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SUSTAINABLE CONSTRUCTION MANAGEMENT SYSTEM

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ABSTRACT

This paper presents a systematic approach to environmental management of pollution and/or hazards caused by construction projects. It proposes a qualitative approach to assess and control the problem and a method to calculate the Construction Pollution Index (CPI) which provides a quantitative measurement of pollution and/or hazards caused by the construction projects.

Questionnaires were distributed to the organization and the results were made into percentage, level of readiness index and regression test to analyze the organizations responds. Results was analyzed through Statistical Package for the Social Sciences tools

Environmental impact assessments (EIA) and environmental management systems (EMS) enable organizations to identify, access and manage environmental impacts throughout a development's lifecycle, improving overall environmental performance. Based on the analysis and discussions, the paper further proposes that major construction companies should obtain ISO 14001 Environmental Management System (EMS) certifications.

Keywords: environmental management, hazards, Environmental impact assessments (EIA), environmental management systems (EMS).

1. INTRODUCTION

1.1 General

For data collection purpose the quantitative method of data collection is adopted. The collected data is further used for analysis purpose. The collected data is used to know the variations in task, as well as for knowing the individual causes of variation. The individual causes are grouped in main cause groups depending on their characteristics and nature of occurrence on site. The onsite interviews are taken for this purpose. In which the care is taken that the all levels of authorities are involved in this process. The necessity of involving all levels of authorities is to consider the perspective of all levels of authorities towards the delay problem. And also it gives the exact causes of the variation in construction tasks.

Data collection process is carried out on construction sites from the Coimbatore and erode region. The ten weeks data is recorded for data collection. And this data is used for data analysis.

2.DATA COLLECTION METHODS

- Data was collected using questionnaire survey, distributed to all project managers involved in managing major capital projects and experts in construction industry. Data was also collected through focus group interviews conducted with the selected project decision-makers and expert interview method.
- Focus group interviews considering the nature of the study, a convenience sample method was used to conduct a group focus interviews with Engineers designated as Project Directors, contractors and consultants.
- The focus group interview helped finalize the design and content of the questionnaire. This was decided by the researcher given the time constraints for the study completion.
- Describe this as a group of individuals selected and assembled by the researcher to discuss and comment on, from personal experience, the topic that is the subject of the research.
- The main purpose of the focus group research according to respondent's attitudes, feelings, beliefs, experiences and reactions in a way which would not be feasible using other methods, e.g. observations, one-on-one interviews or questionnaire surveys.
- Comparing this to individual interviews, which aim to obtain individual attitudes, beliefs and feelings, focus group elicit a multiplicity of views and emotional processes within a group context.
- In conclusion, the article goes on to say that a focus group enables the researcher to gain larger amount of information in a shorter period of time. The advantages of focus group interviewing are much cheaper and quicker to run than intensive one-on-one interviews and respondents tend to be more complete and less inhibited.

2.1 IDENTIFICATION OF RISKS & PROBLEMS

- The identification of each source of risk, problems and components allow the risk item to be separated from others. Consideration of each influencing factor will simplify the analysis and management of risk. The key questions to ask is 'what are the discrete features of the project (risks & problems) which might cause such failure?'
- The early identification of risks and problems, it focuses the attention of project management on the strategies for the control and allocation of risks.

- Identification of risks and problems are analyzed from project managers, engineers and experts in construction industry. Each and every factor should be identified from group discussions between project management team in construction industry.

2.2QUESTIONNAIRE DESIGN:

Questionnaire is prepared with, the site information, interviewer position and his authority towards work, type of task and factors causing delay for that task. The questionnaire is divided into two main parts. First part is related to general information for both the company and respondent. Second Part includes the list of the identified causes of delay in construction project. These causes are classified into three groups according to the main sources of delay i.e. client, contractor and consultant related issues in construction firms.

For each cause group two questions were asked i.e. what frequency of cause occurrence is. And what is the degree of se-verity of this cause on project delay? Both the frequency of occurrence and severity were categorized on a five-point scale system. Frequency of occurrence is categorized as follows: strongly agree, agree, average, disagree and strongly disagree (from 5 point to 1 point on scale respectively).From which the severity index and the frequency index of the cause occurrence on site has came to know and which can further used in preparation of the risk assessment matrix.

2.3SITE SELECTION FOR DATA COLLECTION

In this the variation survey will be done at three residential construction sites and then root causes of these variations will be found through questionnaires at different level of management. The site selection process is done with following criteria:

• The site should be residential and commercial type.
• Scheduled bar chart should be prepared for the work and the work is followed with scheduled bar chart.
• The site should cover maximum activities within data collection period.

The sites are selected based on the criteria for data collection purpose in Coimbatore and erode region. The sites are with well-prepared bar chart.

Those data's are collected from top and middle level companies, contractors, consultants and clients.

All data's and details are gathered from residential and commercial type of projects. Each and every activity process, risks and problems are effectively monitored from site and group discussions.

Observed information are verified and finalized from experienced project managers, engineers and contractors.

2.4FOCUS GROUP INTERVIEWS

Considering the nature of the study, a convenience sample method was used to conduct a group focus interviews with Chief Engineers designated as Project Directors and the project engineers in construction field.. The focus group interview helped finalize the design and content of the questionnaire. These five senior employees were excluded from the census. This was decided by the researcher given the time constraints for the study completion.

The main purpose of the focus group research according to Social Research Update is to draw upon respondent's attitudes, feelings, beliefs, experiences and reactions in a way which would not be feasible using other methods, e.g. observations, one-on-one interviews or questionnaire surveys. Comparing this to individual interviews, which aim to obtain individual attitudes, beliefs and feelings, focus group elicit a multiplicity of views and emotional processes within a group context. In conclusion, the article goes on to say that a focus group enables the researcher to gain larger amount of information in a shorter period of time.

2.5QUESTIONNAIRE FORM PART-I

First part is company and respondent profile. This part is designed based on the skills, experience and company details in respondent.

Company and Respondent Profile

1. Organization/Company Name :
2. Name of the person contacted :
3. Type of job/position :
4. Age (Years) :
   (a) 20 – 29 (b) 30 – 39 (c) 40 – 49(d) Above 50
5. Yours experience in construction fi :
   (a) Less than 2 years (b) 2 to 5 years (c) 5 to 10 years (d) 10 to 15 years
   (e) 15 years and above
6. company experience in building and construction business :
   (a) Less than 5 years (b) 5 to 10 years
   (c) 10 years and above
7. Respondent sign & seal

2.6QUESTIONNAIRE FORM PART-II

Second part is questionnaire survey factors. This part is designed depending on the risks and problems in construction industry.

The survey was designed based on the 75 causes of delay shown in below to which participants were asked to indicate the level of importance of each cause. These causes were categorized into three major groups namely client, contractor and consultant.

Client Related issues for construction delays

1. Delay in progress payments to contractor / consultant
2. Conflicts between joint-ownership
3. Change orders by client during construction
4. Delay in revising and approving design documents by client

5. Delay in approving shop drawings and sample material by client
6. Poor communication and coordination from contractor / consultant
7. Slowness in decision making process
8. Conflicts between consultant / client & contractor / client
9. Technology changes & modification from client
10. Difficulty in requirement of supervisors and site engineers
11. Stop work orders because of infringements of government regulations by client
12. Poor selection of contractor / consultant
13. Poor scheduling and co-ordination
14. Mode of financing and payment for completed work
15. Long waiting time for approval of drawings
16. Late supply of information and late decision making
17. Routine of government authorities and approvals
18. Irregular attending of weekly meetings
19. Duration is not enough for constructing the project
20. Project objectives are not very clear

Contractor Related issues for construction delays:-

1. Difficulties in financing the project by contractor
2. Conflicts in sub-contractors schedule in execution of project
3. Rework due to workers mistakes
4. Conflicts between contractor and other parties
5. Poor communication and coordination of labor
6. Low efficiency & shortage of equipment.
7. Improper construction methods & implementation
8. Delays in sub-contractors' work
9. Poor qualification of the contractor and technical staff
10. Delays in site mobilization
11. Administration problem during work
12. Inadequate contractor's work
13. Frequent change of sub contractor
14. Understanding and study of site drawings & execution method
15. Delays in material delivery & procurement
16. Shortage of Technical, managerial and supervisory personnel
17. Lack of responsibilities & Contract Management
18. Improper equipment delivery
19. Labor Un availability And Absenteeism At Worksite
20. Lack of labor
21. Congested work area
22 .Construction planning errors & equipment failure
23. Mistakes and discrepancies in contract documents
24. Supply of poor quality material
25. Price level changes of material in market
26. Centralization with top management
27. Unexpected weather conditions Inadequate site investigation
28. Preparing the method statement for each work activity & Work permits

2.7FINAL FORMAT OF QUESTIONNAIRE

Final questionnaire formats are prepared with the support of experts in construction industry, project manager/engineer and construction management people.

This risk factor will be finalized based on the focus group interview, feelings, experience and performance of working people in construction industry.

3. ANALYSIS OF PROBLEMS / THEORETICAL CONCEPTS

3.1 PROBLEM ANALYSIS

This chapter explores the problem further with theoretical concepts. The focus of this study is to analyze the root causes of major project issues and it is therefore appropriate to begin with a thorough account of the theoretical aspects of project management as a management approach. The concept of project management will be theoretically researched in this chapter to have a better understanding of the importance of project failure or success and the themes identified in chapter two will be further explored.

3.2 PROJECT MANAGEMENT

The project management body of knowledge defines a project as "A temporary Endeavour undertaken to create a unique product or service (outcome or result). Temporary means that every project has a definite beginning and a definite end. Unique means that the product or service is different in some distinguishing way from all similar products or services." Table 3.2 below indicates some of the special features of a project.

Table 3.2.1 Special features of the project:

Start and finish	A project has a clear start and finish
Life cycle	A project has a beginning and an end with a number of distinct phases in between
Schedule and timeline	Projects are often time limited. This means they must finish by a certain date
Budget	Projects have a clear budget, often broken down to a budget per work package
Non – repetitive	Activities are essentially unique and non-repetitive
Resources	Resources may be sourced from different functional departments and need to be co-ordinate
Single point of responsibility	The project manager or leader is responsible for whole project
Teams	Project teams are formed to complete the project

3.3 DETERMINATION OF SUCCESS OR FAILURE OF A PROJECT

In order to measure the success of any project; goals, requirements and deliverables must be clearly defined at the onset. Project goals should follow the SMART rule:

Table 3.3.1 SMART Rule:

S	Specific	• The project goals should be stated in clear, concise and understandable terms and should be documented in the project charter. • Projects exist to bring about a unique, specific product or service that has not existed before.
M	Measurable	• The deliverables of the project should be measurable against verifiable outcomes or results.
A	Accurate	• The verification and measurement of requirements and deliverables are used to determine accuracy and to ascertain if the project is on track according to the project plan.
R	Realistic	• Projects are unique and produce tangible products or services. The triple constraints (time, cost, scope) of any project help to define realistic goals and realistic requirements based on the limitations the constraints place on the project.
T	Time-bound	• Projects are preformed in specific time frames, with a definite beginning and definite end date.

Project requirements are not the same as goals and objectives. Requirements are Specifications of the goals or deliverables. If a project delivers on specification and the prerequisites that make up the product or service, then the project is deemed successful.

Deliverables are measurable outcomes, measurable results, or specific items that must be produced to consider the project or project phase completed. Deliverables, like goals, must be specific and verifiable. Hence, identifying whether or not a project is successful can be easily accomplished if these parameters are clearly defined at the onset of the project.

The new success criteria involve four dimensions developed from two data sets of major projects.

Table 3.3.2 SUCCESS DIMENSIONS:

Success dimensions	Measures
Project efficiency	• Meeting schedule goal • Meeting budget goal
Impact on the customer	• Meeting functional performance • Meeting technical performance • Fulfilling customer needs • The customer is using the product • Customer satisfaction
Preparing for the future	• Creating a new market • Creating a new product line • Developing a new technology
Business success	• Commercial success • Creating a large market share

3.4 SOURCES OF UNCERTAINTY

Uncertainties and risk cause the range of problems during the implementation of construction project. In this part of article three parts are presented with description of uncertainty sources and possible consequences. Sources and consequences are combined in three groups to clarify the type of uncertainty source.

3.5 MATRIX ORGANIZATIONAL STRUCTURE

The matrix organizational structure illustrates how the project structure overlays the functional structure and outlines the relationship between the project manager, functional manager and their subordinates. In this case the vertical lines represent the functional department's responsibility and authority while the horizontal lines represent the project's responsibility and authority The matrix structure is considered by many practitioners to be the natural project organizationstructure and can be applied at different levels ranging from weak to strong.

The project manager's role is more one of a coordinator or expediter than that of a manager. In a similar fashion, strong matrices have many of the characteristics of a project organization that is full-time project managers with considerable authority and full-time administrative staff. It is widely agreed that the choice of management structures used

to implement innovative, temporary, cross-functional and complex project endeavors has important implications.

"successful organizations will have to change their business processes from being hierarchical, functional organizations to being fast tracking, entrepreneurial enterprises made up of portfolios of projects that are ever changing and renewable. This needs a faster, cheaper, better way of doing business embodied in a project management culture".

3.6 CROSS FUNCTIONALITY

In traditional hierarchical organizations, each functional area works in isolation on their part of the process and then passes the activity to the next department in a serial decision making process. The cross functional project team is typically comprised of people from several functional areas who, at one time or another are involved in the design, engineering or marketing of the product or service.

The following key factors to building and maintaining cross functional project teams.

Project sponsorship and upper management support: the project sponsor requests the project and holds the budget and resources for getting the project accomplished. In addition to full commitment of the project sponsor, management support from all affected areas is crucial in order for the team to have the time, resources and recognition to accomplish their goals.

- Project goals/ scope/ objectives: the project's merit to the organization and its link to the corporate strategy and objectives must be clear to the entire organization and particularly to the project team.
- Leadership: the project manager must have a positive attitude, commitment to the project, effective leadership skills and be in a position of authority with respect to the project and the project sponsor.
- Membership/ resources: adequate team staffing and membership with complementary skills are critical to the success of any cross functional project team.
- Communication: communication is key to breaking down functional and physical boundaries when cross functional teams first form. Good communication with a high level of trust, honesty and respect is critical in building and maintaining high team performance.
- Performance/ reward system: Cross functional team, member's performance must be evaluated and rewarded within the team context and with equal weight to the work they do outside of the project.

3.7 PROJECT PORTFOLIO MANAGEMENT

A portfolio of projects is said to 'have a business scope that changes with the strategic goals of the organization and success is measured in terms of aggregate performance of portfolio components' (PMI, 2006).

Project portfolio management is a methodology providing the necessary mechanism to bridge the divide between project and strategy execution. However, for project portfolio management to be effective, certain degrees of project management maturity levels need to be achieved before real benefits can be derived. Common challenges that face organizations not utilizing a project portfolio management methodology due to lack of visibility into their portfolio are:

- No formal process for aligning investments with business strategies
- Not able to priorities project requests from businesses competing for scarce Resources
- Inefficient and over allocation of the scarce resources (money. people. time)
- Allocation of scarce resources to "urgent" projects instead of 'important" projects
- No accountability of the business benefits through project life cycle through to post implementation level (only important while project is in execution stage):
- Projects high project failure rate
- Projects regularly exceeding available budget, time overruns and other tying down of the resources.
- While project management may help to an extent in executing a specific project within budget and time, it is ultimately the management of the portfolio that is responsible for selecting and prioritizing the right amount of projects that should be carried out.

3.8 PROJECT MATURITY LEVEL

A Project Management Maturity assessment model is a tool for establishing project management excellence, which is considered a condition for success.

Level 1 – Common Language: the organization recognizes the importance of project management and the need for a good understanding of the basic knowledge on project management along with the accompanying language and terminology.

Level 2 – Common Processes: at this level, the organization recognizes that common processes need to be defined and developed such that project successes on one project can be repeated on other projects. Also included in this level is the recognition that project management principles can be applied to and support other methodologies by the company.

Level 3 – Singular Methodology: in this level, the organization recognizes the synergistic effect of combining all corporate methodologies into a singular methodology, the centre of which is project management. The synergistic effect also makes process control easier with a single methodology than with multiple methodologies.

Level 4 – Benchmarking: this level contains the recognition that process improvement is necessary to

maintain competitive advantage. Benchmarking must be performed on a continuous basis. The company must decide whom to benchmark and what to bench mark.

Level 5 – Continuous Improvement: at this level the organization evaluates the information obtained through benchmarking and must then decides whether this information will enhance the singular methodology.

All companies desire to achieve maturity and excellence in project management. Unfortunately, not all companies recognize that the time frame can be shortened by performing strategic planning for project management.

4. CRITICAL FACTOR FINDINGS& ROOT CAUSE ANALYSIS

4.1 CAUSAL ANALYSIS

The goal of the analysis approach was to identify common 'root' causes and establisha regime of measures that might be implemented to mitigate them in future projects.Through the analysis process, it emerged that the following categories were recurrent.

1. Client related issues in construction industry
2. Contractor related issues in construction industry
3. Consultant related issues in construction industry

Based on the questionnaire survey and respondent ranking the top ten critical factors are determined and analyzed. Those problems and risks will be analyzed based on the feelings, attitude and risks in project managers, engineers and project consultant and contractors.

4.2 METHODOLOGY FOR FINDINGS

The methodology will be used in this paper by statistical in relative importance index methods (RII)

4.2.1 Rating scale

(Rate the factor for the above Response rated)

- Rating scale will be arrived based on accuracy of statistical method. This weighting will be filled by respondents.
- Respondents rank will be taken to find out the top ten critical risk factors in construction issues.
- This ranking is given in the questionnaire form based on experience and knowledge of respondents.
- This questionnaire forms are distributed to respondents through mail and direct interviews.
- Formula used in relative importance index

RII = ∑ (Xi x Yi) ÷ (Zi x 5)

Where,

RII - relative importance index
Xi - number of responses of the factors
Yi - the value of rating
Zi - total number of responses to the factors

4.3 ROOT CAUSE ANALYSIS

Root cause analysis of the top most critical factors is determined and gives suggestions and recommendations in construction industry.

This method will be helpful to minimizing the project delays and reduce problems in construction industry. This approach will be mostly useful for project managers, engineers, contractors, clients and consultants.

This process will be able to get reduce risks, problems and projects delays in construction industry.

5. CONCLUSION

This thesis was studied and gathered information about issues and cause of construction delays in construction field. Based on this research paper information and details are collected from experts in construction industry and focus group interviews.

Finally questionnaire format was determined and finalized. This questionnaire format was prepared based on the three categories like client, consultant and contractor related issues in construction delays.

Each and every risk factor was identifying based on the construction project manager/engineer and experts experience, feelings and problems in construction field.

Questionnaire survey, analysis and identification of top ten risk factors and root cause analysis of those ten factors are determined in effectively and give possible solution to reduce problems and project delays in construction industry.

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Category	Strongly disagree	Disagree	Avg.	Agree	Strongly agree
Response rated	1	2	3	4	5

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