

Chapter one

1.1 Introduction:

The construction industry is plays an important role for the development of any nation .in many ways, the speed of the economic growth of any nation can be measured by the development of infrastructures, such as buildings, roads and bridges. Construction project development involves many parties, various processes, different phases and stages of work, the major aim being to bring the project to a successful conclusion.

Construction industry plays a major role in the development and achievement of the goals of society. Construction is one of the largest industries. Construction industry has complex in its nature because it contains large number of parties as clients, contactors, consultants, workers, shareholders, stakeholders, regulators and the community at large. The performance of construction industry is affected by national economies.

There are other different reasons affecting construction projects performance such as:

- Poor management and leadership.
- Poor relations and coordination.
- Absence of motivation.
- Control.
- Monitoring or decision making system.
- Political problems.
- Cultural problems.

- Economic conditions.
- Risk management.

The project can be successful when it is finished on time, within budget, in accordance with specifications and to stakeholder's satisfaction. Unfortunately, due to many reasons, high project performance and project success are not commonplace in the construction industry, especially in developing countries.

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

1.2 Research objectives:

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

To identify the factors affecting the performance in construction projects (key performance indicators)

To determine contactors perceptions towards the relative importance of the key performance indicators construction

projects in order to evaluate performance of construction projects.

To identify the most significant key performance indicators of construction projects in Sudan.

To evaluate the degree of agreement /disagreement between contractor regarding the ranking of key performance indicators.

1.3 Problem statement:

Successful construction industry plays an important role of the country development. For the past few years, the construction industry has developed in size, complexity and high demand by client, causing construction project becoming more difficult for achieving project objective (time, cost and quality). the level of success in carrying out construction and development depends heavily on clarity of project objective , detailed specifications of plant and a good schedule , client consultation and involvement , and effective monitoring and controlling of the project . Although there are guidelines for monitoring and controlling of construction project success, nonetheless there are construction companies facing problems in completing the project according to project goals.

This research will evaluate the factors affecting the performance of construction projects in Sudan in order to assist contractors to overcome performance problem and to improve performance of their construction projects.

1.4 The importance of study:

The importance of this study is to identify and evaluate the main factors affecting the performance of construction projects in Sudan. The practices concerning with the key performance indicators KPIs such as time , cost , project owners satisfaction and safety checklists will be analyzed in order to know the main practical problems of projects performance and then to formulate recommendations to improve performance of construction projects .

In this study, the factors affecting the performance of construction projects will be studied. These factors can be considered 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.

1.5 Research hypotheses:

There is a significant degree among the part of contractors in cost factor.

Productivity factor also have a significant degree among the part of contractors.

There is significant degree among the part of contractors in client satisfaction factor.

1.6 Research Structure:

This thesis consists of six main chapters as follows:

Chapter One introduces the main objectives of research, statement of the problem and the importance of study.

Chapter Two this chapter describes construction management, construction projects, performance of construction project, measurement of project performance, key performance indicators, benchmarking.

Chapter Three this chapter shows factor affecting performance of manager, factors affecting cost and time performance and common factor affecting the construction project performance.

Chapter Four is dedicated to the research Methodology. Describes the main methodology used in this study and methodology of data analysis and order to achieve the required objectives.

Chapter Five results discussion are presented in chapter, including analysis, description and discussion of research results.

Chapter Six contains the conclusions and recommendations of the research.

Chapter Two

2.1 construction management:

The management of construction projects requires knowledge of modern management as well as an understanding of the design and construction processes.

Constructions projects have a specific set of objectives and constraints such as a required time frame for completion. While the relevant technology, institutional arrangements of processes will differ, the management of such projects has much technology domains (The British Government Web Site).

There is a strong relation between project management and project performance. Management in construction industry is considered as one of the most important factors affecting performance of works. The evaluation undertaken demonstrates that BPM as it is presently implemented in the UK fails to perform as expected in relation to the three predominant performance evaluation criteria, time, cost and quality (Abu Shaban 2008).

The model for performance measurement which assist both firm's top management and operational managers for continuous feedback on operational activities. Documenting and archiving performance data could be useful for future reference, such as for settling disputes on claims, and in maintenance and repair works (Roshana, 2005).

While project management is only one of the many criteria upon which project performance is contingent, it is also arguably the most significant as people formulating the processes and systems who deliver the projects. An adequate understanding and knowledge of performance are desirable for archiving managerial goals such as improvement of institutional transformations, and efficient decision making in design, specification and construction, at various project-level interfaces, using appropriate decision-support tools. Project management practices led to better performance, and recommended key project management practices that could be adopted by foreign construction firms to improve project performance.

2.2 Success of construction project:

Success of construction projects depends mainly on success of performance one of the principle reasons for the construction industry's poor performance has been attributed to the inappropriateness of the chosen procurement system. Three important structures are underlying the dynamic of a project performance which are:

- The work accomplishment structure
- Feedback effects on productivity and work quality and effects from upstream phases to downstream phases
- The main performance criteria of construction projects as financial stability
- Progress of work
- Standard of quality

- Health and safety
- Resources
- Relationship with clients
- Relationship with consultants
- Management capabilities
- Claim and contractual disputes
- Relationship with subcontractors
- Reputation and amount of subcontracting (Abu Shaban 2008).

Construction time is increasingly important because it often serves as a crucial benchmarking for assessing the performance of a project and the efficiency of the project organization (Takim, a, 2002)

Control system is an important element to identify factors affecting construction project effort. For each of the project goals, one or more project performance indicators (PPI) are needed. Human factors play an important role in determining the performance of project.

The most important of practices relating to scope management are controlling the quality of the contract document, quality of response to perceived variations and extent of changes to the contract. It was recommended for foreign firms to adopt some of the project management practices highlighted to help them to achieve better project performance (Abu Shaban, 2008).

2.3 Performance of construction project:

In construction industry, many parties who directly or indirectly involved will measure the project performance throughout the construction period. Person who directly involve and evaluate the project performance may come from project owner or client, construction team players such as project consultant and contractor, supplier and etc. however, person who indirectly involves may be the end user of the product , stakeholders , local authority or other third parties . It is generally accepted that a construction project is successfully completed and handed over to the client, if the project is delivered on time, within budget, and is of the appropriate quality (Michail, 2001)

Performance indicators will be used as a benchmark to indicate that construction project has achieved the expectations. For project team members, it is an important indicator for measuring the efficiency of a construction work as compared to a plan which includes using schedule, cost, quality, etc. in recent years; the concept of benchmarking becomes a popular technique in conjunction with performance indicators to evaluate a project performance. The benchmarking is a continuous systematic process in evaluating product , service or work process of organization that are recognized as representing best practice for the purpose of organization improvement.

In the long term, the final result is more reliable and of a better quality, which satisfies the stakeholders. It can only make a judgment whether or not a projects goal has successfully been

met, once the product has been utilized, and this can only happen many years after the project has been completed. When applied to construction, the evaluation of successful project performance should be focused throughout the overall project, ranging from the procurement process to the final outcome.

2.4 Problems of Performance in Construction project:

The failure of any construction project is mainly related to the problems and failure in performance. Moreover, there are many reasons and factors which attribute to such problems. The construction industry performance problems in developing economies can be classified in three layers:

- I. Problems of shortages or inadequacies in industry infrastructure (mainly supply of resources)
- II. Problems caused by clients and consultants and problems caused by contractor incompetence / inadequacies.
- III. The performance problems arise in large construction projects due to many reasons such as:
 - Incompetent designers/contractors
 - Poor estimation and change management
 - Social and technological issues
 - Site related issues and improper techniques and tools
 - Poor budgetary and time control (Abu Shaban, 2008).

The traditional performance measurement systems have problems because of large and complex amount of information with absence of approaches to assist decision maker understand, organize and use such information to manage organizational

performance. Traditional project performance control is usually generic (e.g., cost control techniques). It relies on manual data collection, which means that it is done at low frequency (normally once a month) and quite some time after the controlled event occurred (i.e., not in real -time). Moreover, manual data collection normally gives low quality data.

International construction projects performance is effected by more complex and dynamic factor than domestic projects; frequently being exposed to serious external uncertainties such as political, economical, social, and cultural risks, as well as internal risks from within the project.

2.5 Measurement of Project Performance:

Performance measurement systems have been one of the primary tools used by the manufacturing sector for business process re-engineering in order to monitor the outcomes and effectiveness of implementation.

An evaluation framework to measure the efficiency of construction project management by using conventional economic analysis tools such as time, cost and quality. Performance measurement systems are imminent in the construction firms. Effective and efficient management of contactors organizational performance requires commitment to effective performance measurement in order to evaluate, control, and improve performance today and in the future (Roshana, 2005)

Performance measurement is a complex issue that normally incorporates at least three different disciplines: economics, management and accounting.

Measurement of performance has attracted significant interest recently among both academics and practitioners. The choice of a suitable measurement technique depends on a number of factors, including the purpose of the measurement; the level of detail required; the time available for the measurement, the existence of available predetermined data, and the cost of measurement (Abu Shabana, 2008).

Performance measurement as a comparison between the desired and the actual performance. For example, when a deviation is detected, the construction manager analyzes the reasons for it. The reasons for deviation can be schematically divided into two groups: (a) unrealistic target setting (e.g., planning) or (b) causes originating from the actual construction (in many cases the causes for the deviation originate from both sources). Performance measurement is needed not only to control current projects but also to update the historical database. Such updates enable for better planning of future projects in terms of cost, schedules, labor allocation, etc. the measurement of project performance can no longer be restricted to the traditional criteria, which consist of time, cost and quality.

A Project Performance Evaluation (PPE) framework covers a wide range of performance factors. PPE factors are communication, time, cost, quality, safety, claims and issues resolution, environment, contract relations.

The main purpose of PPE is to extend project performance measures to cover soft parameters also, such as communication and dispute resolution. In the UK, a project performance measurement tool referred to as the Key Performance Indicators (KPIs) was developed by the KPI working group under the UK Construction industry best practice programmed to include time, cost, quality, client satisfaction, change orders, business performance, health and safety.

Measuring the performance of any construction project is a very complex process because modern construction projects are generally multidisciplinary in nature and they involve participation of designers, contractors, subcontractors, specialists, construction managers, and consultants. With the increasing size of the project, the number of participants in the project also increases.

The objectives or goals of all participants need not be the same even in a given project. Hence to measure performance of a project without specifying the participants and without specifying the criteria for judging the performance holds no meaning. Past researchers have employed different criteria such as compliance to schedule, cost and quality to judge the project performance.

The system comprises of construction business perspective including innovation and learning, processes, project, stakeholders, and financial perspective.

The indicators developed from perspectives are categorized into three main groups which are driver's indicators, process indicators and result indicators. The Key to the success or failure of the

measurement system is leadership commitment; employee's involvement and empowerment; and information coordination and management.

A method for measuring the environmental performance of construction activities committed by a contractor carried out through calculating the contractor's environmental performance score (EPS). The level of EPS serves as a simple indicator for measuring and communicating the level of a contractor's environmental performance.

Cost performance can be measured through a cost performance index (CPI) computed as:

$$\text{CPI} = \text{BCWP} / \text{ACWP} \quad (2-1)$$

Where:

BCWP = budgeted cost of the work performed

ACWP = actual cost of the work performed

From previous equation:

If CPI value of one means, the cost was as planned (at the budget value)

If CPI value above one means, the project was below its budget.

If CPI of less than one means, the project exceeded its budget.

Based on previous equation, time performance is measured through a schedule performance index (SPI) computed as:

$$\text{SPI} = \text{BCWP} / \text{BCWS} \quad (2-2)$$

Where:

BCWP = budgeted cost of the work performed.

BCWS = budgeted cost of the work scheduled.

From previous equation:

If SPI value of one means, the time was as planned (at the time value).

If SPI value above one means, the project was ahead of schedule.

If SPI of less than one means, the project was behind schedule (Abu Shaban, 2008).

2.6 Performance criteria:

2.6.1 Providing Proper Planning and Scheduling:

Planning and scheduling of maintenance work can be a very difficult task due to the fact that, in general, construction work cannot be done continuously, access to the site might not be easy, space is restricted, and there is a problem of interference between building occupants and workers.

Performance evaluation of planning and scheduling of construction work involves many measures including; meeting schedules and deadlines set by company representative, efficiency of the work schedule, and quality of the complete task.

2.6.2 Procuring Material to the Site:

Procurement of material is a very important factor because the quality of the construction work depends on the choice of proper materials. The cost of the entire construction project may vary due to the variation in the cost of the materials. In addition, the execution time of the project may be extended due to delays in the delivery of the material.

The measure of the performance evaluation of this factor includes providing the same material specified in the contract, providing the same quantities specified in the contract, and providing the required material on schedule.

2.6.3 Providing Suggestions on Cost Cutting:

Construction projects costs involves the cost of labour, material, equipment, and overheads. Any reduction in any of these costs would be beneficial to both owner and contractor.

This evaluation measure involves providing ideas for reducing man power, material costs, and operating costs.

2.6.4. Providing Safety Precautions at Construction Site:

Safety is very important in construction. Safety involves humanitarian, economic, legal, and regulatory concerns. Safety precautions include, for example driving vehicles inside the construction site within speed limit, wearing hard hats and safety shoes during work, fastening formwork, and avoiding loose electrical connections.

The evaluation measures involve the availability of safety shoes, gloves, and hard hats, specifying speed limits inside the construction site; providing first aid supplies, providing a clear safety program, and conducting regular meetings to explain the safety program.

2.6.5 Subcontractors Control:

The control of the subcontractors is important because the quality and timely completion of his work has a direct effect on the overall performance of the general contractor. This criterion* involves providing well-qualified subcontractors, who can do the work efficiently.

2.6.6 Ensuring Efficient Administration and Supervision:

Administration staffs are vital to the efficient executing of the construction work. Record keeping and distribution is important to communication between owners and contractors. The supervision of the construction work by the contractor assures the quality and timely execution of the assigned work.

The performance measures of these criteria include providing the required man power for supervision, providing well-organized mobile offices to the site, and organizing current documents and records.

2.6.7 Ensuring Availability of Required Equipments and Facilities:

It is important to have the proper equipment available for construction workers to perform their work adequately. The success and failure of completing the construction task depends on the utilization and availability of the right equipment.

The performance measure in this criterion providing the required quantity and quality of equipment, making sure that the equipment and facilities are well-maintained, and providing the required vehicle (Puspasari, 2005).

2.7 Factor Affecting Performance of Managers:

The knowledge that would influence potential performance enables project managers to pay special attention to control performance more effectively. The effective communication and fast information transfer between managers and participants help to accelerate the building construction process and performance. The impact of the use of a project management based organizational structure, project manager training, frequency of design meetings, and frequency on design reports on design phase cost performance. The process of 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.

Data are collected and used for construction managers as a basis to evaluate the project performance indicators (PPI) actual value

to compare it with the planned value and forecast its future value based on past performance.

The importance of the working environment variables for the performance of a project manager in the private and public sectors is according to three main groups which are job condition, project characteristic and organizational related categories. The result revealed that working hours, physical condition 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 contactors and consultants groups. Team relationship was ranked as the most important variable affecting the performance of a project manager. It is obtained that project manager's experiences do not have much effect on how they perceive their working environment.

2.8 Factors Affecting Cost and Time Performance:

Various countries appear to have contributed significantly to the body of knowledge relating to time performance in construction projects over the past three decades, while project performance in terms of cost is studied since 1960s. These studies range from theoretical work based on experience of researcher on one end to structured research work on the other end. Moreover, there have been many past studies on project performance according to cost and time factors.

A number of unexpected problems and changes from original design arise during the construction phase, leading to problems in cost and time performance. It is found that poor site

management, unforeseen ground conditions and low speed of decision making involving all project teams are the three most significant factors causing delays and problems of time performance in local building works.

Cost and time performance has been identified as general problems in the construction industry worldwide. Project complexity, client type, experience of team and communication are highly correlated with the time performance; whilst project complexity, client characteristics and contractor characteristics are highly correlated with the cost performance. Project schedule and budget performance are controlled by the dynamic feedback process.

Those processes include the rework cycle, feedback loops creating changes in productivity and quality, and effects between work phases.

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. Otherwise, the use of project managers training and a project management based organizational structure were found to be processes that do not create a statistically significant in reducing design phase costs.

The factors affecting cost performance are: project manager's competence; top management support; project manager's coordinator and leadership skill; monitoring and feedback by the participants; decision making; coordination among project

participants; owner's competence; social condition, economical condition, and climatic condition. Coordination among project participants was as the most significant of all the factors having maximum influence on cost performance of projects.

Specific technological and managerial strategies should be implemented to increase speed of construction and so to upgrade the construction time performance. It is remarked that effective communication, fast information transfer between project participants, the better selection and training of managers, and detailed construction programs with advanced available software can help to accelerate the performance.

Managing speed in engineering, procurement and construction projects is a key factor in the competition between innovative firms. It is found that customers can consider time as a resource and, in that case, they will encourage the contractor to improve the time performance (Abu Shaban, 2008).

2.9 Common Factors Affecting the Construction Project Performance:

As the process of construction project is very complicated with combination of various parties' endeavors, many stages of work and taking a long time to complete, there are many factors which will affect its performance. Delay factors are assembled into nine major groups with different levels of important to different parties. Sixty causes were indentified, classified and concluded as the following: the delay occurred frequently in medium and large size projects, and considered severe in small projects. There are

many important causes of delay related to owner involvement, contractor performance, and the early planning and design of the project. Important causes are 16 financial problems, changes in the design and scope, delay in making decisions and approvals by owner, difficulties in obtaining work permit, and coordination and communication problem.

The major factors influencing cost overrun are material cost increase due to inflation, inaccurate material estimation and degree of complexity. While in time overrun, the most important factors causing delays are design changes, poor labor productivity, inadequate planning and resource shortage.

The main causes of delay were related to designer, user changes, weather, site conditions, late deliveries, lack of experience, poor estimation practices, wrong decisions in regulating company's policy and national slump in the economy are the server factors, economic conditions and increase in quantity. The genuine attention to manage these factors will help industry practitioners in minimizing contract disputes. Delays have strong relationship with failure and ineffective performance of contractors.

Generally a construction project team itself is a nature of problem due to the diverse people and cultures, diverse disciplines and business objective. Hence the project team must be united and share the same goals to achieve good project performance. In the following sections we will further discuss the factors affecting project performance.

2.9.1 Project –related Factors:

The importance of project scope factors is echoed by other researchers. The attributes used to measure this factor are type of project, nature of project, number of floors of the project, complexity of project and size of project.

2.9.2 Procurement –related Factors:

The importance of procurement factors is as a framework within which construction is brought about, acquired or obtained. Therefore, two attributes are used to measure this factor; they are procurement method (selection of the organization for the design and construction of the project) and tendering method (procedures adopted for the selection of the project team and in particular the main contractor).

2.9.3 Project Management Factors:

Project management action is a key for project success. By using the management tools, the project managers would able to plan and execute their construction projects to maximize the projects chances of success. The variable in project management include inadequate communication, control mechanism, feedback capabilities, troubleshooting, coordination effectiveness, decision making effectiveness, monitoring, project organization structure, plan and schedule followed, and related management experience.

A number of attributes will affect this factor, including the communication system, control mechanism, feedback capabilities, planning effort, organization structure, safety and quality

assurance program, control of subcontractors work, and finally the overall managerial actions.

2.9.4 Project Participants- related factors:

Projects participants are the key players, including project manager, client, contractors, consultants, subcontractor, supplier, and manufactures. The influence of client and client's representative as a significant factor on construction performance. The client-related factors are concerned with client characteristics, client type and experience, knowledge of construction project organization, project financing, and client confidence in the construction team, owner's construction sophistication, well- defined scope, owner's risk, and client project management.

Designers play a vital role as their work continues from interception to completion on a project. The design team-related factors consist of design team experience, project design complexity, and mistakes/delays in producing design documents.

The main contractor and subcontractors start their main duties when the project reaches the construction stage. The variables include contractor experience, site management, supervision and involvement of subcontracting, contractors cash flow, effectiveness of cost control system, and speed of information flow. Variables under these factors consist of the skill and characteristics of project managers, their commitment, competence, experience, and authority.

A construction project requires team spirit; therefore team building is important among different parties. Team effort by all parties to a contract-owner, architect, construction manager, contractor, and sub-contractors-is a crucial ingredient for the successful completion of a project. The attributes of these factors can be mainly into two categories: one is related to client, another is the project team. For the first group, it includes clients experience and ability, nature of client, size of client organization, client's emphasis on cost, time and quality, and client contribution to the project. For the second group, it includes project team leaders experience and skill, project team leader's commitment on time, cost and quality, project team leader's involvement, project team leader's adaptability and working relationship, and the last one is support of the project team leader's parent companies.

2.9.5 External Factors:

Various researches support "environment" as a factor affecting the project success. "Environment" as all external influences on the construction process, including social, political, and technical systems. The attributes used to measure this factor are economic environment, social environment, political environment, and level of technological advanced (Puspasari, 2005)

Chapter Three

Research Methodology

3.1 Introduction:

This research discusses the main factors affecting performance in construction project in Sudan. From literature review and past studies, there were different approaches and methodologies used to achieve objectives of research. Some of previous studies focused on measurement of construction projects performance. Other studies focused on factors affecting the poor performance of construction projects. Some of studies deal with different aspects related to performance such as information technology (IT).

3.2 Literature Review:

Literature was reviewed to identify the factors affecting the performance of construction projects, Performance of construction project, problem of performance in construction project, Performance criteria and measurement of project performance.

3.3 Methods for data analysis:

A questionnaire was established to study the impact of factors affecting performance. The questionnaire aimed to study the attitude of contractors towards the factors that affect on performance in the construction industry. The questionnaire was distributed to contractors where 100 questionnaire copies were

conducted and the response was from 71 contractors. The questionnaire was designed in two parts the first part consists of general information and the second part factors affecting the performance of construction project both part were analyzed statistically and using the relative importance index method (RII).

The relative importance index method (RII) is used here to determine contractor's perceptions of the relative importance of the key performance indicators in construction projects. The relative index is computed as:

$$RII = \frac{\sum W}{A * N} \quad (3-1)$$

. Where:

W = is the weight given to each factor by the responders and ranges from 1 to 5.

A = the highest weight =5

N= the total number of responders

$RII > 0$

$RII < 1$

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 an appropriate method that can be applied and not others.

In this research, ordinal scales were used. Ordinal scale as shown in table 1 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 intervals between scales are equal, nor do they indicate absolute quantities. They are merely numerical labels.

Table Ordinal scale used for data measurement

Item	Very Low Important	Low Important	Medium Important	High Important	Very high Important
Scale	1	2	3	4	5

Results analysis and discussion

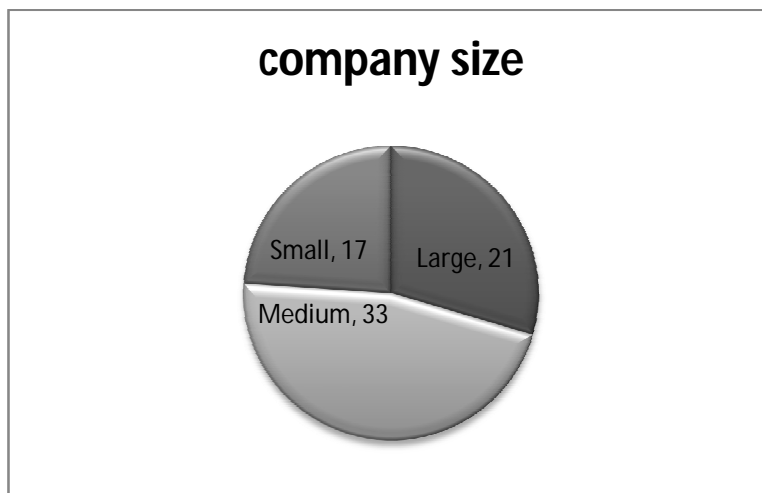
This chapter concerned of the analysis of the questionnaire. The results of this analysis are as follows:

3.4 Part one:

General Information:

1/ Company size:

Fig (3-1) company size



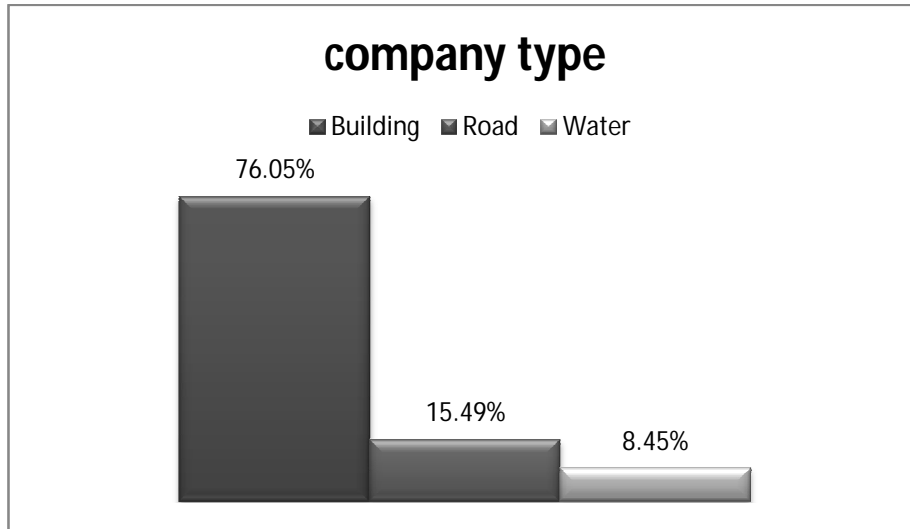
Company size	No. of responses	Percent%
Large	21	29.56%
Medium	33	46.47%
Small	17	23.94%
TOTAL	71	100%

Table (3-1) company size

71 questionnaires were distributed as 21% to large company, 33% medium company, 17% small company, as respondents.

2/ Specialization of company:

Fig (3-2) Specialization Company



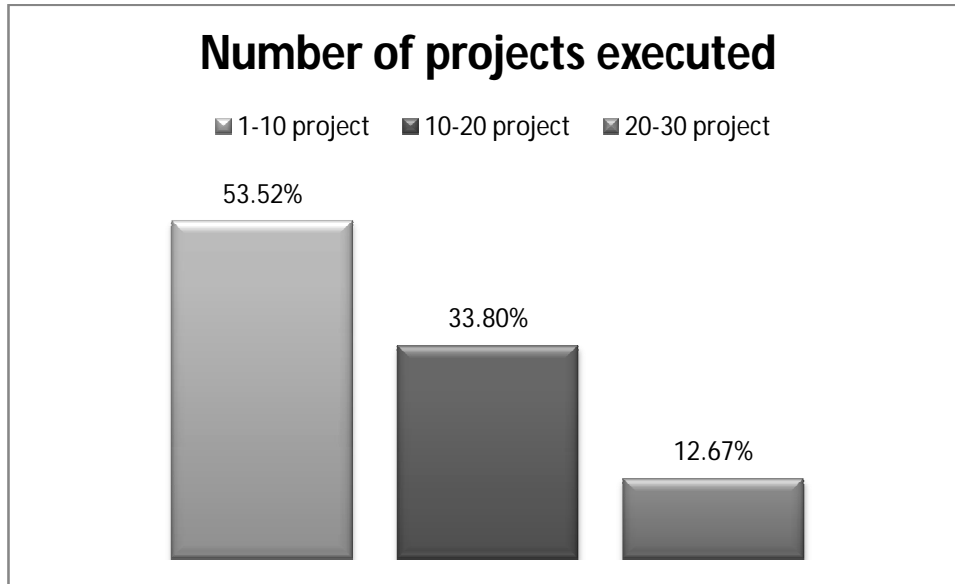
	No. of responses	Percent%
Building	54	76.05%
Road	11	15.49%
Water	6	8.45%
TOTAL	71	100%

Table (3-2) Specialization Company

76% of company worked in construction project. Te questionnaire were distributed to expert engineers such as projects managers, site engineer, office engineer and organizations managers.

3/ Number of projects executed in the last five year:

Fig (3-3) Number of projects executed



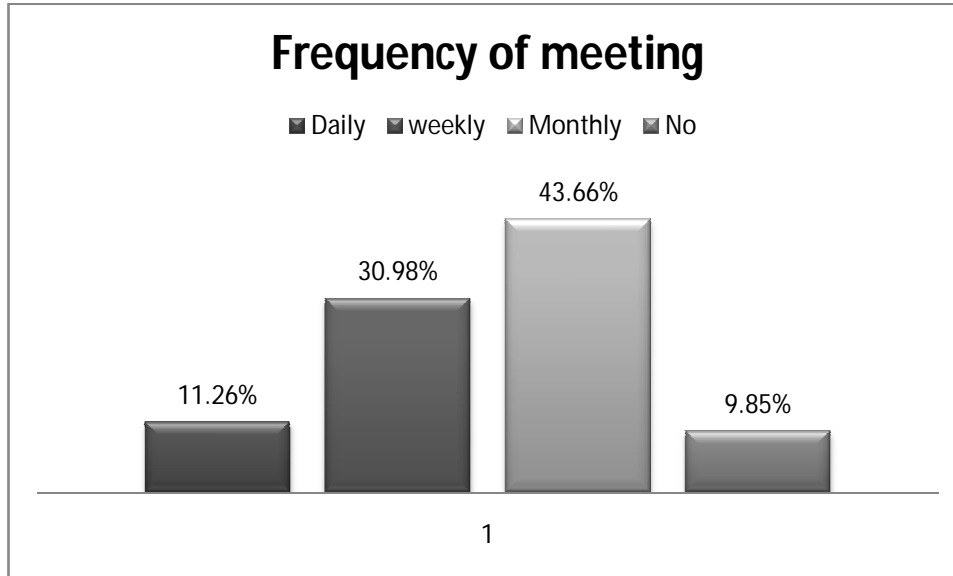
Num of projects executed	No. of responses	Percent%
1-10 project	38	53.52%
10-20 project	24	33.80%
20-30 project	9	12.67%
TOTAL	71	100%

Table (3-3) Number of projects executed

53% of contractors worked from 1 to 10 projects per year.

4/ Frequency of meeting:

Fig (3-4) Frequency of meeting



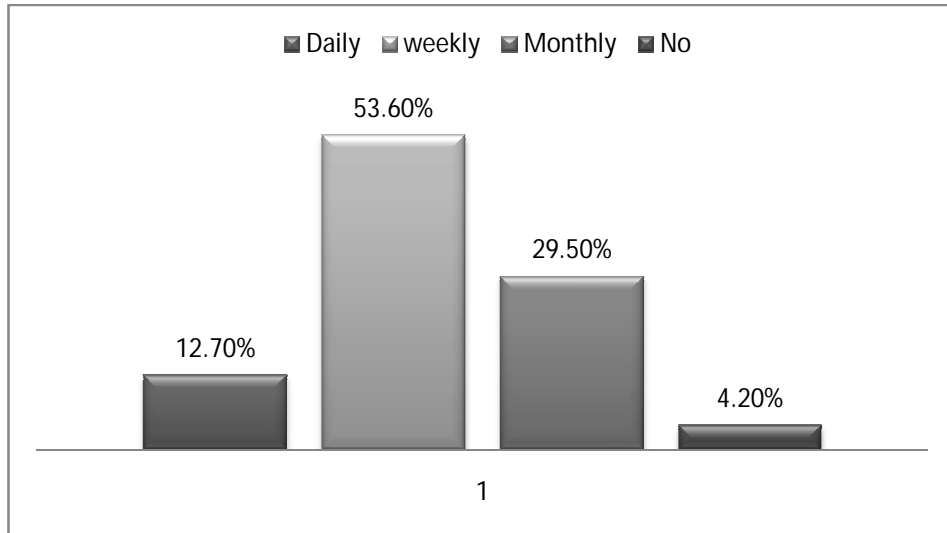
Column1	No. of responses	Percent%
Daily	11	15.51%
weekly	22	30.98%
Monthly	31	43.66%
No	7	9.85%
Total	71	100.00%

Table (3-4) Frequency of meeting

43.66% of contractors meet monthly of discussion of monitoring, updating and controlling the progress. The project team should meet weekly for discussion monitoring, updating and controlling the progress because they can solve problem earlier and evaluate performance and improve future work.

5/ How often do you coordinate your schedule with master schedule of the project owner?

Fig (3-5) Coordinate current schedule



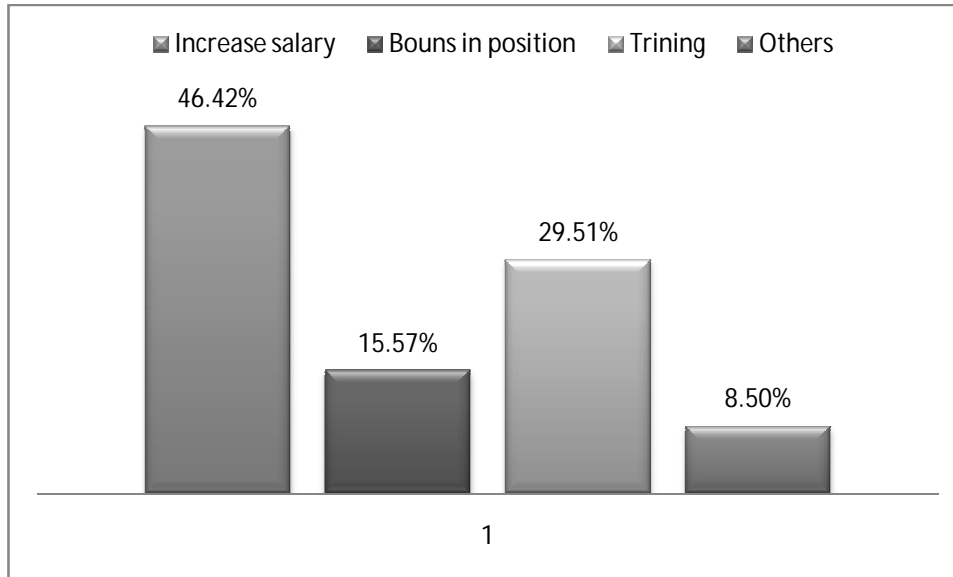
Column1	No. of responses	Percent%
Daily	9	12.70%
weekly	38	53.60%
Monthly	21	29.50%
No	3	4.20%
Total	71	100.00%

Table (3-5) Coordinate current schedule

53% of contractors always review and coordinate current schedule with master schedule of the project owner on week. Contractors are to coordinate current schedule with master schedule of the project owner on weekly basis because this can assist them to evaluate time performance of the project compared with the base schedule and to have continuous monitoring, controlling and updating of time performance of the project.

6/ How do you supply the incentive system to stimulate the construction time?

Fig (3-6) system of incentive



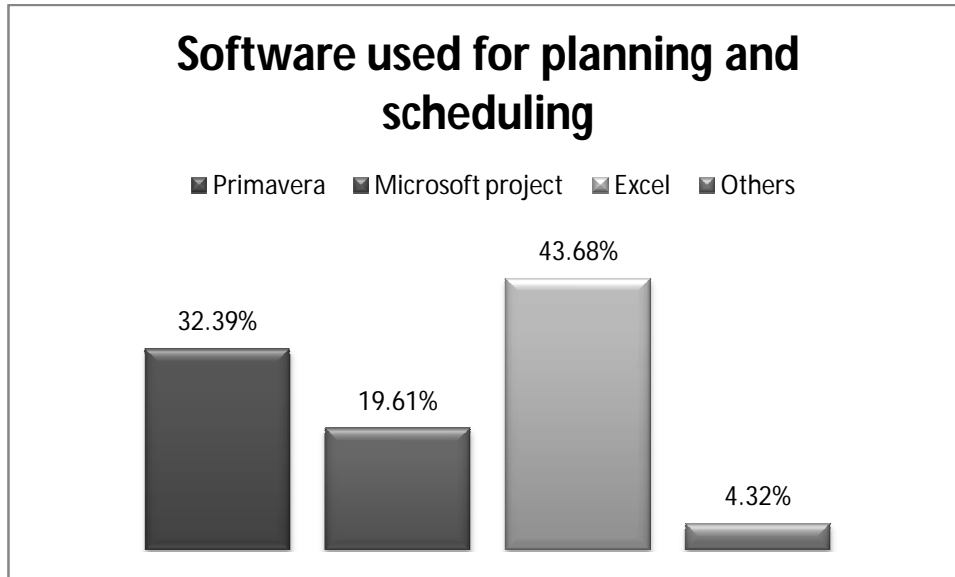
Column1	No. of responses	Percent%
Increase salary	33	46.42%
Bonus in position	11	15.57%
Training	21	29.51%
Others	6	8.50%
Total	71	100.00%

Table (3-6) system of incentive

46.42% of contractors are increase salary to supply the incentive system to stimulate the construction time and 29.51% of them do that by training programs. Regular increase in salaries is useful to supply the incentive system and to stimulate the construction time. As contractor responses way will motivate employees as assist them to improve productivity and performance.

7/ which software does apply for planning and scheduling the progress the project

Fig (3-7) Software used for planning and scheduling



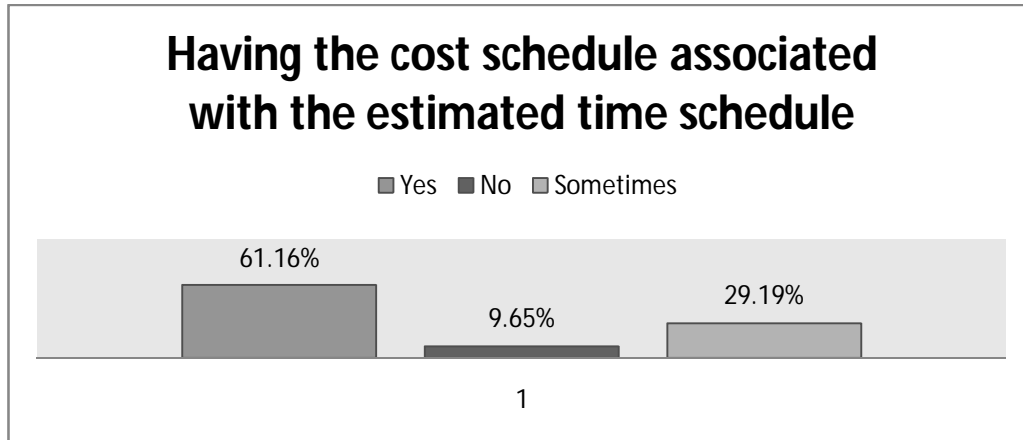
Column1	No. of responses	Percent%
Primavera	23	32.39%
Microsoft project	14	19.61%
Excel	31	43.68%
Others	3	4.32%
Total	71	100.00%

Table (3-7) Software used for planning and scheduling

43.68% use Excel sheet and 32.39% use primavera to planning and scheduling the progress the project. These programs enable them to schedule, monitor, update and control many criteria of project such as time, cost and resources.

8/ Do you have the cost schedule associated with the estimated time schedule?

Fig (3-8) cost schedule associated with the estimated time



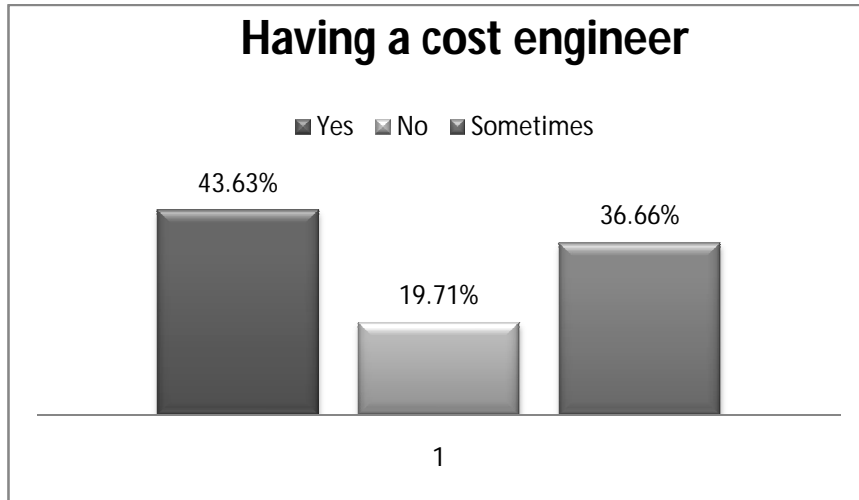
Column1	No. of responses	Percent%
Yes	43	61.16%
No	7	9.65%
Sometimes	21	29.19%
Total	71	100.00%

Table (3-8) cost schedule associated with the estimated time

61.16% of contractors use the cost schedule associated with the estimated time schedule. Contractors use the cost schedule associated with the estimated time schedule, it evaluate performance of cost and time and time together at any stage throughout the project implementation and know if project is ahead or behind of schedule and if it is over or under estimated cost.

9/ Do you have a cost engineer who is only responsible for dealing with cost control?

Figs (3-9) have a cost engineer



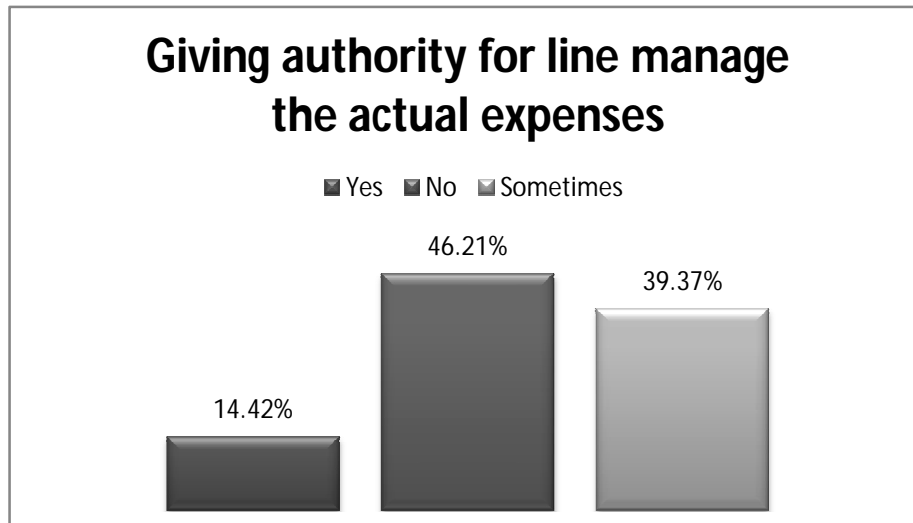
Column1	No. of responses	Percent%
Yes	31	43.63%
No	14	19.71%
Sometimes	26	36.66%
Total	71	100.00%

Tables (3-9) have a cost engineer

43.63% of contractors have cost engineering that is only responsible for dealing with cost control. Most of contractor have cost engineer who is only responsible for dealing with cost control, because cost engineering assist in evaluating cost and time performance of projects and allows the calculation of cost and schedule variances and performance indices and forecasts of project cost and schedule duration.

10/ Do you give right and authority for line managers to manage the actual expense?

Fig (3-10) authority for line managers to manage the actual expense



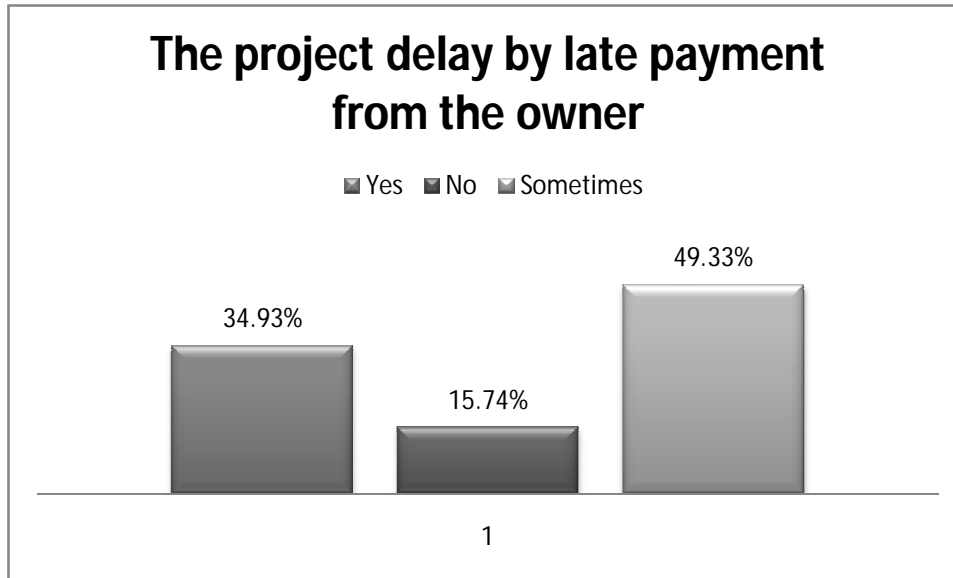
Column1	No. of responses	Percent%
Yes	11	14.42%
No	32	46.21%
Sometimes	28	39.37%
Total	71	100.00%

Table (3-10) authority for line managers to manage

46.21% contractors said no but sometime they give right and authority for line managers to manage the actual expenses because this is considered as an effective communication tool and fast information transfer between managers and participants, it helps to accelerate the building construction process and performance.

11/ Did the project delay by late payment from the owner?

Figs (3-11) the project delay by late payment from the owner



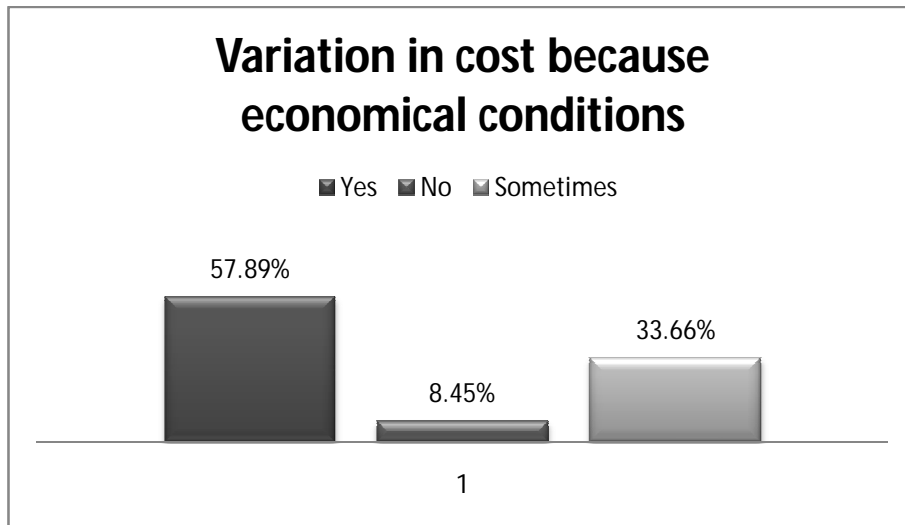
Column1	No. of responses	Percent%
Yes	28	34.93%
No	9	15.74%
Sometimes	34	49.33%
Total	71	100.00%

Table (3-11) the project delay by late payment from the owner

49.33% of contractors sometime the project delay by late payment from the owner and 34.93% of contractors says the project delay by late payment from the owner. The project delays by late payment from the owner which leads to delay of contractors performance and cause problem in time performance and may also lead to claims and disputes between owner and contractor of the project.

12/ Did the actual cost of projects be more than the estimated cost because economical conditions?

Figs (3-12) Variation in cost because economical conditions



Column1	No. of responses	Percent%
Yes	41	57.89%
No	6	8.45%
Sometimes	24	33.66%
Total	71	100.00%

Table (3-12) Variation in cost because economical conditions

57.89% of contractor responded that the actual cost of projects be more than the estimated cost because economical conditions. Most of contractors responded that the actual cost of projects be more than the estimated cost because of economical conditions such as escalation of construction material prices and that lead to poor performance of projects.

3.5 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 relative importance index is computed as:

$$RII = \text{SUM } W / A * N \quad (3-1)$$

. Where:

W = is the weight given to each factor by the responders and ranges from 1 to 5.

A = the highest weight =5

N= the total number of responders

1 = Very Low Important

2= Low Important

3 = Medium Important

4 =High Important

5= Very high Important

1/ Time related factor:

Time related factor	No. of responses					RII
	1	2	3	4	5	
Planned time for project construction	3	11	16	31	10	0.51327
Time needed to implement variation orders	0	15	22	32	2	0.623989
Time needed to rectify defects	2	6	18	37	6	0.431526
Average delay in payment from owner to contractor	0	7	20	33	11	0.69834
Availability of resources as planned throughout project duration	0	6	23	23	17	0.77702

Table (3-13) RII of time related factor

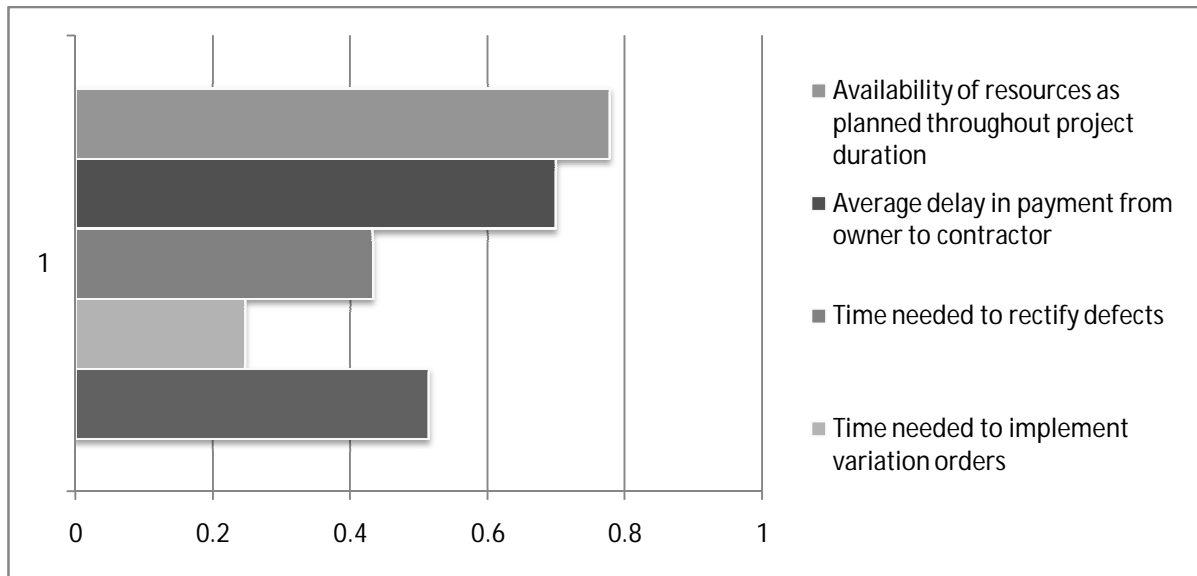


Chart (3-13) RII of time related factor

Availability of resources as planned throughout the project duration has been ranked the contractors per their answers as the

first importance with RII equal 0.77702. This factor affects the performance of the project. If resources are not available for contractors are planned the project will suffer from problem of time and cost performance. This factor affects directly and practically on contractors performance through projects.

The average delay in payment by the owner to the contractors is ranked by the audience in the second level importance with RII equal 0.69834. Delay in payment leads to drop of contractor's performance and causes problems in time performance. This may also lead to disputes and claims between contractor and consultant of project. All these factors will affect the overall performance of the project during implementation.

Time needed to implement variation orders has been ranked by the contractors per their answers in the third level with RII equal 0.623989.

Time needed to implement variation orders will affect the performance of basic schedule. The contractor cannot implement any stage throughout the project without implement variation orders. This factor affects strongly on time performance.

Planned time for project construction has been ranked by contractors in the fourth level with RII equal 0.51327. The performance of project will suffer delay and hence disputes between the contractor and the consultant planned time for project construction is an important factor for contractor because this factor affects strongly contractor's performance for project time.

2/ Cost related factor:

cost related factor	No. of responses					RII
	1	2	3	4	5	
Cash flow of project	2	2	21	34	12	0.787161
Profit rate of project	2	19	37	9	4	0.37625
Project design cost	1	22	31	12	5	0.21337
Material and equipment cost	0	0	16	34	21	0.826869
Project labor cost	0	0	14	38	19	0.762751
Cost of rework	6	11	29	18	7	0.57278
Cost of variation orders	7	13	16	24	11	0.470898
Waste rate of materials	8	14	27	16	5	0.50976
Escalation of material prices	0	2	25	31	13	0.78751
Variation in exchange rate	3	2	21	19	6	0.65278

Table (3-14) of cost related factor

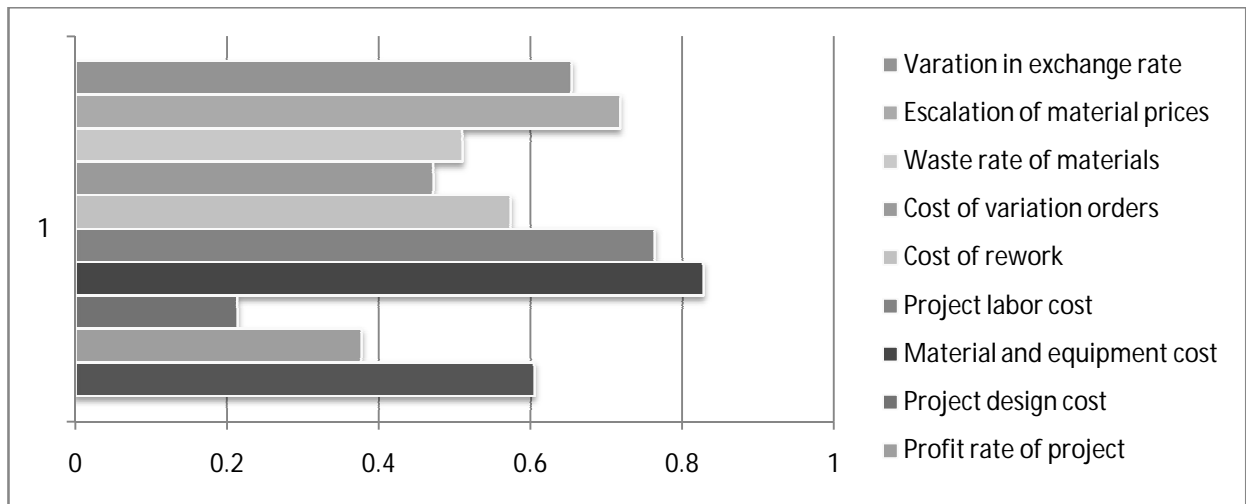


Fig (3-14) RII of cost related factor

Material and equipment cost has been ranked by the contractors in the first level with RII equal 0.8268. This factor considered as one of the cost components. Therefore, material and equipment cost affects the contractors profit rate and hence their cost performance.

Escalation of material prices and cash flow of the project has been ranked by the contractor's respondents in the second level with RII equal 0.787. Cash flow can give an important evaluation for the contractors cost performance at any stage of the project. In addition, contractors can improve their cost performance based on continuously cash flow review. Cash flow is a significant factor for evaluation and measurement of construction contractor's performance.

Escalation of material prices is the most important for contractors' to reimburse their losses. This escalation prices affect the liquidity of contractors and profit rate of their projects.

Variation in exchange rate has been ranked by the contractor's respondents in the third level with RII equal 0.652. Variation in exchange rate affects the projects profit rate for contractors and the cost performance. Contractors suffered from variation in exchange rate because difficult political and economical situation.

3/ Quality related factor:

Quality related factor	No. of responses					RII
	1	2	3	4	5	
Conformance to specification	0	2	24	27	18	0.771719
Availability of personals with high experience and qualification	0	4	21	29	17	0.800027
Quality of equipment and raw materials in project	0	3	27	32	9	0.803437
Quality assessment system in organization	4	7	35	19	6	0.497628
Quality training / meeting	7	11	29	15	9	0.266458

Table (3-15) Quality related factor

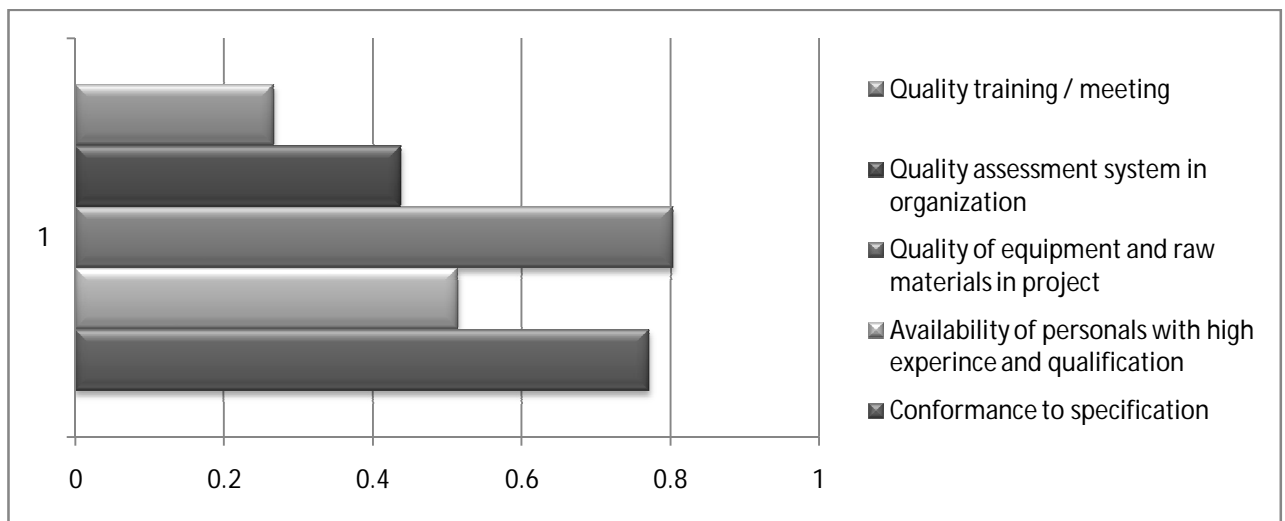


Fig (3-15) Quality related factor

The quality of equipment and raw materials in the project has been ranked by the contractor's answers in the first level important with RII equal 0.803437. Contractors must implement their projects according to required and agreed upon quality because owners and consultants usually want materials to be

used according to the specification and agreement. This factor affects the quality performance and the degree satisfaction of owners and consultant.

Availability of personal with high experience and qualification has been ranked by the contractor's respondents in the second position with RII equal 0.800027. This factor is the most important for contractors because availability of personals with high experience and qualification assist contractors to implement their projects with a successful and suitable performance.

Conformance to specification has been ranked by the contractors in third level with RII equal 0.771719. This factor is significant for contractors as it is related to consultants and owners satisfaction.

Quality assessment system in organization has been ranked by the contractor's answerers in the forth level with RII 0.497628. Quality assessment system in organization is rarely achieved or implement throughout construction projects this factor affects on contractors performance.

4/Client related factor:

Client related factor	No. of responses					RII
	1	2	3	4	5	
Information coordination between owner and project parties	0	3	12	27	19	0.877866
Leadership skills for project manager	0	0	20	33	18	0.769139
Speed and reliability of service to owner	0	0	23	37	11	0.58684
Number of disputes between owner and project parties	3	4	27	21	16	0.646197
Number of reworks	4	15	29	14	9	0.151954

Table (3-16) client related factor

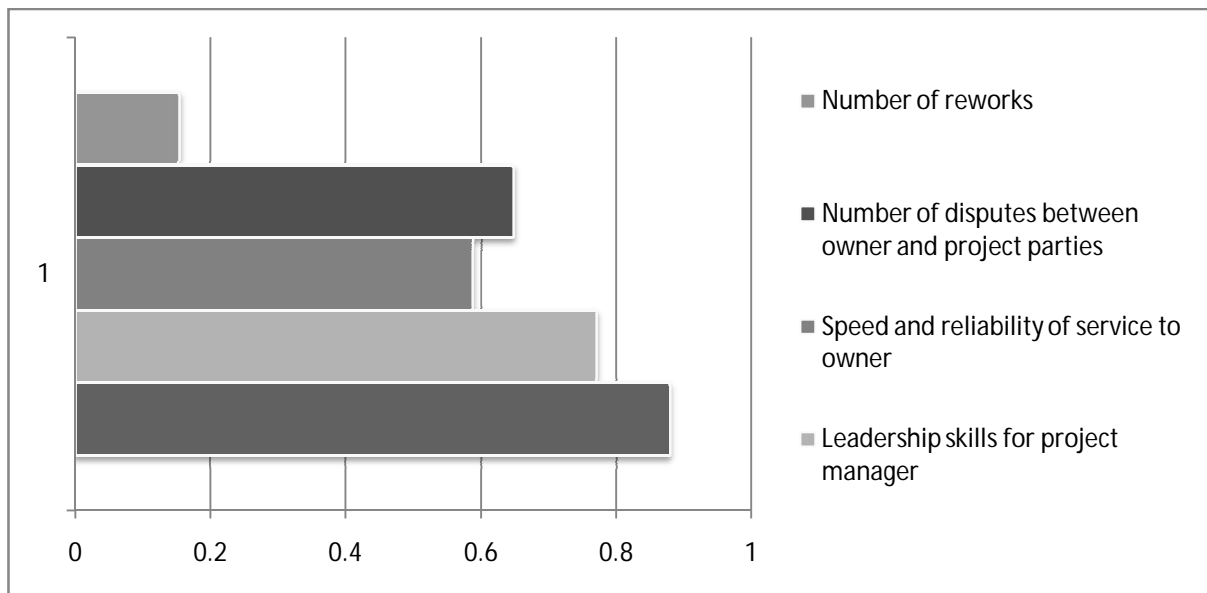


Fig (3-16) Client related factor

Information coordination between owner and project parties has been ranked by the contractors in the first level with RII equal 0.877866. This factor is the most important because good information coordination between the owner and the project parties will leads to successful performance and strong relationship between the project parties.

Leadership skills for project manager have been ranked by the contractors in the second level with RII equal 0.769139. Also this factor is important to contractors because it has a significant effect on the project performance.

Number of disputes between owner and project parties has been ranked by contractors in third level with RII equal 0.646197. Disputes between owner and project parties will affect on relationship between them can affect the performance of project.

Speed and reliability of service to owner has been ranked by the contractors respondents in forth level with RII equal 0.58684. This factor has an effect on the project performance because it is a function of the client satisfaction degree.

5/Health and safety related factor:

Health and safety related factor	No. of responses					RII
	1	2	3	4	5	
Application of health and safety factors in organization	2	13	27	19	10	0.605832
Easiness to reach to the site (location of project)	0	11	31	25	4	0.674563
Reportable accidents rate in project	27	19	17	5	3	0.246765
Assurance rate of project	21	15	26	7	2	0.326864
wastes around the site	3	9	27	21	11	0.750346
Climate condition in the site	5	11	29	17	9	0.58323

Table (3-17) Health and safety related factor

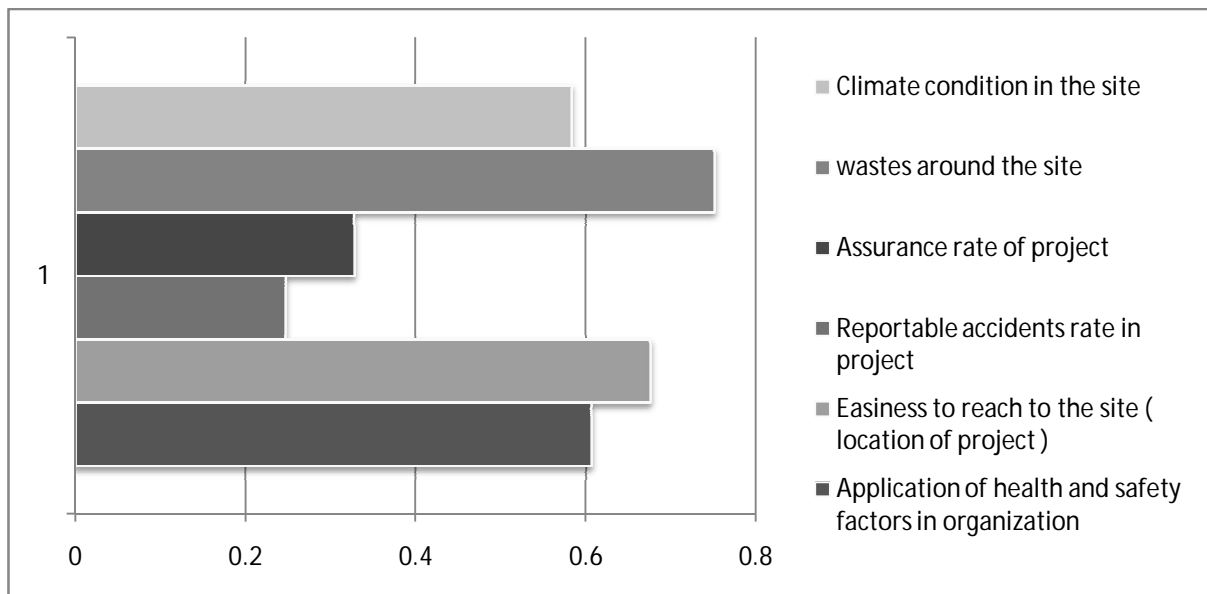


Fig (3-17) Health and safety related factor

A waste around the site has been ranked by the contractor's answerers in the first level with RII equal 0.750346. Wastes around the site affect the health and safety of employees.

Easiness to reach to the site (location of project) has been ranked by the contractors in second level with RII 0.674563. Easiness to reach the site affects the degree of health and safety for project employees and time project.

Application of health and safety factors in organization has been ranked by the contractors in the third level with RII equal 0.605832. This factor is the important for contractors because the application of health and safety measures in the construction projects will improve construction contractor's performance.

Climate condition in the site has been ranked by the contractors answerers in the forth position with RII 0.58323 and they considered this factor as the most important because climate condition in the site affects the productivity and time performance of project.

6/ Innovation and learning related factor:

Innovation and learning related factor	No. of responses					RII
	1	2	3	4	5	
Learning from own experience and past history	0	2	14	34	21	0.833198
Learning from best practice and experience of others	0	4	17	28	22	0.75943
Training the human resources in the skills demanded	3	7	27	23	11	0.6298
Review of failures and solve them	0	5	18	37	11	0.592442

Table (3-18) Innovation and learning related factor

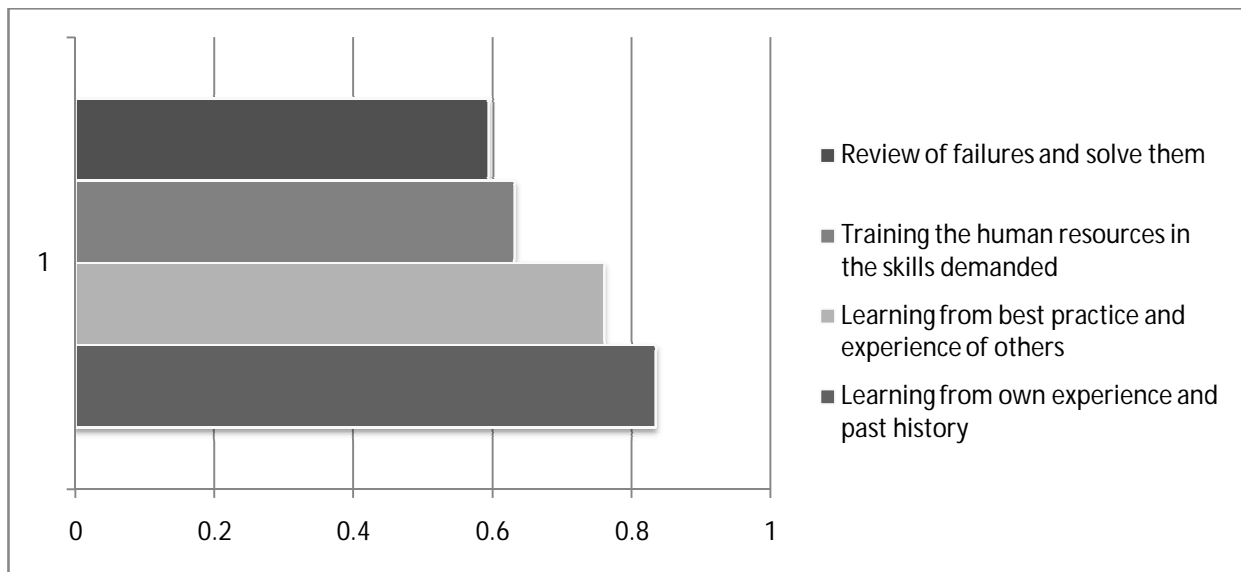


Fig (3-18) Innovation and learning related factor

Learning from own experience and past history has been ranked by the contractors in the first level with RII equal 0.833198.

Learning from best practice and experience of others has been ranked by the contractors in the second level with RII equal 0.75943. Contractors considered this factor as important because it can improve and develop the performance of current and future projects.

Training the human resources in the skills demanded has been ranked by the contractors in the third level with RII equal 0.6298. Contractors should train their employees in different areas and improve their skills in order to be capable for different types of projects.

7/ Productivity related factor:

Productivity related factor	No. of responses					RII
	1	2	3	4	5	
Number of new projects / year	5	18	31	15	2	0.353367
Management - labor relationship	0	7	21	27	16	0.761093
Absenteeism rate through project	12	8	28	17	6	0.49244
Sequencing of work according to schedule	2	5	19	21	24	0.69823

Table (3-19) productivity related factor

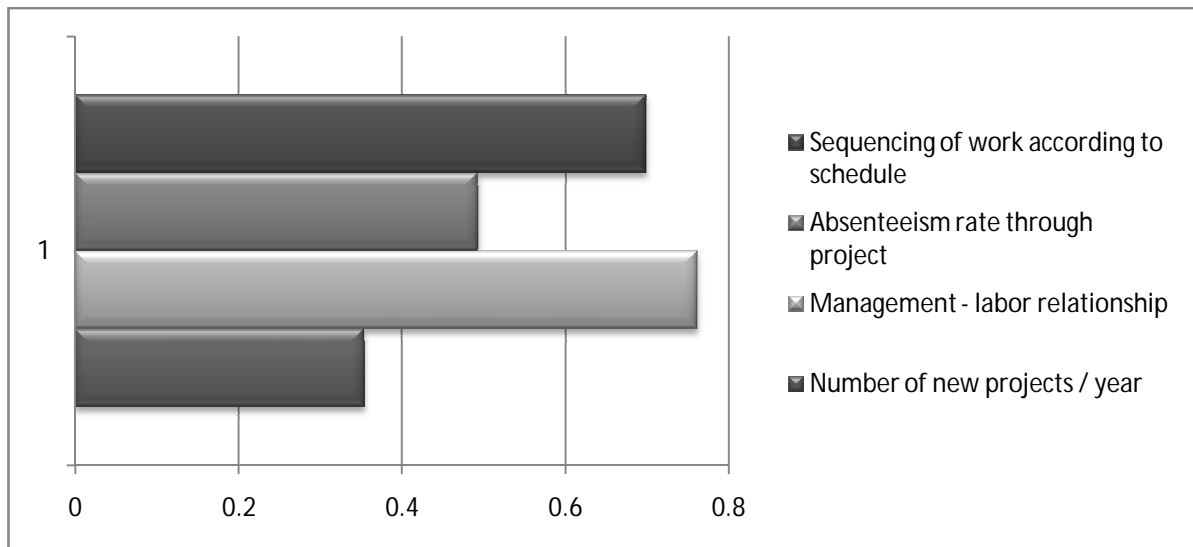


Fig (3-19) Productivity related factor

Management - labor relationship has been ranked by the contractors in first level with RII equal 0.761093. Management of labor relationship can assist for strong coordination and motivation between the labor level and the managerial level. This

will lead to implement project with success productivity and suitable time performance. Management of labor relationship is significant for productivity performance of construction projects.

Sequencing of work according to schedule has been ranked by the contractors in second level with RII equal 0.69823. This factor is the most important for contractors because sequencing of work according to schedule assists contractors to implement project according to schedule time. The contractors will not suffer from time and cost performance problems.

Absenteeism rate through project has ranked by contractors in third level with RII equal 0.49244. Absenteeism through project will affect the productivity. The contractor will suffer from time performance problem. This absenteeism through project implementation is very influential for contractors because it affects the productivity performance of contractors.

3.6 Hypothesis Test:

To test the degree of agreement between parts of contractors (large, medium, small) use Kendall's Coefficient of concordance is used to measure the agreement among rates. For each variable, the sum of rank is computed. Kendall's W, ranges between **0 (no agreement)** and **1**

(Complete agreement).

To determine whether there is degree of agreement among the level of each of the factors affecting the performance of construction projects for each large, medium, and small contractors, Kendall's Coefficient of concordance says that the degree of agreement on a zero to one:

Null Hypothesis: H₀: There is insignificant degree of agreement among the type of contractors.

Alternative Hypothesis: H₀: There is significant degree of agreement among the type of contractors.

Kendall's Coefficient of concordance = $C+D+1 / C-D-1$

Table (3-20) Kendall's Coefficient of concordance

Factors groups	W	Test result
Time related factor	0.517	Reject H0
Cost related factor	0.418	Reject H0
Quality related factor	0.589	Reject H0
Client related factor	0.5647	Reject H0
Health and safety related factor	0.305	Don't reject H0
Innovation and learning related factor	0.265	Don't reject H0
Productivity related factor	0.482	Reject H0

For Cost, Time, Quality, Productivity, Client Satisfaction factors the null hypothesis, H0, is reject and the alternative hypothesis, H1, is accepted. Therefore, it can be said that there is a significant degree of among the parts of contractors regarding factors affecting the performance of construction projects.

On the other hand, for innovation and learning, health and safety factor. 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 parts of contractors regarding factors affecting the performance of construction projects.

Chapter Four

Conclusion and Recommendation

4.1 Conclusion:

The performance of the construction industry is affected by clients, contractors, consultants, stakeholders, regulators, national economies and others.

To identify the factors affecting the performance of construction projects (Key performance indicators):

Literature about performance was reviewed 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, variation in exchange rate, average neighbors and site condition problems, belonging to work and location of project.

34 factors that affecting performance of construction projects were selected these factors were grouped into 7 groups. These groups give a comprehensive summary of the main key performance indicators.

The main groups considered in this study are concerned of cost, time, quality, productivity, client satisfaction, health and safety, innovation and learning.

To determine contractors perceptions towards the relative importance of the key performance indications construction

projects in order to evaluate performance of construction projects:

The questionnaire assists to study the attitude of contractors towards key performance indicators in the construction industry. Pilot study of the questionnaire was achieved by a scouting sample, which consisted of 1 units. The 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 target groups in this research are contractors. 100 questionnaires were distributed as follows (21%) to large company (33%) to medium company (17%) to small company as respondents.

To identify the most significant key performance indicators of construction projects in Sudan.

According to contractors response the quality of equipments and raw materials in the project is the most important performance factor as it has the first rank among all factors with $RII = 0.803$, availability of personals with high experience and qualification, review of failures and solve them as it has the second rank among all factors with $RLL=0.800$, material and equipment cost, sequencing of work according to schedule and leadership skills for project manager it has the third rank of all factor with $RLL=.826$.

Innovation and learning group has been ranked by the contractor respondents in the first position learning from own experience and past history has been with $RLL=0.758$.

Time factor has been the third rank with availability of resource planned throughout project duration $RLL=.777$, this group is also more important it concerned with planned time for project completion.

Most contractors use software program in order to facilitate planning, monitoring and controlling cost. The most used programs in construction organization are, excel, and primavera programs.

Most organization is familiar with these software programs because they are easy to be used and have different facilities and functions to control cost.

Most 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 because it depends on current situation. However, historical data sometimes be used for contractors because an experience can assist for quick evaluation and estimation.

Most contractors stated that the project was sometime delayed by late payment from the owner. Contractors usually suffer from this problem. Delay in payment from owner to contractor lead to a decrease in contractors' performance and cause problem in time performance. This may also lead to claims and disputes

between the owner and the contractor. All of that will affect the overall performance of project.

Generally, it is obtained that most of contractors' project are highly satisfactory to the owners. In addition, some contractors and project are of medium degree of satisfaction to owner. This is because of many reasons such as; poor quality non conformance to specification, problems in cost and time performance, lack of coordination or relationship between projects participants, occurrence of accidents during implementation stage, claims and disputes.

Bar chart method is an important tool for planning and scheduling for contractors because this method can facilitate time performance control for each scheduled activity throughout the project lifecycle. However, critical path method (CPM) also considered being important for consultants because CPM can be used to determine critical activities of project .this will assist consultants to evaluate overall time performance and identify the effectiveness of critical Path on completion date of project.

Contractors often meet weekly for discussion on weekly basis. Weekly meeting assist them for monitor, update and control the progress throughout the project implementation. In addition, they can solve problems, evaluate current performance, and improve future work.

Most of contractors use increase salary system in order to stimulate the construction time. This system motivates employees and assists them to improve productivity and performance. This

system is more important for employees than bonus or training system because these later systems are rarely affected on employee's performance or their productivity. Training is required according to nature and duration of the project. In addition, training is an important for improvement and development of the overall performance of organization.

Primavera and excel sheet are commonly used techniques they are easy program used by contractors for planning and scheduling. These programs enable users to schedule, monitor, update and control many criteria of the project such as time, cost and resources. Most organizations are familiar with this program as tools for planning and scheduling processes. It is observed that primavera program is an advanced and complex program compared with Microsoft project. Construction organizations are not familiar with Microsoft project in practice. However, excel program has a limitation in usage for planning and scheduling

4.2 Recommendation:

- Evaluate project overtime throughout the project lifecycle to improve time and cost performance.
- Time need to implement variation order should be estimated and scheduled without affecting the project time completion.
- Having regular meeting among project participant it enhance performance.
- Should have continuous safety training to achieve better performance.
- Contractor should not over out themselves by having more projects which cannot be perforated successfully.
- Contractors should consider political and business environment risk in their cost estimation.
- Proper motivation and safety systems should be established to improve the productivity.
- Conformance with project specification to overcome disputes.
- The quality of material should be more important to improve cost, time and quality performance.
- Contractors have to care for the sequences of work according to schedule.
- Contractors should have a cost engineer in their project to control cost successfully.
- Must have continuous training program to improve management of labor relationships and leadership skills.

- Must have system to review failures and solution the problems early.
- Continuous coordination and relationship between project parts.
Owner must facilitate payment to contractor.

Reference

1. Abu Shaban, S.S,(2008)
"Factors Affecting the Performance of Construction Projects in the Gaza Strip",
B.sc Civil Engineering,
The Islamic University,
Gaza Strip 2008.
2. Michal Kagioglou, r.c, g.a(2001)
. "Performance Management in Construction: A Conceptual Framework"
Department for the built and human environment,
University of Sal ford 2001.
3. Puspasari.t.r, (2005)
"Factor Causing the Poor Performance of Construction Project"
Faculty of Civil Engineering,
University Technology Malaysia 2005.
4. Roshana Takim,(2005)
School Of Built and Nature Environment,
Glasgow Caledonian University,
"A Framework for Successful Construction Project Performance",
April 2005.

5. Roshana Takim,(2002)
"Performance Indicator for Successful Constriction Project Performance"
School Of Built and Nature Environment,

6. Glasgow Caledonian University,(2002)
April 2002.
The British Government,
www.bis.gov/home.htm
14/3/20015

Appendix