Sudan University of Science and Technology
College of Graduate Studies

Performance measurement of construction projects managed by ISO-certified contractors in Khartoum

قياس الأداء في مشاريع البناء المدارة بواسطة المقاولين الحاصلين على شهادة الأيزو في ولاية الخرطوم

Thesis submitted in civil engineering partial fulfillment of the requirements for the degree master of science (construction)

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الآية

قال تعالي

(قَالُواْ سُبْحَانَكَ لاَ عِلْمَ لَنَا إِلاَّ مَا عَلَّمْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ)

صدق الله العظيم

سورة البقرة الاية (32)

Dedication

To

My beloved country Sudan,

My family,

To that person who gives me strength and encouragement in all my steps my father,

All of my friends,

And to everyone who teach us a letter.

Acknowledgement

I am deeply indebted to my Supervisor, for her valuable suggestions and helpful discussions throughout the preparation of this work and for her careful comments on.

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Abstract

Today, getting a high quality project is a necessary requirement for both the owner and the executing companies, so all companies are seeking ISO certification, but on the other hand, increasing competition showed another aspect other than quality, which is getting a high performance project which is almost a very difficult task. For the multiplicity of participants in the field of construction must therefore use performance indicators to ensure that the objectives of any project has been implemented as planned because the process of measuring performance is a tool used in the management of projects to evaluate the project and ensure that the objectives set have been achieved as required and planned. To determine the measurement indicators used to evaluate performance in local construction organizations in Sudan and to know the difference between projects implemented by ISO and non-ISO certified companies, 120 questionnaires were distributed to contractors, consultants, owners and other participants in the construction field 60 questionnaires were distributed to ISO certified companies and 60 questionnaires were distributed to non-ISO certified companies. About 74 of the questionnaires were returned, 61.6% of the total, half of whom were employed in non-ISO certified companies. Accredited by ISO and the other half are not accredited by ISO. The data were analyzed by statistical analysis using SPSS 2018.The results reveal that the majority of respondents confirmed that performance measurement indicators are sometimes used or rarely used in construction in Sudan and informally required to do so, but they are aware of the importance of use and one of the most commonly used indicators on both sides is the defects index. The satisfaction of the project team, and the safety index, they also confirmed that the companies that are ISO certified carry out high quality projects from their non-ISO counterparts This result gives a better look for the future study, especially on the impact of the use of performance measurement indicators in companies over the implementation of projects in the field of high-performance construction.

المستخلص

اليوم اصبح الحصول على مشروع بجودة عالية هو مطلب ضروري سواء للمالك اوالشركات المنفذة لذلك تسعى كل الشركات للحصول على شهادة الايزو, ولكن نجد في الجانب الاخر زيادة المنافسة اظهرت جانب آخر غير الجودة، وهو الحصول على مشروع بأداء عالي الذي يكاد ان يكون مهمة صعبة جداً نسبةً لتعدد المشاركين في مجال البناء لذلك يجب استخدام مؤشرات قياس للاداء للتأكد من ان اهداف اي مشروع قد نفذت بالصورة المخطط لها لان عملية قياس الاداء هي الاداة المستخدمة في إدارة المشاريع لتقييم المشروع و التأكد من ان الاهداف الموضوعة قد تحققت بالصورة المطلوبة والمخطط لها .يهدف هذا البحث الى تحديد مؤشرات القياس المستخدمة لتقييم الاداء في منظمات التشيد المحلية في السودان ومعرفة الاختلاف بين المشاريع المنفذة بواسطة الشركات المعتمدة من الايزو والغير معتمدة من الايزو ، تم توزيع 120 استمارة استبيان على المقاولين والاستشاريين والمالكين وغيرهم من المشاركين في مجال التشيد 60 استمارة تم توزيعها على العاملين منهم في الشركات المتعمدة من الايزو وال60 استمارة المتبقية على العاملين في الشركات غير المعتمدة من الايزو للحصول على رد فعلهم ورؤيتهم نحو الغرض من هذه الدراسة ، تم ارجاع حوالي 74 من الاستمارات بنسبة 61.6% من الاجمالي نصفها من المعتمدين من الايزو والنصف الاخر من غير المعتمدين من الايزو . تم تحليل البيانات عن طريق التحليل الإحصائي باستخدام برنامج SPSS 2018، وتكشف النتائج أن غالبية المستجيبين أكدوا أن مؤشرات قياس الاداء تستخدم أحيانا أو نادرا في البناء في السودان وبصورة غير رسمية تلزم بذلك لكنهم يدركون مدى اهمية استخدامها ومن اكثر المؤشرات استخداما لدى الطرفين هي مؤشر العيوب, ورضا فريق المشروع، ومؤشر السلامة، كما اكدوا ان الشركات الحاصلة على شهادة الايزو تنفذ مشاريع بجودة عالية من نظيرتها غير الحاصلة على الايزو هذه النتيجة تعطي نظرة أفضل للدراسة المستقبلية وخاصة على أثر استخدام مؤشرات قياس الاداء في الشركات الحاصلة على شهادة الايزو على مدى تنفيذ مشاريع باداء عالى في مجال البناء.

Table of Contents

List of Tables

List of Figure

CHAPTER ONE

INTRODUCTION

Chapter One

Introduction

1.1 General

The construction industry has numerous problems to deliver quality construction projects because it comprises of a multitude of professions, occupations and organizations. The quality of service delivered by consultants has often been a subject of thorough investigations. Some clients have underestimated the impacts of substandard consultancy service to the success of a construction project (Barber et al, 2000). Many delays, cost overruns, reworks, variations, claims and disputes can be traced back to erroneous design, poor contract administration or lax supervision of the client's representative (Chini and Valdez, 2003). Furthermore, the production processes of construction projects are generally non-standardized; hence, it is difficult to ensure quality. Therefore, some local building authorities seek to alleviate the quality problem by making certification to ISO 9000 mandatory for all contractors who are tendering for public sector projects. Errors induced by a system can be prevented or at least minimized through the implementation of a quality management system (QMS) (Latham,1994). Among various QMSs, ISO 9000 certification has been widely adopted by the construction industry in many countries. For instance, in Hong Kong all consultants must have a certified ISO 9000-based QMS before they can bid for public construction projects (Works Bureau, 2001). With the release of ISO 9000:2000, an unprecedented emphasis is placed on customer satisfaction and continual improvement (Murphy,2002). 'Satisfaction' can be measured by comparing the difference between what is expected and actually received (Hill et al, 2002), and clients would satisfy with the performance of a consultant when the quality of service provided exceeds or at least meets their

expectations. Continual improvement can only be realized if consultants are aware of their weaknesses or deficiencies and make corresponding adjustments to satisfy the expectations of their clients (Love et al, 1998). ISO 9000-based QMSs have been reported to be able to improve the service quality of the fi rm. This will subsequently increase the clients' satisfaction, market share, revenue as well as workers' morale. However, to what extent International Organization for Standardization (ISO)-certified contractors could satisfy clients 'needs in construction projects are still inconclusive. There are still a lot of complaints reported relating to the quality of delivery. Therefore, this article will present the performance of construction projects carried out by ISO-certified contractors.

1.2 Statement of the Problem:

The last few decades Sudan construction industry is facing several problems and, a number of trials have been made to study and evaluate construction activities but few of these researches focused on performance measurement.

lack of use of performance measurement indices to asses projects progress in the construction industry in Sudan, is an issue of concern the huge demands from customers to improve the quality of work is an evidence, and enterprises to develop driver them self-according to their customers' requirements.

Think of most people on the assumption that if the internationally recognized quality management system (ISO) standards are implemented and all effective performance measures are used, construction organizations could achieve high performance. Sudan construction industry is not exceptional, thus projects executed by ISO certified consultation organizations should be implementing using comprehensive measures rather than focusing on financial and tire related measures only.

1.3 Research importance:

Based on the study problem, there is a need to develop a management model to help measuring the performance of the project and assessing the strengths and weaknesses of the Sudanese construction regarding their conformity with the planned projects objectives. It is noted that there are a number of mismanagement problems in the construction industry leading to delayed projects, budget problems poor workmanship, materials loss and non –conformance to specs, failure to achieve profitability, bad safety, project team dissatisfaction, customer dissatisfaction.

This in turn leads to conflicts au rang the project participates something that might disrupt to project progress an give change to claims and tether disputes which may stop the project in same cases, for this reason, this research tried to shed the light on the possible benefits acquired if a performance measurement based QMS is considered in construction organization in Sudan.

For this reason construction Projects managed by ISO–certified concoction organizations were tested to verify this stated assumption.

Quality management is a subset of management that includes the process required to meet needs and complete them at a specific time and budget. Quality is very important to achieve customer satisfaction and further improvement, so understanding quality standards and influencing factors will make it possible to deal with much better quality problems. Finally, the results obtained from this study will assist future efforts to develop and build a management model to measure the performance of projects according to ISO standards, leading to a tangible development of the construction sector in Sudan.

1.4 Objectives of the Study:

1) To determine the performance measures used by local construction organizations to assess their projects or company performance.
2) To get acquainted with the adopted mathematical models used for performance assessment.
3) To gauge the differences in the performance of projects executed by ISO-certified companies and those which are non –ISO-certified.

1.5 Research hypotheses:

1) Construction organizations in Sudan are using non –comprehensive measures for the assessment of their projects performance.
2) Construction projects executed by ISO-certified companies have better performance than those executed by non –ISO certified companies.

1.6 Research questions:

1. What is the extent of awareness of the projects participations with the importance of measuring the performance of projects?
2. Does projects performance measurement have benefits regarding the achievement of the basic project objectives?
3. Are engineers and planners knowledge about with performance indicators other than cost, time and quality?
4. Do local companies take into account the need for putting and developing a general model for measuring and evaluating project performance?
5. Can the project manager assess the performance of the project without putting a specific measurement model?

1.7 Research layout:

This research consists of five chapters. Chapter one: gives a general introduction to the study and statement of the problem, the objectives of the research and the layout.

Chapter two: gives the review of the Literature an introduction to the concept of measuring and evaluating performance, project performance hierarchy, quantification and normalization of the project Performance Indices, Project performance indicators, Quantification of the Priority Weights. Chapter three Data Collection, chapter four Results Analysis and Discussion the last chapter is five, which summarizes the work that has been done and gives some conclusions and the recommendations, then the references and appendix.

CHAPTER TWO
LITERATURE REVIEW

Chapter Two

2. Literature Review

2.1 Quality and quality management systems:

BS 5750(1987) defines quality as ‘ The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs’ Quality is understood differently by different people and different organizations.

For instance, Lesley and Malcolm(1992) opined that quality is probably the best way of assuring customer loyalty, the best deference against foreign competition and the only way to secure continuous growth and profits in difficult market conditions. In order to manage quality, the starting point for the organization is to understand the meanings of the term ‘quality’. In the views of Jab noun (2000), quality is defined as conformance to requirements. All of the definitions given above define quality from the perspective of the customers. In essence, quality can be understood as ‘meeting the customer’s expectation’. These definitions imply that the needs of the customer must be identified first because satisfaction of those needs is the ‘bottom line’ of achieving quality. For construction organizations, quality is defined as meeting the requirements of the owner need as to functional adequacy; completion construction project on time and within budget, life-cycle costs and operation and maintenance (Arditi and Gunaydin, 1997). Construction companies need to consider quality in the tendering process, contract review, project planning, financing control, sub-contractor and supplier selection, leadership and utilization, resource allocation and other management aspects (Abdul-Rahman, 1994).

As quality became a major focus of business throughout the world, various organizations started to practice standards and guidelines. This sees the introduction of the ISO 9000 series in 1987, which has since become a worldwide quality management norm for organizations, regardless of their

sizes and products. The ISO 9000, originated from the military procurement standards in the Second World War, is a series of guidelines for companies that establish their quality systems by focusing on procedures, control and documentation. ISO 9000 standards are supposed to help companies identify mistakes, streamline their operations and be able to guarantee a consistent level of quality (Kartha, 2002). The standard also drew the attention of quality professionals worldwide. Owing to its original intent to create a two-party, non-binding standard, it penetrated barriers of culture and language, which no other quality standard could achieve. Therefore, it became a non-political baseline for quality, accepted internationally as quality management framework and an excellent marketing tool for entering the global market. It gradually spread from Europe to North America, Japan and the rest of the world (Taormina, 2002). Many studies reveal that effective implementation of ISO 9000 can benefit organizations through the improvement of management control (Lee, 1998), efficiency (Ebrahimpour et al, 1997), productivity (Terziovski et al, 2003; Terziovski and Power, 2007) and customer services (Yeunget al, 2003). With the revision of ISO 9000 by its publisher (the ISO) approximately every 7 years, the newest revision is called ISO 9000:2008 which was published on 14 November 2008. ISO 9001:2008 has been developed in order to introduce clarifications to the existing requirements of ISO 9001:2000 and to improve compatibility with ISO 14001:2004. Nevertheless, the research will focus on the ISO 9000 series of year 2000 since the latest 9000 series had just been published and most ISO-certified contractors have still yet to change their certification to the new ISO 9000:2008. The ISO 9000 series for the revision of year 2000 consist of the following:

ISO 9000:2000 Quality Management Systems – Fundamentals and Vocabulary;

ISO 9001:2000 Quality Management Systems – Requirements; and ISO 9004:2000 Quality Management Systems – Guidance for Performance

Improvement. The ISO 9000 series concentrate on the five key areas of quality-management systems, that is, management responsibility, resource management, product or service realization, measurement, analysis and improvement(Zuckerman, 2001 ; Cianfrani et al 2002).

Unlike the 1987 and 1994 versions, the 2000 version of ISO 9000 standards has incorporated many changes. Certified companies can have higher flexibility in integrating the environmental, health and safety standards with the new quality system (Coleman and Douglas, 2003). The combination of the former three elements (9001 / 2 / 3) into one (9001) has simplified the system, resulting in decreasing any artificial complexity in implementing ISO 9000(Biazzo and Bernardi, 2003). Studies have also found an overall positive perception of the value of the ISO 9000 – 2000 quality system standard and a consistently higher appreciation of the 2000 version compared with the 1994 version. The results indicate that as far as this sample is concerned, the revision of ISO 9000 has proved that the 2000 version is an improvement from the 1994 version.

2.2 Performance measurement:

Performance measurement is defined as the process of evaluating performance relative to a defined goal. It provides a sense of where we are and, more importantly, where we are going (Rose, 1995). Rose further stated that measurement can guide steady advancement toward established goals and identify shortfalls or stagnation. Willis and Willis (1996) maintained the importance of measuring performance because it will indicate status and direction of a project. It is widely accepted view that, at a minimum, performance measures of a project are based on time cost and quality (Barkley and Saylor, 1994). Atkinson (1999) noted that these three components of project performance as the ‘iron triangle’. However, Kumaraswamy and Thorpe (1999) considered variety criteria in measuring a project. This includes meeting budget, schedule, and the quality of workmanship, stakeholder’s satisfaction, transfer of technology, and health

and safety. Similarly, Chan and Tam(2000) noted that various other key components also used in measuring project performance such as health and safety, environmental performance, user expectation satisfaction, actor' s satisfaction and commercial value.

The Construction Industry Institute (CII) project organization Task Force considers the objective-setting process as a critical element to the success of projects (Rowings, Nelson, & Perry, 1987). The same study indicated that on projects experiencing difficulties, the objectives lacked definition, clarity, and consistency. Identification, evaluation, and selection of the project objectives are the first and most important step in planning (Pinnell, 1980).

Objectives are essential to the concept of project management (Pinnell, 1980). Objectives or goals provide the project management team a sense of direction by focusing attention on priorities.

2.2.1 A structured goal hierarchy for a project:

- ❖ Provides an analytical platform for decisions and corrective action plans.
- ❖ Provides a clear and direct method of communicating objectives.
- ❖ Serves as a basis for project performance evaluation.
- ❖ Provides a rationale for the quantification of the overall project performance.
- ❖ Without objectives it is difficult to measure results and performance against prior expectations and the project leader may not have any idea of whether the project is on the right track or not.

Because project objectives must be consistent with the policies and procedures of the organization, the objective setting process for construction projects is an extensive exercise that involves many functional departments within the contractor's organization. Some of the areas that are usually part of the objective setting process are: operations, quality, safety, cost/schedule control, human resources, and finance. Once the project objectives are set, sub-objectives are defined in order to track the variance in each main

objective. This will enable management to monitor progress for any specific project objective during the project's construction.

In addition, executive management needs to support the project objectives and needs to motivate those who will achieve them. This is best accomplished by developing the project objectives at upper management level with input from the various functional areas of the company. This will ensure that the project objectives are in line with the overall company goals. During the execution phase, the project management team should review the performance indicators periodically, analyze any overruns, propose, and implement corrective actions. It is the ultimate responsibility of the project manager to make sure the project objectives are communicated and accomplished.

2.3 Construction projects Performance measurement:

Setting up a hierarchy of objectives and priorities for a construction project is necessary but not sufficient. The project objectives need to be communicated to all participants through a set of mechanisms. Rowing's et al. (1987) identified two categories of mechanisms: primary and reinforcing. Primary mechanisms are used to directly communicate **objectives to project participants and can include items such as:**

- ❖ Scope of work
- ❖ Contract clauses
- ❖ Policies and procedures
- ❖ Written objectives and priorities.

Primary mechanisms are vital to project success, but alone, would not guarantee the success of a project. Reinforcing mechanisms will maintain focus and will support the communication of objectives and priorities in an indirect manner. These mechanisms give project leaders the opportunity to clarify the objectives.

2.3.1 The following is some of the reinforcing mechanisms identified by Rowing's et al. (1987):

- ❖ Weekly progress meetings.
- ❖ Progress reports.
- ❖ Safety reports.
- ❖ Project instructions.
- ❖ Cost and schedule reports.
- ❖ Toolbox safety talks.
- ❖ Upper management reviews.

The objectives of the project must be made known to all project personnel and team leaders at every level of the organization (Kerzner, 1989). If the project goals are not timely and accurately communicated, then it is entirely possible that functional managers and project leaders may all have a different understanding of the ultimate project objective, a situation that generates conflict among competing objectives.

2.3.2 Identification of Construction Performance Objectives:

Most construction organizations look only at the time and cost parameters. If a schedule slippage or cost overrun occurs, then project managers will identify the cause of the variance. Looking only at time and cost performance might identify immediate contributions to profit, but will not tell whether or not the project itself was managed properly. Construction project success is often measured by the evaluation of three parties: the project team, the construction organization, and the client's organization. The assumption here is that a construction project cannot be considered successful unless it is recognized so by the three groups. Hierarchy of construction performance objectives that takes into account all success factors as viewed by the major players. The proposed goal hierarchy is systematic, and flexible enough to handle specific project requirements. realize although project procedures can vary from project to project, project policies are usually similar in nature and do not differ between projects.

2.3.3Quantification and normalization of the Project Performance Indices:

Before Construction Company sets up the performance indices hierarchy, it is necessary to develop an understanding of the multi-dimensional nature of performance. Indicators of construction success must be identified, understood and agreed upon by the project management team. Each performance index needs to be: (1) quantified, (2) normalized or measured to a standard scale, and (3) prioritized.

2.4 Measurement of Project Success: A Challenge

Measurement of project success is a real challenge and quite a complex task. Performance measurement is also a must for all organizations executing any type of projects because if success cannot be measured, it cannot be improved upon. Some researchers have indicated that the task of measuring project success in solely objective terms is impossible (de Wit, 1986; Morris, 1986). The complexity of measurement of **performance is due to the following facts:**

- ❖ Project objectives are dynamic in nature and change over time.
- ❖ Many project participants representing various interests are involved in defining and prioritizing the project objectives.
- ❖ Some of the desirable objectives are subjective in nature.

2.5 Benefits of using performance measurement indicators:

2.5.1. Focus on key themes and extend the organization with a clear idea of costs, quality and overall performance in a limited time period

2.5.2. Enabling the organization to pursue organizational activities and processes to achieve enterprise project objectives.

2.5.3. Enable the organization to focus on the objectives to be achieved. Action when necessary.

2.5.4. Assist in achieving justice in compensating and rewarding the project team for their efforts, based on performance measurement results.

2.5.5. Provide valuable information on the performance of the current project team and achievements.

2.5.6. Enable the organization or company to identify the training needs of the project team based on performance measurement results.

2.5.7. Develop programs, policies and procedures used in the management and implementation of the project

2.5.8. Providing support to the organization or the company in developing and implementing appropriate management strategies and dealing with weak performance.

2.5.9. Confidentiality and privacy preservation because it gives measured results expressed in proportions.

2.6 Obstacles to the use of performance measurement systems:

2.6.1. Individual Constraints these constraints are a set of factors related to the individual:

- ❖ The abilities and the skills.
- ❖ The psychological composition of him.
- ❖ Social structure

2.6.2. Institutional constraints, including:

- ❖ Duties and tasks entrusted to individuals.
- ❖ Social organization.
- ❖ Resources and financial resources.

2.6.3. The ambiguity of the objectives of the performance measurement system, where the lack of clarity in this is a direct cause of the disruption of the process of measurement of performance in the right manner, and thus reach the results are completely inconsistent with the objectives of the establishment.

2.6.4. The lack of measurement of objectivity and accuracy by some of those involved in the measurement process, and the impact on a number of factors such as personal relationships and sometimes indulgence or for governs.

2.7 Project performance indicators:

Traditionally, cost, schedule, quality and safety are considered the most important goals for successful construction projects. As science and research progressed, eight performance indicators were identified and a methodology was introduced to measure the overall performance index.

2.7.1 Cost Performance Index (CPI):

The Cost Performance Index (CPI) is a measure of the cost efficiency of the project. The CPI is determined by dividing the earned value by the actual costs incurred. Any value of CPI < 1 indicates that costs are overrun. For example, a CPI of 0.85 indicates that for every dollar spent; only 85 cents of value is earned and consequently 15 cents are lost. The CPI is given by (Nassar, N. k, 2009):

$$\mathbf{CPI} = \frac{\mathbf{BCW}}{\mathbf{ACWP}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (2.1)$$

Where,

BCWP = Budgeted Cost of Work Performed. It is the budgeted amount of cost for work-completed to-date or the cost allowed (based on budget) to be spent for the actual work done.

ACWP = Actual Cost of Work Performed. It is the cost incurred to complete the accomplished work to-date.

The values for the BCWP and ACWP used to calculate the CPI in the above equation are cumulative and include all project work up to the current data date.

The cost variance **VC**, is the difference between what was earned (BCWP) and what was incurred **(ACWP**). For example, 50% of the project budget may have been expended to accomplish only 25% of the budgeted work. In this case, the project is over budget. VC is represented as:

$$\mathbf{VC = BCWP - ACWP} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..2.2)$$

A positive **VC(CPI >1.0**) is desired because it means that the actual cost of work performed is less than the budgeted cost of the same work and

therefore the project is under budget. Critical variances are reported to management for further analysis and corrective action.

Because construction projects are unique in nature, performance-rating tables are unique to every project and must reflect the specific conditions and the cost control philosophy of the project. The cost rating table as shown in Table 2:1 is proposed for illustration purposes only.

Table 2: 1 Cost Performance Rating by (Nassar, N. k, 2009).

Condition	Rating	Index Range
A	Outstanding performance	I>1.15
B	Exceeds Target	1.05<I≤1.15
C	Within Target	0.95<I≤1.05
D	Below Target	.085<I≤ 0.95
E	Poor performance	I≤.085

2.7.2 Schedule Performance Index (SPI):

The Schedule Performance Index (**SPI)** is a measure of the schedule efficiency of the project; the SPI is determined by dividing the earned value by the scheduled value. Any value of **SPI < 1** indicates that we are running behind schedule. The SPI is given by Equation 3by (Nassar, N. k, 2009):

$$\mathbf{SPI} = \frac{\mathbf{BCWP}}{\mathbf{BCWS}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. (2.3)$$

Where,

BCWP = Budgeted Cost of Work Performed. It is the budgeted amount of cost for work completed to date.

BCWS = Budgeted Cost of Work Scheduled. It is the budgeted amount of cost for work scheduled to date.

The schedule variance **VS**, is the difference between what was done (BCWP) and what was planned (BCWS) and is represented by Equation 4:

$$\mathbf{Vs = BCWP - BCWS} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (2.4)$$

A positive **VS (SPI >1.0)** is desired because it means that the actual amount of work performed is greater than the amount of work scheduled and the project is therefore ahead of schedule. The Schedule Rating Table is shown in Table 2:3 to demonstrate the proposed methodology and it is up to each company to specify its own index ranges.

Table 2: 2 – Schedule Performance Rating by (Nassar, N. k, 2009).

Condition	Rating	Index Range
A	Outstanding performance	I>1.15
B	Exceeds Target	1.05<I≤1.15
C	Within Target	0.95<I≤1.05
D	Below Target	.085<I≤ 0.95
E	Poor performance	I≤.085

2.7.3. Profitability Performance Index (PPI):

The Profitability Performance Index (**PPI**) is a measure of how profitable the project is to date. The PPI is determined by dividing the Earned Revenue of the Work Performed (ERWP) by the Actual Cost of the Work Performed (**ACWP**). The actual cost should be inclusive of all direct, in-direct and overhead costs incurred to date. At the end of the project, the PPI is indicative of the overall project profit and the ERWP will be equal to the total Contract Amount. The PPI is given by the following equation by (Nassar, N. k, 2009):

$$\mathbf{PPI} = \frac{\mathbf{ERWP}}{\mathbf{ACWP}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (\mathbf{2.5})$$

Where,

ERWP = Earned Revenue of Work Performed, or the revenue earned for the actual work accomplished.

ACWP = Actual Cost of Work Performed. It is the cost incurred to complete the accomplished work.

PPI value greater than 1.0 is desired because it means that the revenue earned for the amount of work achieved to date is greater than the cost incurred for that same work and the project is therefore profitable.

The **PPI** rating table is shown in Table 2:3.

Table 2:3 Profitability Performance Rating and Normalization (Nassar, N. k, 2009).

Condion	Rating	Index Range	PPI Range
A	Outstanding performance	I>1.15	PPI>1.3
B	Exceeds Target	1.05<I ≤1.15	1.2<PPI≤1.3
C	Within Target	0.95<I ≤1.05	1.05<PPI≤1.2
D	Below Target	.085<I ≤ 0.95	0.90<PPI≤1.05
E	Poor performance	I≤.085	I ≤0.90

2.7.4 Safety Performance Index (SFI):

The Safety Performance Index (**SFI**), as proposed in this model, is a measure of how safe the site activities are carried out without lost time incidents. Maintaining an excellent safety record is vital to the project success and is considered to be one of the most important project

performance indices. In almost all projects, the contractor and owner's business objectives place a strong emphasis on construction safety. In order to maintain a good reputation within the construction industry and to properly care for the safety and wellbeing of the project staff and labor force, it is obvious that safety be a top business objective in any company.

In this research, the calculation used to determine the safety performance of projects is based on an industry-wide formula. Accordingly, the non-normalized SFI is the Lost Time Incident (LTI) Frequency Rate given by (Nassar, N. k, 2009) :

$$\mathbf{SFI} = \frac{\mathbf{LTI} * \mathbf{C}}{\mathbf{M}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(2,6)$$

Where,

LTI = Number of Lost Time Incidents to date
M = Total man-hours expended to date; and
C = is a constant (200,000) which represents 100 employees working for a full year (100 x 2,000).

SFI is calculated for the project as a cumulative value to reflect to date safety status. Although every company should work toward the ultimate goal of "Zero Harm" and the elimination at source of any risks, a project safety rating scale is proposed in table 2:4for illustration only.

Table 2:4 Safety Performance Rating and Normalization Table (Nassar, N. k, 2009).

condition	Rating	Index Range	SFI Range
A	outstanding performance	I>1.15	SFI=0
B	Exceeds Target	1.05<I≤1.5	0<SFI≤0.1
C	Within Target	0.95<I≤1.5	0.1<SFI≤.3
D	Below Target	085<I≤0.95	0.3<SFI≤1.
E	Poor performance	I≤.085	SFI>1

2.7.5 Quality Performance Index (QPI):

The demand for high quality projects is on the rise throughout the construction market. Quality is a major project performance attribute that requires measurement and continuous improvement. Strong quality performance can have the following benefits:

Enhances an organization's ability to market its services. Increases the client satisfaction and consequently the chances for repeat Business.

Reduces the amount of rework, and improves the effectiveness and efficiency of construction operations.

The Quality Performance Index (**QPI)** is a measure of consistency in the application of the Project Standards and Procedures as well as the compliance of the delivered product with the project specifications. Non-consistency in the application of project processes will lead to rework, poor quality audits and high number of Non Conformance Reports **(NCRs**). From the contractor's perspective, the QPI is best measured by the Construction Field Rework Index (**CFRI**), as defined in the pilot study for "Measuring and Classifying Construction Field Rework." The study was carried out by the University of Alberta and presented to the "Construction Owners Association of Alberta (**COAA**) Field Rework Committee" (Fayek, Dissanayake, &Campero, 2003). The study defined field rework as:

"Activities in the field that have to be done more than once in the field, or activities which remove work previously installed as part of the project regardless of source, where no change order has been issued and no change of scope has been identified by the owner."

The non-normalized QPI is given by Equation (8) (Nassar, N. k, 2009) :

QPI = CFRI = Construction Field Rework Index, where:

$$\mathbf{CFRI} = \frac{\textbf{Total Direct and Indirect Cost of Rework performed in the Field}}{\textbf{Total Field Construction phase Cost}} \quad (2.7)$$

QPI reflects the cumulative quality status. The project quality ratings table is proposed under table 2:5.

Table 2:5 qualities Performance Rating and Normalization (Nassar, N. k, 2009).

Condition	Rating	Index Range	QPI Range (%)
A	Outstanding performance	I>1.15	CFRI≤.5
B	Exceeds Target	1.05<I≤1.15	.5 <CFRI ≤1
C	Within Target	0.95<I≤1.05	1 < CFRI ≤2
D	Below Target	.085<I≤ 0.95	2 < CFRI ≤4
E	Poor performance	I≤.085	CFRI > 4

2.7.6 Team Satisfaction Index (TSI):

Human factors have a major impact on project quality and the successful completion of projects. The Project Team Satisfaction Index (**TSI**) is a measure of how satisfied the project team is. Building and sustaining high performing teams in today's competitive construction environment is a challenging task. Team members should support each other and communicate openly and clearly. Research conducted by the Construction Industry Institute Planning Research Team (CII, 1995) has established a clear link between teamwork and positive project performance. Many studies indicate that project team motivation is one of the top factors contributing to project success. Mohsini and Davidson (1992) maintained that inter-organizational conflicts in a construction project would negatively impact its performance. Developing a team atmosphere on a project is necessary for the project to be successful because the team members will work together towards the objectives (Rowings et al., 1987). Parker and Skitmore (2005) found that project management turnover occurs predominantly during the execution phase of the project and is mainly due to career and personal development and dissatisfaction with the organizational culture. The same study confirmed that turnover negatively impacts the performance of the project team, and consequently the project. Based on

above, it is of paramount importance to regularly monitor and evaluate the performance of the project team and deal with team functioning problems as it is directly related to project performance.

The TSI is determined by calculating the earned rating for every area of concern to the team member based on his or her evaluation and the priority assigned to every area of concern. The priority weights can be either assumed by the project management team through consensus or measured, using some quantitative techniques, like the AHP methodology. The non-normalized TSI is given by source (Nassar, N. k, 2009):

$$\mathbf{TSI} \sum_{\mathbf{i=1}}^{\mathbf{12}} \mathbf{wi} * \mathbf{Ri}$$

$$= \mathbf{w1} * \mathbf{R1} + \mathbf{W2} * \mathbf{R2} + \mathbf{W3} * \mathbf{R3} + \cdots . + \mathbf{W11} * \mathbf{R11}$$

$$+ \mathbf{W12} * \mathbf{R12} \ldots . (\mathbf{2.8})$$

Where,

W's = Relative weights for the various areas of concern. $\sum_{\mathbf{i=1}}^{\mathbf{12}} \mathbf{w}, = \mathbf{1}$.

R's = Ratings for the areas of concern on a scale from 1 to 10, 10 being the highest.

Based on discussions carried out by the author with team members in various construction projects, 12 areas of concern were identified and are listed in table 2:6

Table 2:6 Project Team Members Satisfaction Rating by (Nassar, N. k, 2009).

No	Team Member Area of concern	Priority wt.	Satisfaction from(1-10)	Earned Rating
1	Involvement in the project	W1	R1	W1*R1
2	Client /suppliers response TM need	W2	R2	W2*R2
3	Project manager response to TM needs	W3	R3	W3*R3
4	Adequacy of equipment to get the work done	W4	R4	W4*R4
5	Training received to carry out the job	W5	R5	W5*R5
6	Financial compensation	W6	R6	W6*R6
7	Clarity of project related responsibilities	W7	R7	W7*R7
8	Quality of supervision	W8	R8	W8*R8
9	Interests in nature of work	W9	R9	W9*R9
10	Coordination with the various discipline	W10	R10	W10*R10
11	Execution of work as per company procedure	W11	R11	W11*R11
12	Access to project baseline &progress report	W12	R12	W12*R12

To normalize the calculated index, a project team satisfaction-rating scale is proposed in table2:7

Table 2:7Team Satisfaction Performance Rating and Normalization by (Nassar, N. k, 2009).

Condition	Rating	Index Range	TSI Range
A	Outstanding performance	I>1.15	TSI>9.5
B	Exceeds Target	1.05<I≤1.15	9.0<TSI≤9.5
C	Within Target	0.95<I≤1.05	8.0<TSI≤9.0
D	Below Target	.085<I≤ 0.95	6.0<TSI≤8.0
E	Poor performance	I≤.085	TSI≤6.0

2.7.7Client Satisfaction Index (CSI):

Meeting the expectations of the project owner (client) is the only way to ensure that a contracting company will continue to have repeat business. A formal survey or asking very basic questions could help us know better our clients. Because what gets measured gets done, it is important to measure the clients' expectations against an established baseline. Sims and Anderson (2003) suggested eight steps, including quantification of expectations, which a contracting organization can use to maintain an on-going and working relationship with its clients.

In this pace, the Client Satisfaction Index (CSI) evaluates the satisfaction of the Client's needs in a global sense. The CSI is determined by calculating the earned rating for every Client's area of concern based on the evaluation and the priority assigned by the Client to each area of concern. The areas of concern and their significance should be evaluated taking into consideration the client's specific objectives. The priority weights can be measured using the AHP process or using the subject chive assessment of the project management team. This performance measurement will help the Project Leader to get client feedback in a structured manner and address any area of concern the customer might have. TSI and CSI are interdependent in the sense that ignoring the needs of the project team members makes it very

difficult to create a desire within the team to care for the needs of the external customer. The non-normalized CSI is given by source (Nassar, N. k, 2009):

$$CSI = \sum_{i=1}^{12} wi * Ri = w1 * R1 + w2 * R2 + w3 * R3 + \cdots \ldots + w12 * R12 \ldots \ldots \ldots \ldots . . (2.9)$$

Where, $\sum_{i=1}^{12} Wi = 1$

W's = Relative weights for the twelve areas of concern.

R's = Ratings for the areas of concern on a scale from 1 to 10, 10 being the highest.

Based on discussions carried out by the past study with many client organizations and construction project owners, 12 areas of concern were identified and are listed in Table 2:8

Table 2:8 Client Satisfaction Rating (Nassar, N. k, 2009).

No	Client Area of Concern	Priority wt.	Satisfaction from(1-10)	Earned Rating
1	Understanding of the project requirement	W1	R1	W1*R1
2	Understanding of Client system and procedures	W2	R2	W2*R2
3	Response to the Client request and /or needs	W3	R3	W3*R3
4	Flexibility and adjustment to change	W4	R4	W4*R4
5	Overall capability of contractor project team	W5	R5	W5*R5
6	Effective communication	W6	R6	W6*R6
7	Innovation in problem solving	W7	R7	W7*R7

8	Performance with respect to cost	W8	R8	W8*R8
9	Performance with respect to schedule	W9	R9	W9*R9
10	Performance with respect to service quality	W10	R10	W10*R10
11	Performance with respect to product quality	W11	R11	W11*R11
12	Performance with respect to safety procedures	W12	R12	W12*R12

Once a formal Client Satisfaction Survey is completed, the Contractor should use it to propose mitigation actions if required. This feedback will help the construction company to continuously improve its work processes and services to its customers thus enabling the company to gain competitive edge over other contractors. Most often, informal “face-to-face” surveys of client satisfaction conducted by the Contractor's representative would not disclose the real situation and the client's answers tend to be diplomatic.

To normalize the obtained index, a client satisfaction rating scale is proposed in table2:10. The proposed scale is for illustration only and needs to be modified to reflect the project specific conditions.

Table 2:9 Client Satisfaction Rating and Normalization (Nassar, N. k, 2009).

Condition	Rating	Index Range	CSI Range
A	Outstanding performance	I>1.15	R>9.5
B	Exceeds Target	1.05<I≤1.15	9.0<R≤. 9.5
C	Within Target	0.95<I≤1.05	8.0<R≤9
D	Below Target	.085<I≤ 0.95	6.0<R≤8
E	Poor performance	I≤≤. 085	R≤6

2.8 Project Performance Index (PI):

Controlling all of the above performance attributes defines the need for a multi-dimensional Integrated Project Performance Management system. To develop a useful index of project performance from the above results, a common measurement platform was established to normalize all the indices. Moreover, the classification of the performance variables into a common value scale made it possible to combine all eight indices into a performance index (PI) equation. Combining the variables identified with the corresponding weights yields a weighted equation for the total project performance. PI can be expressed in a linear additive form as follow (Nassar, N. k, 2009).

PI=W1*CPI+W2*SPI+W3*BPI+W4*PPI+W5*SFI+W6*QPI+W7*TSI+W8*CSI…… (2.10)

Where $\sum_{i=1}^{s} wi = 1$ **and**

CPI, SPI, BPI, PPI, SFI, QPI, TSI, and CSI are the normalized performance indices and can be calculated as defined earlier. W1 W8 are the respective priority weights or relative importance of each index with respect to the overall project PI.

Measurement of the project performance indices should take place at regular intervals, certainly monthly, but recommended to be weekly especially for short term or fast track projects. This is true for all indices except for the TSI and the CSI where measurement is not practical every week and can be assessed on a quarterly basis or whenever the project management team feels the necessity. These eight indices provide a wealth of data reflecting the true health of projects and assist the project management team to monitor, analyze, and initiate preventive measures if required.

2.9 Integrated Project Performance Evaluation Model (IPPM):

The application of the AHP Methodology, developed by Saaty (1982), is proposed to derive the priority weights (Ws) or relative importance of the indices. These weights will indicate the sensitivity of the outcome, or the overall PI, to the individual performance indices. At least three reasons support the use of AHP: First, the ability of AHP to incorporate the qualitative and quantitative factors involved in project evaluation. Second, the structure of the project performance hierarchy is identical to the hierarchical design of AHP. Third, the ability of AHP to incorporate the experience and the knowledge of project managers to define weights. The reader is referred to Saaty (1982) for a detailed description of the weights quantification process using AHP.

CHAPTER THREE

RESEARCH METHODOLOGY

Chapter three

Research Methodology

3.1 Introduction

Dealing with the previous research outcomes in the about the construction industry and targeting the objectives of this research, the methodology was approval to take research problem is a descriptive approach by survey the industry to measure some aspects from the service in which they occur tool is questionnaire design to investigate in the performance of the construction sector. This research work was carried out in four major sections, namely: questionnaire design for population and sample, pilot study, data collection and instruments and data analysis. Accordingly this chapter will shows how the research problem was investigated, and how information was collected analyzed in distractive ways and methods. Finally this study represent an exploratory study in which the industry was surveyed using a questionnaire as main tool for data collection.

3.2 Questionnaire design:

Taking into consideration the objectives of this work which was demonstrated and stated in chapter one section 1.4 the research work was carried out in two steps. The first stage was concerned with the questionnaire while the second one is using of SPSS technique for analyses approach.

The questionnaire was developing to answer the research questions and tackle the research problem. Great effort and brainstorming has been put for designing of the questionnaire. Special care also was taken into phrasing of it, such as language and easily understood by respondents. In anticipation that many respondents may not be fluent English readers or speakers, an Arabic version of the questionnaire was developed also. Accordingly the same effort was put into the Arabic version to present a clearness and easy understanding.

3.2.1 Questionnaire Layout:

The questionnaire which has been developed and presented in Appendix A is divided into four sections.

The first section included “Instructions and participants information ” to respondents defining the key terms in the study and providing respondents with instructions on completing the questionnaire and contains general information about the respondents such as contact address, company size, type industry characteristics such as size experience, amount of change, etc.

The second section addressed “Performance measurement indicators used in construction companies Khartoum”. A list of the most commonly used measurement indicators was compiled from the literature which was presented by respondent were asked. The respondent also has been asked about the state frequency of their use for these indicators in their companies, and also they were asked to rate the Most frequent causes as accuracy.

The third section addressed the possible “Evaluation of engineers' based on their opinions on the importance of using performance indicators for construction projects". This list was developed from the literature review.

The fourth section addressed the Benefits of using performance indicators and trammels for their use in companies and institutions responses in this section were give on a 5-points scale with very often and ending with never.

3.2.2 Population and Sample:

Based on the idea and definition of statistical science, regarding the main difference between populations and sample, a measureable characteristic parameter of populations has to represent by a sample parameter to some extent, because the study of statistic revolves around the study of data sets.

According to the sampling criteria the three restrictions were imposed on the selection process of respondents (1) Restricted to contractors, consultant, owners and projects managers (2) as applied building projects(Administrative, Commercial, Residential, Hospital),(3) executed the area of Khartoum State. The size of the sample required from each

population was determined on the basis of statistical principles for this type of exploratory research. For such research, sample size was determined as follows:

$$\mathbf{n_0} = \frac{\mathbf{p \times q}}{\mathbf{v^2}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{(3.1)}$$

$$\mathbf{n} = \frac{(\mathbf{n_0})}{\left(\mathbf{1} + \frac{\mathbf{n_0}}{\mathbf{N}}\right)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{(3.2)}$$

Where: $\mathbf{n_0}$: First estimate of sample size, P: The proportion of the characteristic being measured in the target population, q: Complement of „p‟ or 1-p, V: The maximum standard error allowed, N: The population size, n: The sample size. To maximize n, p is set at 0.5. The target populations N are 70 and 60 for contractors and consultants respectively. To account for more error in qualitative answers of this questionnaire, maximum standard error V is set at 10% or 0.1. Substituting in Equations 3.1 and 3.2 above, minimum required sample has to be calculated, for contractors and consultants respectively.

3.3 Pilot Study

In this case, a judgment sample of 10 respondents with good spread of respondents‟ characteristics was chosen for the preliminary testing of the questionnaire. Questionnaires were administered to contractors, consultants, owners meeting in person. Nevertheless, all 10 valid responses were received from respondents constituting 100% response which was considered a statement for validation.

3.4 Questionnaire Reliability and Consistency:

3.4.1 Main Features of SPSS:

SPSS is software for editing and analyzing all sorts of data. These data may come from basically any source such as scientific research. SPSS can open all files formats that are commonly used for a structured data (spread sheet, plan text files, etc...)

In this research the analysis of data was carried out with the help of statistical package for social sciences (SPSS) version 16. Data was carefully analyzed statistically using reliability test, frequencies and factor analysis, Importance index, Pearson's correlation coefficient and descriptive statistics.

3.4.2 Importance Index:

Then Importance index for each factor was calculated according to the

Equations (3), (4) and (5) source (Kothari, C. R., 2004)

Importance Index= ($Wi\ x\ Xi$**)/**N **(3)**

Where:

Wi: the weight is assigned to the option of factor; Xi: the number of Respondents who selected the option of factor; N: the total number of Respondents.

3.4.3Reliability and Consistency:

Reliability refers to the degree to which the results obtained by a measurement and procedure can be replicated. Lack of Reliability my arise from divergence between

Observers or instruments of measurement such as questionnaire or instability of the attribute being measured which will invariability affected the validity of such questionnaire. Reliability in research is influenced by random errors. As random error increases, reliability decreases. Provided a commonly accepted rule of thumb for describing internal consistency using Cronbach's alpha is as follows:

Table (3.1): Cronbach's consistency alpha

Cronbach's Coefficient Alpha	Internal Consistency Remarks
$\alpha \geq 0.9$	Excellent
$0.7 \leq \alpha < 0.9$	Good
$0.6 \leq \alpha < 0.7$	Acceptable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Reliability test has to carry out to determine whether the questionnaire was capable of yielding similar scores or not, if the respondents have used it twice. The test should be conducted by using SPSS version 16 software. The determined Cronbach's alpha coefficient values which was shown in table 3.1, is going to be use, for consistency and reliability test.

3.4.3 Reliability and Consistency

Reliability test was carried out to determine whether the questionnaire was capable of yielding similar scores if the respondents have used it twice. The test was conducted using SPSS version 16. The determined Cronbach's alpha coefficient value for questionnaire was 0.755 for the ISO certified Institutions responds as shown in table 3.2, Cronbach's alpha coefficient value for questionnaire was 0.508 for the non ISO certified Institutions responds as shown in table 3.2, and all ISO certified Institutions responses add non ISO certified Institutions responses determined Cronbach's alpha coefficient value for questionnaire was.58.This value indicates that the questionnaire items form a scale that has reasonable internal consistency reliability. Impliedly, the survey instrument used was good reliable and acceptable and that an agreement exists between construction industry participants.

3.5 Pearson's correlation coefficient:

Pearson's correlation coefficient is the covariance of the two variables divided by the product of their standard deviations. The Pearson correlation coefficient, r, can take a range of values from +1 to-1. A value of 0 indicates that there is no association between the two variables. A value greater than 0 indicates a positive association; that is, as the value of one variable increases, so does the value of the other variable.

The P-value is the probability that you would have found the current result if the correlation coefficient were in fact zero (null hypothesis). If this probability is lower than the conventional 5% ($P<0.05$)

the correlation coefficient is called statistically significant (Yin, R. K., 2009).

$$\mathbf{r_{xy}} = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i-\bar{y})^2}} \quad \text{.....(3.2)}$$

Where:

r_{xy}: The sample Pearson correlation coefficient

N: is sample size

$x_i y_i$: Are the individual sample points indexed with i

$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$(The sample mean); and analogously for $\bar{y}$

Table (3.2): Measure of correlation accuracy by (George D & P Marllery.2003)

R Values	Accuracy
<0.25	Not good
0.25-0.55	Relatively good
0.56-0.75	Good
>0.75	Very good

CHAPTER FOUR
RESULTS ANALYSIS AND DISCUSSION

Chapter Four

Results Analysis and Discussion

4.1 Introduction:

This chapter outlines the obtained result and discusses the possible inferences to be made from these it also tests the hypotheses presented earlier ti check if there is enough evidence to support them .

The questionnaire questions will be analyzed in the same order of the questions appeared in the form.

4.2 Sample Configuration:

Of the total sample 37 copies of the questionnaire were administered for ISO-certified construction organization and 37 copies to non ISO Certified construction organization to facilitate the comparison Outcomes.

4.2.1Participants Work Area:

The configuration of the participants was as presented in table (4.1) and Figure (4.1).

ISO – certified organization			Non -ISO – certified organization		
Category	No	Category	No	Category	No
Owner	4	Owner	4	Owner	4
Contractor	11	Contractor	11	Contractor	11
Consultant	18	Consultant	18	Consultant	18
Project manager	4	Project manager	4	Project manager	4
Total	37	Total	37	Total	37

Table (4.1): Participants work area for organizations

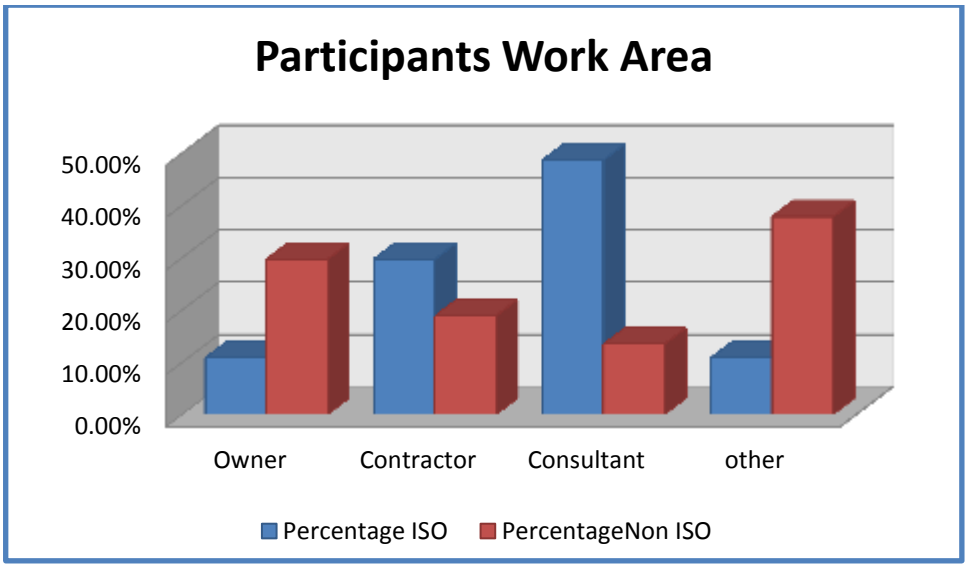

Figure (4.1): Participants work area for organizations

4.2.2 Participants Academic Qualification for organizations:

The academic qualifications of the overall participants were as presented in Table (4.2) and figure (4.2).

Table (4.2): Participants' academic qualification for organizations

ISO – certified organization			Non ISO – certified organization		
Category	No	Percentage %	Category	No	Percentage %
Diploma	3	8.1%	Diploma	5	13.5%
Bachelor	25	67.6%	Bachelor	16	43.2%
Master	7	18.9%	Master	15	37.8%
PhD	2	5.4%	PhD	1	2.7%
Total	37	100%	Total	37	100%

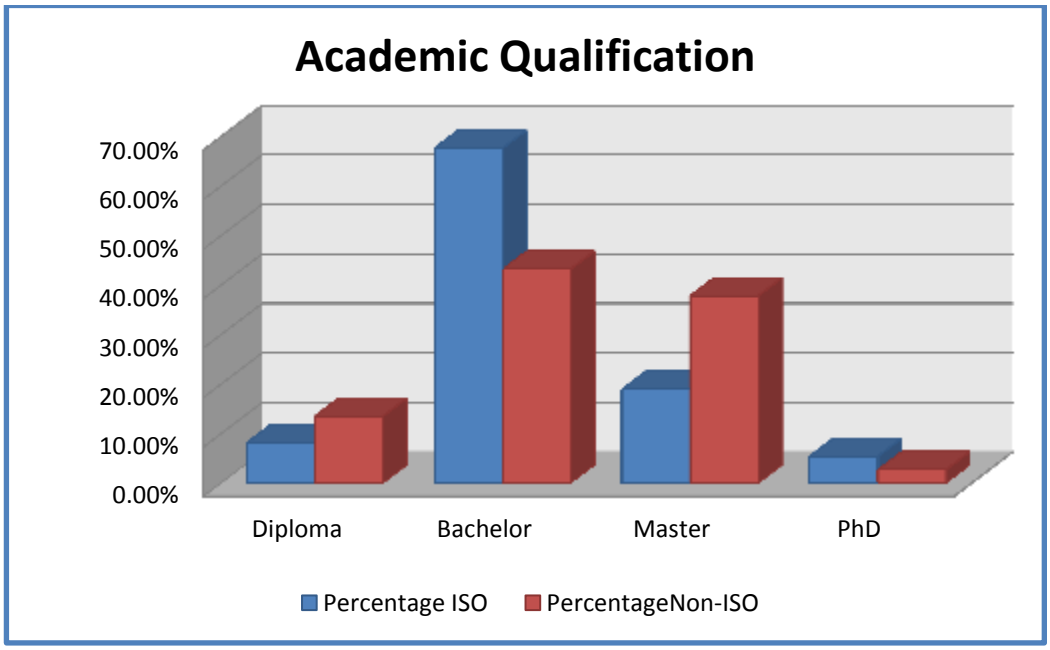

Figure (4.2): Participants academic qualification for organizations.

4.2.3 Participants' work Sector for organizations:

The Participants' work Sector of the overall participants were as presented in Table (4.3) and figure (4.3).

Table (4.3): Participants work sector for organizations:

ISO – certified organization			Non ISO – certified organization		
Category	No	Category	No	Category	No
Public	10	Public	10	Public	10
Private	27	Private	27	Private	27
Project manager	0	Project manager	0	Project manager	0
Total	37	Total	37	Total	37

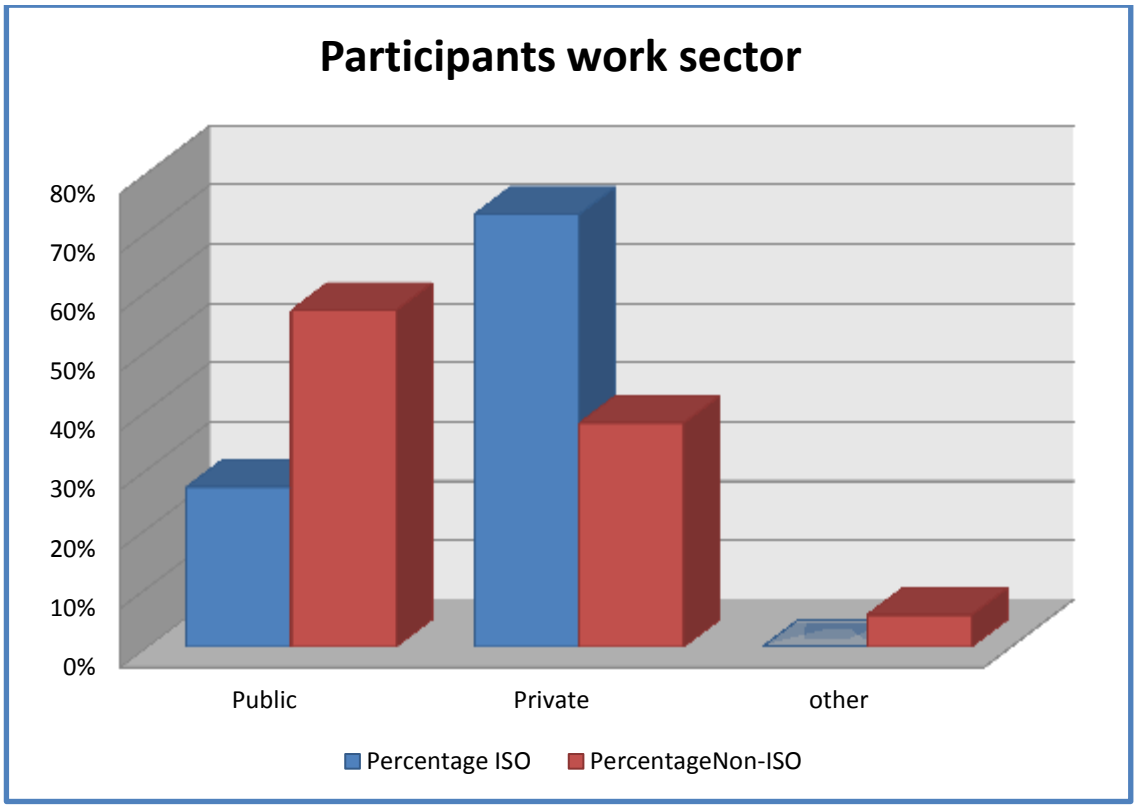

Figure (4.3): Participants work sector for organizations

4.2.4 Participants Specialization for organizations:

The Participants Specialization of the overall participants were as presented in table (4.4) and figure (4.4).

Table (4.4): Participants' specialization for organizations

ISO – certified organization			Non ISO – certified organization		
Category	No	Percentage %	Category	No	Percentage %
Civil	22	59.5%	Civil Eng.	18	48.6%
Architect	8	21.6%	Architect Eng.	2	5.4%
Project manager	7	18.9%	Other	17	45.9%
Total	37	100%	Total	37	100%

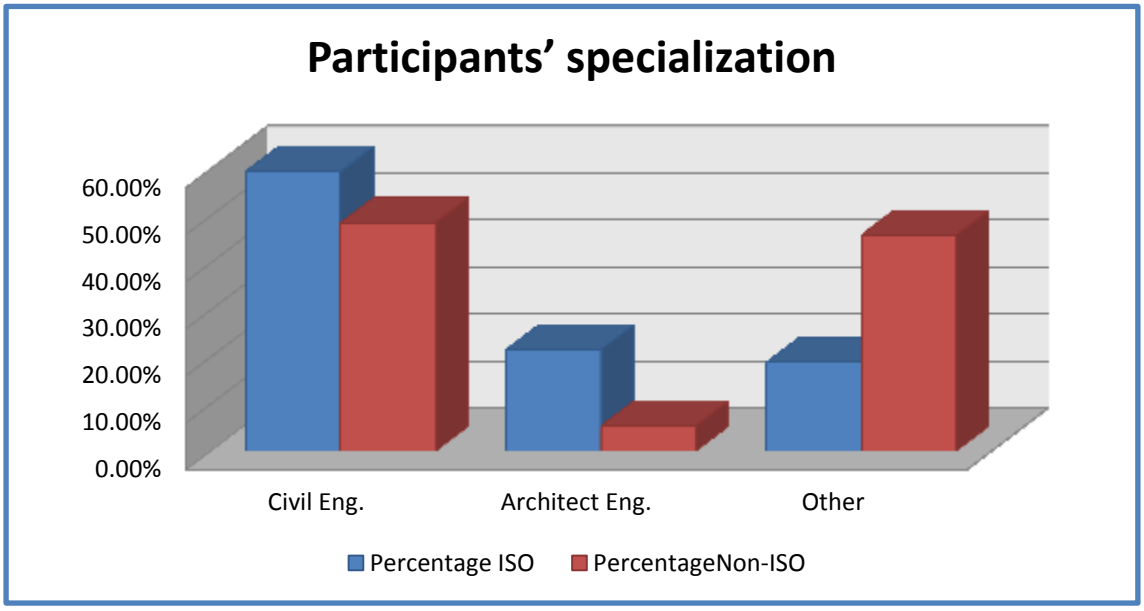

Figure (4.4): Participants' specialization for organizations

4.2.5 Participants Experience for organizations:

To evaluate the respondent's experience, Table (5_5) and Figure (5_5) shows the frequency distribution of the sample of the study according to the variable years of experience.

Table (4.5): Years of experience for organizations:

ISO – certified organization			Non ISO – certified organization		
Category	No	Percentage %	Category	No	Percentage %
Less than 5 years	12	32.4%	Less than 5 years	12	32.4%
5 -10 years	13	35.1%	5 -10 years	13	35.1%
11 - 15 years	3	8.1%	11 - 15 years	3	8.1%
20-16years	3	8.1%	20-16years	3	8.1%
More than 20 years	6	16.2%	More than 20 years	6	16.2%
Total	37	100%	Total	37	100%

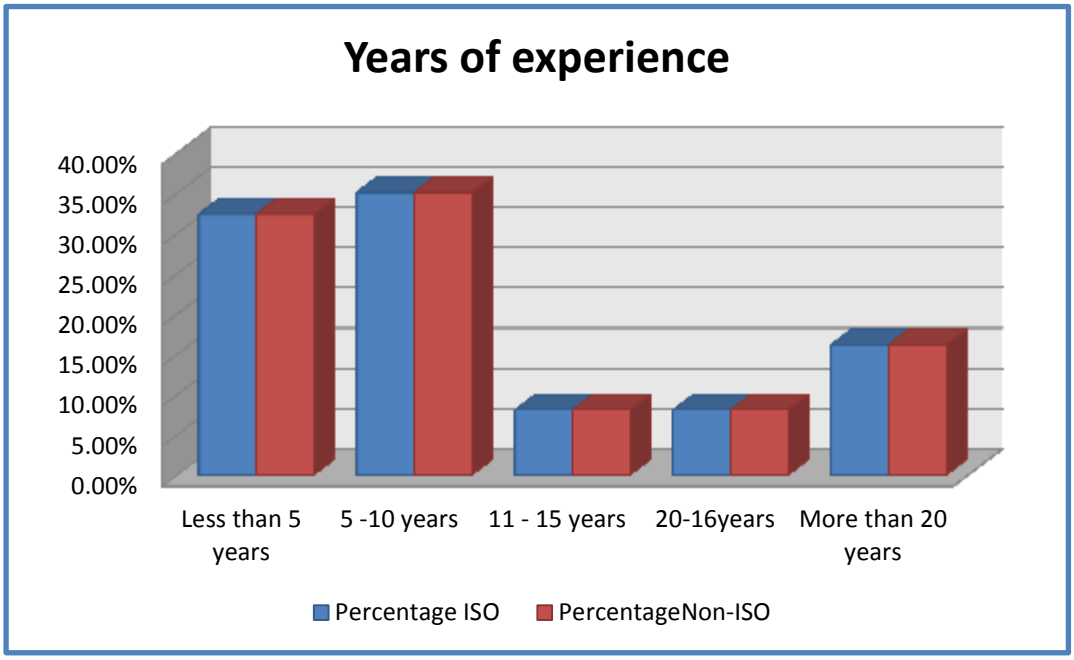

Figure (4. 5): Years of experience for organizations

4.2.6 Number of projects executed for organization:

respondents were asked to state the numbers of projects execute with witnessed in all executed projects Table(4.6) and Figure(4.6) shows the frequency distribution of the sample of the study according to the variable number of projects that you implement annually.

Table (4.6): Number of projects executed for organizations

ISO – certified organization			Non ISO – certified organization		
Category	No	Percentage %	Category	No	Percentage %
Less than 5 Projects	5	13.5%	Less than 5 Projects	9	24.3%
5 -10 Projects	12	32.4%	5 -10 Projects	9	24.3%
11 - 15 Projects	6	16.2%	11 - 15 Projects	8	21.6%
20-16 Projects	4	10.8%	20-16 Projects	0	0.0%
More than 20 Projects	10	27.0%	More than 20 Projects	11	29.7%
Total	37	100%	Total	37	100%

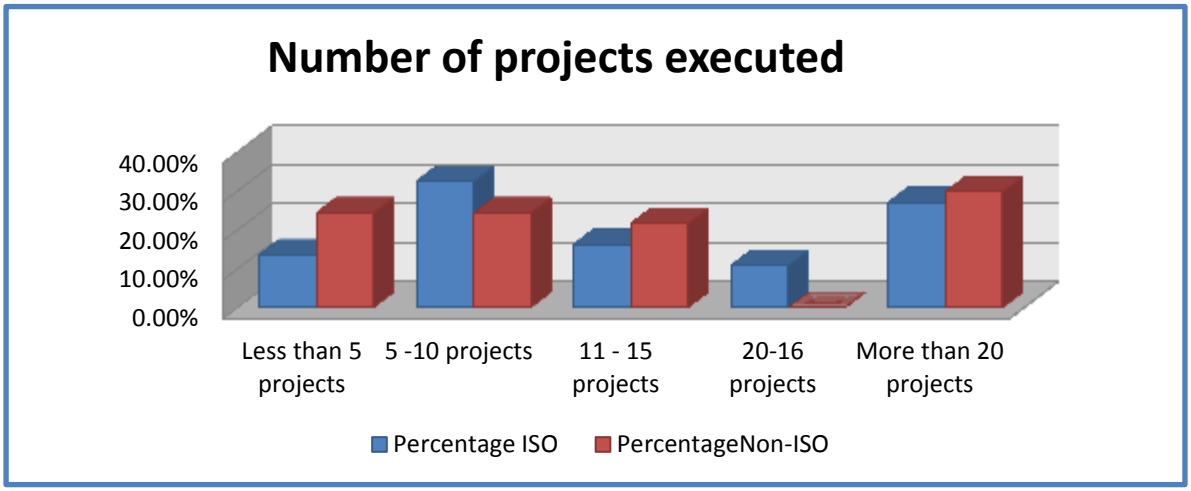

Figure (4. 6): Number of projects executed for organizations.

4.2.7 Average annual work volume (million Sudanese pounds) respondents were asked to state the numbers:

Table (4.7) and Figure (4.7) shows the frequency distribution of the Study Sample according to the variable average annual work volume (One Million Sudanese pounds)

Table (4.7): Average annual work volume (million Sudanese pounds) for organizations

ISO – certified organization			Non ISO – certified organization		
Category	No	Percentage %	Category	No	Percentage %
Less than 5 million	4	10.8%	Less than 5 million	5	13.5%
5 -10 million	2	5.4%	5 -10 million	3	8.1%
11- 50 million	10	27.0%	11- 50 million	11	29.7%
51-100 million	0	0.0%	20-16years	2	5.4%
More than 100 million	21	56.8%	More than 20 years	16	43.2%
Total	37	100%	Total	37	100%

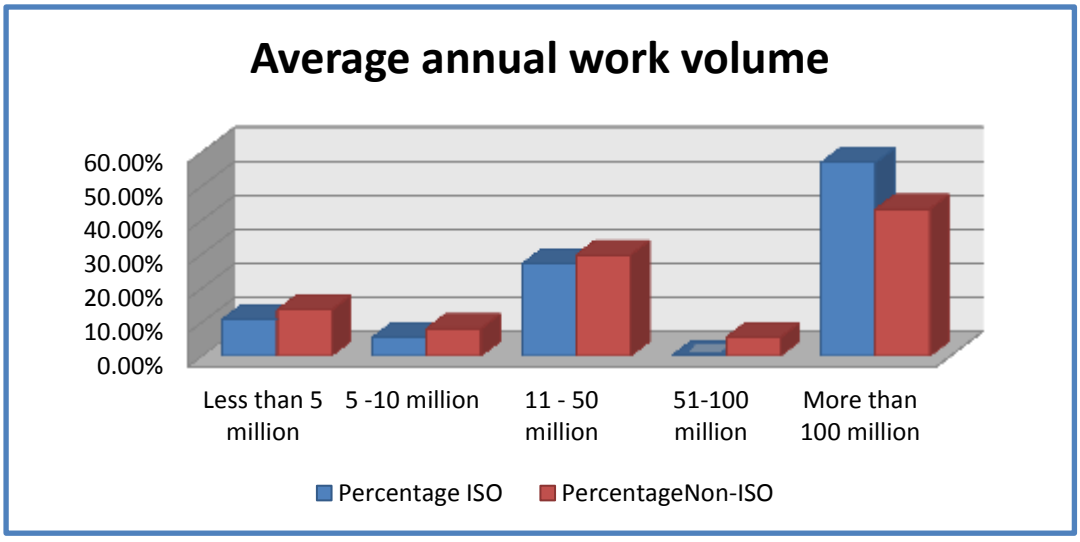

Figure (4.7): Average annual work volume for organizations

4.3 ISO and Non ISO- certified organizations – performance measures adopted the organization:

1- In this questionnaire a Likert point was scale was used where the responses are weighted as indicated in table (4.8) showing the expected interpretation for each range of value.

2- The selected performance indicators (PI) were listed and respondent's feedback is illustrated in table (4.8), (4.9) where the frequencies percentages and importance index value are presented.

Table (4.8): Likert 4 scale:

The general trend	Importance Index
Never	1 - 1.74
Seldom	1.75 - 2.49
Sometimes	2.5 - 3.24
Always	3.25 - 4

Table (4.9): Likert 5scale

The general trend	Importance Index
Never	1 - 1.8
Seldom	1.81 - 2.6
Sometimes	2.61 - 3.0
Often	3.41 – 4.2
Very Often	4.21 - 5

Table (4.10) Performance indicators used ISO-certified organization:

No	Performance Indicators	Always	Sometimes	Seldom	Never	Importance Index	Standard deviation
1	Time	17	9	7	4	1.95	1.05
		45.9%	24.3%	18.9%	10.8%		
2	Cost	25	11	1	0	1.35	.53
		67.6%	29.7%	2.7%	0.0%		
3	Quality	12	17	7	1	1.91	.79
		32.4%	45.9 %	18.9%	2.7%		
4	Safety	10	17	5	5	2.14	.97

		27.0%	45.9%	13.5%	13.5%		
5	Project team satisfaction	7	15	8	7	2.41	1.01
		18.9%	4.5%	21.6%	18.9%		
6	customer Satisfaction	16	21	0	0	1.56	.50
		43.2%	56.8%	0.0%	0.0%		
7	Productivity	15	18	4	0	1.70	.66
		40.5%	48.5%	10.8%	0.0%		
8	Profitability	26	8	0	3	1.45	.86
		70.3%	21.6%	0.0%	8.1%		
9	Defects	10	8	10	9	2.8	1.14
		27.0%	21.6%	27.0%	24.3%		
Total							1.91

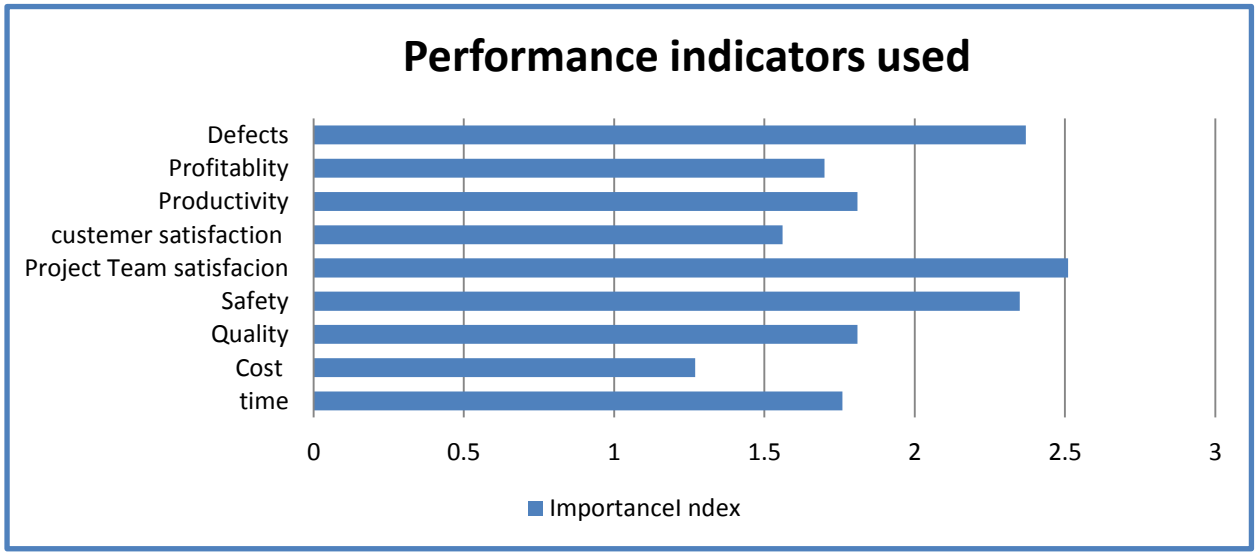

Figure (4.8) Importance index of factors which Performance indicators used ISO-certified organization.

Table (4.11) Performance indicators used Non ISO-certified organization:

No	Performance Indicators	Always	Sometimes	Seldom	Never	Importance Index	Standard deviation
1	Time	15	16	6	0	1.76	.72
	%	40.5	43.2	16.2	0.0		
2	Cost	28	8	1	0	1.27	.50
	%	75.7	21.6	2.7	0.0		
3	Quality	16	13	7	1	1.81	.84
	%	43.2	35.1	18.9	2.7		
4	Safety	8	13	11	5	2.35	.97
	%	21.6	35.1	29.	13.5		
5	Project team satisfaction	4	17	9	7	2.51	.93
	%	10.8	45.9	24.3	18.9		
6	customer Satisfaction	19	15	3	0	1.56	1.56
	%	51.4	40.5	8.1	0.0		
7	Productivity	13	19	4	1	1.81	1.81
	%	35.0	51.4	10.8	2.7		
8	Profitability	19	12	4	2	1.70	1.70
	%	51.4	32.4	10.8	5.4		
9	Defects	5	16	13	3	2.37	2.37
	%	13.5	43.2	35.1	8.1		
Total						1.9	

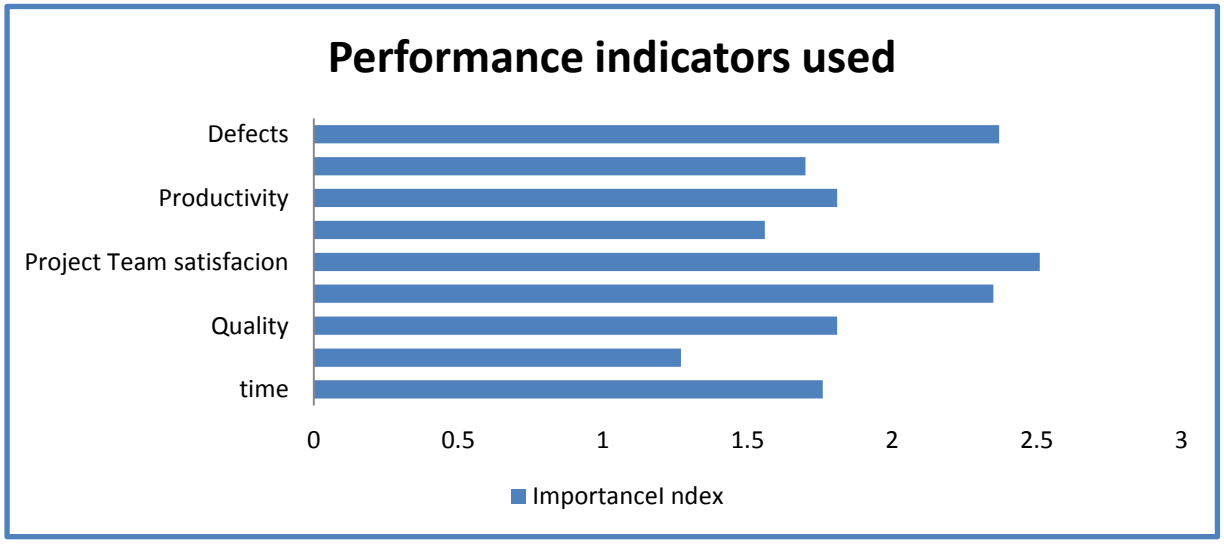

Figure (4.9) Importance index of factors which Performance indicators used Non ISO-certified organizations .

Table (4.12) Ranking of Performance indicators:

ISO – certified organizations			Non ISO – certified organizations		
Performance Indicators(PI)	Importance Index(II)	Ranking	Performance Indicators(PI)	Importance Index(II)	Ranking
Time	1.95	4	Time	1.76	6
Cost	1.35	9	Cost	1.27	9
Quality	1.91	5	Quality	1.81	4
Safety	2.14	3	3	2.35	3
Project team satisfaction	2.41	2	2	2.51	1
customer Satisfaction	1.56	7	7	1.56	8
Productivity	1.70	6	Productivity	1.81	5
Profitability	1.45	8	Profitability	1.70	7
Defects	2.8	1	Defects	2.37	2

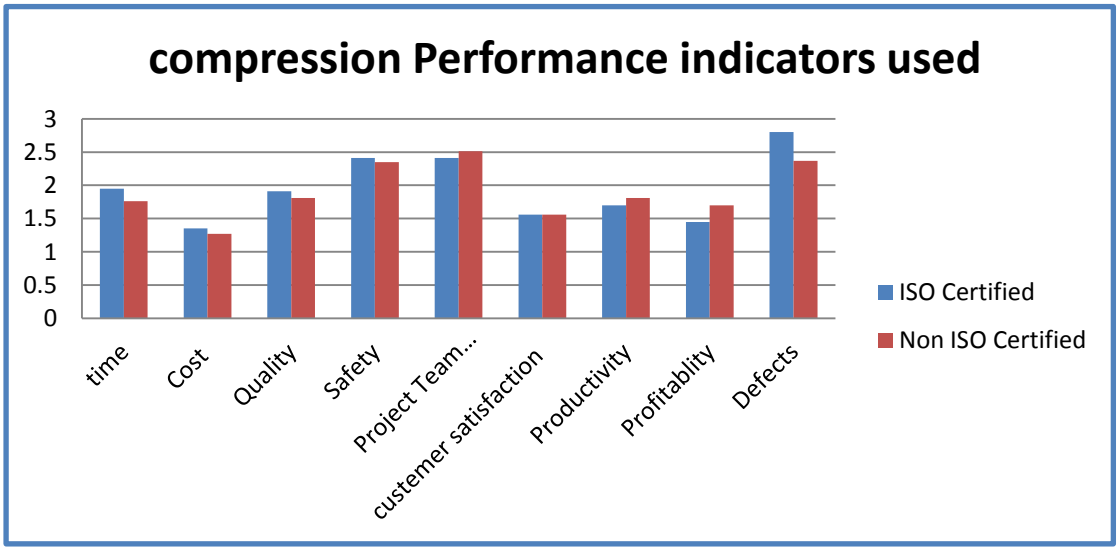

Figure (4.10) Compression performance indicators used between ISO and Non ISO- certified organizations.

Upon checking result from the perspective of the different Participants for Performance Indicators in ISO and Non ISO- certified organizations, Respondents' responses indicated that they did not use performance indicators formally because the average of their responses indicated that they did not use them at the rate of 1.9 and 1.91 for non ISO certified Which indicates non-use according to the Likert Fourfold scale, frequently performance measurements used in ISO (Indicator Defects, satisfaction team project, Safety, Time the quality Productivity customer Satisfaction, Profitability, the cost). But frequently performance measurements used in Non ISO (Indicator satisfaction team project, Defects Safety, Quality and productivity, Time, profitability customer Satisfaction the cost in final).

Table (4.13) Evaluation of engineers' opinions on the importance of using performance indicators for construction projects of ISO-certified organization:

No	Phrase	Very Often	Often	Sometimes	Seldom	Never	Importance Index
1	Engineers and planners realize the importance of measuring project performance.	13	18	4	2	0	4.13
	%	35.1	48.6	10.8	5.4	0.0	
2	There are specialized departments to assess the performance of projects in construction companies.	5	11	13	8	0	3.35
	%	13.5	29.7	35.1	21.6	0.0	
3	Provide the necessary training and education to enable engineers to set up special performance measures and take immediate corrective action when necessary.	25	5	5	2	0	4.43
	%	67.6	13.5	13.5	5.4	0.0	

4	Performance measures are a combination of performance metrics in the past, the future and the present.	15	11	6	5	0	3.97
	%	40	29.7	16.2	13.5	0.0	
5	The measurement of project performance achieves the most important benefits of achieving the basic project objectives as planned.	11	15	5	5	1	3.81
	%	29.7	40.5	13.5	13.5	2.7	
6	Failure to develop a performance measurement model leads to a decrease in the performance of construction projects in Sudan.	22	9	4	2	0	4.37
	%	59.5	24.3	10.8	5.4	0.0	
7	. Engineers and planners do not know performance indicators other than cost, time and quality.	10	11	9	5	2	3.59
	%	27.0	29.7	24.3	13.5	5.4	
8	There are some types of projects that do not need to measure performance.	1	2	9	18	7	2.24
	%	2.7	5.4	24.3	48.6	18.9	
9	The measurement of project performance achieves the most important benefits of achieving the basic project objectives as planned.	16	15	3	2	1	4.16
	%	43.2	4.5	8.1	5.4	2.7	

10	ISO-certified companies implement high quality projects	4	16	11	5	1	3.45
	%	10.8	43.2	29.7	13.5	2.7	
11	Construction companies in Khartoum do not use comprehensive performance measures for all aspects to evaluate project performance	17	8	9	2	1	4.02
	%	45.9	21.6	24.3	5.4	2.7	
	Total						3.77

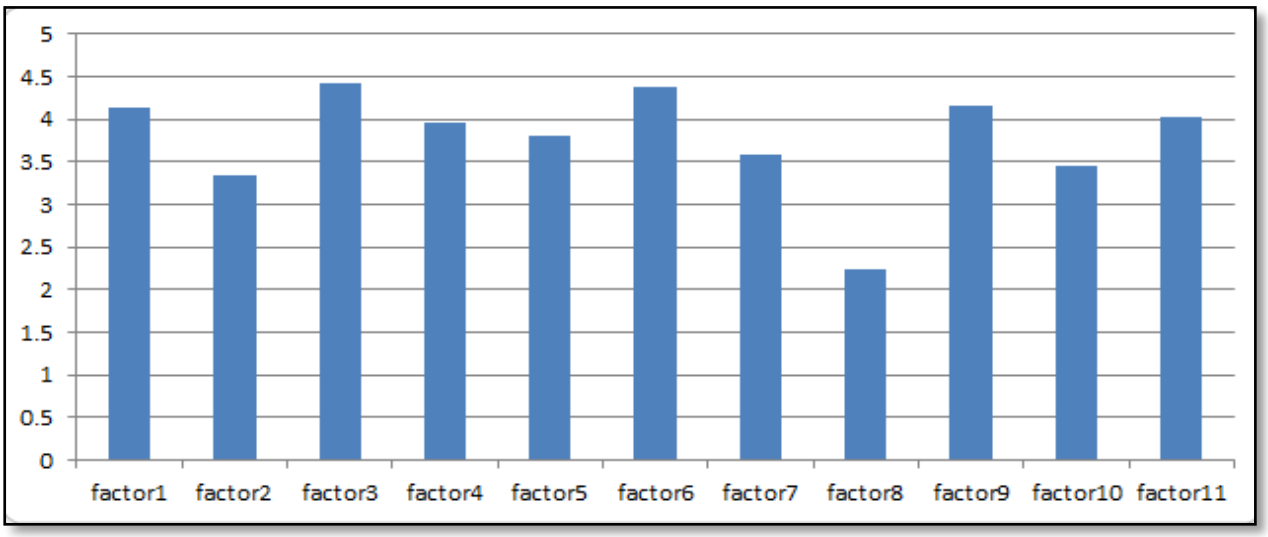

Figure (4.11) Importance index of factors which Evaluation of engineers' opinions on the importance of using performance indicators for construction projects of ISO-certified organization.

Table (4.14) Evaluation of engineers' opinions on the importance of using performance indicators for construction projects of Non ISO-certified organization:

No	Phrase	Very Often	Often	Sometimes	Seldom	Never	Importance Index
1	Engineers and planners realize the importance of measuring project performance.	14	15	7	1	0	4.13
	%	37.8	40.5	18.9	2.7	0.0	
2	There are specialized departments to assess the performance of projects in construction companies.	6	10	14	6	1	3.37
	%	16.2	27.0	37.8	16.2	2.7	
3	Provide the necessary training and education to enable engineers to set up special performance measures and take immediate corrective action when necessary.	14	8	7	8	0	3.75
	%	37.8	21.6	18.9	21.6	0.0	
4	Performance measures are a combination of performance metrics in the past, the future and the present.	9	16	8	3	1	3.87
	%	24.3	43.2	21.6	8.1	2.7	

5	The measurement of project performance achieves the most important benefits of achieving the basic project objectives as planned.	11	6	14	5	1	3.56
	%	29.7	16.2	37.8	13.5	2.7	
6	Failure to develop a performance measurement model leads to a decrease in the performance of construction projects in Sudan.	17	14	3	3	0	4.21
	%	45.9	37.8	8.1	8.1	0.0	
7	. Engineers and planners do not know performance indicators other than cost, time and quality.	9	6	14	7	1	3.40
	%	24.3	6.2	37.8	18.9	2.7	
8	There are some types of projects that do not need to measure performance.	2	7	7	14	7	2.54
	%	5.4	18.9	18,9	37.8	18.9	
9	The measurement of project performance achieves the most important benefits of achieving the basic project	18	13	2	3	0	4.27

	objectives as planned.						
	%	38.6	35.1	5.4	8.1	0.0	
10	ISO-certified companies implement high quality projects	5	12	15	2	3	3.37
	%	13.5	38.4	40.5	5.4	8.1	
11	Construction companies in Khartoum do not use comprehensive performance measures for all aspects to evaluate project performance	12	15	8	0	2	3.94
		32.4	40.5	16.6	0.0	5.4	
	Total						3.67

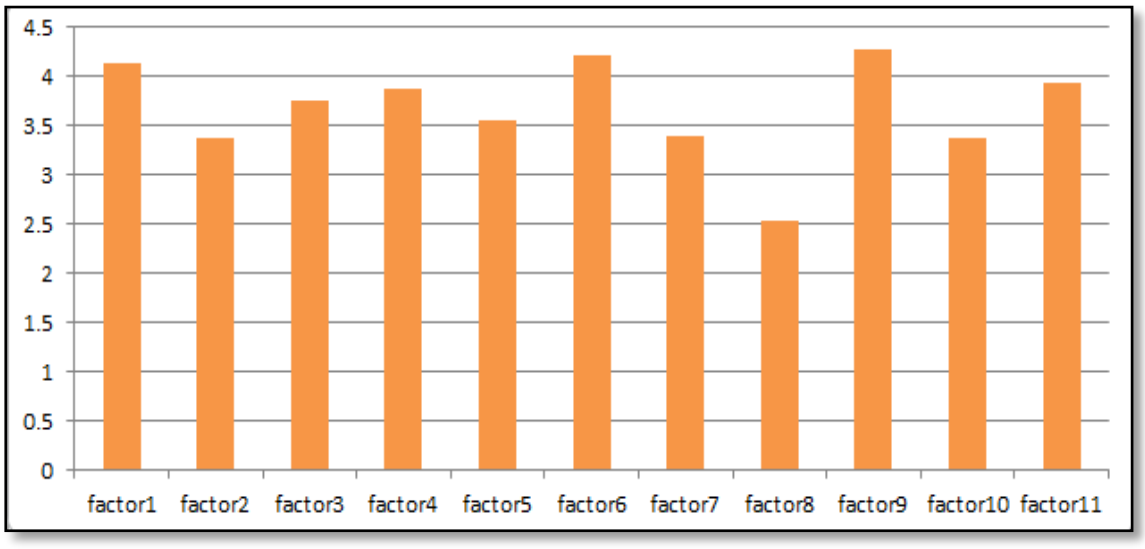

Figure (4.12) Number of projects executed) Importance index of factors

Evaluation of engineers' opinions Non ISO-certified organizations.

Upon checking result from the perspective of the different Participants for Evaluation of engineers' opinions on the importance of using performance indicators for construction projects in ISO certified organizations , appear

Respondents strongly agree on Respondents strongly agree with the proposals made in this sector The proposal to have specialized sections to assess the performance of projects in construction companies is the most important indicator for respondents' opinions, but in non ISO certified organizations, appear Respondents Neutral views according to the Likert fivefold scale on Respondents with the proposals made in this sector The proposal The measure of project performance achieves the most important benefits of achieving the basic project objectives as planned. is the most important indicator for responses' opinions.

Table (4.15) Benefits of using performance measurement indicators of ISO-certified organization:

N0	Phrase	Very Often	Often	Sometimes	Seldom	Never	Importance Index
1	Focus on key themes and extend the organization with a clear idea of costs, quality and overall performance in a limited time period.	13	23	1	0	0	4.32
	%	35.1	62.2	2.7	0	0	
2	Enabling the organization to pursue organizational activities and processes to achieve enterprise project	15	18	3	1	0	4.27

	objectives						
		40.5	48.6	8.1	2.7	0.0	
3	Enable the organization to focus on the objectives to be achieved .action when necessary.	21	14	2	0	0	4.51
	%	56.8	37.8	5.4	0.0	0.0	
4	Assist in achieving justice in compensating and rewarding the project team for their efforts, based on performance measurement results.	18	14	5	0	0	4.35
	%	48.6	37.8	13.5	0.0	0.0	
5	Provide valuable information on the performance of the current project team and achievements.	14	17	4	0	1	4.21
	%	40.5	45.9	10.8	2.7	2.7	

6	Enable the organization or company to identify the training needs of the project team based on performance measurement results.	15	10	8	4	0	3.97
	%	45.5	27.0	21.6	10.8	0.0	
7	Develop programs, policies and procedures used in the management and implementation of the project	17	14	5	1	0	4.27
		45.9	37.8	13.5	2.7	0.0	
8	Providing support to the organization or the company in developing and implementing appropriate management strategies and dealing with weak performance.	11	18	7	1	0	4.05
	%	29.7	48.6	18.9	2.7	0	
9	Confidentiality and privacy	7	15	13	2	0	3.72

	preservation because it gives measured results expressed in proportions						
	%	18.9	40.5	35.1	5.4	0.0	
10	others	15	17	4	1	0	4.24
		40.5	45.9	1.8	2.7	0.0	
	Total						4.19

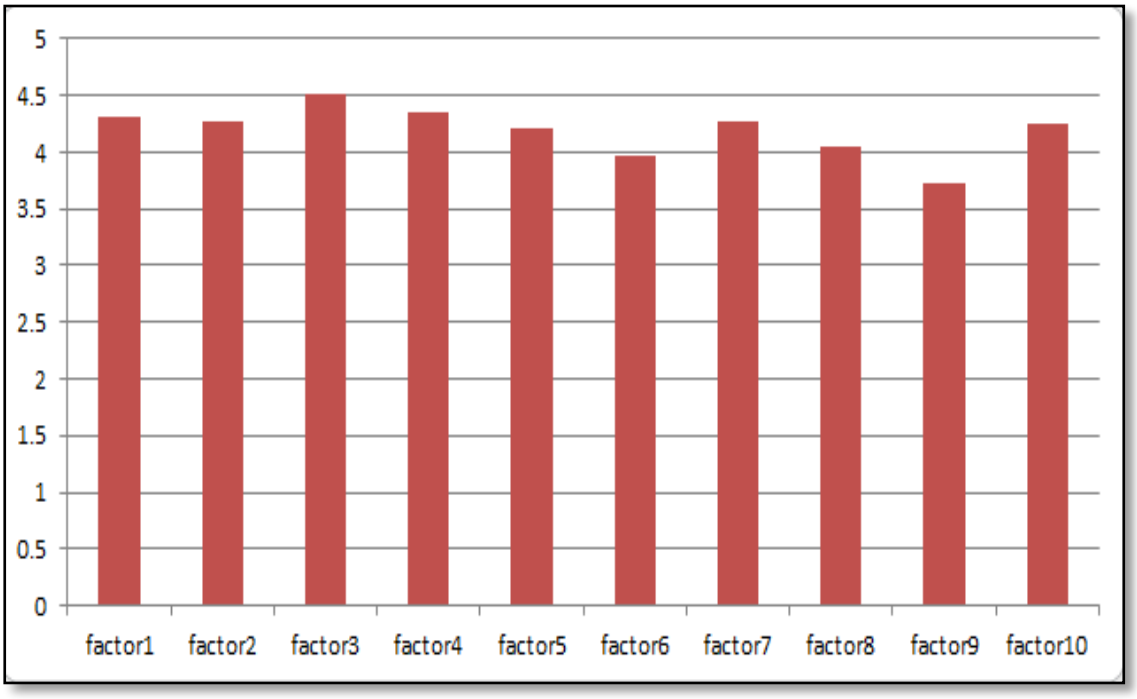

Figure (4.13) Importance index of factors which Benefits of using performance measurement indicators of ISO-certified organization.

Table (4.16) Benefits of using performance measurement indicators of Non ISO-certified organization:

N0	Phrase	Very Often	Often	Sometimes	Seldom	Never	Importance Index
1	Focus on key themes and extend the organization with a clear idea of costs, quality and overall performance in a limited time period.	18	16	1	1	1	4.32
	%	48.6	43.2	2.7	2.7	2.7	
2	Enabling the organization to pursue organizational activities and processes to achieve enterprise project objectives.	16	18	3	0	0	4.35
	%	43.2	48.6	8.1	0.0	0.0	
3	Enable the organization to focus on the objectives to be achieved .action when necessary.	18	14	5	0	0	4.35
	%	48.6	37.8	13.5	0.0	0.0	
4	Assist in achieving justice in compensating and rewarding the project team for their efforts, based on performance measurement results.	17	11	8	1	0	4.18
	%	45.9	29.7	21.6	2.7	0.0	

5	Provide valuable information on the performance of the current project team and achievements.	14	16	5	1	1	4.10
	%	37.8	43.2	13.5	2.7	2.7	
6	Enable the organization or company to identify the training needs of the project team based on performance measurement results.	16	17	3	0	1	4.27
	%	43.2	45.9	8.1	0.0	2.7	
7	Develop programs, policies and procedures used in the management and implementation of the project	13	19	4	1	0	4.18
	%	35.1	51.4	10.8	2.7	0.0	
8	Providing support to the organization or the company in developing and implementing appropriate management strategies and dealing with weak performance.	12	15	7	2	1	3.94
	%	32.4	40.5	18.9	5.4	2.7	
9	Confidentiality and privacy preservation because it gives measured results expressed in proportions	12	14	8	2	1	3.91

	%	32.4	37.8	21.6	5.4	2.7	
10	others	14	17	4	2	0	4.16
	%	37.8	45.9	10.8	5.4	0.0	
	Total						4.05

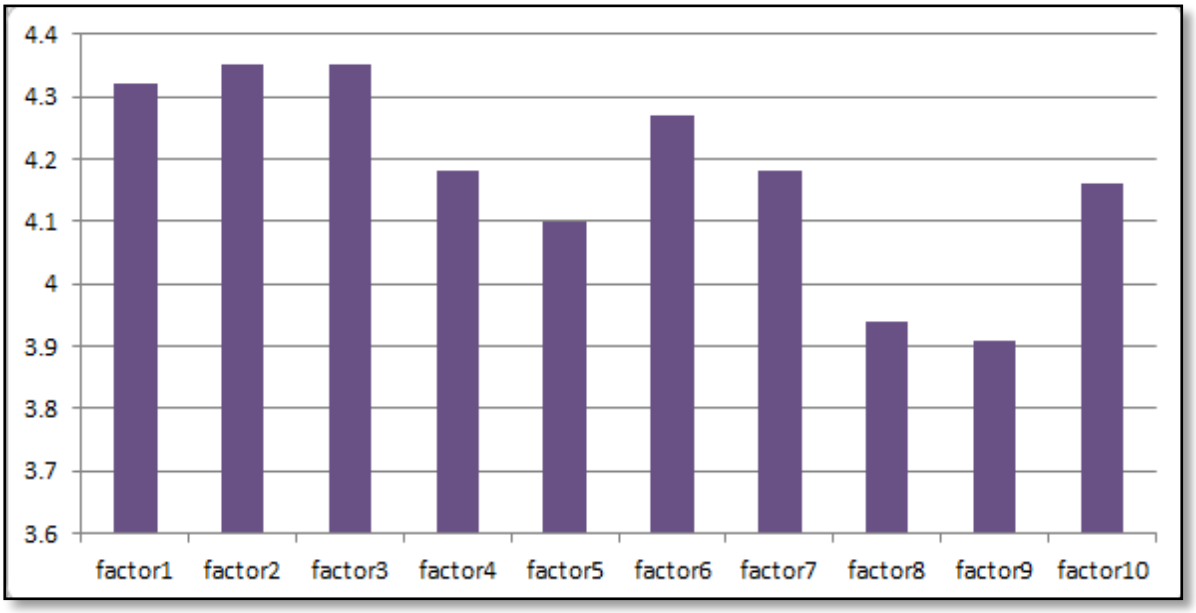

Figure (4.14) Importance index of factors which Benefits of using performance measurement indicators Non ISO-certified organizations.

Upon checking result from the perspective of the different Participants for Evaluation of engineers' opinions on the importance of using performance indicators for construction projects in ISO and Non ISO- certified organizations, appear Respondents Neutral views , They are aware of the importance of using measurement indicators based on the proposals presented to them in this sector, Respondents' opinions showed that they are convinced of the importance of using measurement indicators because of its significant benefits based on the proposals presented to them in this sector as shown in Annex A

Table (4.17) Obstacles to the use of performance measurement systems of ISO-certified organizations**:**

No	Phrase	Very Often	Often	Sometimes	Seldom	Never	Importance Index
1	Individual Constraints These constraints are a set of factors related to the individual: -the abilities and the skills. - The psychological composition of him. - Social structure	4	8	13	8	4	3.00
	%	10.8	21.6	35.1	21.6	10.8	
2	Institutional constraints, including: - Duties and tasks entrusted to individuals. - Social organization. - Resources and financial resources	9	18	6	3	1	3.83
	%	24.3	48.6	16.2	8.1	2.7	
3	The ambiguity of the objectives	15	14	4	4	0	4.08

	of the performance measurement system, where the lack of clarity in this is a direct cause of the disruption of the process of measurement of performance in the right manner, and thus reach the results are completely inconsistent with the objectives of the establishment						
	%	40.5	37.8	10.8	10.8	0.0	
4	The lack of measurement of objectivity and accuracy by some of those involved in the measurement process, and the impact on a number of factors such as personal relationships and sometimes indulgence or	10	16	7	2	2	3.81

	for givens.						
	%	27.0	43.2	18.9	5.4	5.4	
5	Other Constraints	15	15	7	0	0	4.21
	%	40.5	40.5	18.9	0.0	0.0	
	Total						3.78

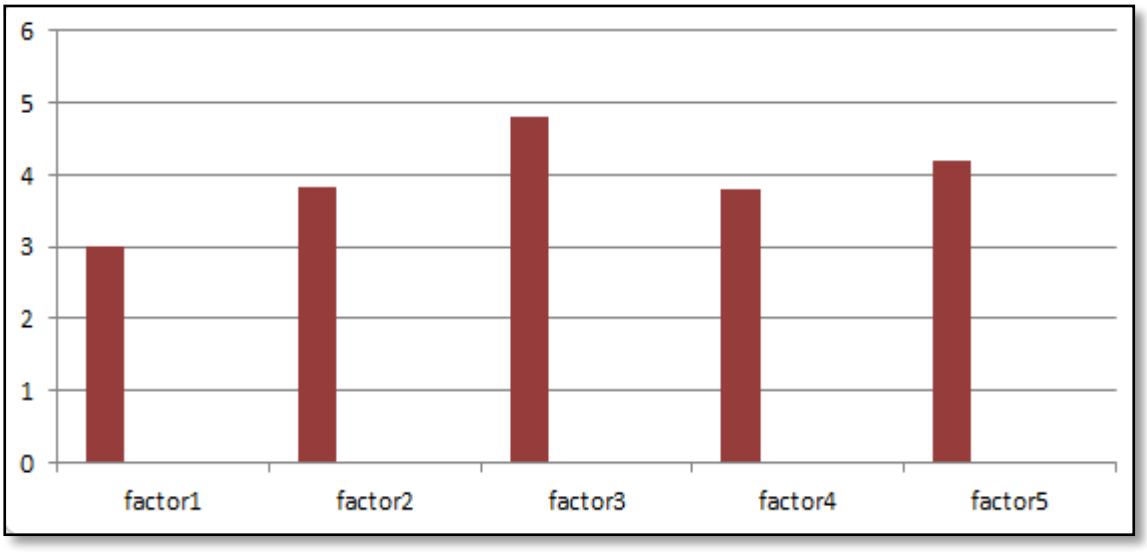

Figure (4.15) Importance index of factors which Obstacles to the use of performance measurement systems of ISO-certified organizations.

Table (4.18) Obstacles to the use of performance measurement systems Of Non ISO-certified organization:

No	Phrase	Very Often	Often	Sometimes	Seldom	Never	Importance Index
1	Individual Constraints These constraints are a set of factors related to the individual: -the abilities and the skills. - The psychological composition of him. - Social structure	13	12	9	3	0	3.94
	%	35.1	32.4	24.3	8.1	0.0	
2	Institutional constraints, including: - Duties and tasks entrusted to individuals. - Social organization. - Resources and financial resources	10	18	6	2	1	3.91
	%	27.0	48.6	16.2	5.4	2.7	
3	The ambiguity of the objectives of the performance measurement system, where the	15	9	10	3	0	3.97

	lack of clarity in this is a direct cause of the disruption of the process of measurement of performance in the right manner, and thus reach the results are completely inconsistent with the objectives of the establishment						
	%	40.5	24.3	27.0	8.1	0.0	
4	The lack of measurement of objectivity and accuracy by some of those involved in the measurement process, and the impact on a number of factors such as personal relationships and sometimes indulgence or for governess.	15	14	8	0	0	4.18
	%	4.5	37.8	21.6	0.0	0.0	

5	Other Constraints	19	9	9	0	0	4.27
	%	51.0	24.3	24.3	0.0	0.0	
	Total						3.78

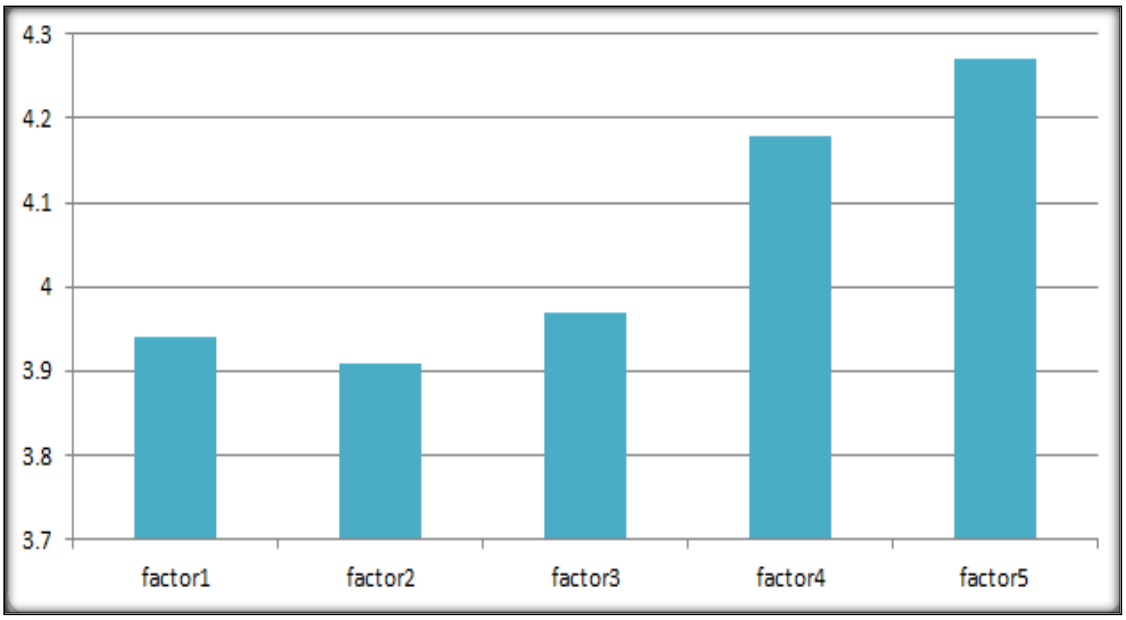

Figure (4.16) Importance index for factors which Obstacles to using performance measurement indicators Non ISO-certified organizations

Upon checking result from the perspective of the different Participants The constrain of using performance indicators to use in ISO and Non ISO-certified organizations, appear Respondents according to the Likert fivefold scale on proposals made in this sector for the constrain of using performance indicators to use in companies and institutions, Respondents confirmed that there are other constraints not mentioned in this sector, which are the most influential.

Table (4.19) Pearson correlation coefficient for the study variables:

Sections ISO certified		Section one	Section two	Section three	Section four
Section one	Correlation	1	-.247	.051	-.127-
	Sig- value		.101	.763	.453
Section two	Correlation	-274-	1	.485**	.268
	Sig- value	.101		.002	.109
Section three	Correlation	.051	458**	1	391*
	Sig- value	.763	.002		.017
Section four	Correlation	-.127-	.268	.391*	1
	Sig- value	.453	.109	.017	
Sections Non ISO-certified					
Section one	Correlation	1	-.363	-.210	-.116-
	Sig- value		.027	.211	.494
Section two	Correlation	-363-	1	.588**	-.028-
	Sig- value	.027		.000	.868
Section three	Correlation	-.210-	588**	1	-.191
	Sig- value	.211	.000		.258
Section four	Correlation	-.116-	-.028-	.191	1
	Sig- value	.494	.868	.258	

Upon checking result from Pearson correlation coefficient for the study variables

- **Firstly ISO- certified organizations:**

It is clear from the table (4.19) that there is a negative correlation between the performance indicators used and assess the opinions of the engineers on this mean no correlation between this sections.

The performance indicators of the construction projects where the value of the correlation is equal to(-2.47) Also note that the value of p.value

equals(.01) which is below the moral level(5%). There is also a positive correlation between the indicators of performance measurement used and the benefits of using the performance indicators and the obstacles to use in the institutional companies where the value of the Correlation (.051) and note that the value of P-value is equal to 7.63 or 7.6, which is greater than the moral level (5%). There is also a relationship of inverse correlation between performance indicators used and performance measurement system impediments, where the correlation value is(-277). It is noted that the value of P-value is(.453) or 4.5%, which is less than the level of morale(5%).

It is also evident that there is an inverse correlation between the evaluation of the engineers' opinions on the importance of using the performance indicators of the construction projects where the value of the correlation is equal to(-2.74) and note that the value of p-value equals 0.01, ie 0.01%.(5) It also shows that there is a very strong and positive correlation between evaluating the opinions of the engineers on the importance of using construction project performance indicators where the correlation value is equal to(.485 **) and note that the value of p-value(.002). The correlation between the evaluation of the engineers' opinions on the importance of using performance indicators for construction projects and the impediments of the systems of performance measurement indicators was found to be significant. The value of the correlation was equal to(.268). The value of p-value is (.109) (5%).

It also shows that there is an inverse relationship between the impediments to the use of performance measurement systems and performance indicators used where the value of the correlation is equal to-277 and the value of p-value is 453(4.5% less than the moral level) 5%). There is also a positive correlation between the constraints of the use of performance measurement systems and the evaluation of the opinions of the martyrs about the importance of using the performance indicators of the construction projects where the value of the correlation is equal to (268.) The value of p-value is

equal to 109. 10%(5%). There is also a positive and statistically significant relationship between the obstacles of using performance measurement systems and the desired benefits from the use of performance indicators and barriers to their use in companies and institutions where the value of the correlation was equal to 391 *. Note that the p- value.

❖ **Secondly Non ISO certified organizations:**

Upon checking result from Pearson correlation coefficient for the study variables.

It is clear from the previous table that there is an inverse correlation between the performance measurement indicators used and the evaluation of the engineers' opinions on the performance indicators of the construction projects where the value of the correlation was(-363). Also, the value of p.value equals.027, ie 2.7% which is below the moral level(5%). There is also an inverse relationship between the indicators of performance measurement used and the benefits of using performance indicators and impediments to use in corporate organizations where the value of the correlation 210.-) and note that the value of P-value equals 2.11 or 2.11 which is less than the moral level(5%),. There is also a relationship between the correlation between the performance indicators used and the performance measurement system impediments, where the correlation value is equal to(-1.16). The value of P-value is equal to(494) or 4.94%, which is less than the moral level(5) %).

It is also apparent that there is an inverse correlation between the evaluation of the engineers' opinions on the importance of using construction performance indicators and the performance indicators used. The correlation value is(-363) and the value of p-value is 0.27%(5%). It is also clear that there is a very strong and direct correlation between evaluating engineers' opinions on the importance of using performance indicators for construction projects and the benefits of using performance indicators and barriers to using them in companies and institutions. Note that the value of p-

value(.000). It was also found that there is a direct correlation between the evaluation of the engineers' opinions on the importance of using performance indicators of construction projects and the constraints of the systems of performance measurement indicators where the value of the correlation is equal to(-028) and note that the value of p-value is(.868) or 8.68% Moral level(5%).

It is also apparent that there is an inverse relationship between the benefits of using performance indicators and the barriers to their use in the companies and institutions and the performance indicators used, where the value of the correlation was(-210). Note that the value of p-value equals(211.)(5%). It is also clear that there is a very strong correlation between the benefits of using performance indicators and the obstacles to using them in companies and institutions and evaluating the opinions of the martyrs about the importance of using performance indicators of construction projects where the value of the correlation is equal to(588. ** Note that the value of p-.value is equal to(000.) It also turns out that there is a correlation I direct correlation between the benefits of the use of performance indicators and barriers to use in companies and institutions and constraints of the use of performance indicators to measure where the correlation value is equal to(191) systems.

It was also found that there is an inverse relationship between the impediments to the use of performance measurement systems and the performance measurement indicators used, where the correlation value is equal to-16.1. It is noted that the value of p-value equals 211. %(5%). There is also an inverse relationship between the constraints of using performance measurement systems and the evaluation of the opinions of the martyrs about the importance of using performance indicators of construction projects where the value of the correlation is equal to (- 028). The value of p-value is (868) of the level of morale (5%). There is also a positive correlation between the impediments to the use of performance

measurement systems and the desired benefits from the use of performance indicators and barriers to their use in companies and institutions where the value of the correlation is equal to 191. The value of p-value is 258).

Table (4.20) Regression model for study variables:

Independent variables for ISO certified	Section one used correlation(Y)	F- test	R2	T-test	sig
Section2	-.274-		.135	-2.020-	
Section3	.051	1.718		1.377	.052
Section4	-.127			-.786-	
Independent variables for Non ISO certified					
Section2	-.363-	1.929	.149	-1.595-	.816
Section3	.235	.205	-.395	.235	

- **Comment for ISO- certified organizations:**

  The estimated regression pattern is Y = 2.458 + x^2(0.269)

  From the previous regression model it is clear to us:

  The B-0 constant is equal to(0.269)

  The regression coefficient is B-1 equals(2.458).

  It was found that the value of the coefficient of determining the quality of the model $R^2$is 0.52, which is a statistically significant value.

- **Comment for Non ISO- certified organizations:**

  The estimated regression pattern is Y = 3.672 + x(.050)

  From the previous regression model it is clear to from table 2.34:

  The B-0 constant is equal 3.677.

The regression coefficient is B-1 equals (.816).

It was found that the value of the coefficient of determining the quality of the model R^2 is equal to (.149) which is a statistically significant value.

4.4 Test hypothesis :(ANOVA)

Hypothesis	ISO- certified organization			Non ISO- certified sections		
	Sections	p- value	Result	Sections	p- value	Result
H1	Section1	.043	reject	Section1	0.056	Accept.
	Section2	.081	Accept	Section2	0.388	Accept.
	Section3	0.214	Accept	Section3	0.005	Accept.
	Section4	0.742	Accept	Section4	0.53	Accept.
H2	Section1	0.85	Accept	Section1	0.638	Accept.
	Section2	.093	Accept.	Section2	0.732	Accept.
	Section3	.078	Accept.	Section3	0.513	Accept
	Section4	0.547	Accept.	Section4	.8740	Accept

Table (4.21) Results of Test hypothesis:

Comment: Normal level (5%). Table (4.21): ANOVA test from the above table it was found that the first and second hypothesis for respondents from ISO-based and non-ISO-certified organizations met acceptance and this means proving the hypothesis of research.

CHAPTER FIVE

CONCULSION AND RECOMNDATIONS

Chapter Five

Conclusion and Recommendations

5.1. Conclusion

Upon checking the obtained result from the perspective of the different participants over all sample for Performance Indicators in ISO and Non ISO- certified organizations, Respondents' responses indicated that they did not use performance indicators formally, However, the most common measurement indicators used by the local construction organizations in general is(Defects, satisfaction team project, safety) Among the nine most widely used measurement indicators globally that is means engineers and planners knowledge about with performance indicators other than cost, time and quality and Construction organizations in Sudan are using non – comprehensive measures for the assessment of their projects performance.

From the perspective of the different Participants Construction projects executed by ISO-certified companies have better performance than those executed by non –ISO certified companies.

from the perspective of the different Participants for Evaluation of engineers' opinions on the importance of using performance indicators for construction projects appear the extent of awareness of the projects participations with the importance of measuring the performance of projects, This means the project manager cannot assess the performance of the project without putting a specific measurement model because this must of local companies take into account the need for putting and developing a general model for measuring and evaluating project performance.

The perspective of the different Participants appear also projects performance measurement have benefits regarding the achievement of the basic project objectives.

The perspective of the different Participants The trammels of using performance indicators to use in companies and institutions the analysis

concludes that it turns out that the respondents of the ISO holders are sure that there are obstacles to the use of measuring indicators while stopping the non-holders.

5.2 Recommendations:

Considering the research findings it is possible to make the following recommendations:

1) It is recommended to choose another tool to now another performance indicators measure no answer in this study but possible to help in measuring performance in construction project.
2) It is recommended to build a general mathematical model to help engineers in measuring performance in construction.

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Appendix

Sudan University of Science and Technology

College of graduate Studies

Master of Construction Management

Questionnaire on performance indicators used to measure the performance of construction projects in Khartoum State

- The study aims to use a mathematical model of measurement where practitioners can use it to present the results to assess the performance of the project during the construction phase.
- Your kindness to fill this questionnaire contributes to the achievement of the objectives of this study, hoping that the benefit to all.
- The information to be received will be used for scientific research purposes only

First Sector (General Information)

1- Name (Optional): ……..

2- Organization (Optional): ……

3- Is the organization you work in ISO-certified?....Date obtained……

1- Academic qualification											
Diploma		Bachelor		Master		PhD		Other(specify)			
2- Work Area											
Project Manager			Contractor			Owner			Consultant		
3- Work Sector											
Public			Private			other (please specify)					
4-Specialization											
Civil			Architect			other (please specify)					
5- Experience											
Less than 5 years		5-10 years		10-15 years		More than 15 years					
6-Average annual work volume (million Sudanese pounds											
Less than 5		5-10		11-50		51-100		More than 100			
7- Number of projects executed											
Project Less than 5		5-10 Projects		10-15 Projects		More than 15projec					

Second section Performance Measurement Indicators used:

What indicators are actually used to measure the performance of construction projects in Khartoum State (Please tick (√) the answer that accurately represents your point of view?)

Number	Phrase	Always	Sometimes	Seldom	Never
1	Time				
2	Cost				
3	Quality				
4	Safety				
5	Project team satisfaction				
6	customer Satisfaction				
7	Productivity				
8	Profitability				
9	Other (please specify)				

Evaluation of engineers' opinions on the importance of using performance indicators for construction projects

(Please tick (√) the answer that accurately represents your point of view.)

Number	Phrase	Very Often	Often	Sometimes	Seldom	Never
1	Engineers and planners realize the importance of measuring project performance.					
2	There are specialized departments to assess the performance of projects in construction companies.					
3	Provide the necessary training and education to enable engineers to set up special performance measures and take immediate corrective action when necessary					
4	Performance measures are a combination of performance metrics in the past, the future and the present.					
5	The measurement of project performance achieves the most important benefits of achieving the basic project objectives as planned.					
6	Failure to develop a performance measurement model leads to a decrease in the performance of construction projects in Sudan.					.

7	. Engineers and planners do not know performance indicators other than cost, time and quality.					
8	There are some types of projects that do not need to measure performance.					
9	The measurement of project performance achieves the most important benefits of achieving the basic project objectives as planned.					
10	ISO-certified companies implement high quality projects					
11	Construction companies in Khartoum do not use comprehensive performance measures for all aspects to evaluate project performance					

Four (Benefits from the use of performance measurement indicators and obstacles to use in organization

What are the benefits and obstacles to measuring the performance of construction projects in Khartoum State? (Please tick (√) the answer that accurately represents your point of view.)

Number	Phrase	Very Often	Often	Sometimes	Seldom	Never
1	Focus on key themes and extend the organization with a clear idea of costs, quality and overall performance in a limited time period.					
2	Enabling the organization to pursue organizational activities and processes to achieve enterprise project objectives					
3	Enable the organization to focus on the objectives to be achieved .action when necessary.					
4	Assist in achieving justice in compensating and rewarding the project team for their efforts, based on performance measurement results.					
5	Provide valuable information on the performance of the current project team and achievements					
6	Enable the organization or company to identify					.

	the training needs of the project team based on performance measurement results					
7	Develop programs, policies and procedures used in the management and implementation of the project.					
8	Providing support to the organization or the company in developing and implementing appropriate management strategies and dealing with weak performance.					
9	Confidentiality and privacy preservation because it gives measured results expressed in proportions.					
10	Other					

Obstacles to the use of performance measurement indicators / systems:

Number	Phrase	Very Often	Often	Sometimes	Seldom	Never
1	Individual Constraints These constraints are a set of factors related to the individual: -the abilities and the skills. - The psychological composition of him. - Social structure					
2	Institutional constraints, including: - Duties and tasks entrusted to individuals. - Social organization. - Resources and financial resources					
3	The ambiguity of the objectives of the performance measurement system, where the lack of clarity in this is a direct cause of the disruption of the process of measurement of performance in the right manner, and thus					

	reach the results are completely inconsistent with the objectives of the establishment					
4	The lack of measurement of objectivity and accuracy by some of those involved in the measurement process, and the impact on a number of factors such as personal relationships and sometimes indulgence or for givens..					
5	Other Constraints					

جامعة السودان للعلوم والتكنولوجيا

كلية الدراسات العليا

ماجستير إدارة التشييد

إستبيان حول مؤشرات الاداء المستخدمة لقياس أداء مشاريع البناءبولاي الخرطوم

موجهات :

- تهدف الدراسة الي استخدام نموذج رياضي للقياس حيث يمكن لممارسي البناء استخدامه لعرض النتائج لتقييم أداء المشروع خلال مرحلة البناء.
- تكرمكم بملء هذا الاستبيان يسهم في تحقيق اهداف هذه الدراسة آملين في أن تعم الفائدة للجميع.
- المعلومات التي سترد ستستخدم لاغراض البحث العلمي فقط.

القطاع الاول (اسئلة عامة)

1. **الاسم (اختياري):**

_____

_____

_____

_____

_____

_____

2. **اسم المؤسسة او الشركة (اختياري):**

_____

_____

_____

_____

_____

3. هل المؤسسة او الشركة التي تعمل فيها حاصلة على شهادة الايزو؟

_____

تاريخ الحصول عليها: _____

4. المؤهل العلمي									
دبلوم		بكالريوس		ماجتسير		دكتوراه		أخري (حدد)	
5. طبيعة العمل									
مالك		مقاول		إستشاري		أخري (حدد)			
6. نوع العمل									
قطاع خاص		قطاع عام		أخري (حدد)					
7. التخصص									
مدني		معماري		أخري (حدد)					
8. سنوات الخبرة العملية									
أقل من 5		10-5		15-11		20-16		أكثر من 20	
9. متوسط حجم العمل السنوي (مليون جية سوداني)									
أقل من 5		10-5		50-11		51- 100		أكثر من 100	
10. عدد المشاريع التي تقومون بتنفيذها سنويا									
أقل من 5		10-5		15-11		20-16		أكثر من 20	

القسم الثاني : (مؤشرات قياس الاداء المستخدمة) :

ما هي المؤشرات المستخدمة فعلاً في قياس اداء مشروعات البناء بولاية الخرطوم (فضلا أشر بعلامة (√) علي الإجابة التي تمثل وجهة نظرك بدقة) .

الرقم	العبارة	دائما	احياناً	نادراً	لايستخدم
1	الزمن .				
2	التكلفة .				
3	الجودة .				
4	السلامة .				
5	رضا فريق المشروع.				
6	رضا العميل .				
7	الانتاجية .				
8	الربحية .				
9	العيوب .				
10	اخرى (حدد فضلاً) _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____				

القسم الثالث : (تقييم اراء المهندسين حول أهمية إستخدام مؤشرات اداء مشاريع التشيد) :

(فضلا أشر بعلامة (√) علي الإجابة التي تمثل وجهة تظرك بدقة)

الرقم	العبارة	اوافق بشدة	اوافق	أحيانا	لا اوافق	لا أوافق بشدة
1	المهندسين والمخططين يدركون أهمية قياس أداء المشاريع.					
2	توجد أقسام متخصصة لتقيم اداء المشاريع بشركات التشييد.					
3	توفير التدريب والتعليم اللازمين لتمكين المهندسين من انشاء مقاييس الاداء الخاصة واتخاذ اجراءات تصحيحية فورية عند الضرورة .					
4	مقاييس الاداء هي مزيج من مقاييس الاداء في الماضي والمستقبل والحاضر .					
5	يتم تحديد مقاييس اداء المشاريع قبل البدء في اي مشروع .					
6	عدم وضع نموزج لقياس الاداء يؤدي الى انخفاض اداء مشاريع التشيد في السودان .					
7	لا يعرف المهندسون والمخططون مؤشرات أأداء بخلاف التكلفة والوقت والجودة.					
8	هناك بعض أنواع المشاريع التي لا تحتاج إلى قياس الأداء .					
9	يحقق قياس أداء المشروعات فوائد اهمها تحقيق أهداف المشروع الأساسية كما هو مخطط لها.					
10	الشركات الحائزة على شهادة الايزو تنفذ مشاريع بجودة عالية .					
11	شركات التشيد في الخرطوم لاتستخدم مقاييس اداء شاملة لكل الجوانب لتقيم اداء المشروعات .					

القسم الرابع : (الفوائد المرجوة من إستخدام مؤشرات قياس الاداءوعوائق استخدامها في الشركات والمؤسسات) :

ما هي الفوائد المرجوة فعلاً والمعوقات التي تواجه قياس اداء مشروعات البناء بولاية الخرطوم (فضلا أشر بعلامة (√) علي الإجابة التي تمثل وجهة تظرك بدقة) .

1- **الفوائد المرجوة من استحدام مؤشرات قياس الاداء :-**

الرقم	العبارة	اوافق بشدة	اوافق	احيانا	لااوافق	لااوافق بشدة
1	التركيز على المواضيع الرئيسية ومد المنظمة بفكرة واضحة عن التكاليف والجودة والأداء العام في فترة زمنية محدودة.					
3	تمكين المؤسسة من متابعة الأنشطة والعمليات التنظيمية لتحقيق أهداف المشروع المؤسسة.					
4	تمكين المؤسسة من التركيز على الأهداف المراد تحقيقها.					
5	المساعدة في تحقيق العدالة في تعويض ومكافأة فريق المشروع على جهودهم، استنادً لنتائج قياس الأداء.					
6	توفير معلومات ذات قيمة عن أداء فريق المشروع الحالي والإنجازات المتحققة .					
7	تمكين المؤسسة او الشركة من تحديد الاحتياجات التدريبية لفريق المشروع استنادًا لنتائج قياس الأداء.					
8	تطوير البرامج والسياسات والاجراءات المستخدمة في الادارة والتنفيذ للمشروع .					
9	تقديم الدعم للمؤسسة او الشركة في تطوير وتنفيذ الاستراتيجيات المناسبة للادراة والتعامل مع الاداء الضعيف .					
10	السرية وحفظ الخصوصية لانها تعطي نتائج قياس يعبر عنها بالنسب .					

2- معوقات استخدام نظم /مؤشرات قياس الاداء :-

الرقم	العبارة	اوافق بشدة	اوافق	احيانا	لااوافق	لااوافق بشدة
1	معوّقات فرديّة وتتمثل هذه المعوّقات بمجموعة من العوامل ذات العلاقة بالفرد تتمثل في :- -القدرات والمهارات.					
	-التركيبة النفسيّة له.					
	-التركيبة الاجتماعيّة.					
1	معوّقات مؤسسيّة، وتشمل كلاً من : -الواجبات والمهام الموكولة للأفراد.					
	- التنظيم الاجتماعي.					
	-الموارد والإمكانيات المادية.					
3	غموض الأهداف المرجوة من نظام قياس الأداء، حيث يعتبر غياب الوضوح في ذلك سبباً مباشراً في عرقلة سير عمليّة قياس الأداء بشكلها الصحيح، وبالتالي الوصول إلى نتائج متناقضة تماماً مع أهداف المنشأة.					
4	افتقار بعض القائمين على عملية القياس للموضوعيّة والدقة بالقياس ، والتأثر بعدد من العوامل المحيطة كالعلاقات الشخصيّة والتساهل أو التجبر في بعض الأحيان.					
5	اخرى (حدد فضلاً) _____ _____ _____ _____					