

A STUDY ON QUANTIFICATION OF FACTORS AFFECTING THE QUALITY OF CONSTRUCTION PROJECTS IN INDIA

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Abstract - Projects are organized to accomplish complex tasks that cannot be handled by alone individuals but by multidisciplinary teams in the construction industry. The level of success in carrying out construction project development activities will depend heavily on the quality of the managerial, financial, technical and organizational performance. So the performance is one of the main points to decide project success. The factors which affect the construction project performance are to be identified from literature survey and using those factors the questionnaire survey is carried out among the site engineers and owners in various companies. The ranking of the factors will be done by using Statistical Package of Social Sciences (SPSS). Using that data's the major factors that affecting the performance have to be identified. From the results suitable suggestions will be given to the companies for improving their project performance. Thus the study aims on identifying the factors which affecting the construction project performance.

Key Words: Factors, Management, questionnaire, SPSS.

1. INTRODUCTION

1.1 General

Projects are organized to accomplish complex tasks that cannot be handled by alone individuals but by multidisciplinary teams in the construction industry. Construction project development involves numerous parties, various processes, different phases and stages of work and a great deal of input from both the public and private sectors, with the major aim being to bring the project to a successful conclusion. The level of success in carrying out construction project development activities will depend heavily on the quality of the managerial, financial, technical and organizational performance of the respective parties, while taking into consideration the associated risk management, the business environment, and economic stability.

Project success depends upon how well the personnel can work effectively to accomplish objectives within scope, cost and quality constraints. In past, many researches have been done to frame an effective performance management system for construction industry based on the flaws in the existing systems adopted globally.

The study aims to identify and evaluate the main factors affecting the performance of construction projects and also give possible recommendations to improve performance of construction projects.

1.1.1 Definition of Performance Management

Performance management is a continuous process of identifying, measuring and developing performance in organizations by linking each individual's performance and objectives to the organization's overall mission and goals.

Performance management is about directing and supporting employees to work as effectively and efficiently as possible in line with the needs of the organization. The central aim of performance management is to,

- Develop the potential of staff and improve their performance
- Linking an employee individual objectives to business strategies and hence improve company's performance

Project manager must have the skills required to build effective project teams to achieve the targeted performance. An effective performance management process enables managers to evaluate and measure individual performance and optimize productivity by:

- Aligning individual employee's day-to-day actions with strategic business objectives
- Providing visibility and clarifying accountability related to performance expectations
- Documenting individual performance to support compensation and career planning decisions
- Establishing focus for skill development and learning activity choice

1.1.2 Performance Measures

Performance measures are values or characteristics which identify the important attributes of, and relationships between, inputs, outputs, outcomes and other relevant data.

✚ Performance Ownership and Responsibility

Performance management involves the identification of those responsible (agency, team, individual, etc) for achieving the desired level of performance.

✚ Performance Reviews

A rigorous performance monitoring and review process should be in place to ensure that the desired level of performance is achieved.

✚ Performance Incentives

Incentives are payments, benefits or concessions to reward staff or organizations (including those working jointly) for meeting desirable standards of work-related performance and/or to encourage improved performance. The term can also be used to embrace sanctions or penalties for substandard performance.

1.1.3 Performance management in construction industry

Within every organization, Performance Management is a critical issue influencing all the other components of Human Resources management. It contributes to the identification, development and retention of high-potential employees and key contributors.

The construction industry's core business is undertaking projects in generating new buildings or refurbishing existing ones for a variety of clients. Therefore, it is not a surprise to find that traditionally performance measurement in construction is approached in two ways:

- a) in relation to the product as a facility
- b) in relation to the creation of the product

Therefore, it is clear to see that the traditional measures of the performance of construction projects are not enough to assess their 'true' performance. It can be argued that the methods used to measure performance in construction industry fall into the three main categories of the BSC:

1. **Financial Perspective:** how do the project's financial stakeholders view the project? For example cash flow forecasting and cost benefit analysis.
2. **The Internal Business Process Perspective:** how are we performing in our key process activities? For example critical path analysis
3. **The Customer Perspective:** how do our existing and potential customers see us? For example quality assurance.

Recently the UK best practice programme has launched the 'Key Performance Indicators' (KPIs) for construction. These KPIs give information on the range of performance being achieved on all construction activity and they comprise of:

1. Client satisfaction – product
2. Client satisfaction – service
3. Defects
4. Predictability – cost
5. Predictability - time
6. Profitability
7. Productivity
8. Safety
9. Construction cost
10. Construction time

These KPIs are intended for use as benchmarking indicators for the whole industry whereby an organisation can benchmark itself against the national performance of the industry and identify areas for improvement. The following are some examples:

1. The predictability of design and construction cost seems to be quite accurate since the means of the cumulative values represent zero and one percent respectively. However, the productivity value is very low. Does this mean that the predicted costs are over estimated to cover low productivity or the measures used to derive the figures are wrong.

2. The client satisfaction in terms of the product and service is quite high (eight out of ten) but the productivity is very low which raises the issue of do the clients really know what the productivity levels of their projects are.

The above illustrate the importance of not only using the 'right measures' to measure the 'right things' but the relationship between the different measures is important and a source of identifying potential collective improvements. Another area that is generally poorly covered in the construction industry is the performance of the suppliers in projects.

1.1.4 Necessity of performance management

As a manager, you need to adopt performance management practices that will facilitate continuous review and ongoing development of your department team in order to deliver departmental objectives. The underlying assumption is that by managing the performance of the individual and team, departmental and organizational performance will follow and by raising individual and team levels of performance, organizational performance will also improve.

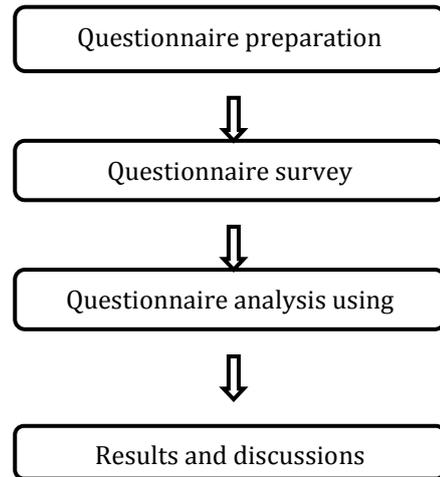
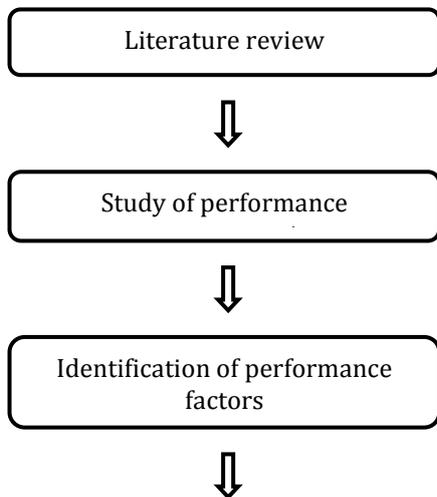
1.1.5 Objectives of Performance Management

- To enable the employees towards achievement of superior standards of work performance.
- To help the employees in identifying the knowledge and skills required for performing the job efficiently.
- Promoting a two way system of communication between the supervisors and the employees for clarifying expectations about the roles and accountabilities, communicating the functional and organizational goals. The performance of a successful project team is measured by three factors:
 - Technical success according to agreed project objectives
 - Performance on project schedule (finish on time)
 - Performance on budget (finished within financial constraints)

There are many advantages associated with the implementation of a performance management system. A performance management system can make the following important contributions:

- Motivation to perform is increased
- Self-esteem is increased
- Managers gain insight about subordinates
- Self-insight and development are enhanced
- Personnel actions are more fair and appropriate
- Organizational goals are made clear
- Employees become more competent
- There is better protection from lawsuits

2. METHODOLOGY



3. IDENTIFICATION OF FACTORS

There are numerous factors affecting the performance of construction project. The following factors are selected from literature study and broadly classified in this project

- Time factors
- Cost factors
- Productivity factors
- Quality factors
- Human/personnel factors
- Client satisfaction factors
- Environmental factors
- Health and safety factors

3.1 Time factors

"Time" or "Schedule" as one of the most important project success criteria for any project. Time has been addressed as a criterion by which to evaluate a project's degree of success. It has also been mentioned as a factor, which can help the other factors/criteria be met. It is found that the definition of "Time" is of great importance. Factors affecting the construction time are,

- ✓ Delays in site preparation works
- ✓ Delays in giving approval
- ✓ Delays due to shortage of resources (manpower, material, money. etc.)
- ✓ Tight project schedule to fulfill the owner requirements

- ✓ Unexpected accident due to improper material and equipment handling
- ✓ Time needed to find out the causes of defects and their rectification

3.2 Cost factors

Without a doubt, every project is dependent on its cost or budget. Various cost factors which affects the construction are,

- ✓ Frequent design variations
- ✓ Variation in project labour cost according to market demands
- ✓ Variation in equipment and material cost
- ✓ Rework due to errors in construction
- ✓ Project overtime cost due to shortage of resources (manpower, material, money, management, machinery)
- ✓ Poor management and site supervision of the respondents
- ✓ Variation in currency price
- ✓ Waste rate of material due improper planning

3.3 Productivity factors

Productivity means “how much and how good we produce from the resources used, Productivity can be measured at different levels. The following factors which affect the productivity are,

- ✓ Site restricted access by the management
- ✓ Lack of experienced or specialized labours
- ✓ Complexity of project
- ✓ Number of new projects / year
- ✓ Absenteeism rate through project
- ✓ Lack of co-ordination between management and labour
- ✓ Work force according to schedule

3.4 Quality factors

A quality specification is an important performance measure of any construction project. Based on customer needs the quality plays major role in the construction. Quality affecting factors are,

- ✓ Unsuitable construction for the project management
- ✓ Uses of low quality materials and equipments during construction
- ✓ Financial issues faced by the management
- ✓ Inadequate motivation to the labour through the management

3.5 Client satisfaction factors

Clients, whether they are directly or indirectly involved in projects and have different views about success, play crucial roles in every project. Factors which affect the client satisfaction are given below,

- ✓ Number of rework incidents
- ✓ Number of disputes between owner and project parties.

3.6 Human/personnel factors

The human/personnel factors are important factors to deciding quality project. The human factors highly depend upon the individuals. The followings factors to affecting the human/personnel's,

- ✓ Age of the labour
- ✓ Attitudes of the employee
- ✓ Improper coordination between team members

3.7 Environmental factors

In construction projects most of the people are affected by the environment. The environmental factor which affects the construction performance are,

- ✓ Amount of wastes around the construction site
- ✓ Frequent variations in air quality due to material handling and working procedure
- ✓ Change in noise level around the work area due to machinery operation and material handling
- ✓ Change in climatic condition

3.8 Health and safety factors

Health and safety is important to everyone working in a construction projects. Every project should ensure the worker safety by using proper safety programs and precautions. The following factors which affects the health and safety,

- ✓ Lack of project safety assurance

- ✓ Rate of reportable accidents in project
- ✓ Application of health and safety factors (safety meeting, program, training, etc.,) in organization.

4. QUESTIONNAIRE PREPARATION

4.1 General

Based on the literatures, a questionnaire was framed relating to factors affecting performance of construction project and survey was carried out.

4.2 Questionnaire outline

The questionnaires are all classified into 2 sections:

- ✓ SECTION A: Company and respondent profile
- ✓ SECTION B: Factors affecting construction project performance management

4.3 Rating scale

- (1) => Strongly Agree
- (2) => Agree
- (3) => Neutral
- (4) => Disagree
- (5) => Strongly Disagree

5. DATA ANALYSIS

5.1 General

The collected data was analyzed by using SPSS software and RII method. From this analysis Frequency, Percentage, Cumulative Percentage, Mean Value & Standard Deviation was founded, based on the obtained mean value the factors are ranked.

5.1.1 Statistical package for social sciences (SPSS)

SPSS is a widely used program for statistical analysis in social science. SPSS can take data from almost any type of file and use them to generate tabulated reports, charts, and plots of distributions and trends, descriptive statistics, and conduct complex statistical analyses.

SPSS trends provide the power and flexibility required by experienced time series analysts, while at the same time being easy enough for those not familiar with time series techniques to use and master quickly

5.1.2 Importance of SPSS software

Producing descriptive and summary statistics, frequency tables and cross tabulations, for example, a Figure

counting the number of visits made to an exhibition by the age group of the visitors.

Modeling different sets of data, for example, regression analysis to determine the strength of the relationship between two or more variables such as staffing levels and workload, this is useful technique for testing efficiency.

5.2 Analysis by using SPSS (Descriptive Statistics)

The collected data was analyzed by using SPSS software. From this analysis mean value was founded. Based on the obtained mean value the factors are ranked.

Description	Numbers
Number of questionnaire distributed	65
Number of questionnaire received	43
Response rate (%)	66

The collected data was analyzed by using SPSS software. From this analysis mean value was founded. Based on the obtained mean value the factors are ranked.

6. THE TOP 10 SIGNIFICANT FACTORS AFFECTING THE PERFORMANCE OF CONSTRUCTION PROJECT (DESCRIPTIVE STATISTICS)

Performance Factors	Mean	Std. Deviation	Rank
Rate of reportable accidents	4.08	0.829	1
Project overtime cost	3.97	0.974	2
Material waste	3.97	1.025	2
Changes in noise level	3.93	1.087	3
Lack of co-ordination between management and labour	3.88	0.958	4
Lack of experienced labour	3.85	1.055	5
Uses of low quality materials and equipments	3.85	1.117	5
Complexity of project	3.83	0.942	6
Unexpected accident	3.75	1.083	7
Leadership skills of project manager	3.75	0.985	7
Time needed for defect rectification	3.70	0.997	8

Rework due to error	3.70	0.979	8
Variations in air quality	3.70	1.013	8
Poor management and supervision	3.68	1.017	9
Age of labour	3.67	1.020	10

6.1 Factors affecting the performance of construction projects according to each category

Factors	Mean	Rank (factor)	Rank (overall)
1.Time factors			
Unexpected accident	3.83	1	7
Time needed for defects rectification	3.70	2	8
Delays in site preparation	3.52	3	16
Tight project schedule	3.38	4	21
Delays in giving approval	3.22	5	25
Shortage of resources	3.13	6	27
2.Cost factors			
Project overtime cost	3.97	1	2
Variation in currency price	3.97	1	2
Material waste	3.93	2	2
Rework due to errors	3.70	3	8
Poor management and site supervision	3.67	4	9
Variation in labour cost	3.50	5	17
Variation in equipment and material cost	3.37	6	22
Design variations	3.17	7	26
3.Productivity factors			
Lack of co-ordination between management and labour	3.88	1	4
Lack of experienced labours	3.85	2	5
Complexity of project	3.75	3	6
Work force	3.60	4	13
Number of projects / year	3.42	5	20
Absenteeism rate of labour	3.42	5	20
Site restricted access	3.02	6	29

4.Quality factors			
Uses of low quality materials and equipments	3.85	1	5
Inadequate motivation to the labour	3.65	2	11
Unsuitable construction	3.53	3	15
Financial issues	3.32	4	23

5.Human/personnel factors			
Age of the labour	3.68	1	10
Attitudes of the employee	3.57	2	14
Improper coordination between team members	3.45	3	19

6.Client satisfaction factors			
Leadership skills for project manager	3.75	1	8
Number of disputes between owner and project parties	3.65	2	11
Speed and reliability of service to owner	3.65	2	11
Number of rework incidents	3.42	3	20

7.Environmental factors			
Changes in noise level	3.97	1	3
variations in air quality	3.70	2	8
Changes in climatic condition	3.62	3	12
Amount of wastes	3.48	4	18

8.Health and safety factors			
Rate of reportable accidents in project	4.08	1	1
Lack of project safety assurance	3.30	2	24
Application of health and safety factors	3.03	3	28

6.2 Reliability Statistics

Statistical reliability is needed in order to ensure the validity and precision of the statistical analysis. It refers to the ability to reproduce the results again and again as required. For example, certain surveys might establish their reliability by asking the participants of the study the same or similar questions at two different times under similar conditions.

Table 6.2.1 Cronbach Alpha Consistency

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent (High-Stakes testing)
$0.7 \leq \alpha < 0.9$	Good (Low-Stakes testing)
$0.6 \leq \alpha < 0.7$	Acceptable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Table 6.2.2 Reliability Statistics Output from SPSS

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No of Items
0.921	0.920	39

6.3 ANALYSIS BY USING RELATIVE IMPORTANCE INDEX METHOD (RII)

The relative importance index method (RII) is used to determine owners, consultants and contractors perceptions of the relative importance of the key performance factors.

Relative Importance Index Method (RII) = $\sum W/A \times N$

Where: **W** is the weight given to each factor by the respondents and ranges from 1 to 5,

A = The highest weight = 5

N = The total number of respondents

Performance Factors	RII	Rank
Rate of reportable accidents	0.820	1
Project overtime cost	0.800	2
Changes in noise level	0.793	2
Material waste	0.786	3
Lack of co-ordination between management and labour	0.776	4
Lack of experienced labour	0.770	5
Uses of low quality materials and equipments	0.770	5
Complexity of project	0.766	6
Unexpected accident	0.750	7

Leadership skills of project manager	0.750	7
Time needed for defect rectification	0.740	8
Rework due to error	0.740	8
Variations in air quality	0.740	8
Poor management and supervision	0.736	9
Age of labour	0.733	10

7. CONCLUSION

A questionnaire-based survey was conducted from owners, site engineer and contractors from various companies through direct survey from that,60 response were collected and analyzed by using SPSS, based on the results the factors are ranked as Rate of reportable accidents, Project overtime cost, Material waste, Lack of co-ordination between management and labour, Uses of low quality materials and equipments, Unexpected accident, Complexity of project, Rework due to error , Age of the labour, Poor management and supervision are the major factors which affecting the construction project performance.

8. SUGGESTIONS

The following suggestions are used to improve the performance of construction project and it will be based on the literatures and respondents feedbacks. The suggestions are given up to 3.75 of mean value.

1. Rate of reportable accidents

- Maintain proper safety culture
- Conducting awareness program
- Proper motivation and safety systems should be established for improving the performance of construction projects

2. Project overtime cost

- Try to minimize the schedule variation
- Try to minimize errors and defects

3. Changes in noise level

- Use earplugs during heavy machine operation
- To use low noise producing machine/ use new machines instead of old machines

- Shutting down noisy equipment when it is not needed

4. Material waste

- Making proper pre- planning for material ordering/purchasing
- Try to reduce material usage through optimistic plan and design
- Protecting materials from damage on site

5. Lack of co-ordination between management and labour

- Making interaction between management and labour through meetings& discussions
- To motivate or award best achievers/labours
- Try to consider each individuals suggestion and recommendations

6. Lack of experienced labour

- Try to provide experienced labour during selection process and work allocation process for a particular work
- Provide special training program

7. Uses of low quality materials and equipments

- Use standard materials and equipment for all projects (ex. Company name)
- To eliminate the low quality materials and equipment through knowledge and tests

8. Complexity of project

- Use specialized team and labours for the complex works
- Making proper planning before going to start a differed project

9. Unexpected accident

- No smoking & drinking while working
- Use personal protective equipments
- Conducting awareness program
- Child labours should not to be allowed
- Everyone should properly know how to use the equipment or machines

10. Leadership skills of project manager

A good leader should have the following qualities,

- A good communicator
- Integrity
- Enthusiasm
- Empathy
- Competence
- Ability to delegate tasks
- Cool under pressure
- Team building skills and
- Problem solving skills

8.1 SUGGESTIONS FOR RESPONDENTS

It is recommended that proper and continuous training programs on construction projects performance should be organized to develop human resources in the construction industry. These programs can assist participants' to be more familiar with project management techniques and can update participants' knowledge. Greater applications of health and safety factors are necessary to overcome problems of safety performance and improving the productivity performance of construction projects.

Owners: In order to overcome delay, disputes, and claims, owners/client are advised to facilitate payment to contractors. All professional should participate in sensitive and vital decision-making. Continuous coordination and relationship between project participants are required throughout the project life cycle for solving problems and developing project performance.

Consultants: In order to improve performance and to increase owners' satisfaction consultants should be more interested in design cost by choosing the most economical criteria. In addition, consultants are advised to accelerate and facilitate orders delivered to contractors to obtain better time performance and to minimize disputes and claims.

Contractors should allow sufficient amount as contingency in order to cover increases in material and equipment cost. Contractors should be more interested in conformance to project specification to engulf disputes, time, and cost performance problems. Contractors should be more interested in ordering for Quality materials to improve cost, time, and quality performance. This can be achieved by organizing quality training and meetings that are necessary for performing an improvement. Contractors are advised to prepare a work plan in accordance to project schedule.

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