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Effect of Subcontracting in Infrastructure Projects

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Abstract: The construction industry leads the national economy in developing countries. It involves industrial requirements, such as developing technologies, related expertise, demand variability, high production speed and progress. Firms in the industry use subcontractors to produce fast, effective solutions. To overcome the demand on special expertise, advanced equipment, and huge investment cost, letting out work to subcontractors has been a norm in construction industry. large presence of subcontracting poses challenges to contractors, client and their project management teams to manage such a large, diverse and fragmented group of subcontractors. Success of a construction project is essentially depending on the ability of general contractor to select the appropriate subcontractor during bidding process, and the sufficient management of subcontractor during construction.

Keywords - Construction management, Sub contractors, Main contractors, Subcontracting, Infrastructure.

1.INTRODUCTION

The construction industry in India involves many parties for the complexation of project viz client, contractor, sub-contractor, PMC, specialized engineering service providers. The intricacies involved in a construction project are numerous and a single contractor finds it difficult to cater all the requirements of the project. Hence often we come across contractors subletting work or some part of it to subcontractors, who performs the work with their in-house capabilities. Contractors providing absolute solution are thus rare in the Indian scenario.

Though the contract defines the roles and responsibilities of client and contractor clearly, there is always a scope for discrepancies and dependencies on other specialized service providers. This affects the time and cost of projects to a great extent and increases the uncertainty involved. The immediate effect is cost and time over-runs.

In infrastructure projects equipment play a major role. This equipment are highly sophisticated and constitute a large project cost. The mismanagement of equipment causes considerable errors in project functioning. Thus a proper procuring, handling and operating
model of these equipment is essential.

Construction is conversion of 4 M's (money, machinery, manpower& materials) in to a constructed facility/structure. The construction has to meet the needs of the user and has to be as per the design. The activity is primarily field oriented though a sizeable work may have to be done in offices. The construction has increasingly become more & more complex over decades and years. This is because,

i. The needs & aspirations of users have become complex & demanding due to development of technology and competition.

ii. New (generally better) Materials, Machinery, Processes and Managerial techniques have been developed. This has been aided by Computer revolution.

This has necessitated development & deployment of a plethora of Agencies/ Organizations in
construction industry. This in turn has resulted a specialized branch of Management viz. Contract Management. Due to large variation in structures/projects, their value, organizations and their role/size and so on, a large body of tools & systems have been developed. In the pre historical times persons used to design and build their own houses. Then first Contractors emerged followed by Architects & Designers and from recent times, Project Management Consultants. In between was Contract Law,

Courts/Lawyers, Disputes, arbitration and so on. al with study of various causes of accidents and suggests some counter measures to avoid it.

PROBLEM STATEMENT

. Relation between contractor & sub-contractor are very much important to completed the project with in stipulated time frame & cost. The construction industry's inadequate contractual relationship, which is plagued by disputes and misunderstandings, has harmed the industry's development. With the booming of the construction industry which requires high involvement of subcontracting. The performance of subcontractors, whether good or bad, has a direct impact on the industry's overall performance.

2. LITERATURE REVIEW

1) **Causes of construction delay: Traditional contract**

The authors Abdalla Odeh and Hussien Battaineh in their paper published in International Journal of Project Management vol.20(2002) 67-733 are of the view that many projects experience extensive delays and therby exceed initial time and cost estimates. In addition to imparting the economic feasibility of capital projects, extensive delays provide a fertile ground for disputes and claims. According to the author the most important causes of delays in construction projects with traditional type contracts from the viewpoint of construction contractors and consultants. The survey carried out by them indicate that contractors and consultants agreed that owner interference, inadequate contractor experience, financing and payments, labour productivity, slow decision making, improper planning and subcontractors are among the top ten most important factors.

Labour and equipment group was ranked high by contractors as well as consultants. This was true for labour productivity and for equipment availability and failure. The higher ranking of contractors of equipment availability and failure indicate problems associated with ownership of new equipment, maintenance and repair, and availability and reliability of the rental option.

2) **Issues In Subcontracting Practice**

David Arditi and Ranon Chotibhongs member ASCE Journal of construction engineering & management ASCE /August 2005 indicates that these issues include the timeliness of payments by general contractors, the process of selecting subcontractors, subcontractor bonding, construction insurance, safety issues on the construction site, partnering arrangements with various parties, and productivity issues. A questionnaire survey was administered to subcontractors, general contractors, and construction owners to investigate these issues and to determine the differences in perceptions between the parties.

3) **The Contractor-subcontractor Relationship: The Subcontractor's view**

The writers Jamie Hinze and Andrew Tracey member ASCE Journal of Construction Engineering and Management, Vol. 120, No. 2, June, 1994. discuss ways in which subcontractors can be effectively managed on a project. In the construction of most projects, a significant role is played by specialty contractors, also commonly referred to as subcontractors. On many projects, particularly building projects, it is common for 80-90% of the work to be performed by subcontractors. Despite the importance of subcontractors, little is publicized about the actual process by which subcontracts are initiated, how award arrangements are made, or how subcontracts are managed. The writers carried out an exploratory study was conducted that focused on this subject. Information was obtained on bidding practices, subcontracting arrangements, administrative practices, payment procedures, and project closeout. The results provide information on various methods used by general contractors to place subcontractors at risk.

4) **Golden Rule of Contractor- Subcontractor Relationships**

written by Joseph R. Proctor Jr in February 1996 periodical of the ASCE, the corrective measures possible to improve the progress of work at project sites are suggested using some working rules for contractors and subcontractors. Here Proctor Jr the four C's which comprise the Golden Rule. These are – Consideration, Communications, Cooperation, and Compensation. The paper concludes that a major responsibility lies with the general contractors for successful completion of work – operations scheduling of subcontractors, prompt payments averting costly disputes etc.

5) **Improved Subcontractor Selection Employing Partnering Principles**

A paper published by Mohan M. Kumaraswamy and Jason D. Matthews in the Journal of Management in Engineering, Vol 16, May/June 2000 the importance of appropriate selection techniques for subcontractors and partnering techniques. Despite the increasing extent of subcontracting in construction, the importance of subcontractor selection is frequently underestimated. While the subcontracting element needs more attention in contractor selection itself, subcontractor selection techniques themselves need considerable improvements. This paper examines how such techniques can beneficially draw from improved multi criteria contractor selection methodologies in general, and specifically from recent developments in client-contractor partnering.

6) **Factor- based path analysis to support sub-contractor management**

The paper authored by Wei-Chih Wang and Jang-Jeng Liu12 says Current practice separates subcontractor management from schedule control. A factor-based model is proposed to measure the sensitivity of each factor to uncertainty by decomposing the effects of uncertainty at the level of activity, and then integrating these individual effects at the path level. By viewing the path of a schedule network as the working route of one or several subcontractors, the proposed model enhances knowledge of what to control on each subcontractor, such as those factors that a subcontractor is sensitive to, and the subcontractors that are most sensitive to a particular factor. Consequently, a project delay is averted. And management can control subcontractors and the schedule in an integrated manner.

7) **Impact of subcontracting on site productivity**

Lesson learned in Taiwan " by Ting –ya Hsieh Journal of construction engineering & management March / April 1998/91. The Study of this paper is to provide some explanation of the effects of subcontracting on site productivity. The paper highlights the importance of subcontracting in construction and argues that subcontracting is the missing element in productivity studies conducted to date. According to the findings of an extensive survey in Taiwan's construction industry, subcontracting has become a standard practice employed by general contractors for project execution. General contractors subcontract construction work as much as possible to allow downsizing of their firms and to ensure better handling of the unstable market conditions.

8) **The Major Problem between main contractor & Sub contractor in construction project in Egypt.**

Dalia A. Kshaf , Mohamed A. Mohamed b , Karim M. El-Dash .The Purpose of this paper In this study, it was targeted to explore the causes of the main conflicts between the contractor and sub - contractors and the responsibility distribution of these causes. The basic columns of any project are main contractor and subcontractor, so the relationship between them must be good and effective in achieving the project's goals on time.

9)**Transaction-Cost-Based Selection of Appropriate General Contractor-Subcontractor Relationship Type**

Hyun-soo Lee, Joon-oh Seo, Moonseo Park, Han-guk Ryu, and Soon-seok Kwon the findings of this study show that transaction costs incurred by general contractors and subcontractors vary according to the type of relationship established. Therefore, for the purpose of comparing transaction costs incurred in both competitive and partnership relationships, transaction-cost-based profit models for both general contractors and subcontractors are developed, respectively, for each relationship type. As well, by applying different strategies to maximize profits in each relationship, and by simulating the parameters affecting the nature of the subcontracted work, the conditions and relationships under which general contractors' profits are optimized have been determined. Finally, based on simulation, practical guidelines for choosing the most appropriate relationship type are proposed.

10) **Subcontracting and rework cost sharing in engineering–procurement–construction projects.**

Zhenzhen Chen a , Wanshan Zhu b,∗ , Pascale Crama In this study, we model an EPC contract with three parties: the end user, the main contractor, and a representative subcontractor. We compare the end user's cost and quality trade-off for the recommended lump-sum contract and the proposed incentive contracts. We find that the lump-sum contract can achieve the first-best trade-off under limited circumstances, whereas the appropriate incentive contract can do so for a wider range of circumstances. Rework cost sharing can cause under- or over-investment in efforts and reduce system welfare compared to the first-best outcome by weakening the incentive contract's ability to overcome moral hazard. However, for a subcontractor with limited liability, rework cost sharing can improve project outcomes by allowing the main contractor to reduce the subcontractor's risk exposure.

3. Subcontracting in infrastructure project

Subcontracting in infrastructure projects in India has a mixed impact, offering benefits like cost reduction and specialized expertise while also presenting challenges like communication breakdowns and potential delays. Effective management of subcontractors, including clear contracts, efficient communication, and trust-based relationships, is crucial for mitigating risks and maximizing the positive effects of subcontracting.

3.1 Benefits of Subcontracting:

3.1.1 Cost Reduction:

Subcontracting allows businesses to leverage specialized expertise and skills without the overhead costs associated with hiring full-time employees, like benefits, training, and equipment.
Specialized Expertise:
By outsourcing specific tasks or projects, main contractors can access specialized labor and resources, potentially improving the quality and efficiency of the work.

3.1.2 Flexibility:

Subcontracting provides flexibility in managing workloads and adapting to project changes, as contractors can scale their workforce up or down as needed.

3.2. Challenges of Subcontracting:

3.2.1 Communication Issues:
Breakdowns in communication between the main contractor and subcontractors can lead to delays, cost overruns, and even safety hazards.

3.2.2 Payment Disputes:
Delays in payments to subcontractors can create financial difficulties and strained relationships, impacting project performance.

3.2.3 Quality and Safety Concerns:
Lack of oversight and inconsistent quality control by subcontractors can lead to problems that impact project outcomes and safety.

3.2.4 Scheduling Conflicts:
Coordination challenges between different subcontractors on a project can cause delays and disrupt the workflow.

3.3 Recommendations for Effective Subcontracting:

3.3.1 Clear Contracts:
Establish well-defined contracts that outline the scope of work, responsibilities, timelines, and payment terms for all parties involved.

3.3.2 Effective Communication:
Develop clear communication channels and procedures to facilitate information sharing and address issues promptly.

3.3.3 Trust-Based Relationships:
Foster a collaborative environment with subcontractors by building trust, promoting open communication, and working together to achieve project goals.

3.3.4 Strong Project Management:
Implement robust project management practices to monitor progress, manage risks, and ensure timely completion of the project.

3.3.5 Focus on Quality and Safety:
Establish clear quality standards and safety protocols, and provide adequate training and supervision to subcontractors to ensure adherence.
By addressing the challenges and implementing best practices, the positive aspects of subcontracting can be maximized, contributing to the successful execution of infrastructure projects in India.

4.0 Quantitative Assessment of Subcontracting Impacts on Infrastructure Project Performance: A Descriptive Statistical Analysis

Subcontracting is a widely adopted practice in infrastructure projects, especially in large-scale construction where specialized tasks are outsourced to third-party firms. While subcontracting can bring benefits such as cost efficiency, access to specialized skills, and greater flexibility, it can also introduce risks related to

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communication, delays, safety compliance, and quality control. This study aims to quantitatively assess how subcontracting affects infrastructure project performance in the Indian context, focusing on key metrics such as cost, time, quality, safety, and productivity.

The study employs a **descriptive statistical approach** to analyze data collected from industry professionals through a structured questionnaire survey. The goal is to identify trends, highlight areas of concern, and provide a clear picture of how subcontracting practices influence project outcomes.

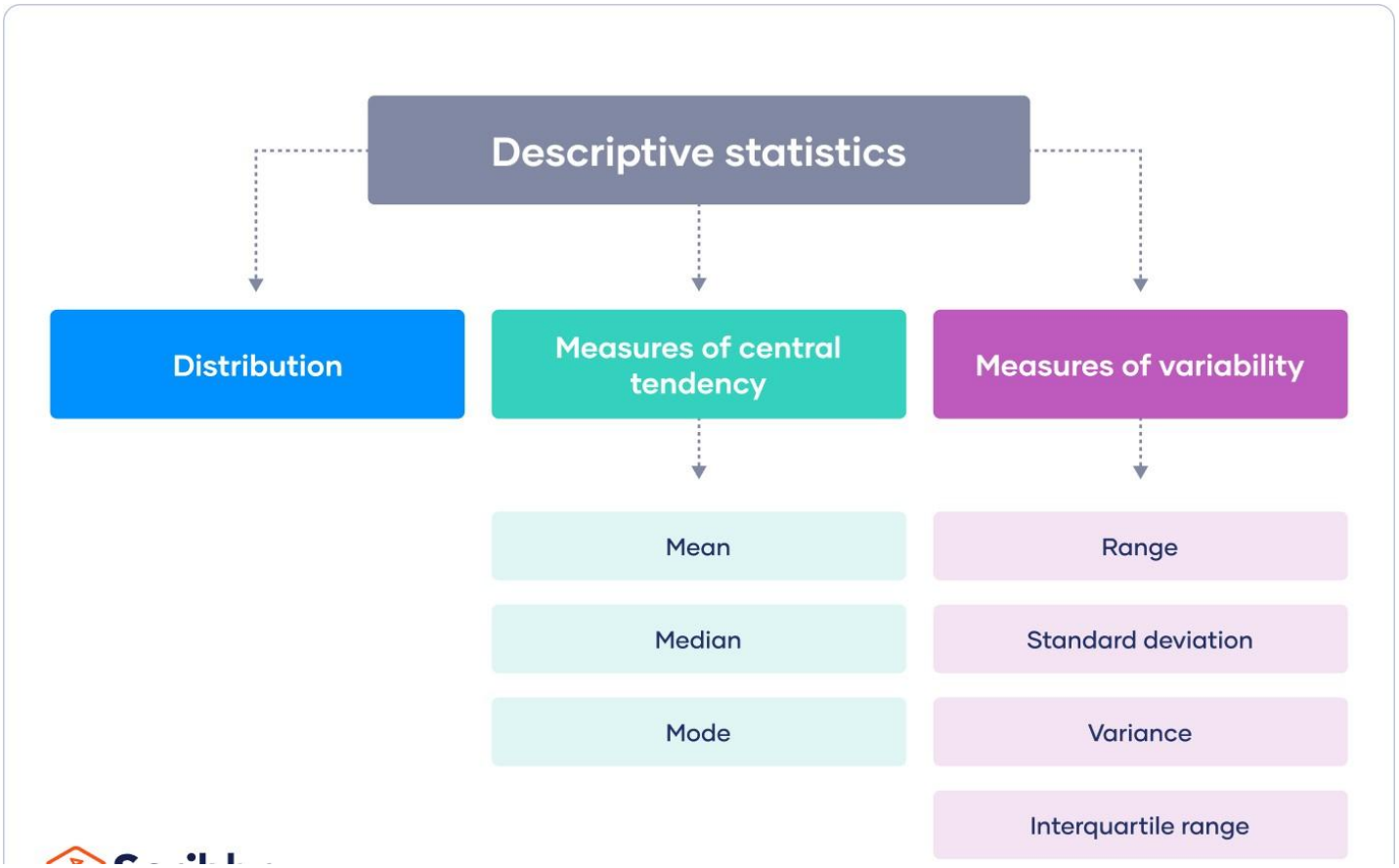

Figure No.1 Descriptive statistics

Quantitative assessment involves the collection and analysis of numerical data to objectively evaluate the effects of subcontracting in infrastructure projects. This method provides a measurable and data-driven understanding of how subcontracting influences key project parameters such as cost, time, quality, safety, communication, and productivity.

The study uses data obtained from a structured questionnaire filled out by industry professionals. Responses are analyzed using descriptive statistics, allowing researchers to detect trends, central tendencies, and variations among various subcontracting practices and project outcomes.

Quantitative analysis involves the use of numerical data and statistical methods to analyze and interpret data. Quantitative analysis is a critical component of this study, aimed at interpreting the numerical data collected through the structured questionnaire survey. This section systematically analyzes the responses of industry professionals to assess the measurable impact of subcontracting on infrastructure projects. The focus is on deriving statistical insights that highlight regarding project cost, time, quality, safety, Selection of contractors, terms & conditions in subcontracting practices.

Descriptive statistics provide a foundational understanding of the dataset collected through the questionnaire survey by summarizing and organizing the raw data into meaningful patterns. This section presents a statistical overview of the responses received from professionals working in infrastructure projects, focusing on their experiences, perceptions, and related to subcontracting.

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The primary objective of this analysis is to describe the central tendencies, dispersion, and frequency distributions of various variables, offering a clear picture of the overall trends in the data. Descriptive statistics help in simplifying large amounts of data into manageable and interpretable figures without making inferences beyond the data collected.

descriptive measures used in this section include:
Frequency distributions of key variables
Mean (Average): To find the central value for Likert-scale responses regarding cost, time, quality, and subcontractor performance.
Median and Mode: To identify the most typical and most frequent responses where applicable.
Standard Deviation: To measure the spread or variability of responses around the mean, especially for ratings on subcontractor effectiveness and project delays.
Range: To highlight the minimum and maximum values recorded for specific variables.

CONCLUSION

The strategic use of subcontracting in infrastructure projects can enhance efficiency and flexibility, allowing access to specialized expertise that can improve the quality of the project. However, for subcontracting to be effective, robust contract management, communication, and oversight mechanisms are essential. Properly managed subcontracting can contribute to successful project delivery, while poor management may lead to delays, quality issues, and budget escalations.

Moreover, subcontracting allows main contractors to focus on core responsibilities while delegating complex or labor-intensive tasks to specialists. It can also reduce fixed labor costs and operational risks through the transfer of responsibility. When subcontractors are selected based on merit, experience, and capability, their involvement can introduce innovation and technical excellence into the project.

However, the benefits of subcontracting are highly dependent on effective integration and coordination between all project stakeholders. Misalignment of expectations, unclear scopes of work, and lack of communication can significantly impact progress. Disputes over deliverables, payment delays, and safety compliance are common challenges that arise from poor subcontractor management.

Additionally, over-reliance on subcontractors without proper vetting or oversight can lead to quality degradation and project fragmentation. To mitigate these risks, implementing clear performance metrics, regular monitoring, and transparent contractual obligations is crucial. Ultimately, strategic subcontracting, when managed effectively, can be a key enabler of project success in the increasingly complex field of infrastructure development.

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