25 (1)	-	-
Moderately	68.75 (12)	56.00 (14)	52.17 (24)
Extensively	25.00 (4)	44.00 (11)	47.83 (22)

Table 4.52 shows that in most cases, an overall project safety factors has been moderately implemented in construction organizations. This is because of absence of safety control or its application through project implementation stage. In the Sudan, there are many contractors do not care with applying health and safety factors during construction of projects. In addition, consultants do not have sufficient control or continuous supervision for safety application. All of that will lead to occurrence of accidents and problems in construction projects. Cheung et al (2004) remarked that safety factor affects strongly on performance of projects.

How often do you organize the meeting for safety issue?

**Table (4.53) Meeting frequency for safety issue**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
None	6.25 (1)	8.00 (2)	26.67 (12)
Monthly	50.00 (9)	64.00 (16)	20.00(9)
Weekly	25.00 (4)	16.00 (4)	24.44 (11)
Daily	18.75 (3)	12.00 (3)	28.89 (14)

Table 4.53 shows that most of owners and consultants organize the meeting for safety issue monthly. However, most of contractors organize the meeting for safety issue daily. This is because contractors are more interested with operational factors which require frequent and continuous meeting for safety issues. Otherwise contractors, owners and consultants are more familiar with clients and technical factors.

3. On average, how much ongoing formal safety training did workers receive each month?

**Table (4.54) Safety training numbers each month**

Item	Percent% (Frequency)		
	Owner	Consultant	Contractor
None	68.75 (12)	58.33 (15)	41.30 (19)
Less than 1 hr	31.25 (5)	25.00 (6)	52.17 (24)
1 . 4 hrs	-	8.33 (2)	4.35 (2)
4 . 7 hrs	-	4.17 (1)	2.17 (1)
Over 7 hrs	-	4.17 (1)	-

Table 4.54 shows that most of owners and consultants do not have any formal safety training. However, most of contractors have formal safety training less than 1 hr per month. Generally, in the Sudan, it is observed that most of construction organizations do not have formal safety training. This will lead to absence of safety application and will contribute to occurrence of many accidents and problems in the site. Construction projects in the Sudan are recommended to have formal safety training in order to improve performance of construction projects.

4. To what extent was pre-task planning for safety conducted by contractor foremen or other site managers?

**Table (4.55) Frequency of pre-task planning for safety conducted by contractor foremen or other site managers**

<b>Item</b>	<b>Percent% (Frequency)</b>		
	<b>Owner</b>	<b>Consultant</b>	<b>Contractor</b>
Not at all	11.76 (2)	20.00 (5)	17.78 (8)
Moderately	76.47 (13)	52.00 (13)	53.33 (25)
Extensively	11.76 (2)	28.00 (7)	28.89 (13)

Table 4.55 shows that in most cases, pre-task planning for safety was moderately conducted by contractor foremen or other site managers. This is because of absence of safety planning and control through project implementation stage. In the Sudan, there are many contractors do not care with planning health and safety issues during construction of projects. This will lead to occurrence of accidents and problems in construction projects.

## CHAPTER FIVE

### 5. CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Conclusions

Construction industry is considered as an important sector in the world as it develops and achieves the goals of society. Clients, contractors, consultants, stakeholders, regulators, national economies and others, affect the performance of the construction industry. The main aim of this thesis is to identify the local factors affecting the performance of construction projects in the Sudan.

- Bar Chart method is the most important planning and scheduling method for owners and contractors because Bar Chart method can facilitate time performance control for each scheduled activity through project implementation. However, Critical Path Method (CPM) is the most important one for consultants because CPM can be used to determine critical activities of project. This will assist consultants to evaluate overall time performance and to identify the effectiveness of critical path on completion date of project.
- Training is required according to nature of project and its duration. In addition, training is an important for improvement and development overall performance of organization.
- Microsoft project is the most important, famous and easy program used by owners, consultants and contractors for planning and scheduling. This program enables them to schedule, monitor, update and control many criteria of project such as time, cost and resources. In addition, most organizations in the Sudan are familiar with this program to be used for planning and scheduling processes. It is observed that Primavera program is an advanced and a complex

program compared with Microsoft project. Construction organizations in the Sudan are not familiar with Primavera to be used or applied. However, Excel program has a limitation in usage for planning and scheduling.

- Most owner, consultants and contractors agree that projects were delay because of Sudan political conditions. Continuous closures in the Sudan lead to rapid shortage of construction materials and delay of projects. This problems can be considered as an obstacle for time performance of construction projects. All owners, consultants and contractors feel with such this sensitive problem in their projects.
- Most owners and contractors give right and authority for line managers to manage the actual expenses. However, most of consultants do not give right and authority for line managers to manage the actual expenses. However, giving right and authority for line managers to manage the actual expenses depends mainly on the nature and size of works.
- Most owners, consultants and contractors use software program in order to facilitate planning, monitoring and controlling cost. The most programs used in construction organization in order to control and monitor cost are : Excel, Ms project and Al Aseel programs. Most organizations are familiar with these software programs because they are easy to be used and have different facilities and functions to control the cost.
- Most owners, consultants and contractors use current quotation for labor, material and equipment cost to estimate the construction cost for the project. This method is more accurate for cost estimation than others because it depend on current situation. However, historical data sometimes is interested to be used for owners,



consultants and contractors because an experience can assist for quick evaluation and estimation.

- Most consultants and contractors stated that the project was sometimes delay by late payment from the owner. In the Sudan, contractors usually suffer from this problem. Delay in payment from owner to contractor lead to delay of contractors' performance and cause problem in time All of that will affect the overall performance. This may also lead to disputes and claims between owner and contractor of project. performance of project which has been implemented.

- Most owners, consultants and contractors agree that actual cost of executed projects was more than the estimated cost because of Sudan political conditions. Continuous closures in the Sudan lead to rapid shortage of construction materials and escalation of construction material prices. This escalation of material prices affect the liquidity and cost performance of projects.

## **5.2 Recommendation**

### **5.2.1 Introduction**

Performance problem is costly and often result in disputes, claims and affect the development of the construction industry. The construction organizations must have a clear mission and vision to formulate, implement and evaluate performance. The environment of construction organizations should be proper to implement projects with success performance. It is important for construction organizations to identify the weaknesses of performance in order to solve and overcome. The following issues are recommendations related to obtained results.

- It is recommended to develop human resources in the construction industry through proper and continuous training programs about construction projects performance. These programs can update their knowledge and can assist them to be more familiar with project management techniques and processes. In addition, it is preferred to develop and improve the managerial skills of engineers in order to improve performance of construction projects. All of that can be implemented by offering effective and efficient training courses in scheduling, time, cost, quality, safety, productivity, information systems and management of human resources. These courses will lead to success performance through construction projects such as availability of resources as planned through project duration, availability of personals with high experience and qualification, proper quality of equipments and raw materials used in project. In addition, training system will assists for improvement of construction time performance.

- It is necessary for construction organizations in Sudan to evaluate both of market share and liquidity before implementation of any construction project because of difficult economic situation in Sudan. That will assist organizations to perform projects successfully and strongly. In addition, it is recommended that a new approach to contract award procedure by giving less weight to prices and more weight to the capabilities and past performance of contractors. It is necessary to establish proper industry regulations and appropriate mechanism for contractors' enforcement. A structured methodology and technique should be identified to overcome the effect of local political and economic situations on the performance of construction projects in the Sudan.
- Owners are recommended to facilitate payment to contractors in order to overcome delay, disputes and claims. All managerial levels should be participated with sensitive and important decision-making. Continuous coordination and relationship between project participants are required through project life cycle in order to solve problems and develop project performance. It is recommended to minimize disputes between owner and project parties. Employees in construction industries should be more interested with belonging to work to productivity and time performance of project.
- Consultants should be more interested with design cost by using multi criteria analysis and choosing the most economic criteria in order to improve their performance and to increase owners satisfaction. In addition, consultants are recommended to facilitate and quicken orders delivered to contractors to obtain better time performance and to minimize disputes and claims.

- Contractors should not increase the number of projects that can not be performed successfully. In addition, contractors should consider political and business environment risk in their cost estimation in order to overcome delay because of closures and materials shortage. There should be adequate contingency allowance in order to cover increase in material cost. A proper motivation and safety systems should be established for improvement productivity performance of construction projects in Sudan. More applications of health and safety factors are necessary to overcome problems of safety performance.
- Contractors are recommended to minimize waste rate through project implementation in order to improve cost performance. They should be more interested with conformance to project specification to overcome disputes, time and cost performance problems. Quality materials should be more interested with contractors to improve cost, time and quality performance. This can be done by applying quality trainings and meetings which are necessary for performance improvement. Contractors are recommended to be more interested with sequencing of work according to schedule. In addition, contractors should have a cost engineer in their projects to control cost successfully.
- For future researches recommended to develop performance measurement framework and modeling system in order to measure performance of construction organizations and projects. In addition, it is recommended to study and evaluate the most important factors as a case study of construction projects in the Sudan.

## References

Abdel-Razek Refaat H., Abd Elshakour M Hany and Abdel-Hamid Mohamed, (2007), Labor productivity: Benchmarking and variability in Egyptian projects, *International Journal of Project Management*, Vol. 25, PP. 189-197.

Al-Momani Ayman H., (2000), Examining service quality within construction processes, *Technovation*, Vol. 20, PP. 643.651.

Assaf Said A, Bubshait AbdulAziz.A, Atiyah Sulaiman and Al-Shahri, Mohammed, (2001), The Management of construction company overhead costs, *International Journal of project Management*, Vol. 19, PP. 295-303.

Augusto Mario, Lisboa Joao, Yasin Mahmoud and Figueira Jose Rui, (2006), Benchmarking in a multiple criteria performance context: An application and a conceptual framework, *European Journal of Operational Research*, Vol. 184, PP. 244 -254.

Becerik Burcin, (2004), A review on past, present and future of web based project management and collaboration tools and their adoption by the US AEC industry, *International Journal of IT in Architecture, Engineering and Construction*, Vol. 2, No.3, PP. 233 . 248.

Brown Andrew and Adams John, (2000), Measuring the effect of project management on construction outputs: a new approach, *International Journal of Project Management*, Vol. 18, PP. 327-335.

Cavalieri Sergio, Terzi Sergio and Macchi Marco, (2007), A Benchmarking Service for the evaluation and comparison of scheduling techniques, *Computers in Industry*, Vol. 58, PP. 656.666.

Chan Albert P.C., (2001), Time . cost relationship of public sector projects in Malaysia, *International Journal of Project Management*, Vol.19, PP. 223-229.

Chan Albert P.C. and Chan Daniel W.M., (2004), Developing a benchmark model for project construction time performance in Hong Kong, *Building and Environment*, Vol. 39, PP. 339-349.

Chan Daniel W. M. and Kumaraswamy Mohan M., (1996), An evaluation of construction time performance in the building industry, *Building and Environment*, Vol. 31, No. 6, PP. 569-578.

Chan Daniel W. M. and Kumaraswamy Mohan M., (2002), Compressing construction durations: lessons learned from Hong Kong building projects, *International Journal of Project Management*, Vol.20, PP. 23-35.

Chen Shih-Pin, (2007), Analysis of critical paths in a project network with fuzzy activity times, *European Journal of Operational Research*, Vol. 183, PP. 442-459.

Cheung Sai On, Suen Henry C.H. and Cheung Kevin K.W., (2004), PPMS: a Webbased construction Project Performance Monitoring System, *Automation in Construction*, Vol. 13, PP. 361-376.

Department of the Environment, Transport and the Regions (DETR), KPI Report for the Minister for Construction by the KPI Working Group, January 2000.

Dissanayaka Sunil M. and Kumaraswamy Mohan M., (1999), Comparing contributors to time and cost performance in building projects, *Building and Environment*, Vol. 34, PP. 31-42.

Enshassi Adnan, Al-Hallaq Khalid and Mohamed Sherif, (2006), Causes of contractor's business failure in developing countries: The case of Palestine, *Journal of construction in Developing Countries*, Vol. 11, No. 2, PP. 1-14

Errasti Ander, Beach Roger, Oyarbide Aitor and Santos Javier, (2007), A process for developing partnerships with subcontractors in the

construction industry: An empirical study, *International Journal of Project Management* Vol. 25, PP. 250-256

Frimpong Yaw, Jacob Oluwoye and Lynn Crawford, (2003), Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study, *International Journal of Project Management* Vol. 21, PP. 321-326

George D. and Mallery P., (2003), *SPSS for window Step by Step*, fourth edition. Goh Bee Hua, (2005), IT barometer 2003: survey of the Singapore construction industry and a comparison of results, *ITcon* Vol. 10, PP. 1 . 13.

Karim K. and Marosszeky M., (1999), Process monitoring for process re- engineering- using key performance indicators, *International conference on construction process reengineering, CPR 99*, Sedney UNSW 12-13 July, Building Research center.

Kuprenas John A., (2003), Project management actions to improve design phase cost performance, *Journal of Management in Engineering*, Vol. 19, No.1, PP. 25-32.

## Appendix

### Appendix A

#### Criterion-Related Validity Test

Correlation coefficient of each item of cost factors and the total of this part

No.	Item	Spearman Correlation Coefficient	P-Value (Sig.)
1	Market share of organization	364	0.000**
2	Liquidity of organization	492	0.000**
3	Cash flow of project	470	0.000**
4	Profit rate of project	543	0.000**
5	Overhead percentage of project	687	0.000**
6	Project design cost	563	0.000**
7	Material and equipment cost	373	0.000**
8	Project labor cost	446	0.000**
9	Project overtime cost	639	0.000**
10	Motivation cost	696	0.000**
11	Cost of rework	689	0.000**
12	Cost of variation orders	635	0.000**
13	Waste rate of materials	592	0.000**
14	Regular project budget update	479	0.000**
15	Cost control system	552	0.000**
16	Escalation of material prices	440	0.000**
17	Differentiation of coins prices	437	0.000**

\*\* Correlation is significant at the 0.01 level



**Correlation coefficient of each item of time factors and the total of this part**

<b>No.</b>	<b>Item</b>	<b>Spearman Correlation Coefficient</b>	<b>P-Value (Sig.)</b>
1	Site preparation time	0.562	0.000**
2	Planned time for project construction	0.539	0.000**
3	Percentage of orders delivered late	0.616	0.000**
4	Time needed to implement variation orders	0.706	0.000**
5	Time needed to rectify defects	0.748	0.000**
6	. Average delay in claim approval	0.701	0.000**
7	Average delay in payment from owner to contractor	0.577	0.000**
8	Availability of resources as planned through project duration	0.543	0.000**
9	Average delay because of closures and materials shortage	0.396	0.000**

\*\* Correlation is significant at the 0.01 level

**Correlation coefficient of each item of quality factors and the total of this part**

<b>No.</b>	<b>Item</b>	<b>Spearman Correlation Coefficient</b>	<b>P-Value (Sig.)</b>
1	Conformance to specification	0.755	0.000**
2	Availability of personals with high experience and qualification	0.795	0.000**
3	Quality of equipments and raw materials in project	0.775	0.000**
4	Participation of managerial levels with decision making	0.565	0.000**
5	Quality assessment system in organization	0.763	0.000**
6	Quality training/meeting	0.678	0.000**

\*\* Correlation is significant at the 0.01 level

**Correlation coefficient of each item of productivity factors and the total of this part**

<b>No.</b>	<b>Item</b>	<b>Spearman Correlation Coefficient</b>	<b>P-Value (Sig.)</b>
1	Project complexity	0.669	0.000**
2	Number of new projects / year	0.609	0.000**
3	Management-labor relationship	0.722	0.000**
4	Absenteeism rate through project	0.778	0.000**
5	Sequencing of work according to schedule	0.731	0.000**

\*\* Correlation is significant at the 0.01 level

**Correlation coefficient of each item of client satisfaction factors and the total of this Part**

<b>No.</b>	<b>Item</b>	<b>Spearman Correlation Coefficient</b>	<b>P-Value (Sig.)</b>
1	Information coordination between owner and project parties	0.511	0.000**
2	Leadership skills for project manager	0.606	0.000**
3	Speed and reliability of service to owner	0.747	0.000**
4	Number of disputes between owner and project parties	0.681	0.000**
5	Number of reworks	0.654	0.000**

\*\* Correlation is significant at the 0.01 level

**Correlation coefficient of each item of regular and community satisfaction factors and the total of this part**

<b>No.</b>	<b>Item</b>	<b>Spearman Correlation Coefficient</b>	<b>P-Value (Sig.)</b>
1	Cost of compliance to regulators requirements	0.869	0.000**
2	Number of non compliance to regulation	0.837	0.000**
3	Quality and availability of regulator documentation	0.890	0.000**
4	Neighbors and site conditions problems	0.678	0.000**

\*\* Correlation is significant at the 0.01 level

**Correlation coefficient of each item of people factors and the total of this part**

<b>No.</b>	<b>Item</b>	<b>Spearman Correlation Coefficient</b>	<b>P-Value (Sig.)</b>
1	Employee attitudes in project	0.847	0.000**
2	Recruitment and competence development between employees	0.829	0.000**
3	Employees motivation	0.872	0.000**
4	Belonging to work	0.881	0.000**

\*\* Correlation is significant at the 0.01 level

**Correlation coefficient of each item of health and safety factors and the total of this Part**

<b>No.</b>	<b>Item</b>	<b>Spearman Correlation Coefficient</b>	<b>P-Value (Sig.)</b>
1	Application of Health and safety factors in organization	0.778	0.000**
2	Easiness to reach to the site (location of project)	0.816	0.000**
3	Reportable accidents rate in project	0.807	0.000**
4	Assurance rate of project	0.888	0.000**

\*\* Correlation is significant at the 0.01 level

**Correlation coefficient of each item of innovation and learning factors and the total of this part**

<b>No.</b>	<b>Item</b>	<b>Spearman Correlation Coefficient</b>	<b>P-Value (Sig.)</b>
1	Learning from own experience and past history	0.772	0.000**
2	Learning from best practice and experience of others	0.707	0.000**
3	Training the human resources in the skills demanded by the project	0.820	0.000**
4	Work group	0.773	0.000**
5	Review of failures and solve them	. 0.837	0.000**

\*\* Correlation is significant at the 0.01 level



**Correlation coefficient of each item of environment factors and the total of this part**

<b>No.</b>	<b>Item</b>	<b>Spearman Correlation Coefficient</b>	<b>P-Value (Sig.)</b>
1	Air quality	0.874	0.000**
2	Noise level	0.810	0.000**
3	Wastes around the site	0.866	0.000**
4	Climate condition in the site	0.777	0.000**

\*\* Correlation is significant at the 0.01 level

## Appendix B :

**Part One: General Information:** Please add (√) as appropriate:

### 1. Type of Organisation:

<input type="checkbox"/> owner	<input type="checkbox"/> Consultant	<input type="checkbox"/> Contractor
--------------------------------	-------------------------------------	-------------------------------------

### 2. Typical of projects of organization:

<input type="checkbox"/> Buildings	<input type="checkbox"/> Roads and transportation
<input type="checkbox"/> Water and sewage	<input type="checkbox"/> Other (specify).....

### 3. Company size :( number of employees) :

Number of employees in your company is ..... employee

### 4. Job title of the respondent:

<input type="checkbox"/> Project Manager/ deputy	<input type="checkbox"/> Site Engineer/ office engineer
<input type="checkbox"/> Organization Manager/ deputy	<input type="checkbox"/> Others (specify).....

### 5. Years of experience of the respondent :

Number of experience years of the respondent is ..... Year

### 6. Number of projects executed in the last five years :

<input type="checkbox"/> 1 to 10	<input type="checkbox"/> 11 to 20
<input type="checkbox"/> 21 to 30	<input type="checkbox"/> More than 30

### 7. Value of executed projects executed in the last five years : (in million dollars)

<input type="checkbox"/> 1 . less than 2 M	<input type="checkbox"/> 2 . less than 5 M
<input type="checkbox"/> 5 . less than 10 M	<input type="checkbox"/> More than or equal 10 M

## Part Two: Factors Affecting the Performance of Construction Projects

Below are numbers of factors affecting the performance of construction projects. From your experience, please express your opinion on the importance of the following factors as key performance indicators of construction projects in Sudan. (Please tick the appropriate box).

Groups/Factors	Very high important	Low important	Medium important	High important	Veru high important
<b>(1) Cost factors</b>					
Market share of organization					
Liquidity of organization Cash flow of project Profit rate of project					
Overhead percentage of project					
Project design cost					
Material and equipment cost					
Project labor cost					
Project overtime cost					
Motivation cost					
Cost of rework					
Cost of variation orders					

Waste rate of materials					
Regular project budget update					
Cost control system					
Escalation of material prices					
Differentiation of coins prices					
<b>(2) Time factors</b>					
Site preparation time					
Planned time for project construction					
Percentage of orders delivered late					
Time needed to implement variation orders					
Time needed to rectify defects					
Average delay in claim approval					
Average delay in payment from owner to contractor					
Availability of resources as planned through project					

uration					
Average delay because of closures and materials shortage					
<b>(3) Quality factors</b>					
Conformance to specification					
Availability of personals with high experience and qualification					
Quality of equipments and raw materials in project					
Participation of managerial levels with decision making					
Quality assessment system in organization					
Quality training/meeting					
<b>(4) Productivity factors</b>					
Project complexity					
Number of new projects / year					

Management-labor relationship					
Absenteeism rate through project					
Sequencing of work according to Schedule					
<b>(5) Client Satisfaction factors</b>					
Information coordination between					
owner and project parties					
Leadership skills for project manager					
Speed and reliability of service to owner					
Number of disputes between owner and project parties					
Number of reworks					
<b>(6) Regular and community satisfaction factors</b>					
Cost of compliance to regulators requirements					

Cost of compliance to regulators requirements					
Number of non compliance to regulation					
Quality and availability of regulator documentation					
Neighbors and site conditions problems					
<b>(7) People factors</b>					
Employee attitudes in project					
Recruitment and competence					
development between employees					
Employees motivation					
Belonging to work					
<b>(8) Health and Safety factors</b>					
Application of Health and safety factors in					

organization					
Easiness to reach to the site (location of project)					
Easiness to reach to the site (location of project)					
Reportable accidents rate in project					
Assurance rate of project					
<b>(9) Innovation and learning factors</b>					
Learning from own experience and past history					
Learning from best practice and experience of others					
the skills demanded by the project					



Training the human resources in Work group					
Review of failures and solve them					
<b>(10) Environment factors</b> Air quality					
Noise level					
Wastes around the site					
Climate condition in the site					

**Part Three: The Practices Concerning with the Factors Affecting the Performance of Construction Projects:**

**1. The time management practice:** Please add (√) as appropriate:

1. What kind of method do you use to represent the project planning and scheduling?

<input type="radio"/> Bar Chart method	<input type="radio"/> Critical path method	<input type="radio"/> S-Curve method	<input type="radio"/> Others (.....)
--	--	--------------------------------------	--------------------------------------

2. How often your project team does formally meets for discussion of monitoring, updating and controlling the progress?

<input type="radio"/> Daily	<input type="radio"/> Weekly	<input type="radio"/> Monthly	<input type="radio"/> No
-----------------------------	------------------------------	-------------------------------	--------------------------

3. How often do you coordinate your schedule with master schedule of the project owner?

<input type="radio"/> Daily	<input type="radio"/> Weekly	<input type="radio"/> Monthly	<input type="radio"/> No
-----------------------------	------------------------------	-------------------------------	--------------------------

4. How often do you require the sub-contractors or supplier to submit their detail activities schedule for you in advance to adjust your actual schedule?

<input type="radio"/> Daily	<input type="radio"/> Weekly	<input type="radio"/> Monthly	<input type="radio"/> No
-----------------------------	------------------------------	-------------------------------	--------------------------

5. How do you supply the incentive system to stimulate the construction time?

<input type="radio"/> Increase salary	<input type="radio"/> Bonus in position	<input type="radio"/> Training	<input type="radio"/> Others (...)
---------------------------------------	---	--------------------------------	------------------------------------

6. Which software do you apply for planning and scheduling the progress the project?

<input type="radio"/> Primavera	<input type="radio"/> Microsoft project	<input type="radio"/> Excel sheet	<input type="radio"/> Others (...)
---------------------------------	---	-----------------------------------	------------------------------------

7. Did your company formally participate in the pre-project planning effort?

<input type="radio"/> Yes, as the pre-project planner	<input type="radio"/> Yes, as the consultant	<input type="radio"/> No
---	--	--------------------------

8. Did projects be delay because of Gaza strip political conditions?

<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> Sometimes
---------------------------	--------------------------	---------------------------------

**2. The cost management practice:** Please add (√) as appropriate:

1. Do you have the cost schedule associated with the estimated time schedule?

<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> Sometimes
---------------------------	--------------------------	---------------------------------

2. Do you apply the actual value and earned value concept in controlling cost for the project?

<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> Sometimes
---------------------------	--------------------------	---------------------------------

3. Do you have a cost engineer who is only responsible for dealing with cost control?

<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> Sometimes
---------------------------	--------------------------	---------------------------------

4. Do you give right and authority for line managers to manage the actual expenses?

<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> Sometimes
---------------------------	--------------------------	---------------------------------

5. Do you apply any software to plan, monitor, and control cost?

<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> Sometimes
---------------------------	--------------------------	---------------------------------

If yes, what is the name of software program? .....

6. Do you apply the following records to estimate the construction cost for the project? (Can be selected more than one option)

<input type="checkbox"/> Historical cost data	<input type="checkbox"/> Current quotation for labor, material and equipment cost	<input type="checkbox"/> Others (...)
---	---	---------------------------------------

7. Did the project delay by late payment from the owner?

<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Sometimes
------------------------------	-----------------------------	------------------------------------

8. Did the actual cost of projects be more than the estimated cost because of Sudan political conditions?

<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Sometimes
------------------------------	-----------------------------	------------------------------------

**3. The owner satisfaction management practice :** Please add (√) as appropriate:

**1. Product (project)**

How satisfied are the owner with the finished product of projects executed by your company?	Low satisfied	medium satisfied	high satisfied

**2. Organization**

How satisfied are the owner with the services of your company?	Low satisfied	medium satisfied	high satisfied
Overall performance			
Ability to keep to price quoted			
Ability to keep to time			
Ability to keep to quality			
Resolution of any defects			
Trust/ Overall confidence in your ability			

### 3- Defects

What was the impact of defects on the owner at the time of handover?		
few defects with low impact on the owner	Some defects with some impact on the owner	many defects with high impact on the owner

#### 4. The safety management practice: Please add (√) as appropriate:

1. To what extent has an overall project safety factors been implemented?

<input type="radio"/> Not at all	<input type="radio"/> Moderately	<input type="radio"/> Extensively
----------------------------------	----------------------------------	-----------------------------------

2. How often do you organize the meeting for safety issue?

<input type="radio"/> None	<input type="radio"/> Monthly	<input type="radio"/> Weekly	<input type="radio"/> Daily
----------------------------	-------------------------------	------------------------------	-----------------------------

3. On average, how much ongoing formal safety training did workers receive each month?

<input type="radio"/> None	<input type="radio"/> Less than 1 hr	<input type="radio"/> 1 . 4 hrs	<input type="radio"/> 4 . 7 hrs	<input type="radio"/> Over 7 hrs
----------------------------	--------------------------------------	---------------------------------	---------------------------------	----------------------------------

4. To what extent was pre-task planning for safety conducted by contractor foremen or other site managers?

<input type="radio"/> Not at all	<input type="radio"/> Moderately	<input type="radio"/> Extensively
----------------------------------	----------------------------------	-----------------------------------