The Key Performance Indicator for Five Construction Projects in Khartoum State: Case Study

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Abstract - Performance measurement is continuous observing and period follow-up of the project achievements which achieved by the specified cost, time, quality and specifications required to satisfy the owner and customer., this study aimed to identify the performance measurement indicators that affect the project and verify that, the means of follow-up and monitoring are used probably to transfer resources to the project system. To verify that, we based on the criteria and equations of the indicator's measurement according to the methodology of (KPI GROUP 2000) .It was applied to five housing projects in Khartoum State., then application of standards and equations are applied and the results were analyzed which indicated that the reasons of unsatisfactory results are due to the absence of follow-up and monitoring means, interpreted in exchange rate and insufficient planning and scheduling. In order to verify the company's experience with these concepts and how to calculate the completion rates, a field survey was conducted as a second part, then a questionnaire distributed to several companies' sector in Khartoum State. So, the descriptive analytical method which is based on the study of reality and phenomenon was used and implemented to the targeted sample study in a company which included the project manager or planning manager according to their scientific degrees, then data was analyzed using the statistical analysis program(package 2019), so most important results were appeared which represented in the absence of advanced means of monitoring and lack of knowledge of the concept or application of performance measurement indicators.

Keywords Performance measurement indicators, construction projects, modern technologies, project monitoring, performance standards, Khartoum State.

المستخلص – قياس الاداء هو رصد مستمر ومتابعة دورية لانجازات المشروع التي يحققها بالتكلفة والزمن المحددين وبالجودة والمواصفات المطلوبة لارضاء المالك او الزبون. هذه الدراسة هدفت الى تحديد دلائل ومؤشرات قياس الاداء التى تؤثر في المشروع والتحقق من وسائل المتابعة والمراقبةللمشروع. وللتحقق من ذلك تم الاستناد على معايير ومعادلات دلائل ومؤشرات القياس حسب منهج (KPI GROUP 2000) وتم تطبيقها على خمسة مشاريع سكنية في ولاية الخرطوم. ثم تم تطبيق المعايير والمعادلات وتم تحليل وتفسير النتائج والتى كان اهم اسبابها غياب وسائل المتابعة والمراقبة وتغيير سعر الصرف وسوء التخطيط والجدولة.وللتحقق من المام الشركات بتلك المفاهيم وكيفية حساب نسب الانجاز تم عمل مسح ميداني كجزء ثاني للبحث على عدة شركات في ولاية الخرطوم ايضا. وتم استخدام المنهج الوصفي التحليلي وتم توزيع استطلاع على عينة الدراسة المستهدفة في داخل الشركة وهو مدير المشروع او مدير التخطيط حسب درجاتهم العلمية ثم تحليل البيانات باستخدام برنامج التحليل الاحصائي SPSS (حزمة 2019) تم التوصل لنتائج مهمة وهي غياب الوسائل المتطورة في المراقبة وعدم الالمام بمفهوم اوتطبيق دلائل ومؤشرات قياس الاداء.

INTRODUCTION

In Sudan, efficient construction projects can provide a solid platform reviving economy and building amore balance and independent economy. They have had to work in every difficult physical, social, political economic and industrial circumstance. Performance is related many topics and factors such as time, cost, quality, client, satisfaction, productivity and safety from many problems and complex issues in performance.

There are many realistic reasons such as closures, amendment of drawing and amendment of the design. in addition, there are many realistic reasons such as closures, amendment of drawing and amendment of the design. In addition, they are other different reasons affecting construction project performance in the Sudan such as poor management and leadership, inappropriate participants, poor relation and coordination absence of motivation, control, monitor, and political problems [6].

These are measurable quantitative measure continuous monitoring and accurate monitor of targets. It is a report of achievements and weaknesses that have been identified for a particular program that may be a project, a job or any work that is predetermined. There are two types of Indicators, leadership performance indicators and background indicators, the first one-measure leadership indicators activities that have a significant impact on future performance, while the background indicators measure the results of leadership indicators, which used because of corrective decisions for improvement [1].

They are means of measuring progress in the project activities and detecting constraints and comparing performance by setting a certain standard of time, cost, quality, customer satisfaction and facing the changes requested by the customer. Measuring the shape, security and safety of the project and the structure of the incentive to receive the project. It is considered as a reference point for the company's projects, improving profits, reducing budgets, working efficiently and paying attention to quality [2].

It is a group of highly experienced engineers and a number of ministers in the United Kingdom - London - the group are headed by The Minister of Housing Conte to review the construction sector and to face the challenges and risks facing engineers in the construction sector. In order to achieve continuous improvement, it decided to develop a comprehensive, integrated and binding framework for all companies and institutions operating in the construction sector by setting specific standards and a set of indicators to measure the company's performance, to compare the internal projects and institutions among themselves.

There are ten measures; the most important are: cost, time, quality, customer satisfaction, change orders and modifications which are used to push the construction industry forward, also to achieve the desire of project clients to deliver their projects on time, on budget, with high efficiency, free of defects and safety [1].

Performance Evaluation:

The performance of the evaluator (individual, institution or any work system) is subjected to judgment or appreciation in quantitative and qualitative terms using some reference measures with various elements of the calendar through a process.

Indicator

A quantitative or qualitative variable provides a simple and reliable way to measure achievement or to detect changes associated with development intervention or help to estimate performance [2] .

Performance

The work or activity achieved by the team or the individual in the organization is subject to quantitative and qualitative measures.

Standard

It is a benchmark and a guide to specifications that can be guided and relied upon when evaluating performance at the institution's levels [3].

Key Performance Indicators Characteristics

This is evidenced by its close association with the objectives related to the institution, Easy to understand and to apply, repeated measurement of achievement. Implemented by higher management for it is impact on success factors and ongoing corrective measures [4].

Implementation of the Key Performance Indicators in General

The concept is implementation by follow the steps carefully Identify and select indicators that suit the institution ,Involve all employees, suppliers and customers in the selection ,Setting the standards and measurement methods needed to apply them, Linking standards and principles to the institution's

strategy, Measure the actual performance and then compare with the standards and plans established ,Select a team to follow through a particular database to read distractions, Implement the indicators and corrective decisions to improve performance after discovering strengths and weaknesses in performance and Reporting for internal and external comparison work[5].

RESEARCH IMPORTANCE AND DEFINITION

Perform measurement indicators to contribute effectively in construction project production with standard specifications is will satisfying conditions of time, cost and quality. The success of any work or project depends on the performance indicators measurement. Construction sector considered as a pillar of economic development in any country because of it is highly contribution in national income. The construction project in Sudan has recently faced many problems, conflicts, risks and conflicts, including

• Skewed costs, scheduling and non-conformity of specifications as planned.

• Many projects have been stopped due to differences in performance and disagreement.

• Companies are not keeping up with modern technologies and in adequate training.

There are Six stages for each project:

    i. Feasibility study stage, A.
    ii. Contracting stage, B.
    iii. Implementation stage, C.
    iv. Defect correction stage, D.
    v. Project life end, E.

RESEARCH OBJECTIVES

• Study the concept of performance measurement indicators in construction projects and how they are applied to projects under kpi group 2000.

• Inventory and analysis of the most influential indicators on the construction project.

• Show the achievement ratios, including identifying the weaknesses of the project and interpreting the result.

• Analysis the factors affecting the performance of the project in construction companies, examining their follow-up and monitoring methods through a field survey of several companies in Khartoum State.

• To reveal the extent to the advanced methods and techniques used in planning and monitoring up to date

PREVIOUS STUDIES

Walla Abdul Karim[6] - The study aimed to analyze local factors that affect the performance of projects in Sudan, identify the perceptions of owners, consultants and contractors, identify points of disagreement, problems and obstacles, and evaluate the degrees of disagreement and agreement through a field survey of several companies, (Khartoum State).

The most important results were the identification of factors and influences that affect performance, the most important of which is financing and contract procedures, and the most important recommendations were Facilitate work in financing and payments and trying to reduce disputes. Factors Influencing Completed Construction Projects in Sudan - Sudan University for Science and Technology 2015.

Hani Abdul Shakur. The objective of the study is to identify the set of indicators that can be implemented by project managers in the performance of measuring the level of companies in (Saudi Arabia) by means of a questionnaire of several companies and statistical analysis. The results were that the most important indicators are customer satisfaction, project safety, business efficiency and the most important recommendations are to fight traditional financial measures.

Khalid Al-Qatari and Ibrahim Al-Masilahi [7] - Indicators of the performance of contracting companies in Saudi Arabia - Department of Civil Engineering - King Saud University 2011.

Tariq Ali Al-Jamaz [8]- This study aimed to show the impact of administrative factors on construction projects in (Qatar) with a field survey after the boom that occurred since 2005.

The most important results are a significant impact of the high management efficiency, leadership abilities and skills in some companies and, lack of others. The most important recommendations to investigate, scrutinize and establishment of some companies. Assessing the factors causing the delay of construction projects - Qatar 2010.

TABLE 1: TIME INDICATOR AND DEFINITION

Indicators	Definitions
Excepted time for design	Changes between real design time in stage (B) and estimated design time in stage (A).
Expected time for construction.	Changes between real construction time in stage (C) and estimated construction time in stage (B).
Expected design time Construction	Changes between real design and construction time in stage (C) and estimated design and construction time in stage (A).
Expected time to remedy Changes requested by the customer.	Description of changes and orders requested by the Customer and between real construction time in stage (C)
Expected time to remedy Errors and flaws.	Time pledged to correct errors, defects and maintenance in stage (C) and estimated time to correct defects in the contract in stage (D).

TABLE 2: COST INDICATORS AND definition

Indicators	Definition
Expected cost of design.	Changes between the real design cost in stage (C) and the estimated design cost in stage (A).
Expected cost for construction	Changes between the real construction cost in stage (C) and the estimated construction cost in stage (B).
Expected cost of both design and construction	Changes between real cost of design and construction in stage (C) and estimated cost of design and construction in stage (A).
Expected cost to remedy changes requested by the customer	Description of changes requested by the Customer and the real cost of construction in the phase (C).
Expect cost to remedy changes requested by the owner.	Description of the cost agreed in correcting errors and defects in stage (C) and the estimated cost of correcting errors and defects in stage (A).

TOOLS AND METHODS

Use mathematical equations and criteria for calculating performance indicators according to KPI GROUP 2000 methodology, which are applied to five projects in Khartoum State executed by the same company under the following research hypotheses

• What are the performance indicators that affect the project mostly?

• Do companies determine the monthly achievement rates and making critical decisions to improve?

• Are these operations carried out based on mathematical methods, the appointment and allocation of resources?

Use Questionnaire to collect information from construction companies in Khartoum State to verify the application of performance indicators and some planning and scheduling information.

Analysis of the results of the questionnaire using the Statistical Analysis Program Package 2019[10]. This method accurately describes how to performance KPI group 2000 calculates indicators in the construction sector

TABLE 3: QUALITY INDICATORS AND definition

Indicator	Definitions
Errors	Shows errors in the Progress of the Project.
Quality problems at the use stage.	Expresses quality problems and seeks to correct them.
Quality problems at the end of the period correcting of defects and errors.	Explain the issues agreed up on in the contract concerning quality.

TABLE 4: CUSTOMER SATISFACTION INDICATOR AND DEFINITION

Indicator	Definition
omer satisfaction with standard Product specifications.	Expresses the owner satisfaction and acceptance of the Product by a specific standard.
Customer satisfaction with standard service specifications	Expresses the owner satisfaction with the service to a certain standard
Customer satisfaction with the Product (special requirements(	Expresses Customer satisfaction with the Product according to requirements.

TABLE 5: CHANGE ORDERS DEFINITIONS AND INDICATORS

Indicators	Definition
Changes requested by the owner	Individual changes of orders are approved by the owner in Stage (B) and Stage (C).
Changes requested by contractor or project manager.	Individual changes of order approve by the Project manager in stage (B) and stage (C).

TABLE 6: TIME INDICATOR FACTORS

Indicator	Factor
Real design time in stage B	b
Estimated construction time in stage A	c
Estimated design time in stage A	a
Estimated contracting time B	d
Real contracting time in stage B	e
Real construction time in stage C	f
Additional time for the changes requested by the owner in stage (B-C	g
Real time uniforms are taken to correct the defective warranty period in the stage (C-D)	k

*All the duration by the weeks

TABLE 7: TIME INDICATOR EQUATIONS

Indicator	Equations
The forecast design time	(b-a)/a
The forecast construction time	(a-e)e
The forecast design and construction time	(a +b)-(c +f)/(a +c)
The forecasted time to remand the changes required by the owner	g/d
The forecasted time to remand the changes required by the project manager	h/d
- Time to correct bugs or flaws	Varies

TABLE 8: COST INDICATOR FACTOR

Indicator	Factor
Estimated cost of the stage (A	L
The real design cost in stage (B)	m
Estimated construction cost in stage (A	n
Real construction cost in stage (B)	p
The cost of changes required by the owner in stage (B-C)	q
Estimated cost of construction esquire meter in stage (A)	r
Real cost of construction meter in stage (B)	s
The cost of correcting the defect (C-D)	t

TABLE 9: RESULTS OF PERFORMANCE INDICATORS FOR THE FIVE PROJECTS UNDER STUDY

| Indicators	Results for five projects	Explanation
Time indicators Figure 2: Expected design time (consultant).	The Real design time more than estimated time 60% in project (1), 43% in project (2), 50% in project (3 and 4),	Due to the inaccuracy of the project scheduling, as for project (5) 40% different due to the efficient performance of the work team and the accuracy of scheduling
Expected construction time (contractor- project manager).	The Real construction time is more than the estimated time by 98% in project (1 and 3), 94% in project (2), 97% in project (4),92% in project (5)	increase in the prices of materials, machinery and labor prices - change of exchange rate, and the presence of obstacle son the site
Cost indicators Figure 3: Projected cost of (design consultant).	Design cost beyond expectations by 8% in project (1), 12% in project (2), 25%in project (3), 10% in project (4) 16% in project (5)	Increase in time the design deviates the cost of the design.
The specific cost of construction (contractor- project manager).	Construction cost beyond expectation by an increase 76% in project (1), 40.27% in project (2) 25%, in project (3) 37% in project (4), 26% in project (5)	Increase in the prices of machinery and equipment's and the delay in providing the necessary cost in some stages
Customer Satisfaction Indicator Figure 5: Contractor Consultant.	Customer acceptance of the Product from (4 -10) in project (1), (6-10) in project (2) (4-10) in project (4)	The Customer is not satisfied with the projects as for project (5) the customer was satisfied with it (7-10)
Quality Indicator Figure 4: Contractor - Project Manager.	Error rate 45% in project (1), 47% in project (2), 45% in project (3), 40% in project (4)	.The project is acceptable and good for some projects, as for project (5) the error rate was 30% which means that the project is very good
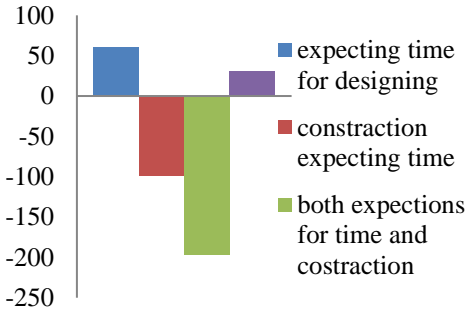
Figure 1: Time indicators
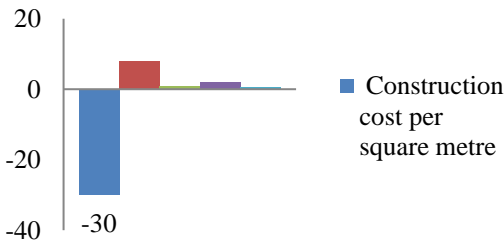
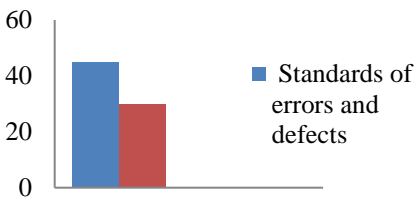**Figure 2: Cost Indicators**

Figure 3: Quality Indicators

Part 2 (Field Survey)

To measure the commitment of companies or institutions operating in the construction sector to the concepts and techniques of monitoring and measuring performance and based on the approach followed in the research, a field survey was designed and used as an appropriate tool to achieve the goals and follow the descriptive analytical approach by targeting project managers in particular according to their grades, scientific degrees and their various experiences in the public and private sectors in Khartoum state.

The field survey is consist of four sections, the first section includes general data and information to identify the sample of the study, while the second section is deal with planning which is considered as the most important operation carried out by the project manager and it gives an important information of time, also to know the means of planning used to adjust project recourses and

processes. The third section is related to the cost and how to calculate and the reasons for its deviation and how to correct it.
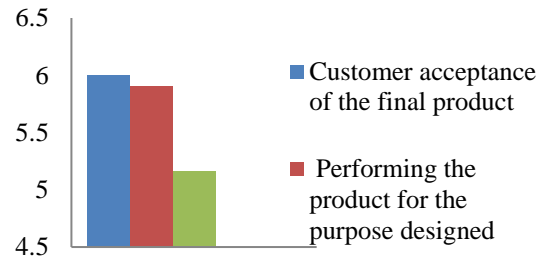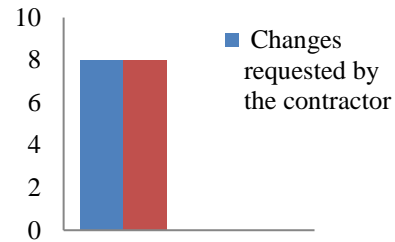

Figure 4: Customer Satisfaction Indicators

Figure5: Orders change indicators

TABLE 6: FOR STATISTICAL ANALYSIS

An answer	frequent	Percentage
The modern method of monitoring	4	8.7٪
Comparison of actual planning and work done	25	54.4٪
The basic linking step to complete the project	3	6.5٪
All of the above	14	30.4٪
Total	46	٪100

*Source Prepared by the Researcher, using SPSS ،2019.

The fourth section is deals with performance indicators as quantitative and qualitative measures, which are used to follow-up progress and to know goals delaying. It was to inquire about performance indicators in dealing see Table (6 and 7) with them as a means of comparison or a binding method to which they are fully committed.

Also, to know if there a database to the company dedicated to measuring the performance of all projects and what are the disgrace Indicators also the extent of interest in performance indicators other than the cost, time and quality indicator see Figure 7.

TABLE 10: INDICATORS RESULT

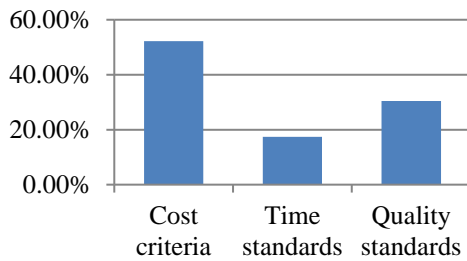| An answer	Frequency	Percentage
Time factors	9	19.6٪
Cost factors	15	32.7٪
Quality factors	7	15.2٪
Customer satisfaction	5	10.8٪
Productivity factors	1	2.2٪
Healthy and safety factors	2	4.3٪
Environmental factors	3	6.5٪
Experience factor team and expert factors	3	6.5٪
Risk factors	1	2.2٪
Total	46	٪100

Figure 6: The most effective performance indicators criteria
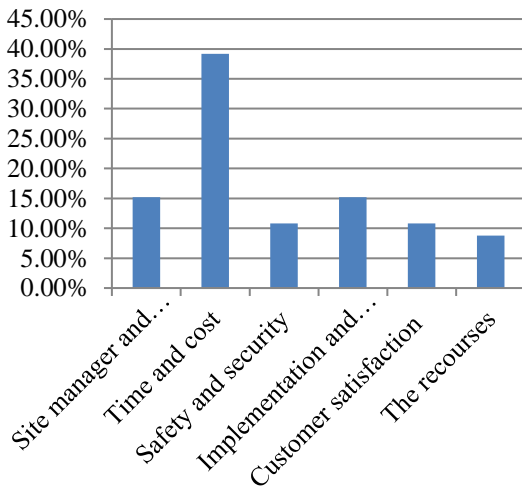

Figure 7: Performance indicators in companies

RESULTS AND ANALYSIS

The percentage of errors and defects for projects respectively by all so, it's considered as acceptable and addressed in a short time according to the KPI group. Customer is not satisfaction for projects (1, 2, 3, and 4) other than project (5) customer satisfied. The results showed that most experiences range from (11-15) years by 45.6% and that the common scientific qualification is bachelor and master's by an equal 39.6%, number of projects implemented by the company range from (5-10) projects by 34.8% and number of projects from the government sector is by 21.7%.

The results of the second section are showed that most of engineers have a lack of experience by 67.4%, the majority agreed that good planning reduces deviation of the tasks of the project by 43.5%, also the majority confirmed that construction firms in Sudan are suffering from lack of training and poor planning by 56.5%. Also 58.7% of them cited that.

The main reason for poor planning is inadequate training and lack of modern monitoring methods, which identify most problems, then, costs, increased and deviated. The majority agreed that the increase and lack of resources and interrupted of exchange rate is the cause of deviation by 52.3% while the unsuitable structural organization and project environment is the second reasons by 41.3%.

In the most important section of performance indicators in construction projects, showed that the majority agreed that it is effective way that to compare actual planning with the scheduling one by 54.4%.

To identify the most effective indicators that used, the majority indicated that, the cost index is the most important by 52.2 percent. To determine the order of the indicators according to their importance to the project manager, the results showed the following cost, time and then quality by 39.2%.

Taking into account the criteria or indicators, It was also found that the financing mechanism is a major reason for the increasing the cost index by 50%, and the contrast analysis and lack of commitment to cost management is the only problem that increases the cost deviation index by 54.3%. See Figure (10 and 11). It is notes that the cost of design is out of expectation for projects this is due to use approximate methods. Also notices that The Most important factor affecting the Project for most companies is cost only. It is very important and urgently to practice training for project managers

on the latest means of monitoring and updated planning methods.

CONCLUSION

For the five projects under study, the results showed, the real design time of the projects was greater than estimated, due to the lack of planning accuracy and poor scheduling as the main reasons other than project (5) different due to the efficient perform of the work team and the accuracy of scheduling. Real construction time was more than planned one for projects respectively of all projects this is due to the lack of materials and mechanisms to the specifications signed in the contract and the presence of obstacles in the sites. The actual cost of construction is more than scheduled one respectively by all projects this is due to the increase in prices of materials, labor, machinery, and labors, also delaying in payments due to the political and economic circumstances in the country represented important reason.

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