Performance Indicators for Construction Project

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Abstract— **A performance indicator (PI) is industry jargon for a type of performance measurement. PIs are commonly used by an organization to evaluate its success or the success of a particular activity in which it is engaged. Sometimes success is defined in terms of making progress toward strategic goals, but often success is simply the repeated achievement of some level of operational goal. Accordingly, choosing the right PIs is reliant upon having a good understanding of important things to the organization. Important things often depend on the department measuring the performance, the PIs useful to construction activities are different than the PIs assigned to accounting. Because of the need to develop a good understanding of what is important, performance indicator selection is often closely associated with the use of various techniques to assess the present state of the project, and its key activities. These assessments often lead to the identification of potential improvements; and as a consequence, performance indicators are routinely associated with 'performance improvement' initiatives. Performance indicators associated with construction projects have got very little attention and somehow there use has been very limited and even limited use is focused on product oriented indicators. This means that the indicators are mostly used for review purposes after project is completed and hence are unable to control the project .There is a need of a great deal of attention on pre and present or process stage of construction project especially for projects in developing countries like India where the adverse conditions are always at the corner including at a preliminary stage or even before the start of a project. This paper describes the idea behind indicators and describes some of the very important indicators regarding the construction projects and also emphasizes the point of value management as one of the most important performance indicator in construction project.**

Index Terms— **performance indicator, construction project, India**

I. INTRODUCTION

Performance indicators are measures of project impacts, outputs and inputs that are monitored during project implementation to assess progress toward project objectives. They are also used later to evaluate a project's success Indicators organize information in a way that clarifies the relationships between project's impacts, outcomes outputs and inputs and help to identify problems along the way that can impede the achievement of project objectives.

Key performance indicators define a set of values used to measure against. These raw sets of values, which are fed to systems in charge of summarizing the information, are called indicators. Indicators identifiable as possible candidates for PIs can be summarized into the following sub-categories

[1]Quantitative indicators which can be presented as a number.
[2]Practical indicators that interface with existing company processes.
[3]Directional indicators specifying whether an organization is getting better or not.
[4]Actionable indicators are sufficiently in an organization's control to affect change.
[5]Financial indicators used in performance measurement and when looking at an operating index.

Key performance indicators, in practical terms and for strategic development, are objectives to be targeted that will add the most value to the business. These are also referred to as key success indicators.

II. IMPORTANT ASPECTS

Performance indicators (PIs) are ways to periodically assess the performances of organizations, business units, and their division, departments and employees. Accordingly, PIs are most commonly defined in a way that is understandable, meaningful, and measurable. They are rarely defined in such a way such that their fulfillment would be hampered by factors seen as non-controllable by the organizations or individuals responsible. Such PIs are usually ignored by organizations.

In order to be evaluated, PIs are linked to target values, so that the value of the measure can be assessed as meeting expectations or not.

A. Identifying indicators of organization

Performance indicators differ from business drivers and aims (or goals). A school might consider the failure rate of its students as a key performance indicator which might help the school understand its position in the educational community, whereas a business might consider the percentage of income from returning customers as a potential PI. Similarly construction projects have indicators like cost, on time completion etc…

The key stages in identifying PIs are

- Having a pre-defined business process (BP).
- Having requirements for the BPs.
- Having a quantitative/qualitative measurement of the results and comparison with set goals.
- Investigating variances and tweaking processes or resources to achieve short-term goals.

A PI can follow the *SMART criteria.* This means the measure has a Specific purpose for the business, it is Measurable to really get a value of the PI, the defined norms

have to be Achievable, the improvement of a PI has to be Relevant to the success of the organization, and finally it must be Time phased, which means the value or outcomes are shown for a predefined and relevant period.

The Construction industry of India is an important indicator of the development as it creates investment opportunities across various related sectors. The construction industry has contributed an estimated 3,84,282 crore to the national GDP in 2010-11 (a share of around 8%). The sector is labor-intensive and, including indirect jobs, provides employment to more than 35 million people. Hence the performance analysis of a construction work is of utmost importance.

III. LITERATURE REVIEW-

Budget, schedule, and quality are the major goals in construction projects. A variety of factors determine the success or failure of the achievement of these objectives. Because the present study focuses on performance indicators for budget, schedule, and quality performance of construction projects, a brief review of related published works is appropriate. Baker et al. (1983) conducted a survey of successful and unsuccessful projects involving manufacturing, construction, government, services, transportation, and other projects and concluded that there are seven critical factors for project success. Performance measurement involves the collection and comprehensive analysis of information about various activities, specifically work in place and the corresponding work-hours over a given period of time. Work hours, quantity and productivity are evaluated against the planned or baseline values used in project estimates (Lin and Shen 2007). In other words, to accurately identify performance indicators associated with a construction process, a base line must first be determined. A historical base line defines an average of past performance. Knowledge of past performance gives a reference point to benchmark against which to measure future performance. Benchmarking aims at comparing the performance of firms relative to each other, allowing these firms to recognize their weaknesses and strengths and by finding examples of superior performance, can adjust their policies and practices to improve their performance (Mohammad et al. 2007). This is also applicable to projects and a base line can be compilations of years of historical data collected on previous projects or a quick measurement of current production prior to initiating a change for improvement. Performance indicators can either be quantitative results of a construction process or by quantitative measures such as workers' behavior on the job (Cox et al. 2003).

Prior to the 1980s, project performance was narrowly defined as meeting cost and time objectives, and adhering to a product specification (Bryde 2003). However, research during the 1980s and 1990s aimed at investigating the dimensions of project success has led to a common agreement that project success is multidimensional and that different people measure project success or performance in different ways and at different times (Ugwu and Haupt 2007). This, therefore, gave rise to different ways of measuring project performance. Key Performance Indicators, according to Cox et al. (2003) are compilations of data measures used to assess the performance of a construction operation. They are the methods used to evaluate the performance of a particular task. These evaluations compare the actual and estimated performance in terms of effectiveness, efficiency and quality in terms of both workmanship and product. In a study by Chan and Chan (2004), a set of Key Performance Indicators (KPI) were developed through a literature review and then subjected to validity test using a set of three case studies. Findings from the study revealed that the KPIs in general are good indicators of the performance of construction projects and provide a useful framework for measuring and comparing project performance. Cox et al. (2003), on the other hand, focused on the managements' perception of KPIs for construction activities. They generated a set of quantitative and qualitative performance indicators through a literature survey before subjecting them to the views of the respondents (Project managers and construction executives). The findings revealed a substantial difference between construction executives and project managers' perception on kpis.

In order to accurately identify the PIs associated with the construction process, a baseline must first be determined. A historical baseline defines an average of past performance. Knowing past performance gives a reference point to benchmark against and to measure future performance. A baseline can be compilations of years of historical data collected on previous projects or a quick measurement of current production prior to initiating a change for improvement. Oftentimes, any variation from the baseline expected. Performance level is an indication of a variance in performance. Variances can be either positive or negative and should bring about a cause for further management interpretation to determine root causes.

IV. QUANTITATIVE PERFORMANCE INDICATORS

The most commonly accepted performance indicators are those that can be physically measured by dollars, units, or man-hours. Like any other form of business, construction companies look first to the areas which show a change in the amount of revenue generated. Without a measurable improvement in terms of a cost reduction or a quantifiable increase in productivity, most managers will consider the change a failure. A review of the definitions provided in the literature of these quantitative types of measurements is therefore warranted.

Quantitative units of measurement should remain simple, easy to gather, and easy to apply, while not placing a heavy burden on field personnel. In most cases, the same units used in the estimating/costing system can be used in the productivity measurement system as well.

A. Units/MH

The Units/MH reporting method is one of the two basic quantitative reporting approaches most commonly found in the construction industry. This method measures the number of completed units put in place per individual man-hour of work (Alinaitwe et al. 2007). This method takes little time to implement and gather information and can be used on any basic task or activity. At the end of evaluation the project manager would be able to pass an objective assessment of a project's success or failure and make immediate adjustment where possible.

B. Rs/Unit

The Rs/Unit performance indicator is the second of the basic quantitative reporting methods. The definition is simply the rupees value associated with putting one complete unit in place, including materials costs, labor costs, waste, and equipment costs. Again, implementation of this method is very easy and generally sufficient for monitoring basic tasks. The two methods, Units/MH and Rs/Unit, offer a simplistic approach to productivity measurement and, based on the literature review, are perhaps the most widely used. The unit of measurement may be easily changed, and the methods provide quick data collection for most crafts on the job. When the units encompass a greater amount of work effort, this performance indicator fails to break down the elements of production to a measurable scale. For example, the placing of one masonry unit can be broken down to the number of man-hours per unit or the rupees per unit with little mathematical manipulation. However, in contrast, the placement of one pressure vessel does not readily separate into measurable units quite so nicely. When the magnitude of the job surpasses easily quantifiable
Components, new performance indicators must be used. At this point, accurate performance reporting requires baseline references or detailed estimates and schedules to properly monitor operations. Unit cost is a measure of relative cost and is defined as the final cost sum divided by the gross floor area. It is associated with putting one complete unit in place and includes the material costs, labor costs, and waste and equipment costs to give the final cost sum. According to Chan and Chan (2004), it is given as

$$UC = FCS / GFA \text{ (square meters)} \quad \text{----------} \quad (1)$$

Where UC = Unit Cost

FCS = Final Contract sum

GFA = Ground Floor Area.

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C. Cost

Job Cost reporting may also be used to predict the success or failure of the overall construction effort.

Job cost involves monitoring performance by comparing current costs allocated for the work against budgeted costs allocated for the work in place, completed to date. In their work asserted that clients are less worried by the initial price but rather interested in an early prediction of total amount they will have to pay and the variance between (Ojo et al. 2006). This approach does not generally single out particular operations, but provides an overall summary of adherence to the budget.

D. On-Time Completion

One of the primary requirements particularly of commercial clients but also equally important for public sector agencies is to be able to predict the time for Completion with some degree of reliability. Buildings form very large parts of any client's investment in his business and the use of a building is usually critical to the success of the client's continuing function. It therefore suffices to say that the business of project execution is definite about time. The on time completion Indicator has three variations.
According to Chan and Chan (2004), they are
Construction time is the absolute time and is calculated as the number of days/weeks from start on site to practical completion of project.

CT = Practical completion date – Project commencement date.

Speed of construction is the relative time which is defined as gross floor area divided by construction time.

Speed of Construction = Ground Floor Area/ Construction Time (days/weeks)

Time variation is measured as percentage increase or decrease in the estimated project duration in days/weeks discounting the effect of extension of time (EOT) granted by the client.

TV = CT – Revised Contract Period
---------- * ---------- 100% -----

Where RCP = Original Contract time – EOT.

The On-Time Completion method parallels the job cost approach in that it serves as a holistic measurement of performance according to schedule duration, and the two are often incorporated to better understand the current construction performance. On-time milestone completion determines if construction is proceeding according to schedule. Acceptable productivity is measured solely on the basis of time spent with respect to the overall scheduled duration.

E. *Resource Management*

Calculating productivity changes by the amount of materials, tools, and equipment expended during the construction operation is another quantitative performance indicator.

Resource Management is a valuable tool for monitoring the material waste prior to a change and then comparing that amount to the waste incurred after the initiated change. In organizational studies, resource management is the efficient and effective deployment of an organization's resources when they are needed. Such resources may include financial resources, inventory, human skills, production resources, or information technology (IT). In the realm of project management, processes, techniques and philosophies as to the best approach for allocating resources have been developed. Resource management is a key element to activity resource estimating and project human resource management. Both are essential components of a comprehensive project management plan to execute and monitor a project successfully. As is the case with the larger discipline of project management, there are resource management software tools available that automate and assist the process of resource allocation to projects and portfolio resource transparency including supply and demand of resources.

One resource management technique is resource leveling. It aims at smoothing the stock of resources on hand, reducing both excess inventories and shortages.

The required data are the demands for various resources, forecast by time period into the future as far as is reasonable, as well as the resources' configurations required in those demands, and the supply of the resources, again forecast by time period into the future as far as is reasonable.

The goal is to achieve 100% utilization but that is very unlikely, when weighted by important metrics and subject to constraints, for example meeting a minimum service level, but otherwise minimizing cost.

The principle is to invest in resources as stored capabilities, and then unleash the capabilities as demanded.

F. Quality Control or Rework

Quality control, or QC for short, is a process by which entities review the quality of all factors involved in production. This approach places an emphasis on three aspects

[1]Elements such as controls, job management, defined and well managed processes, performance and integrity criteria, and identification of records

[2]Competence, such as knowledge, skills, experience, and qualifications

[3]Soft elements, such as personnel, integrity, confidence, organizational culture, motivation, team spirit, and quality relationships.

Quality control emphasizes testing of products to uncover defects and reporting to management who make the decision to allow or deny product release, whereas quality assurance attempts to improve and stabilize construction techniques and associated processes to avoid, or at least minimize, issues which led to the defect in the first place.

Rework traditionally is responsible for 6–12% of the overall expenditure for a construction project. However, the costs associated with rework are at a premium and they greatly increase the overall cost of the job (Zulu and Chileshe 2008) Calculating the change in the number of man-hours and material costs for repairing work in place or rehandling materials can be an effective tool for measuring overall project performance. By reducing the amount of rework on a job, the profits associated with the specific task can increase dramatically.

G. Percent Complete

The Percent Complete method can be estimated by the foreman or supervisor at the work site. This method is useful for relatively minor tasks, usually short in duration, where other more costly and time-consuming methods cannot be justified (Thomas and Kramer 1988). This generally accepted method is widely used in preparing the monthly application for payment request. This approach to the percent complete method of reporting is only as good as the person responsible for the evaluation. As a project manager gains more experience, the method gains accuracy. An alternative Percent Complete method would take measured quantities completed divided by the total estimated quantity to determine Percent Complete progress.

H. Earned Man-Hours

The Earned Man-Hours approach is one of the more popular baseline methods for measuring performance. Man-hours are earned for completed work in place. By multiplying the estimated unit rates by the amount of work completed units. One arrives at the number of man-hours earned for that particular task to date. Subtracting the actual number of man-hours charged to a task from the number of earned man-hours provides an indicator of job productivity.

I. Lost Time Accounting

Lost Time Accounting is another important area that can easily be turned into a large return. Like rework, lost time is wasted work hours with no return. This Method measures productivity according to the number of man-hours lost due to idle time such as waiting for materials, instructions, or daily work orders. By reducing the average worker idle time, the productivity of the workers will increase. The only expense to the company would be to preplan the construction operation to increase efficiency.

J. Punch List

A punch list is generally a list of tasks or "to-do" items. In the U.S. construction industry, a punch list is the name of a contract document used in the architecture and building trades to organize the completion of a construction project. In other places, it is also commonly known as "snag list".

In the United States construction industry, contract agreements are usually written to allow the owner to withhold the final payment to the general contractor as "retainage". The contractor is bound by the contract to complete a punch list of uncompleted contract items in order to receive final payment from the owner.

The designer (typically a licensed Professional Architect or Engineer), is usually also incorporated into the contract as the owner's design representative and agent, to verify that completed contract work has complied with the design.

In most contracts, the General Conditions to the Contract for Construction requires the Contractor, when he believes it to be so, to declare the construction project to have reached "substantial completion" and request a "pre-final" inspection. According to the General Conditions (AIA A201 Section 9.8.2), the Contractor prepares and submits to the Architect a comprehensive list of items to be completed or corrected. This snag list, generated by the Contractor is known as the punch list. Upon receipt of the Contractor's list, the Architect then inspects the work to determine if the Work is "substantially complete." Final contractor payment is made when the punch lists of items are completed to meet the project design required by the contract, or some other mutually agreed resolution for each item is reached. Examples of punch list items include damaged building components (e.g. repair broken window, replace stained wallboard, repair cracked paving, etc.), or problems with the final installation of building materials or equipment (e.g. reinstall peeling carpet, replace missing roof shingles, fire and pressure test boiler, obtain elevator use permit, activate security system, etc.).

The phrase takes its name from the historical process of punching a hole in the margin of the document, next to one of the items on the list. This indicated that the work was completed for that particular construction task. Two copies of the list were punched at the same time to provide an identical record for the architect and contractor.

The final quantitative performance indicator to be discussed in this study is the Punch List item. There are numerous ways to report punch list items, including the total value of the punch list items versus total contract amount, or the man-hours for punch items as a percentage of the total man-hours for the entire job. The use of punch list reporting occurs at the end of any particular task or project.

V. QUALITATIVE PERFORMANCE INDICATORS

Qualitative performance indicators are not commonly accepted as reliable performance and productivity evaluation tools due to their perceived difficulty and/or inability to be measured. Unlike quantitative performance indicators, qualitative indicators do not appear in the estimating/costing system utilized by the majority of construction films. According to the 1997 Edition of Webster's Dictionary, the definition of qualitative is ''relating to, or involving quality or kind.'' Patton (1986) offers a more technical definition in the context of program evaluation ''Qualitative data consists of detailed descriptions of situations, events, people, interactions, and observed behavior; direct quotations from people about their experiences, attitudes, beliefs, and thoughts; and excerpts or entire passages from documents, correspondence, records, and case histories.'' For the purposes of this research, qualitative indicators are defined as those indicators that have the potential for measuring the behaviors of workers on the job site.

The following qualitative performance indicators are addressed in this research, and each item will be defined individually in the remainder of this section

A. Safety

Safety is a major concern for every construction company, regardless of the type of work performed. Safety is measured quantitatively through incidence rates and Experience Modification Ratings i.e. EMR. The objective of a safety program is to eliminate losses due to poor working practices that could impact workforce well-being and it is therefore classified as a qualitative PI in this study. Safety may be used for performance reporting by measuring the change in the number of accidents or safety-related problems on the job site. Poor safety can have a detrimental impact on the job. In the case of accidents, work may stop in one area of the job, worker morale may drop, and productivity will decline. Tracking job performance using safety may allow the company to see benefits due to worker training or due to modification of the construction process. These changes may not always result in immediate cost savings. Also tracking job performance using safety allows an organization to see benefits and correlation between worker training on safety issues and company's productivity (Ojo et al. 2006)

B. *Employee Turnover*

Turnover is a problem that plagues the construction industry and indirectly increases overall costs. Measuring the costs associated with workers leaving the company to seek work elsewhere, and the cost of training new employees to fill those positions, is a valuable tool for determining overall construction performance. High percentages of employee turnover results in lower average worker skills on the site, which can affect the quality of work being performed. Furthermore, funds spent training new employees increase the cost of construction operations. By monitoring the change in company turnover, impacts on performance may be measured (Chitkara 2006).

C. Absenteeism

Performance evaluation based on absenteeism offers more concrete units for measurement. Absenteeism can be measured by the change in the number of lost man-hours due to absences over the duration of the construction project. A decrease in the number of lost man-hours directly results in increased production or output on the job. Decreasing the number of absences helps maintain the budgeted manpower needed to complete the work according to schedule.

D. Motivation

The most difficult indicator to measure is worker motivation. For this research, motivation is defined as the worker's attitude towards the job and the environment created on the job site. The definition can be taken one step further to mean the willingness of employees to perform the task at hand to management's satisfaction .Although qualitative performance indicators may not be categorized under an estimating/cost account, their impact on project costs are very real.

Qualitative indicators play an important role in practically every area of the construction process. Managers who do not incorporate these qualitative indicators may fail to recognize one important area that can have an impact on performance evaluation.

After reviewing all the study material I come to a conclusion that among all the indicators what matters most is the VALUE of the project and if an proper anticipation of project cost considering all the necessary aspects and variables both before and during project work could be known, then it would be having a much higher chances of succeeding than failing, and that's where the study of value management processes is a must. It as an important indicator for a success. That's why a sample questionnaire is being prepared after reviewing literature to act as a check list for an administrator of the project to identify the important points and whether they have been covered while planning, also to check if sufficient funds are provided or not, and to have a discussion on those so that there would be much lesser unknown problems arising in the project work.

I would like to propose to consider following points at every "*value management* planning" stage of a project. It can be used to check if all the aspects have been considered while preparing budget. After all, *precaution is much better than treatment.*

Following is a list of indicators summarized from literature regarding the VM (Value management) and the importance of budget sessions.

Sample Q for Predicting indicators

Sr.	PI
1	Satisfaction of the time when the budget workshop is conducted
2	Disciplines of participants
3	Professional experience of participants
4	Knowledge of participants
5	Numbers of budget VM workshop facilitated
6	Client's support
7	Clear objectives of budget
8	Relevant departments' support

Sample Q for Process Performance Indicators

Sr.	PI
1	Time spent on preparation before workshop
2	Background information collected
3	Number of site visits
4	Duration of each phase
5	Satisfaction of the techniques used in each phase
6	Interaction among participants in each phase
7	Project givens/assumptions clarified
8	Efficiency of idea generation

Sample Q for Outcome Performance Indicators

Sr.	PI
1	Duration to complete the report
2	Quality of the report
3	Percentage of action plan carried out
4	Proposed change on project investment
5	Proposed change on construction schedule
6	Reducing the difficulty of construction, i.e., rework times
7	Improving communication and understanding among stakeholders
8	Deliberating the alternatives
9	Client's satisfaction
10	Participants' satisfaction
11	Facilitator's satisfaction

VI. CONCLUSION

Construction project professionals need to better monitor and control their organization's performance at both the field and office levels. The PIs identified by this study offer a sound approach towards completing successful project-level performance monitoring and evaluation. It is recommended that more in-depth studies should be performed to better understand PIs. From literature review following PIs is found important in Indian scenario. They are Units/MH, Rs/Unit, Cost, On-Time Completion, Lost Time Accounting, Quality Control or Rework, Percent Complete, Earned Man-Hours, Resource Management, Quality Control or Rework, Percent Complete, Earned Man-Hours, Lost Time Accounting, Punch List, Motivation, Employee Turnover, Absenteeism, Safety etc..and if proper care at the initial stage is taken, all these indicators can be controlled

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