Determination of Key Performance Indicators for Residential Building

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Abstract- *The construction industry is believed to be under-achieving with low profit stability due to poor performance and productivity. A right indicator will lead correctly for measurement and evaluation of performance on construction site. This research focuses on identification of key performance indicator in construction industry. Literature supports the dependency of productivity on KPIs and the indicators in description. Quantitative performance indicators and qualitative performance indicators were fixed using Delphi process on which a questionnaire survey was conducted. On identification of perceived key performance indicators (KPIs) basic statistical analysis was done and frequency distributions provide evidence in support of some of the hypothesis of the research.*

Keywords *- Key performance indicators, Performance, Productivity, Delphi process*

I. INTRODUCTION

What is KPI? KPI is a measuring tool which tells weather the progress is as per plan. It helps to focus on strategies and goals planned for the particular activity. KPI provide a snap shot of company's specific business situation (Miroslaw 2009)[3].

KPIs evaluate the success of an organization or of a particular activity in which it engages. Often success is simply the repeated, periodic achievement of some levels of operational goal (e.g. increase of productivity, zero defects, customer satisfaction, etc.), and sometimes success is defined in terms of making progress toward strategic goals accordingly, choosing the right KPIs relies upon a good understanding of what is important to the organization.

Performance indicator in this paper is mainly defined as quantitative indicators (e.g. unit/MH) which measures quantity progress and qualitative indicators (e.g. safety) which measures behavioural progress.

II. OBJECTIVES AND LIMITATIONS

The objective of this paper is to collect and analyze the data on KPIs for the construction industry from the execution and management professionals. The reviews on indicators are collected from client and contracting firm for monitoring productivity and evaluating performance.

The areas focused in this study are:

1. Commonly used quantitative indicators.
2. Commonly used qualitative indicators.
3. Frequently used KPIs by

- Respondent's year of experience
- Level of self-performed work
- Level of management
- Annual volume of company

Limitation of using a set of KPIs is that they cannot be used in a straightforward manner to establish improvement targets. This is because each single indicator has to be compared to some benchmark value without regarding the remaining aspects of the company activity that are not accounted in that indicator (Isabel 2010)[6].

III. LITERATURE REVIEW

The focus of the literature to briefly describe the indicators used and the application of it.

The literature is mainly divided in three parts. The first part explains the use of this indicators for performance and productivity. Second part discusses about quantitative indicators and third part about the qualitative indicators.

Productivity and Performance

Productivity is a measure of efficiency of manpower, machine, system etc. in converting input to output. So productivity can be given as output to input ratio.

With proper monitoring of manpower, material resources and equipment one can gain performance with good productivity. Productivity measurement at construction site level enables companies to monitor their own performance against their site performance (Varma, 2014)[8].

As mentioned before productivity can be judged properly with the baseline for that activity. Projects are executed under the

guidance of a set of plans such as the work breakdown structure, the schedule, the budget, and the resource plan, which are collectively referred to as the baseline plan. Working according with this baseline with correct indicator will result to good performance. The performance measurement revolution has spread to many industries, including the construction industry (H.A.Bassioni 2004)[] .
A prescription for productivity improvement is a collection of fundamental principles that will lead to improved productivity (H. Randolph, 2015)[2]. Hence knowing the past performance reference point future performance measures can be done.

Quatitative Performance Indicators

Quantitative indicators (QI) are those indicators which can be measured physically. These indicators should be easy to collect and easy to apply so that they can be in practice.

QI can be noted as continuous variables (e.g. cost, minutes, hours etc.) which is measured in units.

- Resource management: Productivity is calculated by amount of materials, tools and equipment expended during the construction operation. With the help of resource management wastages can be monitored

- On-time completion: This type of tool is based on the milestone which has been set for particular duration of the project. Periodical measurement of productivity is evaluated. Gradual growth in performance is noticed if the milestone is realistic and taken seriously.

- Quality control/rework: Rework is responsible for the major expenditure of the construction site. Calculating the man-hours and price allocated for repairing can be a great tool to calculate performance and productivity.

- Wastages: Performance can be monitored by the wastages done to carry out that particular work. If the wastage is more than the allowable percent then the performance is not up to the mark.

- No of defects: It is same as the Wastages indicators but it deals the defects occurred during completion of projects.

- Repetitive of work: Due to repetition of work the productivity can be increased because of the continuous process of the activity.

- Percentage complete of project: This process is estimated by the supervisor at work. This indicator is widely used to prepare monthly bills.

- Price/unit: It defines the capital involved to complete the particular unit which includes capital of all resources allotted.

- Innovation: Modern technique and ideas make some work easier than the long traditional methods. Innovations with proper execution in construction increases productivity.

- Actual cost / Budgeted cost : It involves monitoring of performance by comparing current cost accrued to the budgeted cost. This provides measurement for the total project rather than for particular activity.

- Lost time accounting: This method measures productivity according to the number of man-hours lost due to idle time such as waiting for material, instruction, liaison issues, or daily work order. By reducing these factors productivity can increase.

- Actual / Planned performance of labour: This is to monitor the performance of the labours. This approach compares actual labour performance data to targets set in prior periods, usually before implementation of the program. The significant difference is then worked on to achieve the target.

- Earned man-hour: This is the base line method to calculate the performance. Performance is then evaluated by daily target set to daily target of man-hours achieved.

- Labour efficiency: Labor efficiency is a measure of how efficiently a given workforce accomplishes a task, when compared to the standard in construction industry.

- Units/MH: This method is most useful and easily implemented on sites. As the name says it measures the unit completed per man hour.

- Incentives: It is the method to motivate employees by giving extra rewards for their efforts to achieve the achievable targets on time. Thus increase in productivity

- Punch list: A punch list is a document prepared near the end of a construction project listing work not conforming to contract specifications that the contractor must complete prior to final payment.

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.

These indicators are discrete variables (e.g. complaints, accidents, facilities, attitude etc.) which is measured by rating scale

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:

• Client satisfaction (Gongbo 2011)[4]: Customer satisfaction is a term that measures how products or services supplied by a company meet or surpass a customer's expectation. Customer satisfaction is important because it provides executioners and business owners with a metric that they can use to manage and improve their businesses.

• 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 (EMRs). 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 KPI 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.

• On time payment: Change in productivity due to delay in payment.

• Human factors: Due to factors like lack of facilities to labors, sickness, overtime, late night work etc. the productivity can decrease. This factors are to be monitored properly to avoid un-comfort to employees or labors.

• Disputes: If there is disagreement or argument between two stake holds or any party then their won't be a healthy environment to work, leading to decrease in productivity.

Indicators	Expert **1**	Expert **2**	Expert **3**	Expert **4**	Expert **5**	Avg.	Rank	Rev. Rank
Quantitative indicators								
Resource management	10	7	10	8	6	8.2	1	1
Percentage complete of project	7	5	10	7	7	7.2	6	7
Volume per man-hour (unit/MH)	5	6	10	6	4	6.2	11	15
Repetition of work	8	8	9	6	6	7.4	5	6
Actual/Planned performance of labour	5	4	10	7	8	6.8	8	12
No. of defects	8	6	9	6	8	7.4	5	5
Price/Unit	6	6	10	6	7	7.0	7	8
Actual cost/Budgeted cost	7	5	10	6	6	6.8	8	10
On-time completion	7	6	10	8	9	8.0	2	2
Lost time accounting	7	7	8	6	6	6.8	8	11
Innovation	8	6	8	6	7	7.0	7	9
Wastages	10	7	9	7	5	7.6	4	4
Labour efficiency	5	7	8	5	7	6.4	10	14
Incentives	8	5	7	6	5	6.2	11	16
Quality control or rework	8	6	10	8	7	7.8	3	3
Earned man-hour	5	5	10	6	7	6.6	9	13
Punch list	6	6	6	5	6	5.8	12	17
Qualitative indicators								
Safety	7	6	10	7	7	7.4	2	2
Employee turnover/training	6	6	8	5	6	6.2	6	7
Absenteeism	4	7	6	5	4	5.2	7	8
Motivation	6	7	7	6	6	6.4	5	6
Human factors	7	6	7	7	7	6.8	3	4
On-time payment	6	5	10	7	6	6.8	3	3
Disputes	7	6	7	6	7	6.6	4	5
Client satisfaction	8	6	10	8	8	8.0	1	1

•**Motivation:** Motivation of the labour force is of paramount importance because the quality of human performance at the workplace depends largely upon motivation. Suitable motivation of labour can be hypothesized as a key contributor to maximizing worker's productivity (Aynur 2008).

• **Employee turnover or training:** Measuring the costs associated with workers leaving the company to seek work elsewhere, and the cost indicators.

Table no 1. Delphi process for selection of indicators

•**Absenteeism:** 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.

IV. RESEARCH HYPOTHESES

The data obtained from the survey of construction professionals have produced a variety of information on perceived KPIs and their level of usefulness in measuring productivity. The following list contains the hypotheses that will be tested(Robert 2003)[1]:

- H1: There exists a set of perceived KPIs for construction companies, regardless of construction type (client or contractor).
- H2: Differences exist among the different levels of position in their set of perceived KPIs. (Management or execution)
- H3: Perceived KPIs vary depending on the number of years of experience of the respondent.
- H4: Differences in perceived KPIs will exist across annual company volume.(Large or Small)
- H5: Perceived KPIs will differ among reported levels of self-performed work.

The data obtained from the construction industry survey was used to test these hypotheses. The hypotheses were tested using basic statistical analysis. The analyses included such things as determining the mean, standard deviation, standard error, and number of respondents. The Student's t-test was used to test for differences among the mean responses for the applicable hypotheses.

V. RESEARCH METHODOLOGY

To determine the key performance indicators by literature review and experts opinion. Table 1 shows the indicators fixed through the Delphi process. Top 11 from quantitative indicator and top 4 from qualitative indicators were then selected for survey. Then survey questionnaire was done to the selected indicators to find the appropriate indicators for the hypothesis. The industry questionnaires provided responses that could be analyzed according to the basic independent variables of this study. Five hypotheses were tested using the Student's t- test for determining statistical differences among means.

Top indicators	votes	#1 %
Resource management	14	35.71
Wastages	12	41.67
Percentage complete of project	10	60.00
Safety	11	36.36
Human factors	9	22.22
	56/150 (37% of total votes)	

Using responses from a seven point Likert Scale, the mean value for each item of the survey was determined. To further analyze the initial findings, the Student's t-test was used to test for a statistically significant difference in the mean response values among the various industry groups, using a 90% confidence interval. The Student's t-test was selected for its simplicity in identifying whether or not the respondent's opinions were statistically different, thus allowing for the identification of common sets of perceived KPIs, when responses were not found to be significantly different.

VI. ANALYSIS OF RESULT AND CONCLUSION

H1: There exists a set of perceived KPIs for construction companies, regardless of construction type (client or contractor).

The table no 2 shows the top 5 indicators which received top votes on the questionnaire survey. Percentage complete of project got 10 votes but received more no of 1st rank votes (60%).

H2: Differences exist among the different levels of position in their set of perceived KPIs. (Management or execution)

The responses are divided into executioner and manager as in table 3. Resource management and safety has proven significant importance.

H3: Perceived KPIs vary depending on the number of years of experience of the respondent.

The experience age groups are divided into categories and mean value obtained regardless of position. The age group with high experience choose 'safety' and 'wastages' as top indicator and less experience group choose 'Resource management'.

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Volume of company	n	Safety		Resource management		Wastages		Percentage complete of project		Human factors	
		Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
Small (< 1000 Cr	12	5.42	1.54	5.25	1.84	5.00	1.94	4.92	1.72	4.25	1.84
Big (1000 Cr >)	18	4.72	1.62	5.78	1.01	4.94	2.00	4.72	1.62	4.50	1.44

Indicator	Manager	Execution	t-critical	t-calculated	significance
Resource management	5.19	6.00	1.7	2.07	YES
Wastages	5.19	4.71	1.7	0.93	NO
% complete of project	4.81	4.79	1.7	0.06	NO
Safety	5.38	4.57	1.7	1.76	YES
Human factors	4.19	4.64	1.7	0.99	NO

Table no 3 Response at different level

H4: Differences in perceived KPIs will exist across annual company volume.(Large or Small) Table 4.

The 'Safety' (Variance 1.62) and 'Wastages' (variance 2.00) are the indicators important for the large companies and 'Resource management' (Variance 1.84) ,'percentage complete' (Variance 1.72),'human factors' (Variance 1.84) are important for small companies.

H5: Perceived KPIs will differ among reported levels of self-performed work.

Table no 5 level of self performance

Level of self performance	Response % (mean out of 7)	Top rated KPI
0-20	no preference	no preference
21-40	60 (5.57)	Resource mang.
41-60	43 (4.97)	Wastages
61-80	32 (4.8)	% complete
81-100	24 (5.00)	Safety

This Project allowed to a rearranged power model of radio correspondence as it is utilized as a part of [20] and [21]. The vitality utilization can be communicated as takes after:

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