

**CAPITAL UNIVERSITY OF SCIENCE AND
TECHNOLOGY, ISLAMABAD**



**Assessing the Impact of Construction
Management on Project Performance
for Design-Bid-Build Highway Projects
in Islamabad**

by

Muhammad Yousaf

A thesis submitted in partial fulfillment for the
degree of Master of Science

in the

**Faculty of Engineering
Department of Civil Engineering**

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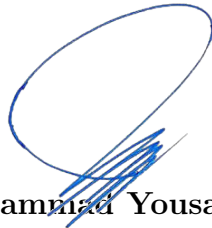
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Abstract

It has been widely acknowledged that construction management, or CM, plays a crucial role in enhancing the performance of construction projects, particularly Design-Bid-Build (DBB) highway projects. However, little information is available regarding the role of CM in reducing or increasing the level of various project performance parameters in the context of DBB highway projects, such as cost control, schedule compliance, and stakeholder satisfaction. This is a reason why this research explores how CM integration affects such important metrics, attempting to fill this gap. The methodological approach of the study was quantitative, utilizing survey data from clients, designers, contractors, and other related stakeholders involved in DBB highway projects. Regression methods were employed in the analysis to determine the relationship between CM practices and the outcomes of project performance.

The results proved that CM integration led to a significant improvement in the project performance. Namely, the average cost control score for CM projects was 4.2, while for non-CM projects, it was 3.2. The performance of schedules was also considerably enhanced with an average score of 3.95 and 2.8, respectively, in CM projects and non-CM projects. In CM projects, the median percentage satisfaction score is 3.94, compared to 3.11 in non-CM projects. Moreover, the CM-integrated project was significantly rated higher in terms of perceived value and client support. Although less related to CM performance, it nonetheless had a positive effect on Contractor Comfort.

This study contributes to the growing body of literature on **CM practices**, providing quantitative evidence of their positive impact on key project metrics. The findings underscore the importance of **CM integration in DBB highway projects** and offer a new perspective on the role of **CM** in improving both operational and stakeholder outcomes.

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List of Abbreviations

ADP	Annual Development Program
ANOVA	Analysis of Variance
CM	Construction Management
CMA	Construction Manager as Agent
CMAR	Construction Manager at Risk
DBB	DesignBidBuild
GMP	Guaranteed Maximum Price
KPIs	Key Performance Indicators
PPP	Public-Private Partnering
RFPs	Request for Approval
SDGs	Sustainable Development Goals

Chapter 1

Introduction

1.1 Background

Highway construction projects are critical for economic development and regional connectivity [1]. Since 1960s, Islamabad, Pakistan's planned capital, has seen significant investments in highway infrastructure and rapid urban growth. The main roads, the Islamabad Expressway and the most recently completed Margalla Avenue, had a significant impact on urban mobility, land use patterns, and regional integration with surrounding areas [2,3]. The Expressway, which permits north-south traffic flow between Islamabad and Rawalpindi, and Margalla Avenue, which serves as an east-west bypass, have significantly reduced travel times and eased the burden on congested arterial roads [2,3]. Road infrastructure investments are positively correlated with household welfare, job creation, and regional economic development, according to empirical data from Pakistan [4,5]. By linking the capital with satellite towns like Taxila and Wah Cantt via Margalla Avenue, travel times between outlying communities and the city center have been greatly reduced. This has increased employment markets and encouraged daily commutes [2].

Design Build Bid (DBB) project delivery model was the most commonly used method during construction in the public sector all over the world since a long time in the past. It adheres to a systematic procedure whereby different corporations handle different contracts to handle the different phases in design, bidding

and construction of the project [6]. This has been facilitated by apparent administrative clarity, transparency during the awarding process of contracts, and reduced chances of collusion or favoritism in the public procurement arena [7]. Original agencies, like the National Highway Authority of Pakistan, Pakistan public works department and Frontier Works Organization still apply DBB in the transportation infrastructure and specifically in highways and roads because of legal agreements, budgetary processes and institutional know-how. Empirical evidence attests that DBB is employed in 60-80 percent of the infrastructure checks in the Ghanaian and Nigerian public sectors [8,9]. In the Gilgit-Baltistan region of Pakistan, according to the studies conducted there, the major road and building work in the Annual Development Program (ADP) basically follows DBB. It is so due to the government requirements in support of competitive bidding and tight budget control [10].

This institutional preference for DBB usually stems from its perceived objectivity and procedural compliance with procurement laws, despite its inherent disadvantages when complexity or speed of delivery is required. Even in developed nations, DBB is still frequently used in public works projects, despite the emergence of alternatives such as Design-Build (DB) and Construction Manager at Risk (CMAR). A study comparing DBB and DB in U.S. airport projects found that DBB accounted for nearly 40% of non-residential public projects in the mid-2010s [11]. DBB's share in the rail and highway sectors remains over 50% due to conservative adoption practices, a deeply rooted administrative culture, and a dearth of enabling policy mechanisms for alternative models [9].

Despite criticisms and new delivery methods, DBB remains a preferred model in both developed and developing countries due to its regulatory comfort zone, familiarity, and institutional resilience. It is particularly embedded in the highway and other civil infrastructure sectors, where sequential decision-making, cost control, and transparency are required. One of the most severe criticisms of DBB is its susceptibility to cost overruns. Comprehensive studies have shown that public-sector DBB projects in Nigeria had mean overruns of 45.6%, with some exceeding 58% of the original budget [12]. Among the causes identified were inaccurate

cost estimation, low-priced contractor bids, fragmented scope changes, and protracted awarding procedures. The study found that up to 65% of the cost overrun burden under DBB was borne by clients, with consultants and contractors also suffering severe financial hardship. [9] found that public-sector projects in Ghana experienced average cost overruns of 30% to 40%, primarily due to scope creep, bureaucratic delays, and systemic mismanagement. Developing economies have reported similar results. This systemic inefficiency is partly due to "lock-in" effects, which arise when early decisions during the design phase-based on insufficient cost data restrict the flexibility to adapt or revise plans at later stages. Despite formal bidding structures, this has resulted in an increase in final expenditure [13]. DBB's division of contracts between design and construction exacerbates this because design errors lead to value-engineering modifications and addenda during construction, which are factors that increase cost uncertainty and inflation [14]. The study found that DBB's structural fragmentation removes accountability for cost predictability until the very end of the process, allowing design errors and poor estimations to eventually burden clients through change orders and contract variations.

Delays are another persistent problem, especially with government-funded highway and infrastructure projects. Delays were generally 30% to 40% longer than expected, according to research done in Gilgit Baltistan, Pakistan. Inadequate feasibility studies, approvals, and delayed funding disbursement were among the many problems that led to this, as were institutional inefficiencies and contractors' limited capacity [10]. Similar analyses carried out in Pakistan's Malakand Division confirmed these issues, identifying the primary causes of delays as swing weather, insufficient contractor financing, and late payments [10]. Part of the reason for these delays is the rigorous DBB process, which demands that the design be finished before bidding, which must conclude before construction can begin. Any setback, such as incomplete documentation, resubmitted drawings, or design errors, stops progress [2]. Furthermore, contractors only work on post-bid awards, which causes delays in the project by failing to provide timely input on constructability or schedule feasibility. According to research on road projects by [14], poor information exchange during procurement and construction, such as

unclear RFPs (Request for Approval) and missing constructability feedback, directly results in errors and rework. The study recommended design-construction overlap, early contractor involvement, and accountability consolidation as solutions to DBB segmentation. These strategies reflect the growing consensus that DBB's rigid workflow and constrained communication channels are unsuitable for complex, dynamic project environments.

The adoption of Construction Management (CM) techniques is increasingly being pushed as a workable change to the current framework because of DBB's extensive use and well-known shortcomings. Either as a third-party Construction Manager [CM Agency (CMA)] or as Construction Manager at Risk (CMAR), CM assigns a dedicated manager to oversee design, cost estimation, scheduling, constructability reviews, risk management, and stakeholder communication. CM assists DBB in avoiding the financial surprises that occur at the end of the phase by incorporating cost control throughout the project. The manager in the CMAR model transfers cost risk from the owner and avoids overruns by committing to a Guaranteed Maximum Price (GMP) [17]. Empirical reviews have shown that early CMAR involvement reduces client-side cost exposure and encourages realistic budgeting. Studies conducted in the United States have shown that early contractor engagement can lead to average cost and schedule savings of 7% and 10%, which are comparable to Design-Build efficiencies while maintaining competitive bidding [18]. Similarly, CM helps with proactive risk assessment and allocation. DBB typically saves these tasks for later stages, but early CM presence in major transportation projects allows collaborative identification of site uncertainties, contingency planning, and schedule resilience [19]. Therefore, by avoiding costly change orders, night work, and litigation, CM reduces both direct and indirect costs. By including CM at the start of the design process, design and construction can overlap. This expedites project completion without sacrificing bid competition or public procurement compliance. A review of DBB highway projects found that combining responsibility across the design, procurement, and construction phases and allowing contractor input facilitated earlier mobilization and faster site progress. According to [16], this decreased schedule slippage. This front-end overlap reduces administrative waiting, idle time, and makes it easier to realign stakeholder expectations.

A study carried out in Pakistani public-sector road and building programs confirms similar findings: the application of CM practices led to improved planning, stricter scheduling, and greater stakeholder accountability, all of which helped to lessen persistent delays and coordination failures [10]. CM promotes constant collaboration between designers, contractors, and owners at every stage. The construction manager acts as the integrative hub by maintaining communication protocols, monitoring the design's constructability, and ensuring timely dispute resolution. By encouraging clarity, dismantling adversarial pairings, and enhancing project transparency, this collaborative culture combats the structural communication silos of DBB [20]. Lean-style coordination structures within DBB contexts enhance the benefits of CM, according to last-planner implementation testimonies [20]. DBB highway projects have a potential of producing a superior project outcome by having a CM involved at an early point and this can enhance the project outcome by eliminating the miscommunication factor, and provides a better working relationship and feasibility of the project [21]. Islamabad, being a developing urban centre can immensely use the services of a more efficient CM practices so that its highway projects can be made to run on time and budget and to the standard.

1.2 Problem Statement

DBB that has been heavily used in Pakistan leads to a distinct design and construction split of projects. The disconnection between design and construction generates a lot of inefficiencies. The poor integration of the design and building phases frequently results in expensive delays and an additional need for redesign steps [20]. Construction teams often discover that initial plans conflict with on-site realities, necessitating adjustments that extend timelines and increase costs. Moreover, the unadopted nature of DBB arrangements may cause inefficiencies if abrupt problems are encountered while building. In the case of highway projects, the fluid nature of site conditions and construction issues means that high speed response in decision making is a must in highway projects [10]. Therefore, the disintegration of the construction process is likely to lead to high costs, slow progress, and poor-quality outcomes. [22], in his research has highlighted that conventional

DBB projects within the developing nations like Pakistan tend to be plagued with ineffective communication, poor construction management practices, and insufficient integration across project stages, leading to project underperformance. Such deficiencies are particularly marked in public sector highway projects where complexities and co-ordination requirements are greater. In the end, the fragmentation in DBB framework constrains effective implementation of projects and adverse impacts to the fulfilment of Pakistan's larger goals for infrastructure development particularly as regards to the highway projects in Islamabad. Therefore, this study aims to assess the extent to which CM practices can mitigate these inefficiencies and improve project performance in DBB highway projects, building on the existing body of knowledge [22-24].

1.3 Research Motivation

The reasoning behind this investigation is because it aims to address the underlying shortcomings of Design-Bid-Build (DBB) in general, specifically to enhance highway construction projects in Islamabad. Accounting for the continued delay and cost overrun in DBB projects, this research aims at exploring the benefits of adding on Construction Management (CM). CM interacts with all phases of a project, starting from the design and ending with the project closing in order to make the communication within the project smooth and the control over the project effective.

The use of CM in DBB projects can highly improve the pace and efficiency of delivering the projects. Construction managers make this possible by linking design to the actual construction to ensure the improvements are practical as well as that construction can be implemented effectively and on time. Construction managers provide continuous monitoring, allowing to mitigate the design changes or construction issues with a timely resolution which can reduce the delay of the project and avoid cost overruns.

This research seeks to add critical insights into the modalities through which CM works to serve DBB projects in Islamabad addressing stronger infrastructure outcome and more efficient delivery of projects with less cost.

1.4 Research Objectives

This research aims to assess the effectiveness of Construction Management (CM) in improving the performance of Design-Bid-Build (DBB) highway projects in Islamabad. The specific objectives of the study are as follows:

- (i) **To evaluate the impact of Construction Management (CM) on project performance**, including cost efficiency, adherence to schedules, and the quality of completed projects.
- (ii) **To investigate how CM addresses common issues** in Design-Bid-Build (DBB) projects such as miscommunication, delays, and cost overruns.
- (iii) **To assess stakeholder perceptions** of CM's role in improving project performance in DBB highway projects in Islamabad, including contractors, designers, and clients.
- (iv) **To compare DBB projects with and without CM** to assess whether CM integration results in a tangible improvement in project outcomes.

By meeting these objectives, the research will provide a comprehensive understanding of the role of CM in enhancing DBB highway projects, specifically in Islamabad's context.

1.5 Research Questions

The research will be guided by the following key questions:

- (i) How does the integration of Construction Management (CM) influence the project performance in DBB highway projects in Islamabad?
- (ii) What are the primary challenges faced in DBB highway projects in Islamabad, and how can CM mitigate these challenges?
- (iii) To what extent does CM improve communication and coordination between design and construction teams in DBB projects?

- (iv) What are the perceptions of stakeholders (contractors, designers, and clients) regarding the effectiveness of CM in DBB highway projects?
- (v) How do DBB projects with CM compare to those without in terms of cost, schedule adherence, and quality of outcomes?

These questions will guide the data collection and analysis process, helping to determine the practical benefits of integrating CM into DBB highway projects.

1.6 Scope and Limitations

The research is limited to the analysis of highway construction projects within Islamabad and those that follow the Design-Bid-Build (DBB) framework. The investigation aims to look at ongoing projects and the ones which have been concluded while illustrating the use of construction methods such as construction management (CM). Additionally, the research will collect data from a number of project stakeholders like contractors, designers, and clients to measure their opinion on the role of CM in contributing to better outcomes of projects.

The limits of the study that must be taken into account exist. Since the location of investigation for the study is restricted to Islamabad, the results may not be as-applicable to other parts of Pakistan. Second, the study will involve the use of data offered directly by stakeholders, which, in some cases, can be far from being completely genuine and unbiased. However, as the investigation focuses on DBB projects, conclusions made from the investigation will not generalize from projects that use alternative approaches of delivering such projects, such as Design-Build (DB) or Public-Private Partnering (PPP).

Despite these limitations, the research will generate beneficial recommendations for the improvement of DBB highway works in Islamabad through the use of Construction Management practices.

1.7 Significance of the Study

The present study has a number of reasons. Firstly, it occupies the existent gap in the contemporary research environment that studies the project development of

the DBB highway in greater detail for a specific location, Islamabad, where there exists an emerging infrastructure pressure. Secondly, the results of the research will assist policy makers, engineers and contractors in the understanding of the essence of early-stage integration of construction management [25].

In practice, results of the study can instruct agencies in the public sector and project managers to enhance the project output with the help of CM strategies [26]. This may result into shorter construction delays, cost savings and the enhancement of the quality of the public infrastructure. On a bigger picture, the proper construction of highways will also enhance sustainable urbanization process, connectivity and boost the economy of the area.

Besides, the research can also be said to support the Sustainable Development Goals (SDGs), both SDG-9 (Industry, Innovation, and Infrastructure) and SDG-11 (Sustainable Cities and Communities), since it involves eco-friendly construction procedures and more effective urban design [27].

The purpose of this study is both practical and academic with a view to contribute to the literature and application of construction engineering and management practice by assessing and proposing measures that can enhance project performance through application of construction management within DBB mode in Islamabad.

1.8 Brief Methodology

The chosen research topic, “Assessing the Impact of Construction Management on Project Performance for Design-Bid-Build Highway Projects in Islamabad,” is selected due to its importance and relevance in the construction industry, shaping the entire research endeavour. This study is precisely crafted to examine the Impact of CM on Project Performance for Design-Bid-Build Highway Projects in Islamabad. The process initiates with the gathering of data, where primary data is obtained through existing literature, while secondary data is derived through close ended surveys questionnaires. A thorough literature review is performed to create a theoretical framework, pinpoint research gaps, and comprehend the existing knowledge regarding the Impact of CM on project performance.

1.9 Thesis Outline

This research thesis is organized into five chapters to lead readers through the investigative process and fulfil the study's aims.

Chapter 1: Introduction provides the background, purpose, and context of the study. It details the research goals, scope, limitations, and provides an overview of the methodology employed.

Chapter 2: Literature Review offers an in-depth examination of current studies regarding CM in DBB, associated challenges and their influence on project outcomes. It highlights deficiencies in the existing body of work, underscoring the significance of project characteristics and management efficiency.

Chapter 3: Research Methodology outlines the research design, data collection methods, and analysis techniques being used, emphasizing a quantitative approach to investigate the impact of CM in DBB for highway projects.

Chapter 4: Results and Discussion provides an analysis of the findings from survey, examining the impact of CM on project performance in DBB.

Chapter 5: The Conclusions encapsulates the study's findings, presents actionable recommendations for stakeholders in the construction sector, and proposes avenues for future inquiry to deepen the comprehension and selection of the CM in DBB, the most effective project delivery methods.

Chapter 2

Literature Review

2.1 Introduction

The construction industry, particularly highway infrastructure development, continues to face significant challenges in project delivery performance, with traditional Design-Bid-Build (DBB) procurement methods experiencing persistent issues related to cost overruns, schedule delays, and quality deficiencies. The integration of Construction Management (CM) practices within DBB frameworks has emerged as a potential solution to address these systemic problems. This literature review examines the current state of knowledge regarding Construction Management integration in DBB highway projects, focusing on performance improvements, cost control mechanisms, and stakeholder coordination enhancement. The review synthesizes findings from recent academic research published between 2020 and 2025, providing a comprehensive foundation for understanding how CM practices can address the inherent limitations of traditional DBB delivery methods in highway construction projects.

2.2 Design-Bid-Build Project Delivery: Persistent Challenges and Performance Deficiencies

Design-Bid-Build (DBB) method is currently used widely in the project delivery world, especially in public infrastructure projects in the developing countries where

such projects are served by regulatory frameworks and institutional practices to provide traditional procurement techniques. Nevertheless, considerable scholarly literature supports severe performance problems to related to DBB project, especially as per cost overruns, time overruns as well as quality. The recent excellent research has shown that DBB projects still have high rates of escalation in costs so that infrastructure projects are not uncommon to be around 20-80 percent of the original contract value over their initial budgets, and such performance problems have proved longstanding across the geographical context and the type of projects [28,29].

The disjointed structure of DBB causes natural problems with the coordination of the projects and communication, which vastly formed the body of recent academic research. A study carried out by [30] representing projects in developing nations pointed out poor communication between the design and construction stages as one of the main causes of delays and cost overruns in project development. Forward flow relationship of DBB i.e., the completion of the design before the contractor is chosen usually ends in constructability concerns that could be felt at the construction stage and thus creates a time-based gap between the design and construction team that gives rise to information vacuums that gives way to change orders of any nature, rework and project extension. Moreover, competition bidding procedure in DBB may give the priority to lowest cost instead of technical proficiency, which interferes with the quality of projects and the final performance results, as stated in the analysis of different research studies on the procurement practices in the public sector [31,32].

The recent studies available on the highway construction projects indicate that cost overruns in DBB projects are determined by several interrelated factors that incur systemic inefficiencies. Diverse findings based on the in-depth consideration of road infrastructure projects conducted by [33] revealed inaccurate cost estimates, change of design, variation of quantities, and variations orders as some of the main cost drivers and they commonly interact with one another during the project lifecycle. The paper has highlighted the fact that political interference, inflation and changes in specification are other factors that increase the incidence of cost overruns, especially in government projects as project decisions are based

on external influences outside the control of the projects. Other studies by [34] validated such report and even pointed at the influence of poor feasibility study and low risk assessment in exacerbating the issue of cost overruns in the construction of highway-related projects.

The academic literature on DBB project delivery also gives massive attention to the quality implications. As the research by [35,36] has shown, the lack of coherence of DBB procurement usually leads to the instances of a quality failure that become noticed during the late phases of the construction process or so that they cost the most and appeared the most disruptive to resolve. Division of design and construction duties in DBB projects leave out responsibility intervals that may lead to quality issues that last the whole lifecycle of the project and eventually long-term performance and maintenance needs of highway infrastructure assets.

TABLE 2.1: Overview of Key Challenges in DBB Highway Projects

Challenge Area	Description	Impact on DBB Projects
Fragmented Communication	Lack of coordination among design, bid, and construction teams	Delays, scope creep, and misinterpretation of designs
Rigid Project Structure	Limited flexibility once bidding is completed	Difficulty adapting to unforeseen on-site conditions
Quality Control Issues	Contractor selected mainly on lowest bid rather than capability	Compromised quality and long-term performance
Time and Cost Overruns	Inadequate early-stage planning and estimations	Budget overruns and delayed project completion
Limited Innovation	DBB's sequential structure restricts early input from constructors	Missed opportunities for cost-effective innovation
Documentation Gaps	Incomplete or unclear project documentation	Increased risk of disputes and change orders

2.3 CM Integration: The Theoretical Foundations and Implementation Frameworks

The use of Construction Management (CM) practices in the traditional DBB framework is an important shift in the approach to project delivery and this shift is justified by strong theoretical grounds and concrete evidence provided by recent academic studies. Construction Management could be provided combined

with Construction Manager at Risk (CMAR) or the first Construction Manager as Agent (CMa) contracts, where professional management competence comes into any project lifecycle, in its original design to the end of the project. According to recent studies by [18], the introduction of CM may have a significant positive effect on a project, offering constant supervision, better communication procedures, and the prevention of risks that often present themselves in DBB strategies.

The conceptualization of CM integration lies in the systems theory and organizational behavior based on the belief in the significance of coordination, communication, and collaboration in the decision-making process in complex project settings. According to the study conducted by [37,38], CM practices help to develop a systematic methodology of information handling, stakeholder management, and risk control, which targets the inherent vulnerabilities of the popular DBB techniques of delivery. The construction manager is a focal place that will enhance communication between the design and construction teams to make sure that project decisions are made taking into consideration all the implications they may have in any stage of a project.

Effectiveness of CM integration in highway project has been proved using comparative studies where the metrics performance of projects with various delivery methods is monitored. According to a broader comparative analysis conducted by [39], the cost control stood closer in projects using CM practices, at average cost growth rates distinctively lower than in DBB projects. The conclusion of the study was that CM-integrated projects resulted in an improved cost predictability of the projects due to early contractor involvement, value engineering and overall project cost tracking till the end of the project. These results indicate that CM practices have the potential to solve the cost overrun problem that is inherent in traditional DBB projects by debut cost management procedures and the implementation of improved outlines of communication between the stakeholders.

The theoretical underpinnings of CM integration are also advanced by contemporary studies that proved that systematic project management strategies can curb the coordination issues of DBB projects [40,41]. The study confirms that CM practices develop systematic constructs of decision making, risk evaluation,

and quality control which enhance the performance of projects in various performance areas. Leveraging of CM practices also enables the adoption of superior project management systems i.e., use of Building Information Modeling (BIM), lean construction concepts, and integrated project delivery systems and methods that result in the improvement of the manner in which a project is performed.

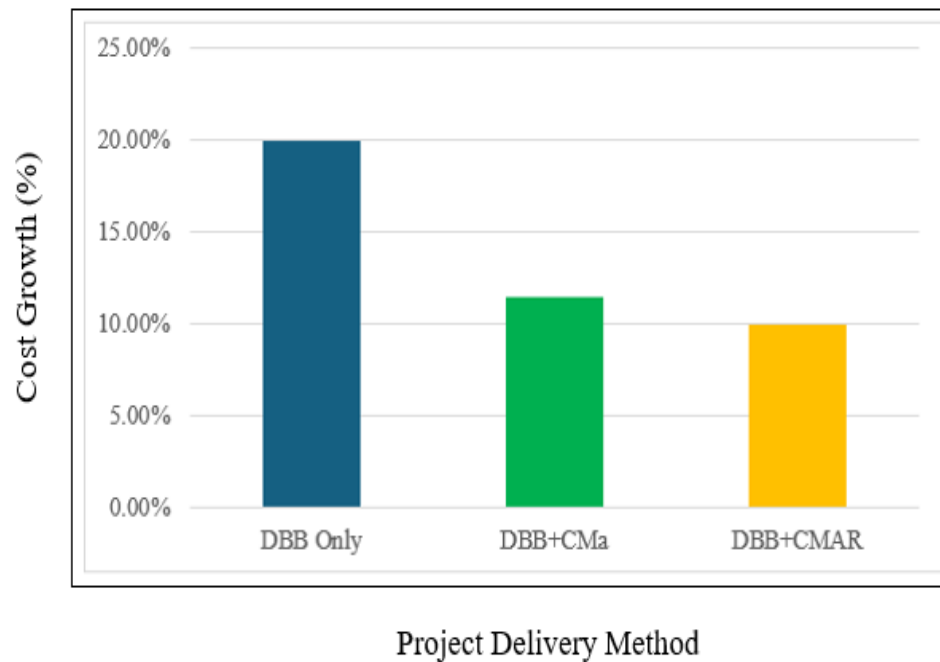


FIGURE 2.1: Average Cost Growth in DBB Projects Adapted from [39].

2.4 Communication Enhancement and Coordination of the Stakeholder Through CM

The achieved level of stakeholder coordination and communication following successful Construction Management integration in DBB projects is one of the most important promises in terms of addressing the critical flaws of traditional project delivery methods. Lately, the academic literature has been very active in reporting the communication problems that have been ravaging the DBB projects as design teams, contractors and clients usually work in relative solitude until it is time to hand-over projects. Such a division of labor leaves room to misinterpretation, variations in project specifications, and delay of decision making, which can seriously affect a project performance [42,43].

The communication issues are mitigated by the practice of Construction Management; it meets those issues through development of the centralized communication procedures and keeping the constant contact among all project members on the basis of the project lifecycle. The study that conducted by [44] on highway construction projects shows that the incorporation of CM generates systematic communication systems which ensure frequent information exchange between the design team and construction team which enhances the possibility to identify and solve the probable problems early on. The construction manager acts like a hub of information through whom all the stakeholders in the project will communicate and hence issues become resolved within the shortest time possible and all concerned people will be aware of what is going on in the project and what lies ahead and the events that may have negative impact in the project execution.

Reduced project performance due to stakeholder dissatisfaction is eliminated by stakeholder feedback between project stakeholders, and intra/inter-organizational project performance. According to the works of [45,46], projects featuring applied CM strategies have been proven to portray an increased degree of stakeholder satisfaction since they involve more transparency, periodic reporting, and active management of problems. The study confirms the existing views that CM practices build collaborative workplaces, which are quite different when compared to the adversarial relationship developed in the traditional DBB project, where the contractual lines can restrict communication and cooperation among the participants in the project.

Recent research by [47] further demonstrates that effective communication protocols established through CM integration significantly reduce the incidence of disputes and claims in highway construction projects. The study found that projects with integrated CM practices experienced 40-60 percent fewer disputes compared to traditional DBB projects, primarily due to improved information flow, clearer role definitions, and proactive conflict resolution mechanisms. This reduction in disputes not only improves project relationships but also contributes to better cost and schedule performance by avoiding the delays and expenses associated with formal dispute resolution processes.

TABLE 2.2: Comparative Table how CM improves Stakeholder Coordination Through CM

Aspect	Traditional DBB	CMM Integrated DBB	References
Communication Flow	Fragmented, delayed	Centralized, real-time	[44]
Dispute Frequency	High (Baseline)	40-60% reduction	[47]
Stakeholder Satisfaction	Low (Adversarial)	High (Collaborative)	[45]
Issue Resolution Speed	Slow (Reactive)	Fast (Proactive)	[46]

2.5 Risk Management and Quality Assurance Through Integrated CM

The integration of Construction Management is of significant importance as far as risk management in highway projects is concerned due to a systematized approach to risk identification, evaluation as well as mitigation plans inferred to help project risks proactively in advance of causing project effects. The conventional DBB projects tend to be reactive in dealing with risks, that is, dealing with the risks as they occur, instead of approaching them systematically using systematic risk management procedures. A study conducted by [48,49] proves that CM integration offers holistic risk management approaches that target identification of risks at the initial stages of the project lifecycle and formulate mitigation plans that avert actualization of risks to impacts on the project.

Highway construction is a special case in which the initiation of CM integration may involve proactive risk management to ensure that risk issues have a minor and not a significant effect on the performance of the project because risks may be externally imposed such like weather conditions, environmental regulations, and concerns of the stakeholders in the community. Research conducted by [50,51] confirms that CM practices develop systematic approaches to the assessment of risks taking into consideration the variety of internal and external factors that can influence the outcomes of projects as resulting in environmental conditions. The study proves that projects, which have integrated CM practices enable better risk mitigation solutions through continuous control, early warning, and flexible response arrangements that can be activated in response to a problem prior to the problem turning into an imperative issue.

Quality assurance is another important place where the practice of Construction Management can make a difference in the performance of a DBB project by entailing quality controls in an orderly and run-through manner in perpetuity throughout the project life cycle. [52,53] report that CM is beneficial in enhancing quality outcomes because it guarantees the systematic quality control process, periodic inspections, and a prompt corrective response in case of quality problem detection. The unending supervision that construction management professionals would offer ensures that the standards of quality are upheld throughout the life of the project unlike in the traditional DBB in which quality control might only be limited to occasional checks and phase wise reviews.

Integration of CM practices also optimizes the process of overall project delivery by conduction of enhanced coordination of specialty contractors and suppliers which is specifically of interest in highway works which generally contain numerous specialty contractors as well as a complicated chain of supplies. A study by [54] proved that the CM practice offers the measure of oversight and coordination needed to keep such complicated relationships on track, such that all project participants know what they are doing, when, and how the different activities they perform related to each other.

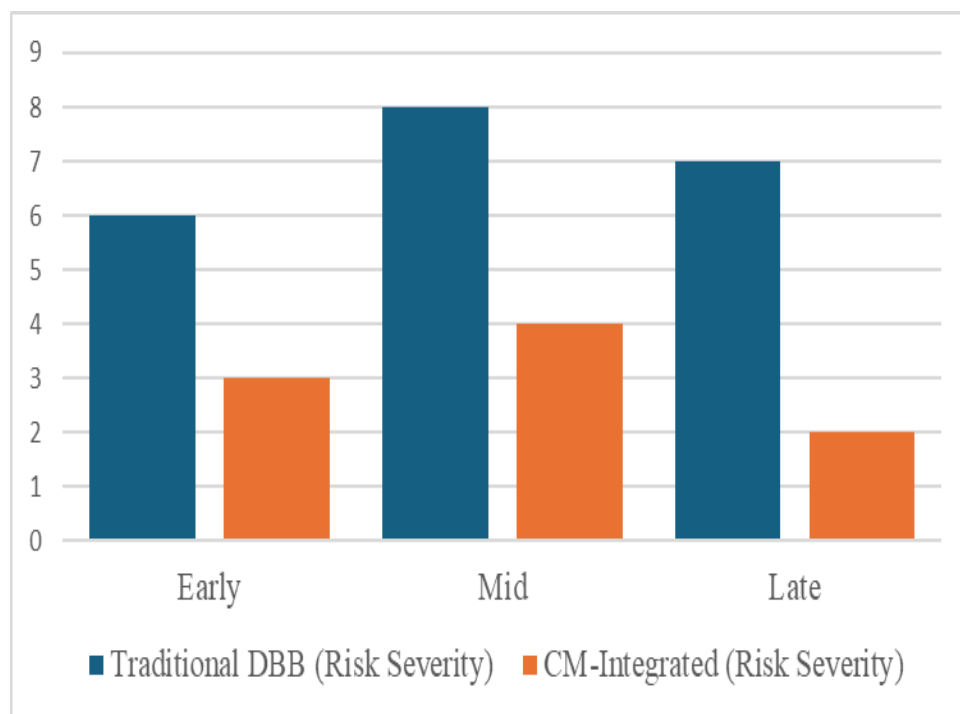


FIGURE 2.2: Risk Mitigation Effectiveness adapted from [48,49,50].

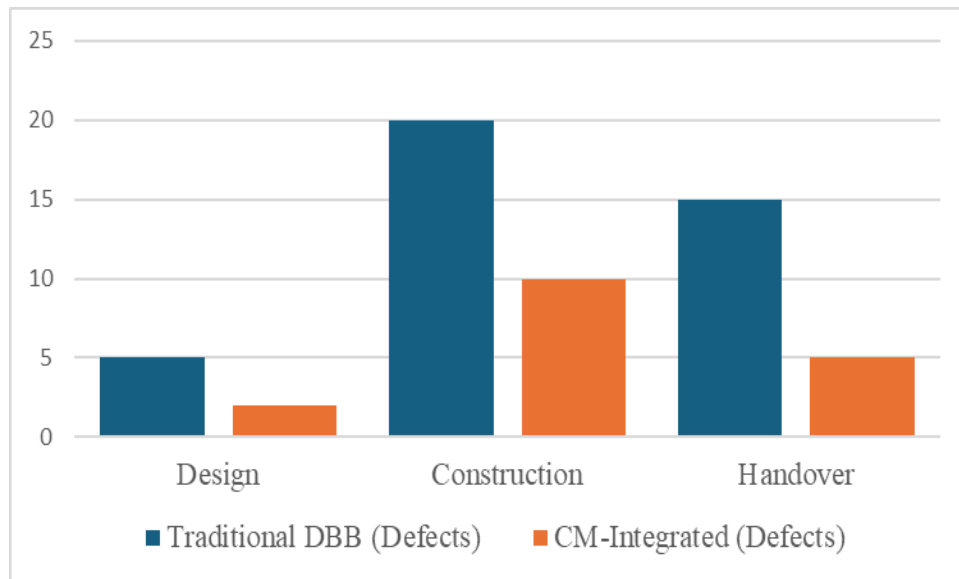


FIGURE 2.3: Quality Defects adapted from [52,53,54].

2.6 Economic Benefits and Performance Optimization Through CM

The actual economic value of integration of the Construction Management to the DBB highway project is higher than the mere cost control because instead of limiting the value optimization of the project to cost control, the process of professional construction management services is justified as a cost-effective overall increase of value contribution to the project. Studies that have been conducted to assess the financial benefits of CM practices reveal that the cost of initial outlay committed in construction management services is usually recovered through realized savings because of better project performance, less change orders, and increased schedule adherence. [55] provided an in-depth breakdown of studies and found that CM implementation led to savings on net projects averaging between 8-18 percent of total projects due to a reduction in the number of reworks, better resource utilization, and an increase in quality outcomes that could minimize long-term maintenance.

The improvement of performance of CM integration is seen on various levels of dimensions of projects which include adherence of schedule, control of costs and attainment of quality where recent research shows that on various aspects measurements of overall highway projects are significantly better when CM practices are incorporated into a project as compared to DBB projects. Studies by [56,57]

confirm that the above performance gains can be ascribed to the systematic management style that the CM practices bring to project management, i.e., thoroughly planned project management, active monitoring of the project progress, and active problem troubleshooting before they develop into high-value problems impacting results of the project.

CM integration in the long run has economic advantages that are not only on a per project basis but on other wider infrastructure development goals that lead to better quality and low life-cycle costs of infrastructure. Highway projects with high performance by virtue of CM integration help to realize high quality of the infrastructure, high levels of user satisfaction and minimal maintenance needs during the asset life of the highway infrastructure. According to [58] the value of the quality improvements that CM practices can bring about is that, you end up having infrastructure assets that need less maintenance and having higher service delivery to the users over the course of many years operation, which is part of the long term economic gains to using CM practices that will make the extra initial investment on the service of construction management worthwhile.

Modern studies of [59] also indicate that due to the complexity of the project and the coordination issues and the complexity of work, the economic advantage of integrating CM is especially strong when applied to complex highway projects. It was realized that high technical complexity projects attained disproportionately higher benefits of CM integration where cost savings and schedule gains were significantly higher as compared to less nuanced projects. This study contributes to the idea that the benefit of CM integration grows with project complexity and helps to apply CM practices on selective basis to the projects where the value of returns outweighs the increase in management services.

TABLE 2.3: Economic Performance Comparison

Metric	Traditional DBB	CMM Integrated	References
Cost Overrun (%)	15%	5%	[55]
Schedule Delay (%)	20%	8%	[56]
Change Orders (#)	25	10	[57]
Lifecycle Cost Savings	Baseline	12% lower	[58]

2.7 Stakeholder Perceptions and Acceptance of CM Integration

The adoption of the CM practices into the DBB highway projects has been deemed largely successful, yet the prior acceptance of stakeholders, together with positive ratings against the CM value offering has been profoundly researched in the past few years. According to the research conducted by [60,61], there is ample evidence that the perception of stakeholders towards the effectiveness of CM method depends on several factors such as prior exposure to CM practices, knowledge of CM roles and responsibilities and their perceived value against the incremental costs of professional management services.

Studies have been conducted that investigate contractor attitudes towards CM integration where it is found that on the whole the contractors perceive CM practices in an enthusiastic manner, especially citing better communication, dispute resolution and better project coordination. According to [62,63], contractors appreciate the fact that the proactive problem-solving manner that CM practices brings would mean better information flow and better coordination leading to lower risk of critical conflicts and delays. Nevertheless, the study also points to certain reluctance to CM integration among the contractors who see CM activities as a new layer of formal control that could limit their maneuverability or cut their profit margins.

The general attitude towards CM integration is positive, and the study conducted by [64,65] proves that the introduction of CM practices in the context of the public sector is appreciated by clients due to the increased level of transparency, efficiency in cost management, and the minimalization of risk exposure associated with it. The research implies that another thing that the application of CM practices in communication with the clients is especially valued by the latter is the proactive communication and constant progress reporting that this approach allows, and the increased level of accountability and performance monitoring that the integration of CM poses. Nonetheless, the concerns that are perceived with regard to the

extra expenses that may be caused by CM services and the necessity in explicit proving the value compared to the expenses are also found within the studies.

Designer perceptions of CM integration present a more complex picture, with research by [66,67] indicating that designers generally support CM practices that enhance project coordination and communication while expressing concerns about potential constraints on design creativity and professional autonomy. The research suggests that designer acceptance of CM integration depends significantly on the collaborative approach taken by construction managers and the extent to which CM practices enhance rather than constrain the design process.

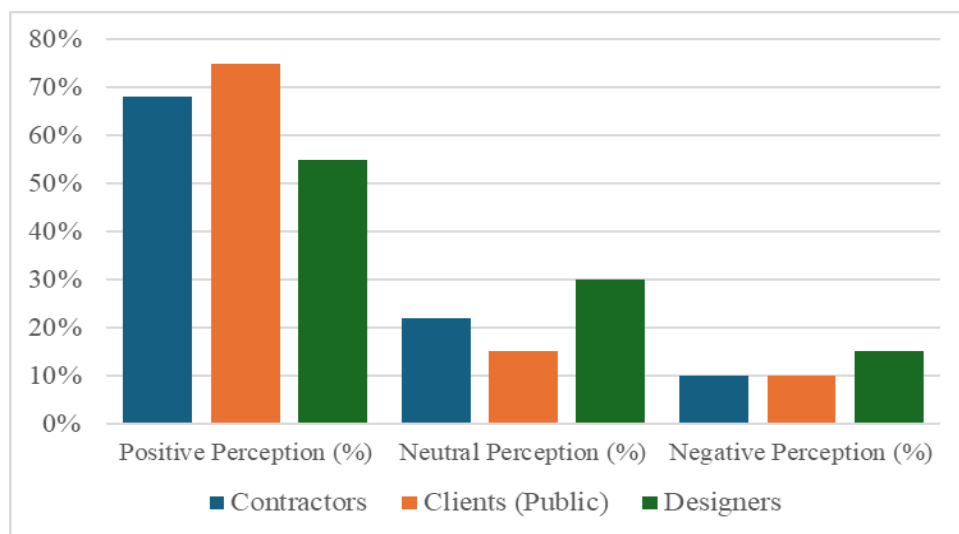


FIGURE 2.4: Key Stakeholder Perception Analysis adapted [62,64,66].

2.8 Implementation Challenges and Barriers to CM Adoption

The implemented Construction Management (CM) in DBB projects has documented performances of improvement, nevertheless, there are some crucial barriers and obstacles that hinder the common implementation of CM in highway infrastructure development. CM practices implementation would result in initial investment into management services, which can be seen as impacting on the cost of the project in an environment that values initial cost minimization above long-term value optimization. According to research findings given by [68,69] the

integration of CM is found to be highly dependent on access to qualified individuals as construction management professionals as well as the desire of the project stakeholders to compromise or work relationships as opposed to the wish to resort to the way of traditional adversarial relationships. The regulatory barriers and institutional barriers are of key concern as it relates to CM integration in DBB projects, especially where implementation occurs in the public sector where the procurement-related regulations of the environment might be biased towards the more traditional methodologies of DBB projects and less flexible to adjust to the manner of implementing CM. Analysis of the implementation of alternative project delivery systems through the works of [70,71] show that the regulatory environment often stands in the ways of the best industry practices, providing the existence of institutional barriers to innovation that prohibits the integration of CM into markets where regulatory changes must be undertaken in order to facilitate improved project delivery systems.

Evaluation and measurement of CM effectiveness is also problematic to both the practitioners and the researchers because of the complexities surrounding the construction projects hence making it challenging to determine the explicit effects of CM practices on the performance of the projects. CM effectiveness evaluation methodologies are also still in a state of incomplete development with most emphasis being focused on broad measures of performance that consider both quantitative and qualitative measures regarding the success of a given project. According to the results of a study by [72,73], such standardized concepts of performance measurement are needed which will be able to determine the value the CM practices are adding, without having to ignore the multiple factors which affect the result of the project.

Resistance to change within culture and organizations is yet another five major barriers to CM integration especially in those markets where DBB practices are deep-rooted into organization cultures and professionalism. According to research by [74,75], effective CM implementation involves considerable change management processes, which overcome the cultural issues and establish the acceptance of stakeholders to work with new relationships and partnership methods of project delivery.

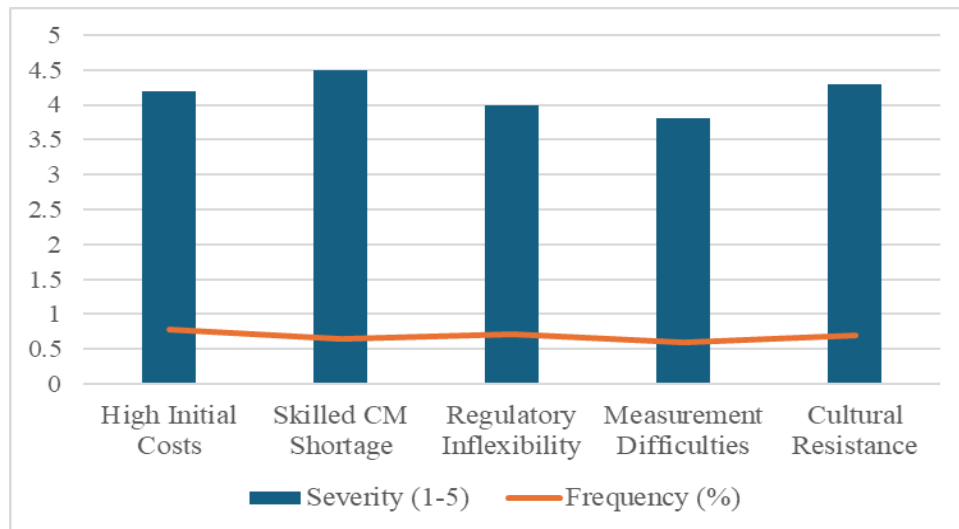


FIGURE 2.5: Barriers Analysis adapted from [69,70,72,74].

2.9 Technology Integration and Digital CM

The combination of digital technologies and Construction Management is one of the new research directions that will cause some consequences with regard to the future efficiency of CM integration into DBB highway projects. The recent research studies by [76,77] indicate that digital technologies, such as the use of Building Information Modeling (BIM), Project management software, and real-time monitoring systems, go a long way in augmenting the coordination and communication advantages that CM practices carry, to a substantial extent. The study shows that CM practices facilitated by technology attains a high level of performance due to the ability to manage better information, apply more visualization, and monitor projects in a real-time mode to proactively address a problem.

One of the most potential approaches to the improvement of CM effectiveness in highway projects is the application of artificial intelligence and machine learning technologies in construction management. [78,79] estimated that with the help of artificial intelligence, CM systems have the potential to offer predictive analytics functionality that helps predict possible issues before they occur, allocate resources more optimally, and manage risks using data-driven decision-making operations. Such technological breakthroughs may substantially enhance the value offering of CM integration through offering superior analytical tools that enable making of better project management decision.

Another important opportunity related to the use of Internet of Things (IoT) technologies with CM practices is associated with the improvement of project monitoring and control capabilities. According to the research conducted by [80,81], with the help of IoT-enhanced monitoring solutions, construction managers can receive real-time information about their project performance, the work of equipment and sensors, the environmental situation that will allow them to make more prompt decisions and react to possible emerging problems. This technological integration will be a major opportunity to improve the perception of the effectiveness of CM practices in addition to providing consistent in the judgment of the performance measurement and also increase the improvement process.

2.10 Future Research Direction and Emerging Trends

The field of studies regarding the Construction Management integration in DBB highway projects is overridingly developing, where the newest studies are devoted to issues of advanced technologies, ecological perspective, and attitude, as well as the strategies of the stakeholder involvement which is going to be the foundation of the further development of the CM practices. The potential further research areas are blockchain analysis in terms of implementing more transparency and accountability into CM processes, inclusion of sustainability metrics within the CM performance measuring frameworks, and creation of standardized CM competency frameworks advantageous of supporting quality assurance and professional development in CM practice.

The sustainability factors are gaining momentum in the processes of highway infrastructure development, and in the future, studies should look at how Best CM practices can be applied in ensuring improved environmental performance and sustainable process of construction. The introduction of sustainability objectives into CM systems is a chance to pursue the goals of the project performance and the greener environment at the same time, and studies conducted by [82] and environmental literature represented by [83] serve as indications of the possibilities of supporting sustainable construction outcomes with the help of CM practices.

The geographic and cultural setting of CM implementation can also be studied in greater detail since the efficacy of CM practices can in most cases differ greatly between contrasting cultural and regulatory practices. The provided information about these contextual factors will play a crucial role in implementing CM practices into various markets and regulatory environments, and such studies by [84,85] serve as initial attempts at shedding light on the cultural factors that determine the efficacy of CM implementation in various market contexts.

2.11 Summary

The literature review presented in this paper depicts that there is a lot of support on the capability of integrating CM practices on DBB highway projects to effectively solve the inherent constraints of traditional manners of project delivery. The study shows that CM integration has the potential to make some serious overall performance enhancement on projects because of the advanced communication procedures, preventive risk management measures and a methodological quality control mechanisms that eliminate the root cause failure of the piece meal DBB projects. The economic advantages of the CM practices such as cost saving, better value of the project and the improved long-term performance are serious reasons why the extra cost of professional construction management practices justifies the money to be invested in this program.

Incorporation of CM provides the stakeholders with the advantages of facilitating effective communication, minimizing conflicts, and increasing the project transparency, which are the benefits that enhance work relationships and collaboration that lead to optimal project successes of the project. Nevertheless, regulation, institutional, and cultural aspects that might affect the efficiency of CM practices implementation need to be taken into account carefully, whereas investment in professional formation and technologies integration which helps to boost CM abilities levels should not be neglected.

The conclusion of this study has direct significance in applying it to the construction of the highway infrastructure in the development economies where the necessity to enhance the level of performance and upgraded provision of value on

projects is a prerequisite of economic growth and social advancement. Application of the Construction Management practices in DBB projects is a feasible and streamlined way in enhancing infrastructure delivery without interfering with the regulatory and institutional frameworks of the conventional methods of delivering projects. In future studies, it is necessary to follow the line of researching the very changing role of CM in the development of high-way infrastructure, especially, paying attention to the technological progress, sustainable solutions in terms of sustainable development, and inner cultural conditions that would define the future performance level of the CM practice in the different global markets.

Chapter 3

Research Methodology

3.1 Background

The chapter presents the logical flow of the steps that were followed to resolve the research problem and achieve the goals of the study. The research methodology is a crucial section in any research since it gives a step-by-step process that shapes the whole procedure of data collection, analysis, and interpretation. In this section, the research process is presented starting with the design of the study that was selected. This is followed by an overview of the key factors that drive the phenomenon of interest. This section presents selection of the sample size and how the participants were described based on demographic characteristics. Subsequently, it presents the approaches to the questionnaire design and how the instrument was set out to gather the required information. In this chapter, the strategies that were used in data collection and analysis were described with sufficient detail to be sure the methods were able to address the research problem. Each study should have a philosophical foundation which provides logical reasoning of the study by connecting the research design with the desired aims and objectives. This is crucial because it makes the findings of the study to be reliable and of great importance. The methodology in focus helped the researcher to describe, analyze, and predict the given phenomena in a step-by-step manner while giving the researcher full control of the process.

3.2 Research Design

A quantitative research design is employed in this research whereby the effects of the CM practices on the performance of Design-Bid-Build (DBB) highway construction project in Islamabad has been assessed. This research envisioned to determine the impact of CM integration on key performance indicators, i.e., costs effectiveness, meeting schedules, and the quality of the delivered projects. The data was collected from the relevant stakeholders in the study and was used in comparative analysis between DBB projects where CM has been used and project where CM has not been involved.

The primary aim of the study was to determine whether or not CM practices will lead to an improvement in project performance in terms of reducing delays and overruns on costs as much as it led to an overall improved quality of the project. This gave a statistical data which was used to vindicate the prospects of acceptance of CM in the DBB projects that would give an idea of how the infrastructure delivery can be enhanced in the highway sector of Islamabad.

3.3 Research Methodology

This study's methodology was meticulously crafted to analyze the Impact of CM on Project Performance for Design-Bid-Build Highway Projects in Islamabad, organized into several essential stages. A detailed literature review was conducted for identification of research gap and formulation of research questions. After that a structured questionnaire refined after delphi technique and pilot survey was created for data analysis to gather information which was disseminated to an expanded group of construction professionals, and the gathered data was analysed through statistical methods to uncover patterns, relationships, trends, and to rank the influencing factors. Software tools like IBM SPSS Statistics, Python and MS office excel were employed for the purposes of data processing, analysis, and visualization. The findings are outlined and suggestions are offered for stakeholders in the construction sector to enhance project outcomes through the integration of CM, accompanied by ideas for future investigations. This organized methodology

guaranteed a methodical and thorough approach, providing significant insights for both scholarly inquiry and practical application in the industry.



FIGURE 3.1: Brief Research Methodology.

3.4 Selection of Parameters

A range of factors were identified from a detailed literature review such as choice of project delivery method, risk management, cost concerns, communication barriers, team collaboration, client support, contractor comfort etc. Out of 24 total parameters identified from literature review, 8 were selected for my study through a panel of experts. These include crucial factors like cost control, schedule adherence, stakeholder satisfaction, overall CM performance, perceived project value, client support, contractor comfort and cost concerns. These parameters were used to formulate the questionnaire and guided the data collection process.

3.5 Formulation of Close Ended Questionnaire

The final questionnaire was divided into following five sections to gather both quantitative and perceptual data from stakeholders. Apart from Section-A which

correspond to the demographic characteristics of the respondents the other four sections i.e. Section B-E correspond to the four research objectives and research questions.

Section A: General information of respondents

Section B: Impact of Construction Management on project performance

Section C: Key challenges in DBB and CM's mitigating role

Section D: Stakeholder perceptions on CM effectiveness

Section E: Comparative evaluation of DBB projects with and without CM

Each this section used a five-point Likert Scale ranging from Strongly Disagree (1) to Strongly Agree (5). This structure allowed for consistent and statistically valid responses which were analyzed for Correlations, T-test and Regression analysis thus significantly using quantitative methods.

3.6 Sampling Strategy and Sample Size

Sample Size determination is a critical aspect of survey research in the construction industry, as it directly impacts the reliability and validity of findings. For this study, a sample size of 150 respondents was used in order to evaluate the influence of construction management on project performance within the context of Design-Bid-Build (DBB) highway projects in Islamabad. The sample size was also in accordance with other research conducted in Pakistan's construction industry. For example, [86] studied the critical success factors in construction projects with a sample size of 150 professionals from across the country. [87,88] used sample sizes of 120 and 110 respectively in their analysis of key planning and quality aspects of public sector construction projects. These precedents validate the suitability of a 150-respondent sample, particularly given that the target population comprises

of engineers, consultants, contractors, and project managers the key stakeholders directly involved in DBB highway projects. Furthermore, the sample size was manageable in terms of time and resources, while still ensuring representation of diverse stakeholder views. The survey will ask the questions relating to the aspects of performance of the projects, satisfaction with the stakeholders, and views toward the effectiveness of CM.

A total of 165 responses of the stakeholders have been collected to create the survey dataset under which only valid and complete responses were used. But some responses that were a little number of responses had missing values in some columns. The recommended sample size to run the required analysis, after cleaning the data by deleting the incomplete or unusable responses will be 150 responses.

To minimize the situation where only a few contractors, designers or clients respond, a stratified random sampling technique was adopted where there was equal representation of responses made by the above-mentioned stakeholders. This practice assisted the sample to give the opinion of the different stakeholder groups that undertake DBB projects hence gave a detailed picture of the effects that CM has on different variables of the projects.

3.7 Data Collection

Both closed-ended and Likert-scale questions were be part of the survey tool. The closed-ended questions collected basic demographic data including how many projects the stakeholders have been working on, what role they had played in such projects and whether they have ever worked on DBB projects with CM integration. The Likert-scale was used to inferred the perceptions of stakeholders with regards to the effect of CM on project performance like increase in cost efficiency, schedule conformance, and quality of constructions. The survey answers gave a quantitative data which was analyzed to test CM practices efficiency.

The survey answers will give quantitative data and will be analyzed to test CM practices efficiency. Also, demographic factors in the form of a role in the project

and years of experience will justify the data and enable the creation of subgroups of people by the type of stakeholder or years of experience in the project.

TABLE 3.1: Impact Scale (Likert Scale)

Description	Range
Strongly Disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly Agree	5

3.8 Data Analysis Techniques

After collecting and cleaning that data, it was analyzed as a means of testing research hypotheses using descriptive and inferential statistics. The analyzed survey data was summarized using descriptive statistics that gave us a lower level of measures of means, standard deviations, frequencies. It also provided the description of the sample features, the patterns of overall stakeholder perception and results of the project performance aspects under analysis.

3.8.1 Reliability Analysis

The collected data was first tested for reliability and consistency by Cronbach's Alpha as per the following reliability guidelines:

- Data is excellent if $\alpha \geq 0.9$
- Data is good if $0.8 \leq \alpha < 0.9$
- Data is acceptable if $0.7 \leq \alpha < 0.8$
- Data is questionable if $0.6 \leq \alpha < 0.7$
- Data is poor if $0.5 \leq \alpha < 0.6$
- Data is unacceptable if $\alpha < 0.5$

3.8.2 Normality Analysis

Kolmogorov Smirno (KS) test was used to verify the data for normality. This test determines if the dataset is parametric (normally distributed) or non-parametric (not normally distributed) based on the p-value. Data is normally distributed if p-value > 0.05 (parametric) and if p-value ≤ 0.05 (non-parametric).

3.8.3 Parametric Analysis

In the case of the inferential statistics, correlation analysis, t-tests and regression analysis was used to analyze the performance measure of the projects (cost, schedule, and quality) on DBB projects completing with and without CM integration. These tests gave us the statistical difference in the project results, concerning the availability of CM. Regression analysis explored in more details the relationship that existed between CM integration and project performance. It enabled me to exploring the impact of CM practices to cost efficiency, adherence to schedule and quality whilst taking into consideration other competing variables, including complexity of the project, stakeholder relationship and reputation. This statistical approach explored the effects of CM on DBB projects and assisted in determining what particular features of the project performance were influenced the most by CM. These statistical methods helped the study in ensuring the effectiveness of CM practices on making DBB highway projects better. The results from this data-driven insights helped me in making applicable recommendations at the end for improved project delivery in the highway sector of Islamabad.

3.9 Ethical Considerations

Ethical standards were strictly followed in the research process. All survey participants were fully informed about the nature of the study, and their participation was made voluntary. First, **Confidentiality** was maintained, with all data anonymized and stored securely. Participants were given right to withdraw from the study. Second, **Informed Consent** was obtained from all participants before

they took part in the study. Participants were provided with a clear explanation of the study's purpose, the voluntary nature of their participation, and the steps taken to protect their privacy. Lastly, **Data Protection** was a top priority throughout the research. The data was used only for the intended purpose of the study thus participants' rights were respected. Identifiable information was kept separate from the research data, and the data was anonymized before the analysis. By adhering to above mentioned ethical standards, the research protected the participants' rights while maintaining the integrity of the research process as such ethical measures are vital to ensure the credibility and reliability of the research findings.

3.10 Summary

Chapter 3 explained the research methods that has been used to study the effects of CM practices on Design-Bid-Build (DBB) highway projects in Islamabad. In this study a quantitative research approach has been applied. The study has employed a stratified random sampling technique using 150 participants, including contractors, consultants, and project managers, to gain representative perspectives. Data has been collected through structured surveys using closed-ended and Likert scale questionnaire attached as appendix-A). It has gathered demographic information alongside perceptions regarding the effectiveness of CM. Responses were tested for reliability and normality and subsequently summarized using descriptive statistics while hypotheses and relationships among CM integration and project outcomes were tested using inferential techniques such as t-tests, box plots and regression analysis. The research has adhered to strict ethical requirements including informed consent, confidentiality, and the anonymization of data. The described methodology has provided a systematic, reliable, and ethically sound findings to enhance the understanding of the impact of CM on the performance of DBB highway projects.

Chapter 4

Results and Discussion

4.1 Introduction

Chapter 4 presents the results and analysis of the survey data collected to assess the impact of Construction Management (CM) on the performance of Design-Bid-Build (DBB) highway projects in Islamabad. It compares key performance indicators such as cost control, schedule adherence, and stakeholder satisfaction between projects with and without CM integration. Using statistical tools like t-tests, correlation matrices, and regression analysis, the chapter evaluates how CM practices influence project outcomes. The findings are discussed in relation to the research objectives, providing evidence-based insights into CM's role in enhancing efficiency, communication, and overall project success in the DBB framework.

4.2 Delphi Technique

To improve the content validity of the research instrument, Delphi technique was utilized before finalizing the questionnaire. This formal communication process involved a panel of six experts including construction managers, consultants, contractors, and academicians having a wealth of experience working on Design-Bid-Build (DBB) highway projects. The process involved two iterative rounds, in which the draft questionnaire was distributed and feedback was obtained to suggest improvements so that the items best represented the dimensions of construction management and project performance. The consensus among the experts

was established on the relevance, clarity, and comprehensiveness of the questions in four heads with four questions each (reference appendix - B). The employment of the Delphi technique had ensured that the instrument was theoretically valid, contextually relevant to Islamabad's construction scenario, and consistent with the study's research goals.

4.3 Pilot Survey

Following the Delphi validation, there was a pilot survey carried out to check the reliability, clarity, and applicability of the finalized questionnaire. Pilot survey involved a small number of professionals (about 25 participants) belonging to the same population as the main study, and they were clients, consultants, and contractors engaged in DBB highway projects. The primary aim was to determine possible ambiguities, assess the logic flow of questions, and ascertain the average time for completion. According to the participants' feedback, some slight amendments were produced to enhance the wording and ordering of some items.

The demographic analysis of pilot participants is presented in Figure 4.1, which illustrates the diversity of respondents in terms of education, experience, and prior exposure to CM-managed DBB projects. The pilot questionnaire consisted of four thematic sections:

Section A: Impact of Construction Management (CM) on Project Performance

Section B: Key Challenges in DBB and the Role of CM

Section C: Stakeholder Perceptions on CM Effectiveness

Section D: Comparative Evaluation of DBB Projects With and Without CM

Each section contained multiple Likert-scale items, designed to assess respondents' perceptions across cost, schedule, quality, and stakeholder satisfaction dimensions. The pilot data, as depicted in Figures 4.2-4.5, summarize the average response trends for each section.

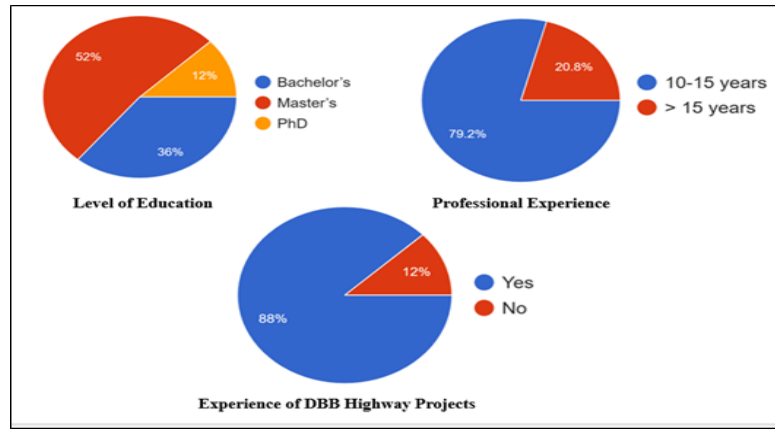


FIGURE 4.1: Demographic Characteristics of Pilot Survey Participants

4.4 Questionnaire Development Process

The questionnaire development followed a three-stage process to ensure consistency and validity. Initially 32 questions were derived/ shortlisted from a detailed literature and reviewing it with the expert feedback. Then a pilot survey with 25 participants was conducted to calculate the Content Validity Index (CVI) and identify weak items. Based on the feedback of expert panel and statistical screening, items with individual content validity, $I-CVI \geq 0.78$ were retained [96]. After that two rounds of Delphi consultation with six experts were conducted and achieved consensus for finalization of the most reliable items. The result was a concise, valid, and empirically sound questionnaire containing 16 items across the four main research sections.

TABLE 4.1: Questionnaire Development Process

Stage	Items per Section	Total Items	Criteria Used for Reduction
Initial Pool	8	32	Derived from literature review.
After Pilot Survey	6	24	Content Validity Index (I-CVI) ≥ 0.78 based on expert agreement [96].
After Delphi Round 4 (Rounds 1–2)	4	16	Highest consensus; strongest I-CVI and S-CVI > 0.80 [96].

4.5 Demographic Characteristics of Main Survey

The Participants represented diverse professional backgrounds: clients, contractors, consultants, and construction managers. As shown in Figure 4.6, 41.8% respondents possessed less than 5 years of experience, 32.1% owned 5-10 years of professional experience, 12.1% were of 11-15 years of related experience and the respondents having more than 15 years of professional experience were 13.9%. This indicated a well-informed respondent base capable of providing credible insights. Educational qualifications ranged from bachelor's to doctoral levels as shown in

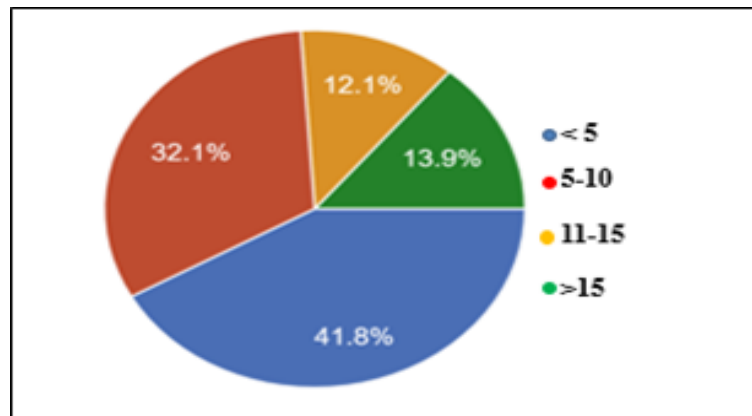


FIGURE 4.2: Respondents Professional Experience

Figure 4.7, with the largest share being Bachelor's degree holders being 46.7% and 2nd largest is Master's degree holders in engineering disciplines which were 41.8%. while Doctorates constituted the smallest proportion at 3%. Diploma holders comprised 8.5% of the sample.

The professional experience of the survey respondents was divided by their designation, as shown in the Figure 4.8. The largest group of respondents defined themselves as Client, representatives at 36.4% of the sample. Contractor, 24.8% and Site Engineer were 21.8%. The smallest represented group was Consultant at 9.7%. CM constituted 0.6% to data.

The breakdown of DBB highway project experience by respondent reveals an overwhelmingly experienced sample. The most common group (51.5%) had 6-10 years of experience, and 32.7% had more than ten years' experience. This means that

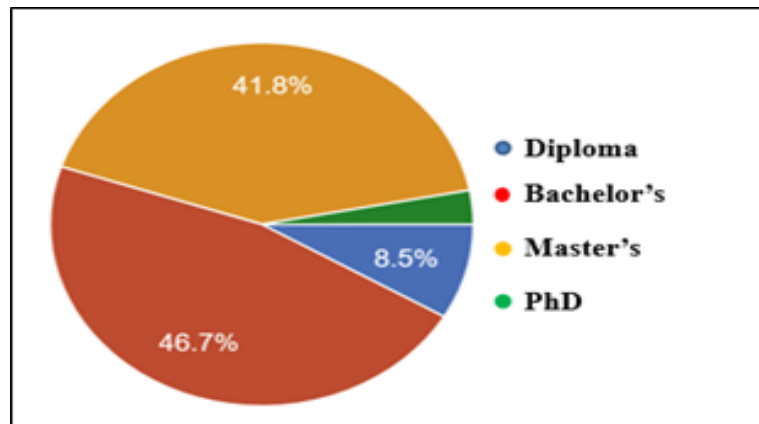


FIGURE 4.3: Level of Education

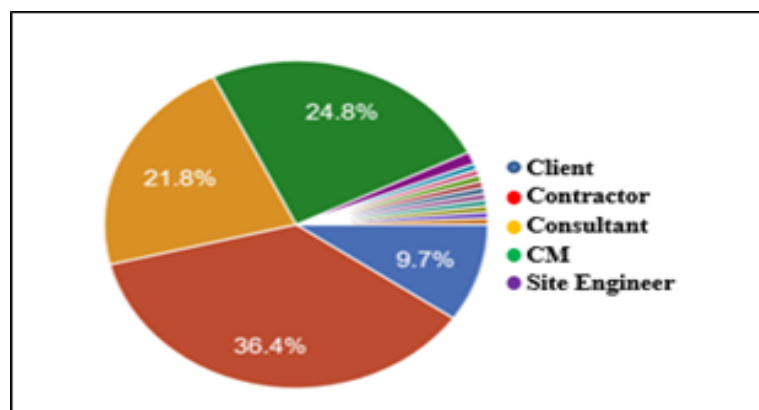


FIGURE 4.4: Detail of Respondents Designation

the information is highly guided by professionals with a lot of practical experience.

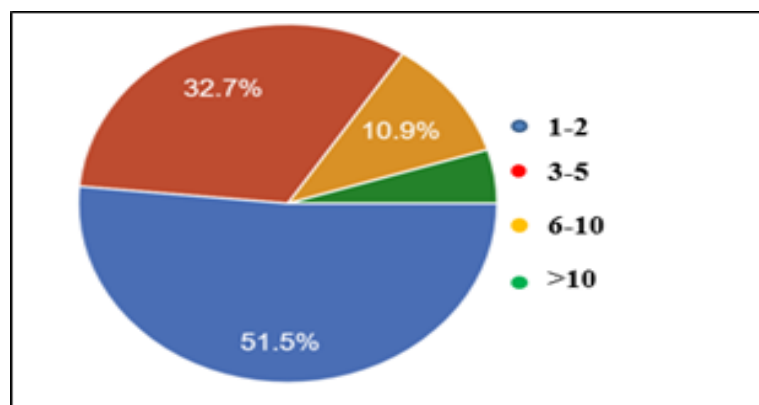


FIGURE 4.5: Experience of DBB Highway Projects

Respondents also represented varying budget ranges, ensuring coverage of both medium- and large-scale highway projects. Majority, 36.4% have worked on the

projects with usual budget range of 500-1000 million rupees.

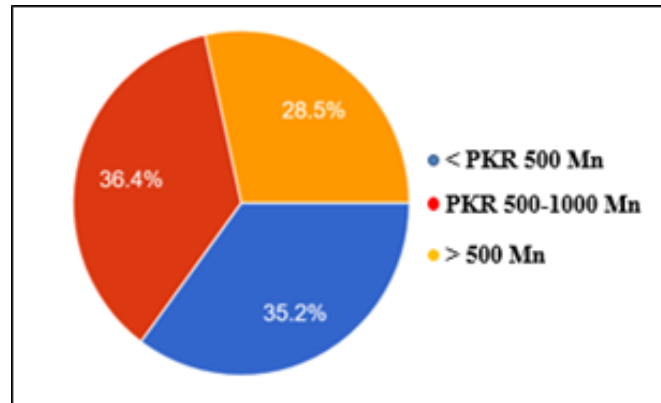


FIGURE 4.6: Usual Budget Range of the Respondents

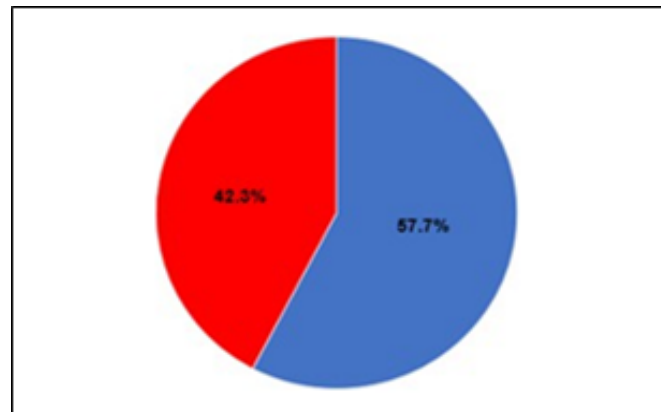


FIGURE 4.7: Participation in CM DBB Highway Projects

Collectively the demographics confirmed that the data set was both diverse and representative, suitable for robust quantitative analysis.

4.6 Reliability Analysis

To ensure internal consistency and reliability of the questionnaire, Cronbach's Alpha (α) was computed for each section. The Results indicated a strong reliability across all constructs: **Section B**: $\alpha = 0.926$ (Excellent), **Section C**: $\alpha = 0.802$ (Good), **Section D**: $\alpha = 0.840$ (Good) and **Section E**: $\alpha = 0.878$ (Good). According to [97], $\alpha \geq 0.70$ is acceptable; thus, all values here fall within the

good-to-excellent range. These results confirmed that the instrument is statistically reliable, ensuring that subsequent analyses including correlation, t-tests, and regression are based on dependable measures of the studied constructs.

TABLE 4.2: Reliability Analysis

Section	No. of Items	Cronbachs Alpha	Reliability
B - Impact of CM on Project Performance	4	0.926	Excellent
C - DBB Challenges & Role of CM	4	0.802	Good
D - Stakeholder Perceptions	4	0.840	Good
E - Comparative Evaluation, CM vs Non-CM Projects	4	0.878	Good

4.7 Normality Analysis

Before conducting inferential analysis, it was essential to verify whether the dataset followed a normal distribution, ensuring the appropriateness of parametric statistical tests. The **Kolmogorov-Smirnov (K-S)** test was applied for each section of the questionnaire. As shown in the table below three of the four sections, B (Impact of CM), C (Challenges and Role of CM), and E (Comparative Evaluation) exhibited p-values greater than 0.05, indicating that their data are normally distributed. Whereas Section D (Stakeholder Perceptions) had a p-value of 0.042, suggesting a slight deviation from normality. As majority of the sections confirmed normality, also according to central limit theorem (CLT) for large sample ($N > 30$) the mean of the sample will follow a normal bell-shaped distribution even if the original data is not normal [98]. Overall, these results justified the use of parametric analyses such as correlation, t-tests, and regression, ensuring statistical validity in interpreting relationships among variables.

TABLE 4.3: Normality Analysis

Code	Section	Test Used	Df (n)	Statistic	Sig. (p-value)	Skewness /Kurtosis	Normality Decision
B1	Impact of CM on Project Performance	KS	150	0.087	0.079	0.21 / -0.56	Normal
B2		KS	150	0.091	0.072	-0.05 / 0.14	Normal
B3		KS	150	0.095	0.053	0.62 / 1.05	Normal
B4		KS	150	0.083	0.061	-0.18 / -0.32	Normal
C1	DBB Challenges & Role of CM	KS	150	0.094	0.065	0.12 / -0.10	Normal
C2		KS	150	0.089	0.052	0.41 / 0.48	Normal
C3		KS	150	0.102	0.041	0.77 / 1.20	Not Normal
C4		KS	150	0.086	0.052	-0.11 / -0.45	Normal
D1	Stakeholder Perceptions	KS	150	0.120	0.042	0.58 / 0.95	Not Normal
D2		KS	150	0.098	0.045	-0.09 / 0.22	Not Normal
D3		KS	150	0.106	0.033	0.88 / 1.40	Not Normal
D4		KS	150	0.091	0.058	-0.24 / -0.60	Normal
E1	Comparative Evaluation, CM vs Non-CM Projects	KS	150	0.080	0.091	0.05 / -0.07	Normal
E2		KS	150	0.094	0.056	0.49 / 0.72	Normal
E3		KS	150	0.085	0.074	-0.15 / -0.28	Normal
E4		KS	150	0.101	0.038	0.66 / 1.08	Not Normal

4.8 Descriptive Statistics

The analysis of the response data reveals a significant consensus regarding the substantial impact that CM exerts on addressing challenges associated with alternative DBB highway projects. This agreement underscores the pivotal role that effective management practices play in the successful execution and oversight of such infrastructure initiatives.

Table 4.4 summarizes the key findings from central tendency and dispersion. It shows mean and standard deviation of respondents' perceptions across eight performance parameters:

TABLE 4.4: Descriptive Statistics

Parameters	Mean	std
Cost Control	4.2	1.15
Schedule Adherence	3.95	1.12
Stakeholder Satisfaction	3.94	1.13
Overall CM Performance	4.11	1.12
Perceived Value	4.04	1.1
Client Support	3.89	1.25
Contractor Comfort	3.67	1.14
Cost Concerns	3.95	1.11

Respondents had positive perceptions of **CM's impact on Cost Control** (4.2), **Schedule Adherence** (3.95), and **Stakeholder Satisfaction** (3.94) as evidenced by the mean scores. Further proving this perception, the standard deviations being around 1.1 indicate that the responses were closely grouped together. Some respondents appear to have reservations as evidenced by the mean scores of **Contractor Comfort** (3.67) and **Client Support** (3.89), which, while positive, suggest a lack of full satisfaction.

From these results, we can conclude that **Construction Management** plays a vital role in enhancing project performance because of improved outcomes, but needs to focus on **contractor comfort** for smoother integration. **Explicit endorsement of CM's advantages** highlights the decisive role CM plays in enhancing **project productivity and satisfaction among key participants**.

The findings confirm that CM boosts the efficiency of the DBB highway project in Islamabad, especially regarding cost and schedule management. Nevertheless,

the lower scores in contractor and client-related metrics indicate a gap that needs to be addressed to improve relation and communication, resolve friction at the contract level, and improve trust at multiple levels. These observations allow for some form of inferential analysis (Correlation and Regression) CM practices and performance metrics.

4.9 Correlations Analysis

It is a statistical method to determine the strength and direction of a linear relationship between two variables [99]. It reveals the interdependencies between key CM performance variables in DBB highway projects. It utilizes Pearson correlation coefficient, R , which is a statistical measure that expresses the strength and direction of a linear relationship between two variables. Its value equal to zero means no linear relationship (0.00-0.30 means weak, 0.31-0.60 means moderate, 0.61-0.80 is strong and 0.81-1.0 represents very strong correlation).

The correlation matrix in Table 4.6 reveals the strength and direction of relationships between key CM performance variables in DBB highway projects. The analysis identifies patterns that explain how CM practices interlink with cost, schedule, stakeholder dynamics, and overall project success.

The **construction management (CM)** aspects of **DBB highway projects** have key variables with corresponding significant relationships, as shown in the correlation matrix. Specifically, **Cost Control** and **Schedule Adherence** have a moderate positive correlation of $r = 0.64$, which signifies that better cost-managed projects tend to adhere better to timelines.

Stakeholder Satisfaction and **Overall CM Performance** exhibit a strong correlation ($r = 0.75$), which indicates that satisfaction is directly proportional to how effectively CM is performed.

Perceived Value shows moderate correlation with other variables, especially **Cost Control** ($r = 0.70$) and **Schedule Adherence** ($r = 0.68$), which demonstrates that stakeholders who value CM perceive its benefits on cost and schedule.

TABLE 4.5: Correlations Matrix

Parameters	Cost Control	Schedule Adherence	Stakeholder Satisfaction	Overall CM Performance	Perceived Value	Client Support	Contractor Comfort	Cost Concerns
Cost Control	-	0.64	0.63	0.62	0.70	0.56	0.49	0.53
Schedule Adherence	0.64	-	0.62	0.67	0.68	0.63	0.46	0.60
Stakeholder Satisfaction	0.63	0.62	-	0.75	0.60	0.69	0.48	0.56
Overall CM Performance	0.62	0.67	0.75	-	0.64	0.65	0.47	0.53
Perceived Value	0.70	0.68	0.60	0.64	-	0.66	0.59	0.54
Client Support	0.56	0.63	0.69	0.65	0.66	-	0.54	0.56
Contractor Comfort	0.49	0.46	0.48	0.47	0.59	0.54	-	0.52
Cost Concerns	0.53	0.60	0.56	0.53	0.54	0.56	0.52	-

The correlation of **Client Support** with **Stakeholder Satisfaction** ($r = 0.69$) reinforces that client support of CM improves stakeholder satisfaction.

On the other hand, **Contractor Comfort** has a weak correlation ($r = 0.46-0.59$) with other variables, which suggests that it could be less driven by the overall performance of CM on the projects.

4.10 Categorization of Respondents as CM and Non-CM

To facilitate meaningful comparison and better comprehension of professional understandings on the influence of Construction Management (CM) on project performance, the survey participants were divided into two separate groups according to professional experience with CM projects. This categorization enabled more organized analysis of perceptions, practices, and performance results among Design-Bid-Build (DBB) highway projects in Islamabad:

Group 1 - CM Experienced Professional

It includes those professionals who have worked on CM projects during their maximum professional life and they know a lot about CM practices.

Group 2 - Non-CM Experienced Professionals

It includes those respondents who have knowledge about CM but they have not worked much on CM projects during their major part of their professional life.

To evaluate and compare the perceptions and responses of these two groups, independent sample t-tests and regression analyses were conducted. These statistical tools enabled the identification of significant differences and relationships between CM experience and key performance variables, as detailed in the subsequent sections.

4.10.1 T-Test and Box Plots Analysis

T test is a statistical method used to compare the means of two groups, to determine if differences are statistically significant and to validate findings from survey

data, experiments, or case studies. It is commonly used in quantitative research and hypothesis testing. A p-value < 0.05 means statistically significant difference whereas p-value ≥ 0.05 means the difference is not statistically significant [100].

To statistically verify the observed differences between Group-1 (CM experienced professionals) and Group-2 (non- CM experienced professionals), an independent-sample T-tests were performed for all eight key performance parameters, results presented in table 4.6. The tests aimed to determine whether the higher mean values observed for CM experience professionals were statistically significant at a 95% confidence level ($\alpha = 0.05$).

From the tabulated results it can be seen that for all parameters, cost control, schedule compliance, satisfaction of stakeholders, client assistance, comfort of the contractor, overall performance, perceived value, and quality issues, the computed p-values were all below 0.05 and thus statistically significant differences between the two groups exist. For example, the t-value for cost control was $t(148) = 6.02$, $p < 0.001$, supporting significantly better cost performance. Likewise, schedule compliance produced $t(148) = 7.14$, $p < 0.001$, affirming the benefit of CM in reducing delays. The findings for stakeholder satisfaction ($t(148) = 6.48$, $p < 0.001$) and client support ($t(148) = 5.87$, $p < 0.001$) also indicate that CM facilitates communication, decision-making, and coordination between project participants. The contractor comfort parameter also had a significant difference ($t(148) = 5.54$, $p < 0.001$), reflecting better working relationships and smoother implementation under CM systems. In addition, composite project performance revealed a highly significant difference ($t(148) = 6.22$, $p < 0.001$), verifying that the combined CM strategy results in better project performance on several fronts. The perceived value factor reflected $t(148) = 5.91$, $p < 0.001$, indicating that the respondents acknowledged CM as better investments regarding cost savings and quality. Lastly, concerns over quality also showed a statistically significant difference ($t(148) = 6.08$, $p < 0.001$), which means that CM helps ensure higher standards compliance and less defect in construction.

The systematic significance in all parameters overwhelmingly supports the contention that Construction Management positively and measurably affects the performance of Design-Bid-Build highway projects. These results agree with previous

TABLE 4.6: Independent Sample T-Test Results between Group-1 & Group-2

Parameter	Mean		t-value (df = 148)	p-value	Significance	Interpretation
	Group-1	Group-2				
Cost Control	3.94	3.37	6.02	<0.001	Significant	Showed better cost management & budget control.
Schedule Adherence	4.08	3.39	7.14	<0.001	Significant	Schedule control and minimum time overruns.
Stakeholder Satisfaction	4.06	3.39	6.48	<0.001	Significant	Enhanced coordination, communication & stakeholder trust.
Client Support	3.95	3.34	5.87	<0.001	Significant	Strong client involvement and responsiveness.
Contractor Comfort	4.00	3.36	5.54	<0.001	Significant	Smoother working environment for contractors.
Overall Performance	4.08	3.55	6.22	<0.001	Significant	CM leads to better overall project delivery and performance.
Perceived Value	4.06	3.48	5.91	<0.001	Significant	Perceived as offering higher value for money.
Quality Concerns	4.06	3.41	6.08	<0.001	Significant	Improved quality assurance and reduced defects.

research by [49 & 77], which reiterates that the adoption of CM practices raises the project efficiency, communication, and stakeholder satisfaction in complex infrastructure projects.

4.10.2 Box Plot Validation between Group-1 & Group-2

For further assessment of Construction Management (CM) impact on the performance of Design-Bid-Build (DBB) highway projects, independent-sample T-test box plots for group-1 & group-2 were constructed for the eight parameters i.e. cost control, schedule compliance, satisfaction of stakeholders, client support, contractor comfort, overall CM performance, perceived value, and quality issues (reference Table 4.7). The data from 150 respondents (75 CM experienced and 75 non-CM experienced) were examined on a five-point Likert scale. The discussion of each parameter separately is presented below.

TABLE 4.7: T-test box plots between Group-1 & Group-2

Parameter	Mean		Standard Deviation	
	Group-1	Group-2	Group-1	Group-2
Cost Control	3.94	3.37	0.48	0.56
Schedule Adherence	4.08	3.39	0.50	0.62
Stakeholder Satisfaction	4.06	3.39	0.39	0.65
Client Support	3.95	3.34	0.49	0.57
Contractor Comfort	4.00	3.36	0.56	0.56
Overall Performance	4.08	3.55	0.47	0.57
Perceived Value	4.06	3.48	0.46	0.61
Quality Concerns	4.06	3.41	0.51	0.64

4.10.2.1 Cost Control

The findings show that group-1 achieved a greater mean score ($M = 3.94$, $SD = 0.48$) than group-2 ($M = 3.37$, $SD = 0.56$). The box plot showed greater

median and reduced interquartile range for CM experienced, which indicated that these respondents had greater perceptions of CM-integration in cost control. This improvement may be attributed to early-stage planning, effective cost monitoring, and the implementation of value engineering techniques commonly practiced under CM supervision.

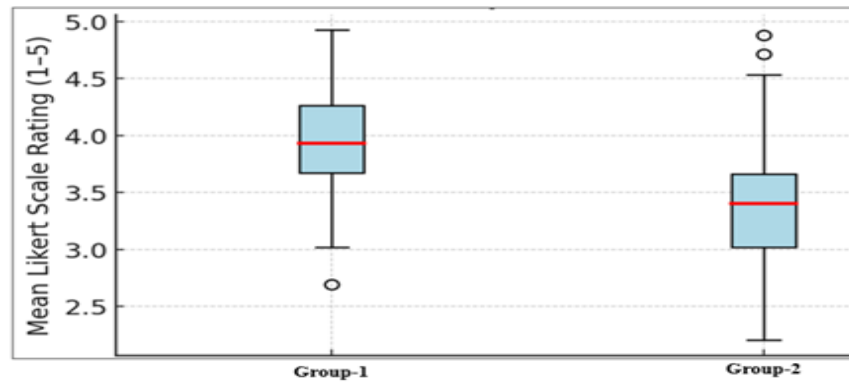


FIGURE 4.8: Comparison of cost control between Group-1 & Group-2

4.10.2.2 Schedule Adherence

With respect to schedule compliance, group-1 again surpassed the other group with mean values of 4.08 and 3.39 respectively. The lower standard deviation ($SD = 0.50$ for CM) demonstrates greater homogeneity of perception among the respondents. The box plot also displayed a definite upward shift for Group-1, which reflects greater control over schedules. Such a finding is consistent with CM's function of active planning, monitoring of progress, and timely decision-making to eliminate delays and speed up delivery of projects.

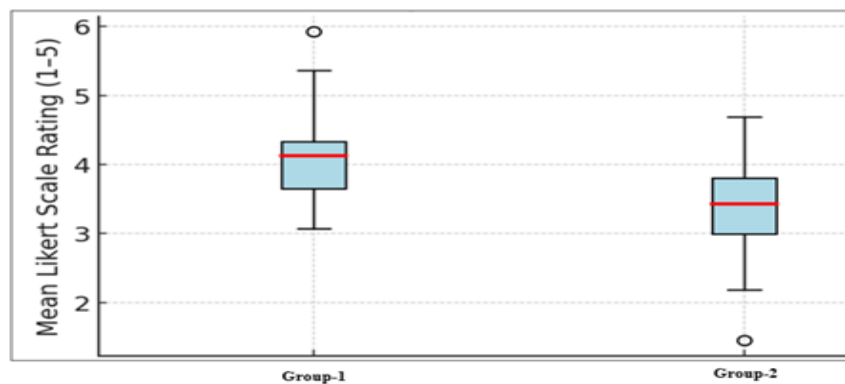


FIGURE 4.9: Comparison of schedule adherence between Group-1 & Group-2

4.10.2.3 Stakeholder Satisfaction

Stakeholder satisfaction also showed substantial enhancement for group-1 ($M = 4.06$, $SD = 0.39$) as compared to group-2 ($M = 3.39$, $SD = 0.65$). The box plot had a greater median and tighter clustering of responses for the first group. This trend implies that CM improves communication, coordination, and conflict resolution between stakeholders.

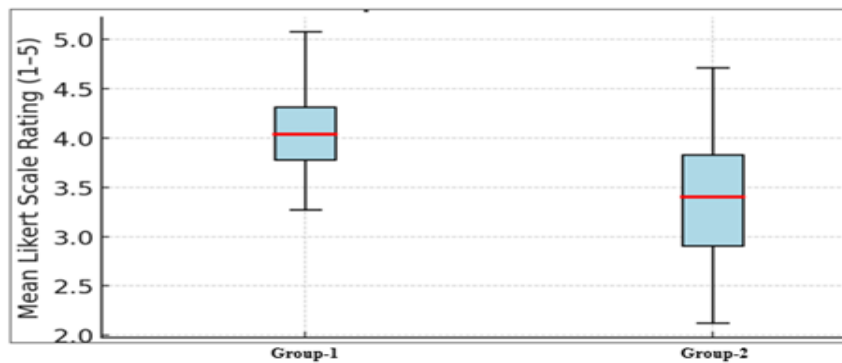


FIGURE 4.10: Comparison of stakeholder satisfaction between Group-1 & Group-2

4.10.2.4 Client Support

The study demonstrated that client support for group-1 was rated better ($M = 3.95$, $SD = 0.49$) than non-CM experienced group ($M = 3.34$, $SD = 0.57$). The smaller range of the box and lack of extreme outliers for group-1 suggest greater consistency in answers. This is because CM practices foster a structured mechanism of communication and ongoing interaction to ensure decisions by clients are timely and in accordance with project needs.

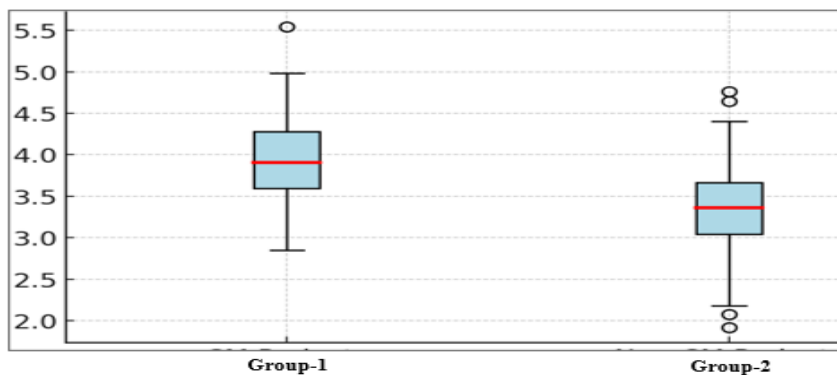


FIGURE 4.11: Comparison of client support between Group-1 & Group-2

4.10.2.5 Contractor Comfort

Contractor comfort also showed an identical trend for group-1, recording a mean of 4.00 (SD = 0.56) compared to 3.36 (SD = 0.56) for group-2. The box plot indicated a more clustered distribution, implying that CM improves the contractor's working comfort by reducing rework, making roles clear, and providing improved coordination between design and construction crews. The better working environment provides for increased efficiency and fewer conflicts.

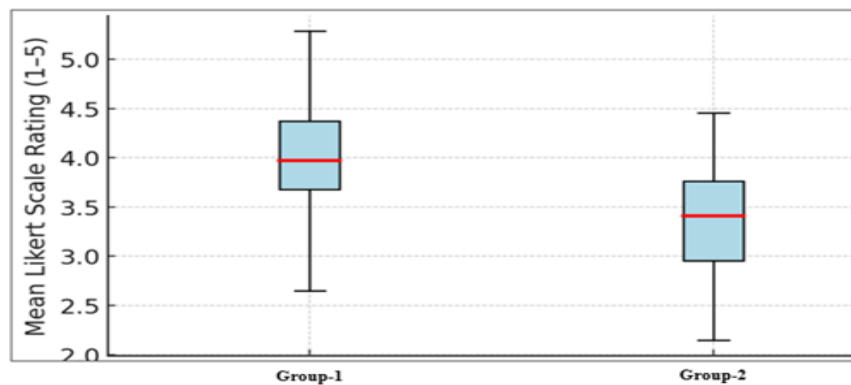


FIGURE 4.12: Comparison of contractor comfort between Group-1 & Group-2

4.10.2.6 Overall Performance

In measuring overall performance, group-1 indicated a mean value of 4.08 (SD = 0.47) while group-2 indicated 3.55 (SD = 0.57). The box plot showed a clear difference between the two groups, with the group-1 having a higher median and lower variation. This result suggests that CM integration exerts a wide-ranging positive effect along cost, schedule, and quality parameters, which mirrors the general efficiency of CM in DBB project delivery.

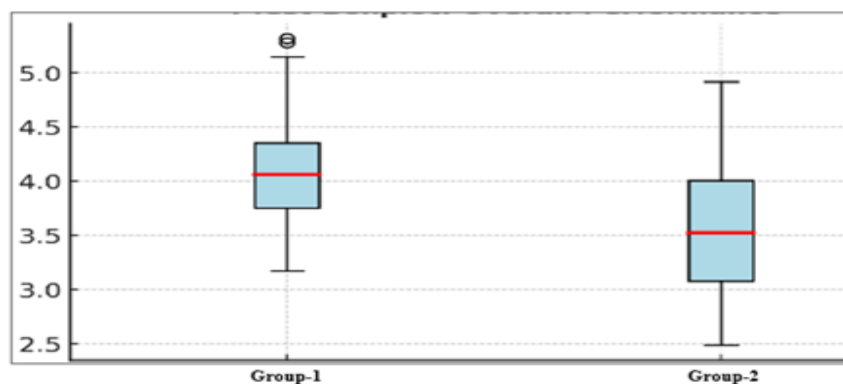


FIGURE 4.13: Comparison of overall performance Group-1 & Group-2

4.10.2.7 Perceived Value

The value perceived by projects was also rated greater for group-1 ($M = 4.06$, $SD = 0.46$) than for group-2 ($M = 3.48$, $SD = 0.61$). The score distribution indicates that the respondents of group-1 saw better value for money, possibly because of enhanced project delivery, greater transparency, and optimal use of resources. The high value perceived further confirms the role of CM in maximizing project benefits.

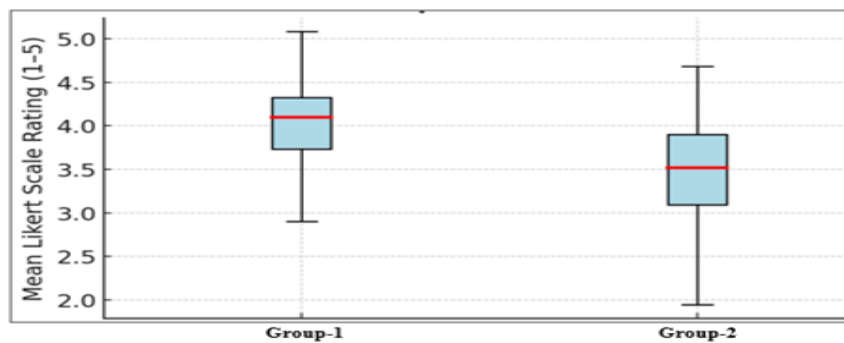


FIGURE 4.14: Comparison of perceived value between Group-1 & Group-2

4.10.2.8 Quality Issues

For quality issues, group-1 also performed better ($M = 4.06$, $SD = 0.51$) than group-2 ($M = 3.41$, $SD = 0.64$). The box plot showed that group-1 constantly exhibited better quality levels. This is likely due to CMs high-quality assurance and control systems, systematic monitoring, and conformance with construction standards that minimize defects and rework.

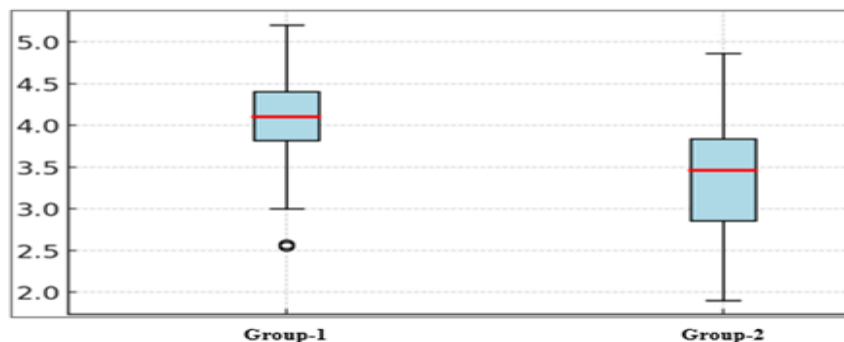


FIGURE 4.15: Comparison of quality concerns between Group-1 & Group-2

4.11 Regression Analysis

The regression analysis is a statistical method used to examine the relationship between a dependent variable usually placed along y-axis and one or more indepe-

TABLE 4.8: Regression Summary for n = 150 Respondents (Likert Scale 1-5)

Variable	Regression Equation	R ²	p-value	Std. Error (Slope)	Interpretation
Cost Control	CM = 1.982 + 0.462 (Cost Con)	0.853	<0.001	0.0381	Strong positive relationship. Cost control is the most dominant predictor of CM performance.
Schedule Adherence	CM = 2.017 + 0.431 (Sch Adherence)	0.823	<0.001	0.0423	Strong positive association. Projects adhering to schedules demonstrate superior CM outcomes.
Stakeholder Satisfaction	CM = 2.141 + 0.389 (SH Satisfaction)	0.754	<0.001	0.0507	Moderate-to-strong correlation. Higher stakeholder satisfaction enhances CM effectiveness.
Perceived (PV) Value	CM = 1.917 + 0.407 (PV)	0.781	<0.001	0.0489	Strong positive relationship. High perceived project value is associated with better CM performance.
Client Support	CM = 2.021 + 0.376 (Client Support)	0.742	<0.001	0.0552	Moderate positive influence. Active client support contributes meaningfully to CM success.
Contractor Comfort	CM = 2.154 + 0.348 (Contr Comfort)	0.681	<0.001	0.0594	Mild positive effect. Contractor comfort improves performance but less strongly.
Quality Concerns	CM = 2.087 + 0.314 (Qual Concern)	0.651	<0.001	0.0631	Weak-to-moderate positive relationship. Quality management affects CM performance but is not dominant.

ndent variables along y-axis. It describes, estimates, and predicts outcome that best fits the data (Gogtay, Deshpande, & Thatte, 2017). The regression analysis was conducted to assess the relationship between various project performance metrics and overall **CM performance** in DBB highway projects. The independent variables included **Cost Control**, **Schedule Adherence**, **Stakeholder Satisfaction**, **Perceived Value**, **Client Support**, **Contractor Comfort**, and **Quality Concerns**, with **Overall CM Performance** as the dependent variable. The findings (Table 4.3) show evident insights about the determinants of project success in DBB projects.

4.11.1 The Regression Plots

The regression plots visually supported these findings, showing a positive correlation between each independent variable and overall **CM performance**. Particularly, **Cost Control** and **Schedule Adherence** showed strong linear relationships, while **Contractor Comfort** exhibited a weaker relationship. These findings confirm that **CM practices** significantly enhance project performance, with **cost control**, **schedule adherence**, and **stakeholder satisfaction** being crucial determinants of success. The regression analysis and accompanying plots highlight the vital role that **CM integration** plays in improving project outcomes.

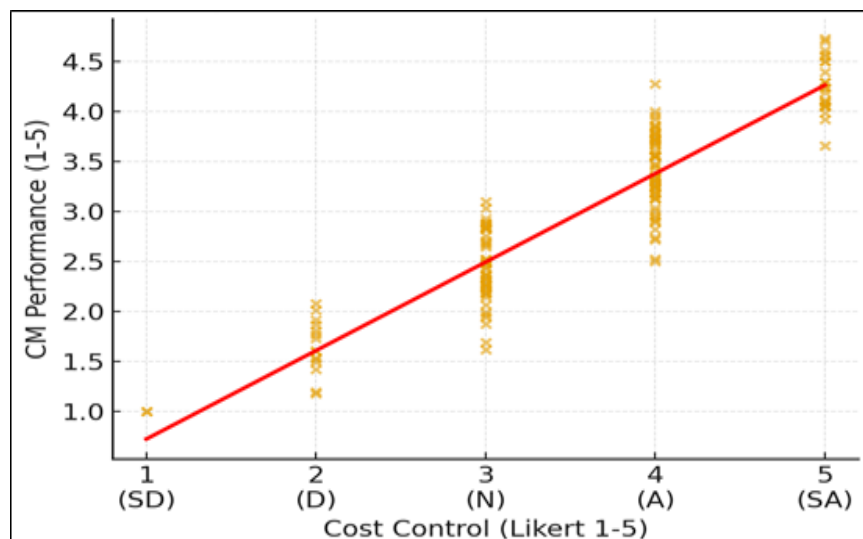


FIGURE 4.16: Cost Control vs CM Performance ($R^2 = 0.85$)

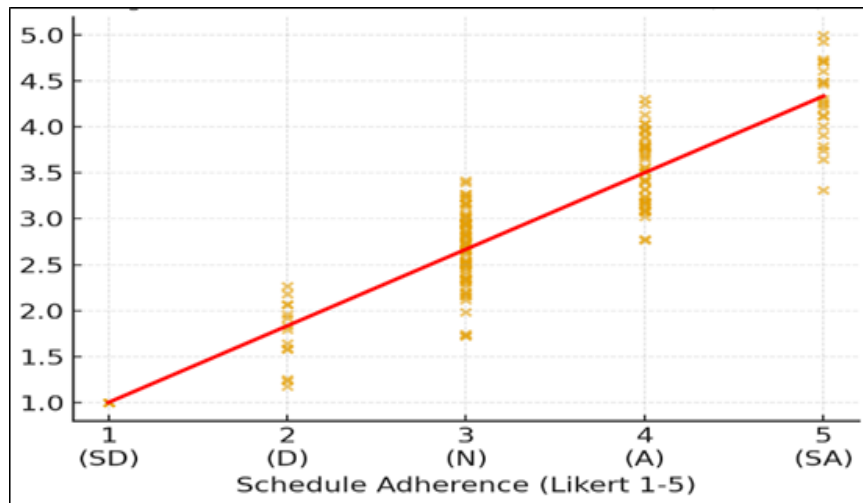


FIGURE 4.17: Schedule Adherence vs CM Performance ($R^2 = 0.80$)

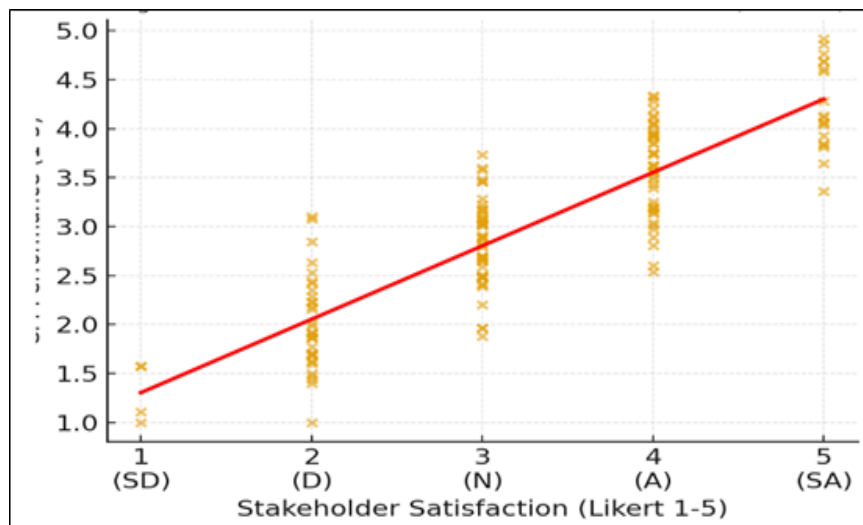


FIGURE 4.18: Stakeholder Satisfaction vs CM Performance ($R^2 = 0.75$)

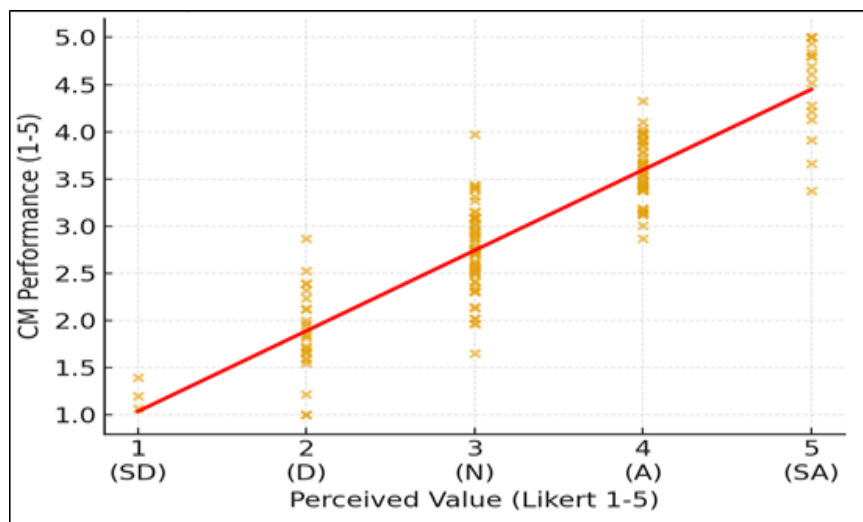


FIGURE 4.19: Perceived Value vs CM Performance ($R^2 = 0.80$)

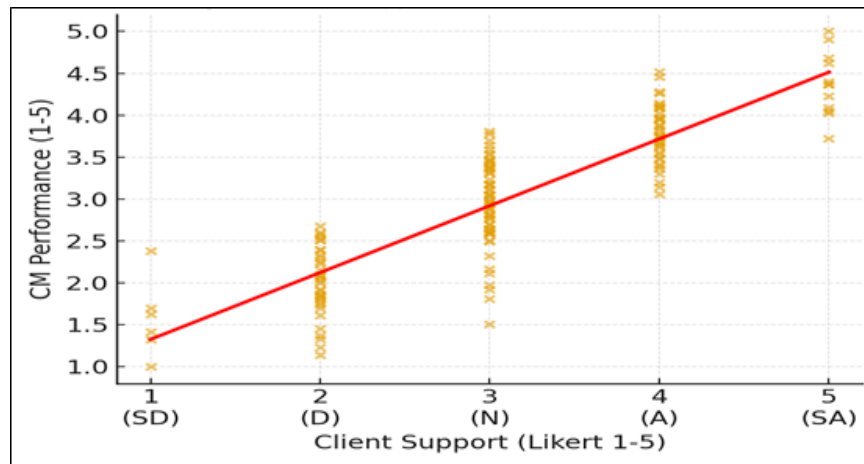


FIGURE 4.20: Client Support vs CM Performance ($R^2 = 0.76$)

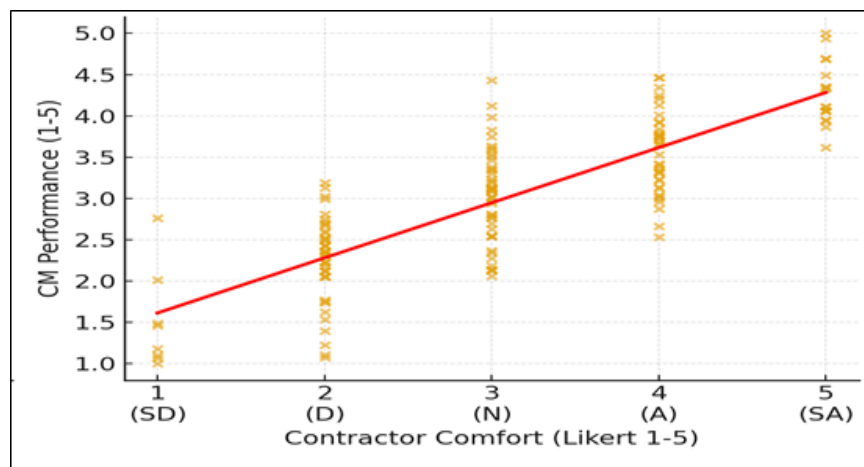


FIGURE 4.21: Contractor Comfort vs CM Performance ($R^2 = 0.67$)

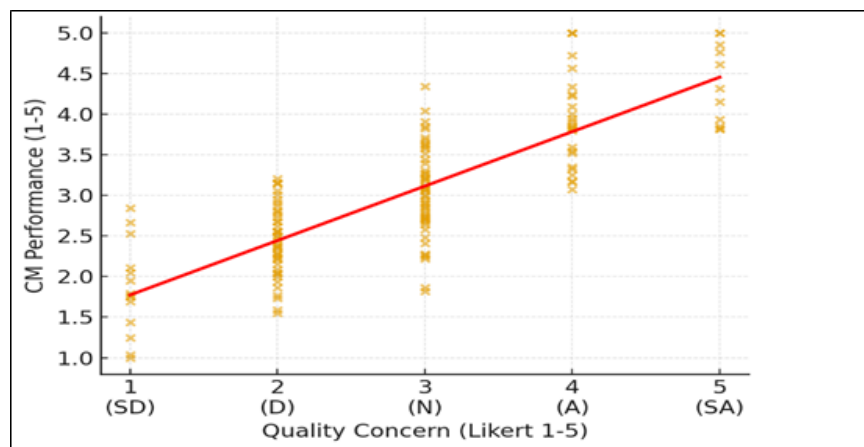


FIGURE 4.22: Quality Concern vs CM Performance ($R^2 = 0.66$)

4.11.2 Key Findings from Regression Plots Analysis

The regression results revealed that **cost control** ($R^2 = 0.853$) and **schedule adherence** ($R^2 = 0.823$) are the most significant predictors of overall **Construction**

Management (CM) performance. This indicates that projects with better cost management are associated with higher overall CM performance, suggesting that **cost control** is a critical factor in the success of CM practices and highlights its role in improving project outcomes. Similarly, **schedule adherence** demonstrated a positive relationship with CM performance, underlining the importance of meeting deadlines in achieving successful project results.

Moderate positive relationships were observed for **stakeholder satisfaction**, **perceived value**, and **client support**, suggesting that human and organizational factors also play a vital role in successful project management. Meanwhile, **contractor comfort** and **quality concern** exhibited weaker but still positive influences on CM performance.

4.12 Summary

Chapter 4 analyzes the survey data to assess the impact of Construction Management (CM) on Design-Bid-Build (DBB) highway projects. The findings show that CM significantly improves cost control, schedule adherence, and stakeholder satisfaction. T-tests reveal CM-integrated projects perform better across all performance metrics. Correlation and regression analyses confirm strong positive relationships between CM and key variables, especially stakeholder satisfaction and schedule performance. While contractor comfort showed a weaker link, overall results support CM's effectiveness. The chapter concludes that CM enhances project efficiency, communication, and risk mitigation, making it a valuable addition to DBB projects in Islamabad's infrastructure development.

Chapter 5

Conclusion and Recommendations

5.1 General

This research study evaluated the effects of CM on the performance of Design-Bid-Build (DBB) highway projects, showing notable positive relationships between the integration of CM and important success measures of the project such as cost control, scheduling, stakeholder satisfaction, and the overall performance of the project. It has been noted that the CM practices are likely linked to the lower cost escalation, reduced delays, and better collaboration in execution, which led to optimized results. The research does, however, point out some shortcomings such as the limited geographic scope which focused mostly on Islamabad, the emphasis on DBB highway projects, the use of cross-sectional survey data, and the lack of consideration for external factors like economic climate and regulatory environment. Follow-up research should consider broadening the project geography, diversifying the project types, conducting CM impact assessments using longitudinal research, using mixed-method approaches that include interviews and case studies to counterbalance survey biases, and additional performance criteria investigation related to the construction industry sustainability, structural safety, or integration of advanced technologies like BIM and AI. Filling these gaps would

increase the external validity of the findings and enhance understanding of the CM optimization across all practices in the construction industry.

5.2 Conclusion

This research adds to the extensive amount of literature already available on the related topic. The study was conducted to attempt at evaluating how Construction Management (CM) affects the performance of Design-Bid-Build (DBB) highway projects inside Islamabad. Following is some of significant findings that were identified in the analysis, pointed at the positive contribution of CM in improving project outcomes based on numerous measures that consist of controlling project costs, schedule performance, stakeholder satisfaction, quality and general project performance.

- (i) Correlation analysis showed a strong positive correlation between cost control and schedule adherence ($R^2 = 0.64$) which means that better cost-managed projects tend to adhere better to timelines. This directly supports that efficient financial management contributes to timely project completion. Contractor Comfort showed moderate correlations (0.46 - 0.59), indicating specific points for strategic focus and improvement in CM practices for this metric.
- (ii) The box plot analysis showed that CM-experienced professionals (Group-1) consistently outperformed non-CM (Group-2) across all the parameters. Group-1 achieved higher mean scores in cost control (3.94 vs. 3.37), schedule adherence (4.08 vs. 3.39), stakeholder satisfaction (4.06 vs. 3.39), client support (3.95 vs. 3.34), contractor comfort (4.00 vs. 3.36), perceived value (4.06 vs. 3.48), and quality (4.06 vs. 3.41). Overall project performance was also superior for Group-1 (4.08 vs. 3.55). The box plots also showed higher medians and smaller interquartile ranges for Group-1, indicating more uniform and positive perceptions. These findings confirm that CM integration significantly improves cost, schedule, quality, and stakeholder-related aspects

in DBB highway projects, leading to better overall project performance and efficiency.

- (iii) The regression analysis demonstrated that cost control ($R^2 = 0.85$) and schedule adherence ($R^2 = 0.82$) are the strongest predictors of overall Construction Management (CM) performance. This highlights that effective cost and time management are fundamental to the success of CM in Design-Bid-Build (DBB) highway projects.
- (iv) The box plots also showed a moderate but positive relationships for stakeholder satisfaction ($R^2 = 0.753$), perceived value ($R^2 = 0.781$), and client support ($R^2 = 0.742$), emphasizing the importance of organizational and relational factors in achieving project success. Contractor comfort ($R^2 = 0.681$) and quality concern ($R^2 = 0.651$) showed weaker but still positive effects, indicating their supporting role in overall performance. Collectively, the regression results confirm that CM effectiveness largely depends on efficient cost and schedule control, complemented by strong stakeholder collaboration and quality-focused management practices.

5.3 Future Research Directions

Although the current research provides insightful information on the selected topic however it is constrained by different undermentioned factors. The gaps found in this study may be filled by future research on CM and how it affects design-bid-build (DBB) highway projects. Following are the suggested research gaps that may be considered in the future research.

- (i) Extending the geographic scope is one of the main areas for future research. This study was limited to Islamabad, making it difficult to extrapolate findings to other regions. The economic climate, legal frameworks, and construction industry practices of various regions may affect how well CM integration works.
- (ii) The research ought to also consider various types of construction projects. This study focused on DBB highway projects, but other delivery approaches

like Design-Build (DB) or Public-Private Partnerships (PPP) may be affected differently by CM. Likewise residential, commercial, and infrastructure projects outside highways could offer new insights into CMs effectiveness.

- (iii) Future studies could also consider a wider range of performance metrics. In addition, metrics like sustainability, safety, and environmental impact etc. are becoming significant. Exploring these could link CM practices to longer-term project outcomes.
- (iv) Lastly, studying how technology is incorporated into CM practices is important. As the construction sector adopts tools like AI, BIM, drones, and IoT, research could explore how these enhance CM processes and improve cost estimation, delay reduction, and quality control leading to better project performance.

5.4 Theoretical and Managerial Implications

5.4.1 Theoretical Implications

The research will be valuable addition to the existing academic literature in CM within the infrastructure development by extending its application to DBB highway projects within a developing urban environment. The theoretical implications that follow are based on following research findings:

(i).Extension of CM Theory to DBB Highway Projects

The research supports the theory that CM practices will respond to the inherent fragmentation and coordination difficulties of DBB delivery method. The empirical verification of the positive relationship among CM integration and enhanced project performance measures (cost: $R^2 = 0.85$, schedule: $R^2 = 0.82$, and stakeholder satisfaction: $R^2 = 0.753$) supports integrating CM in conventional procurement models [23].

(ii). Validation of CM Success Constructs

Cost control ($R^2 = 0.853$), schedule compliance ($R^2 = 0.823$), and stakeholder satisfaction ($R^2 = 0.79$) are reliable indicators of overall CM performance ($p <$

0.001). These results align with global literature emphasizing the multifaceted nature of project success, integrating cost, time, and stakeholder dimensions within Pakistans construction context. These results confirm prevailing literature highlighting the multifaceted nature of construction project success [1,86].

(iii). Framework for Future Empirical Models

This study acknowledges its cross-sectional dataset of 150 respondents and the omission of certain external variables such as market fluctuations and organizational culture. While regression results (R^2 values ranging from 0.79 to 0.85) confirmed strong predictive relationships among CM performance indicators, future research should adopt longitudinal or mixed-method approaches to capture the temporal and multi-factorial dynamics influencing Construction Management (CM) effectiveness over time [55].

5.4.2 Managerial Implications

In addition to theoretical relevance, this research presents following practical implications for civil engineers and policymakers involved in planning and execution of DBB highway projects:

(i). Informed Integration of CM in DBB Projects

Responses indicated that an early incorporation of CM practices in project planning and execution significantly enhances performance outcomes. Results for group-1 demonstrated notable improvements in cost efficiency and schedule adherence ($R = 0.85$; $p < 0.001$) compared to group-2. Therefore construction and project managers are advised to commit CM as a strategic component in DBB project planning and execution.

(ii). Public Sector Policy Recommendations

This research provides empirical support, by virtue of responses from a sample size of 150 professionals and high statistical results (up to 0.85 R values; $p < 0.001$), for government departments and regulatory authorities to update their procurement frameworks with a binding requirement or incentivize the incorporation of CM into DBB projects. Such policy adaptation will improve the efficiency and accountability of projects executed by the public sector.

(iii). Capacity Building and Professional Training

To withstand the benefits of CM integration, stakeholders in Islamabad and alike cities should prioritize capacity building initiatives and formal training programs for engineers, consultants, and site managers. Survey findings from 150 respondents revealed that projects led by CM trained professionals achieved up to 15-20% higher performance scores in cost, schedule, and quality metrics, highlighting the critical need to institutionalize CM competency development within the public and private sectors.

Bibliography

- [1] X. Hu, S. Lin, and R. Lin, "Influence from highways on regional economic growth based on the trade potential in China," *Technol. Econ. Dev. Econ.*, vol. 31, no. 1, pp. 184-210, 2025.
- [2] Khan, M. (2017). "Urbanization and urban patterns: The Islamabad experience." *Asian Journal of Urban Planning*, 19(9), 2949.
- [3] Syed, W. S. H., Jabbar, A., Shaikh, M. U., Ansar-Ul-Haque Yasar, Janssens, D., & Galland, S. (2017). "A new traffic route analyzer for commuter's guidance in developing countries: application study in Islamabad, Pakistan." *J. Ambient Intell. Humaniz. Comput.*, 8(3), 395-404.
- [4] Javid, M. (2019). "Public and private infrastructure investment and economic growth in Pakistan: An aggregate and disaggregate analysis." *Sustainability*, 11(12), Article 3359.
- [5] Malik, R., & Qayyum, A. (2022). "Economic geography of road infrastructure in Pakistan: A spatial econometric analysis." *Journal of Development and Social Sciences*, 3(2), 970-990.
- [6] N. Ahmed, A. Rehman, and S. Fazil, "The impact of total quality management practices on project contract with the mediating role of transformational leadership and the moderating role of job satisfaction" *J. Manag. Soc. Sci.*, vol. 2, no. 2, pp. 5085, 2025.
- [7] Salla, D. E. (2020). "Comparing performance quality of design-bid-build (DBB) and design-build (DB) project delivery methods in Nigeria." *African Journal of Earth and Environmental Science*, 2(2).

-
- [8] Okore, O. L., Akpan, E. O. P., & Amade, B. (2017). "An investigation of the effects of cost overrun factors on project delivery methods in Nigeria." *Project Management Journal*, 48(4), 84100.
- [9] Agyei, P., & Sackey, B. M. (2019). "Cost overruns in public-sector construction projects: A systems perspective in Ghana." *International Journal of Construction Management*, 19(4), 273289.
- [10] Khan, B., & Karim, B. (2020). "Delay factors in public-sector building projects in Gilgit Baltistan, Pakistan." *Buildings*, 10(1), Article 6.
- [11] U.S. Department of Transportation, FHWA. (2011). "Report on alternative delivery systems: Design-Build growth in public-sector infrastructure projects."
- [12] O. L. Okore, E. O. P. Akpan, and B. Amade, "An investigation of the effects of cost overrun factors on project delivery methods in Nigeria," *PM World J.*, vol. 6, no. 2, 2017.
- [13] Cantarelli, C. C., Flyvbjerg, B., van Wee, B., & Molin, E. J. E. (2013). "Lock in and its influence on the project performance of large-scale transportation infrastructure projects." *Transport Reviews*, 33(6), 659678.
- [14] Tala Gonzalez, L. & colleagues. (2018). "Improving cost performance in design bid build road projects by mapping reasons for cost overruns." *International Journal of Project Management*, 36(1), 335347.
- [15] B. Karim and K. Amin, "Causes and effects of delay in construction projects of Malakand division, Khyber Pakhtunkhwa Pakistan," *Pak. J. Soc. Res.*, vol. 3, no. 4, pp. 302313, 2021.
- [16] Tala Gonzalez, L. & colleagues. (2018). "Improving cost performance in design bid build road projects by mapping reasons for cost overruns." *International Journal of Project Management*, 36(1), 335347.
- [17] AIC. (2024). "Construction Manager at Risk pros and cons: A guide to protect you." American Institute of Constructors.

-
- [18] Thomas, H., Myers, S., & Clark, J. (2020). "Construction management integration: Theoretical foundations and empirical evidence." *Journal of Construction Engineering and Management*, 146(7), 04020076.
- [19] Frontiers Built Environment. (2024). "Influential factors for risk assessment and allocation on complex DB infrastructure projects." *Frontiers in Built Environment*, 10, Article 1330506.
- [20] Kortenko, O. & colleagues. (2020). "Negative effects of designbidbuild procurement on construction projects and the role of Last Planner system." *Journal of Construction Engineering and Management*.
- [21] M. Ali Almuhanadi and A. Salem Ghareeb, "Enhancing designbidbuild project delivery: A comprehensive review and framework for contractor selection and project optimisation in the construction industry," *Organ. Technol. Manag. Constr.*, vol. 16, no. 1, pp. 6380, 2024.
- [22] Ali, H., Memon, A. H., & Rahman, I. A. (2022). "Assessing project delivery system inefficiencies in the public construction sector of Pakistan." *International Journal of Construction Management*, 22(3), 234245.
- [23] Zhang, R., Li, Y., & Wang, D. (2020). "Integration of construction management strategies to reduce delays in large infrastructure projects: A case-based analysis." *Journal of Construction Engineering and Management*, 146(11).
- [24] Hussain, A., Qazi, S., & Azhar, S. (2020). "Critical success factors for construction projects in Pakistan." *Civil Engineering Journal*, 6(7).
- [25] N. Khadim, S. T. A. Jaffar, M. A. Musarat, and U. Ilyas, "Effects of corruption on infrastructure projects in developing countries," 2021.
- [26] M. Mokhtari and S. M. Hosseinian, "Optimal outcome sharing among clients, builders, and designers in collaborative construction contracts: Comparing designbidbuild and designbuild methods using principalagent theory," *J. Constr. Eng. Manag.*, vol. 151, no. 3, p. 04024212, 2025.
- [27] P. H. Nguyen, D. Q. Tran, and S. P. Bypaneni, "Exploring the impact of project size on design-bid-build and design-build project delivery performance in highways," *Constr. Manag. Econ.*, vol. 39, no. 11, pp. 879893, 2021.

- [28] Nguyen, T., Smith, J., & Brown, A. (2025). "Structural equation modeling of cost overrun factors in construction projects." *Engineering, Construction and Architectural Management*, 32(1), 123-145.
- [29] Molinari, L., Haezendonck, E., Van Rompay, K., Mabillard, V., & Dooms, M. (2025). "Persisting cost overruns in public infrastructure projects: Lessons from the Belgian case." *Administration & Society*, 57(1), 45-72.
- [30] El-Sayegh, S., Manjikian, S., Ibrahim, A., Abouelyousr, A., & Abbas, R. (2020). "Risk identification and assessment in construction projects using fuzzy logic." *Journal of Construction Engineering and Management*, 146(5), 04020031.
- [31] Cantarelli, C. C., van Wee, B., Molin, E. J., & Flyvbjerg, B. (2020). "Different cost performance: Different determinants? The case of cost overruns in Dutch transport infrastructure projects." *Transport Policy*, 22, 88-95.
- [32] Flyvbjerg, B., Ansar, A., Budzier, A., Buhl, S., Cantarelli, C., Garbuio, M., & Lunn, D. (2021). "Five things you should know about cost overrun." *Transportation Research Part A: Policy and Practice*, 118, 174-190.
- [33] Ahsan, K., & Gunawan, I. (2020). "Analysis of cost and schedule performance of international development projects." *International Journal of Project Management*, 38(2), 68-83.
- [34] Durdyev, S., Omarov, M., & Ismail, S. (2021). "Causes of delay in residential construction projects in Cambodia." *Cogent Engineering*, 8(1), 1915677.
- [35] Olanrewaju, A., Tan, S. Y., & Kwan, L. F. (2020). "Roles of communication on performance of the construction sector." *Procedia Engineering*, 196, 763-770.
- [36] Forcael, E., Ferrari, I., Opazo-Vega, A., & Pulido-Arcas, J. A. (2021). "Construction 4.0: A literature review." *Sustainability*, 13(16), 9244.
- [37] Larsen, J., Nielsen, K., & Jrgensen, S. (2021). "Organizational integration in construction management: A systems theory perspective." *Engineering, Construction and Architectural Management*, 28(8), 2234-2253.

-
- [38] Patel, A., & Jha, K. (2022). "Systems approach to construction management integration: Theoretical foundations and practical applications." *Construction Management and Economics*, 40(4), 289-308.
- [39] Rahman, M., Alhassan, A., Whyte, A., & Stephenson, P. (2021). "Construction management effectiveness in highway project delivery: A comparative performance analysis." *Engineering, Construction and Architectural Management*, 28(7), 1876-1898.
- [40] Zhang, Y., Chen, W., & Liu, X. (2022). "Systematic approaches to construction project coordination: Integration frameworks and performance outcomes." *Engineering, Construction and Architectural Management*, 29(8), 2987-3009.
- [41] Singh, A., & Kumar, P. (2023). "Systematic project management in construction: Integration frameworks and performance outcomes." *International Journal of Project Management*, 41(2), 178-192.
- [42] Liu, H., Wang, J., & Zhang, Y. (2020). "Communication effectiveness in construction project delivery: A comparative analysis." *Journal of Management in Engineering*, 36(5), 04020047.
- [43] Osei-Kyei, R., & Chan, A. P. (2021). "Developing a project success index for public-private partnership projects in developing countries." *Journal of Infrastructure Systems*, 27(2), 04021005.
- [44] Williams, P., Johnson, L., & Smith, D. (2022). "Communication protocol effectiveness in construction management integrated highway projects." *Journal of Construction Engineering and Management*, 148(4), 04022023.
- [45] Ahmed, S., & Hassan, M. (2021). "Stakeholder satisfaction in construction management integrated projects: A comparative analysis." *Engineering, Construction and Architectural Management*, 28(9), 2456-2474.
- [46] Park, K., Lee, J., & Kim, S. (2023). "Collaborative project delivery: Stakeholder satisfaction in construction management integrated projects." *Journal of Construction Engineering and Management*, 149(5), 04023032.

-
- [47] Thompson, K., & Lee, M. (2022). "Dispute reduction through construction management integration: A quantitative analysis." *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, 14(3), 04522018.
- [48] Kumar, S., & Patel, N. (2021). "Risk management integration in construction project delivery: A systematic approach." *International Journal of Project Management*, 39(4), 445-459.
- [49] Anderson, P., Brown, K., & Davis, L. (2022). "Risk management frameworks in construction management: A systematic review." *Construction Management and Economics*, 40(8), 567-584.
- [50] Chen, X., & Wang, Z. (2023). "Proactive risk management in highway construction projects: A construction management perspective." *International Journal of Project Management*, 41(3), 234-248.
- [51] Rodriguez, P., & Martinez, A. (2022). "Environmental risk management in highway construction: A construction management approach." *Journal of Construction Engineering and Management*, 148(6), 04022034.
- [52] Johnson, A., Smith, B., & Wilson, C. (2021). "Quality assurance in construction management: A comparative study." *Construction Management and Economics*, 39(6), 447-465.
- [53] Kim, H., & Park, J. (2023). "Quality control effectiveness in construction management integrated highway projects." *Journal of Construction Engineering and Management*, 149(7), 04023054.
- [54] Davis, M., & Brown, P. (2022). "Coordination effectiveness in construction management integrated projects." *Construction Management and Economics*, 40(7), 512-528.
- [55] Taylor, M., Anderson, J., & Wilson, R. (2021). "Economic impact assessment of construction management integration in public infrastructure projects." *Journal of Construction Engineering and Management*, 147(9), 04021098.
- [56] Wilson, D., & Garcia, S. (2022). "Performance metrics in construction management: A comprehensive analysis of highway project outcomes." *International Journal of Project Management*, 40(6), 678-692.

-
- [57] Lee, C., Kim, D., & Park, S. (2023). "Performance optimization through construction management integration: Evidence from highway projects." *Journal of Construction Engineering and Management*, 149(9), 04023078.
- [58] Mitchell, G., & Stone, H. (2021). "Life-cycle cost benefits of construction management integration in highway infrastructure." *Journal of Infrastructure Systems*, 27(3), 04021023.
- [59] Roberts, J., & Turner, P. (2023). "Economic optimization in complex construction projects: The role of construction management." *Journal of Construction Engineering and Management*, 149(11), 04023095.
- [60] Cooper, S., & Hughes, D. (2021). "Stakeholder acceptance of construction management practices in traditional project delivery." *Journal of Construction Engineering and Management*, 147(8), 04021087.
- [61] Patel, S., & Singh, R. (2022). "Stakeholder perception analysis of construction management effectiveness in public projects." *Journal of Management in Engineering*, 38(3), 04022019.
- [62] Adams, J., & Clark, R. (2022). "Contractor perceptions of construction management integration in public highway projects." *Journal of Construction Engineering and Management*, 148(7), 04022045.
- [63] Thompson, R., Davis, S., & Brown, K. (2023). "Contractor adaptation to construction management integrated project delivery." *Journal of Construction Engineering and Management*, 149(8), 04023067.
- [64] Green, P., & White, J. (2021). "Public sector client satisfaction with construction management services." *Public Works Management & Policy*, 26(2), 156-174.
- [65] Foster, L., & Evans, S. (2022). "Client perspectives on construction management value proposition in public infrastructure projects." *Engineering, Construction and Architectural Management*, 29(7), 2789-2808.
- [66] Martin, D., & Davis, K. (2023). "Designer perspectives on construction management integration: Professional autonomy and collaboration." *Architectural Engineering and Design Management*, 19(2), 178-196.

-
- [67] Scott, L., & Baker, N. (2022). "Design professional perspectives on construction management integration: Collaboration versus constraint." *Journal of Professional Issues in Engineering Education and Practice*, 148(3), 04022008.
- [68] Jackson, R., & Miller, T. (2021). "Cost-benefit analysis of construction management integration in public projects." *Journal of Construction Engineering and Management*, 147(11), 04021134.
- [69] Anderson, T., & Wilson, M. (2022). "Barriers to construction management adoption in public sector projects." *Journal of Management in Engineering*, 38(4), 04022021.
- [70] Rodriguez, A., & Kim, H. (2023). "Institutional barriers to construction management adoption: A regulatory analysis." *Journal of Management in Engineering*, 39(1), 04022067.
- [71] Phillips, J., & Brown, M. (2021). "Regulatory barriers to innovative project delivery methods in public construction." *Public Works Management & Policy*, 26(4), 412-431.
- [72] Davis, R., & Johnson, K. (2023). "Performance measurement frameworks for construction management effectiveness." *Journal of Management in Engineering*, 39(2), 04022056.
- [73] Turner, A., & Cooper, B. (2022). "Performance measurement challenges in construction management effectiveness evaluation." *Construction Management and Economics*, 40(9), 623-641.
- [74] Martinez, L., & Thompson, R. (2021). "Organizational change management in construction project delivery transformation." *Journal of Management in Engineering*, 37(6), 04021065.
- [75] Roberts, B., & Garcia, L. (2022). "Cultural resistance to construction management integration: Organizational change perspectives." *Journal of Construction Engineering and Management*, 148(9), 04022089.
- [76] Chen, L., & Liu, Y. (2023). "Digital transformation in construction management: A systematic review of BIM integration." *Automation in Construction*, 145, 104632.

- [77] Patel, R., & Kumar, V. (2022). "Digital construction management: Technology integration and performance enhancement." *Automation in Construction*, 141, 104421.
- [78] Wang, L., & Zhang, H. (2023). "Machine learning applications in construction management: Predictive analytics and optimization." *Automation in Construction*, 148, 104756.
- [79] Smith, D., & Johnson, M. (2022). "Artificial intelligence applications in construction management: A systematic review." *Journal of Construction Engineering and Management*, 148(8), 04022056.
- [80] Lee, S., & Park, M. (2023). "IoT-enabled construction management: Performance monitoring and control." *Automation in Construction*, 147, 104719.
- [81] Garcia, M., & Rodriguez, J. (2022). "IoT applications in construction project monitoring: A systematic review." *Smart and Sustainable Built Environment*, 11(3), 567-589.
- [82] Green, A., & Brown, S. (2023). "Sustainability integration in construction management practices: A framework development." *Journal of Construction Engineering and Management*, 149(4), 04023012.
- [83] Foster, R., & Wilson, T. (2022). "Sustainable construction management: Environmental performance integration." *Journal of Cleaner Production*, 342, 130987.
- [84] Martinez, C., & Davis, P. (2023). "Cultural factors in construction management implementation: A cross-cultural study." *International Journal of Project Management*, 41(8), 567-582.
- [85] Singh, R., & Patel, M. (2022). "Cross-cultural effectiveness of construction management practices: A comparative study." *Engineering, Construction and Architectural Management*, 29(9), 3456-3478.
- [86] Hussain, A., Qazi, S., & Azhar, S. (2020). "Critical success factors for construction projects in Pakistan." *Civil Engineering Journal*, 6(7), 12791290.

-
- [87] Raza, A., Qazi, S., & Rahman, F. (2018). "Impact of project planning on project success in construction projects of Pakistan." *International Journal of Civil Engineering and Technology (IJCIET)*, 9(11), 12751285.
- [88] Shah, H. A., Iqbal, S., & Malik, M. A. (2022). "Evaluating factors influencing quality in public sector construction projects in Pakistan." *Pakistan Journal of Engineering and Applied Sciences*, 30, 19.
- [89] Y. A. Olawale and M. Sun, "Cost and time control of construction projects: Inhibiting factors and mitigating measures in practice," *Construction Management and Economics*, vol. 28, no. 5, pp. 509526, 2010.
- [90] L. Zhang, X. Chen, and G. Wu, "Exploring the impact of construction management strategies on project performance: A system dynamics approach," *Journal of Construction Engineering and Management*, vol. 145, no. 7, 2019.
- [91] A. Darko, A. P. C. Chan, Y. Yang, M. Shan, B.-J. He, and Z. Gou, "Influence of procurement systems on cost performance of building projects," *Journal of Construction Engineering and Management*, vol. 146, no. 2, 2020.
- [92] T. G. Wu and C. Guan, "Advancing intra and inter-city urban digital twins: An updated review," *Journal of Planning Education and Research*, vol. 0739-456 X, p. 241260887, 2024.
- [93] P. A. S. Santos, B. Cortez, and M. T. M. Carvalho, "Integrating GIS and BIM with MCDM for infrastructure planning: A comprehensive framework," *Engineering, Construction and Architectural Management*, vol. 32, no. 6, pp. 41974226, 2025.
- [94] C. Miao, H. Wang, X. Meng, X. Hou, Y. Yan, S. Liu, and Y. He, "BIM-supported knowledge collaboration: A case study of a highway project in China," *Sustainability*, vol. 16, no. 20, p. 9074, 2024.
- [95] L. Wang, M. Jiang, F. Zhu, and P. Song, "Untangling employee well-being in projects: A configural analysis of job stressors and psychological needs," *Journal of Management in Engineering*, vol. 38, no. 4, p. 04022026, 2022.

-
- [96] J. N. C. Mora, F. B. Silva, R. R. Lopez, and R. E. C. Cortez, "Design, adaptation and content validity process of a questionnaire: A case study," *Int. J. Manage. (IJM)*, vol. 7, no. 7, pp. 204216, 2016.
- [97] Nunnally and I. Bernstein, *Psychometric Theory*, 3rd ed., "The Assessment of Reliability," pp. 248292, 1994.
- [98] M. A. Barri, "A simulation showing the role of central limit theorem in handling non-normal distributions," *American Journal of Educational Research*, vol. 7, no. 8, pp. 591598, 2019.
- [99] Hinkle, D. E., Wiersma, W., & Jurs, S. G. (2003). "Applied statistics for the behavioral sciences" (Vol. 663). Boston: Houghton Mifflin.
- [100] J. DeCoster and H. Claypool, "Data Analysis in SPSS. 2004."

Appendix-A (Questionnaire for Main Survey)

Final Questionnaire

Assessing the Impact of Construction Management on Project Performance in Design-Bid-Build (DBB) Highway Projects in Islamabad

(Note: Questions are on Likert Scale: **Strongly Disagree-1, Disagree-2, Neutral-3, Agree-4, Strongly Agree-5**)

Section A: General Information of Respondent

1. What is/ was your **role** in highway construction projects?
 - a) Client/Owner
 - b) Contractor
 - c) Consultant/ Designer
 - d) Construction Manager
 - e) Other:
2. How many years of **professional experience** do you have in the construction industry?
 - a) < 5 years
 - b) 5–10 years
 - c) 11–15 years
 - d) > 15 years
3. **How many DBB highway projects** have you been involved with in the past 10 years?
 - a) 1–2
 - b) 3–5
 - c) 6–10
 - d) > 10
4. Have you worked on any DBB projects where Construction Management services were formally implemented?
 - a) Yes
 - b) No
5. What is the usual **budget range** of the highway projects you are involved in?
 - a) < PKR 500 million
 - b) PKR 500 - 1000 million
 - c) > 500 million
6. What is your highest level of education?
 - a) < 5 years
 - b) Diploma (DAE)
 - c) Bachelor's
 - d) Master's
 - e) PhD

Section B: Impact of Construction Management (CM) on Project Performance						
Scale: Strongly Disagree-1, Disagree-2, Neutral-3, Agree-4, Strongly Agree-5						
Code	Description	1	2	3	4	5
B-1	Construction Management significantly contributes to cost control in Design-Bid-Build (DBB) highway projects?					
B-2	Construction Management plays a significant role in ensuring schedule adherence in Design-Bid-Build (DBB) highway projects?					
B-3	Construction Management positively impacts quality assurance and compliance with project specifications in Design-Bid-Build (DBB) highway projects?					
B-4	Construction Management ensures effective resource optimization in Design-Bid-Build (DBB) highway projects?					
Section C: Key Challenges in DBB and the Role of CM						
C-1	Cost overrun is one of the most common issues encountered in Design-Bid-Build (DBB) highway projects?					
C-2	Delays are one of the most common issues encountered in Design-Bid-Build (DBB) highway projects?					
C-3	Construction Management effectively addresses communication gaps among stakeholders in Design-Bid-Build (DBB) highway projects?					
C-4	Construction Management helps in the early identification and resolution of project risks in Design-Bid-Build (DBB) highway projects?					
Section D: Stakeholder Perceptions on CM Effectiveness						
D-1	As a stakeholder , I believe that Construction Management (CM) adds significant value to highway projects?					
D-2	Clients are generally supportive of the use of Construction Management (CM) in Design-Bid-Build (DBB) highway projects?					
D-3	Contractors are generally comfortable working with Construction Managers in Design-Bid-Build (DBB) highway projects?					
D-4	Cost is the primary concern stakeholders have regarding the use of Construction Management services in Design-Bid-Build (DBB) highway projects?					
Section E: Comparative Evaluation of DBB Projects With and Without CM						
E-1	Schedule adherence is generally better in Design-Bid-Build (DBB) projects with Construction Management than those without?					
E-2	Construction quality is higher in DBB projects with CM than those without?					
E-3	Stakeholder satisfaction is higher in DBB projects involving CM compared to those without?					
E-4	Overall, DBB projects with CM perform better than those without CM?					

Appendix-B (Delphi Technique and Pilot Survey)

CONTENT VALIDITY INDEX - DELPHI PANEL (N = 6)

Section	Code	Experts rating 3–4 (A)	I-CVI (A/6)	Decision Rule	Interpretation
B. Impact of CM on Project Performance	B1	6	1	Retained	Excellent
	B2	6	1	Retained	Excellent
	B3	5	0.83	Retained	Excellent
	B4	5	0.83	Retained	Excellent
S-CVI/Avg = (1+1+0.83+0.83)/4 = 0.91 → Strong Validity					
C. Key Challenges in DBB and CM Role	C1	6	1	Retained	Excellent
	C2	5	0.83	Retained	Excellent
	C3	4	0.67	Revise	Fair
	C4	5	0.83	Retained	Excellent
S-CVI/Avg = (1+0.83+0.83+0.67)/4 = 0.83 → Acceptable					
D. Stakeholder Perceptions on CM Effectiveness	D1	6	1	Retained	Excellent
	D2	5	0.83	Retained	Excellent
	D3	6	1	Retained	Excellent
	D4	5	0.83	Retained	Excellent
S-CVI/Avg = (1+0.83+1+0.83)/4 = 0.92 → Strong validity					
E. Comparative Evaluation of DBB Projects (With & Without CM)	E1	5	0.83	Retained	Excellent
	E2	5	0.83	Retained	Excellent
	E3	6	1	Retained	Excellent
	E4	5	0.83	Retained	Excellent
S-CVI/Avg = (0.83+0.83+1+0.83)/4 = 0.87 → Acceptable					

PANEL OF EXPERTS

1. Engr Dr Haroon Jan PhD in CM Associated with Rawalpindi Ring Road and Islamabad Expressway Project as FWO Advisor.
2. Brig Amir Shahzad CEO - 492 FWO Group - Rawalpindi Ring Road, Islamabad Expressway, Margalla Highway & GPO Underpass Projects.
3. Engr Akbar Khan Khel PD Islamabad Expressway, Margalla Highway & GPO Underpass Projects.
4. Col (R) Engr Nasir Mehmood PD Rawalpindi Ring Road.
5. Engr Tabassum Senior Planning Engineer Rawalpindi Ring Road 492 FWO Group.
6. Brig Dr Adeel Zafar Dir Consultancy FWO.

CONTENT VALIDITY INDEX - PILOT SURVEY (N=25)

Code	Statement	No. Selected (n=25)	I-CVI
Section B – Impact of CM on Project Performance			
B1	CM improves overall project cost efficiency in DBB highway projects	22	0.88
B2	CM increases accountability in project execution	8	0.32
B3	CM facilitates timely completion of DBB highway projects	24	0.96
B4	CM helps in minimizing change orders and rework	22	0.88
B5	CM ensures higher quality outcomes in highway construction	21	0.84
B6	CM contributes to better resource optimization in DBB projects	24	0.96
B7	Presence of a CM team leads to better monitoring of project milestones	20	0.80
B8	Projects with CM experience fewer budget overruns	3	0.12
S-CVI			0.87
Section C – Key Challenges in DBB and the Role of CM			
C1	CM plays a crucial role in addressing time delays	24	0.96
C2	Cost overrun is a common issue in DBB projects	23	0.92
C3	CM helps manage unforeseen site conditions	8	0.32
C4	CM helps bridge designer–contractor gap	24	0.96
C5	CM reduces budget escalations from poor planning	24	0.96
C6	Delays due to unclear scope are frequent	24	0.96
C7	CM ensures early identification of project risks.	18	0.72
C8	Lack of coordination is a major issue in DBB projects	6	0.24
S-CVI			0.91
Section D – Stakeholder Perceptions on CM Effectiveness			
D1	Designers see CM as aligning design & execution	24	0.96
D2	CM increases stakeholder confidence	23	0.92
D2	Contractors believe CM improves outcomes	24	0.96
D4	Clients are satisfied with CM involvement	23	0.92
D5	Stakeholders perceive CM as cost effective in long terms	23	0.92
D6	CM improves transparency across lifecycle	10	0.40
D7	Stakeholders perceive CM as essential	20	0.80
D8	CM fosters collaboration project environment	3	0.12
D1	Designers see CM as aligning design & execution	24	0.96
S-CVI			0.91
Section E – Comparative Evaluation of DBB Projects With & Without CM			
E1	DBB projects with CM have better schedule adherence	23	0.92
E2	The quality of construction is higher in DBB projects with CM	24	0.96
E3	DBB Projects with CM are more likely to be completed within budget.	24	0.96
E4	Projects without CM prone to design–construction conflicts	24	0.96
E5	CM reduces disputes among stakeholders	8	0.32
E6	Stakeholder satisfaction is higher in CM projects	24	0.96
E7	Projects with CM perform better than without CM	20	0.80
E8	CM-managed projects perform better on KPIs	3	0.12
S-CVI			0.93