EVALUATION OF DESIGN-BID-BUILD (D-B-B) PROJECTS WITH AND WITHOUT AGENCY CONSTRUCTION MANAGEMENT

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Abstract: Agency CM is a construction management system, and is a way to manage the process of construction. Agency Construction Management when paid on hourly Fee tempts to work hours that are not needed to maximize fee. When Agency CM is paid by Lump sum Fee or remunerated by a percentage of the Project Cost, Agency CM is only committed to provide defined services and results for a lump sum Fee. So the Agency CM may be tempted to provide less service than what was contracted for to increase profits and may maximize profits by cutting corners on services at risk of not obtaining expected results. Hence there is a need for the owner to understand whether there is improvement in Project Performance when Agency CM is contracted with any Project Delivery System. Design-Bid-Build (D-B-B), Design-Build (D-B), and Construction Management at risk (CM at - Risk) are the three principal project delivery systems. Agency CM can be used with any type of Project Delivery System. This necessitates a comprehensive investigation in to the performance of projects delivered with Agency CM and projects delivered without Agency CM. This study evaluated the project performance metrics such as Project Cost, Project Schedule and Project quality in Projects where Design-Build (D-B-B) Project Delivery System was used with Agency CM and Projects where Design-Bid-Build Project Delivery System was used without Agency CM. The study included literature review, designing a questionnaire, collecting data from 200 Design –Bid-Build (D-B-B) projects of which 100 projects where Agency CM was used and 100 projects where Agency CM was not used. Analysis of data pertaining to project performance metrics was done by using SPSS statistical software. An understanding of this study can help an owner/client better select the D-B-B project delivery system either with or without Agency Construction management.

Keywords*: Design-Build, Agency Construction Management, Project Delivery Systems, Construction Projects, Project performance metrics*

I. INTRODUCTION :

A project delivery system is the comprehensive process of assigning the contractual responsibilities for designing and constructing a project. A delivery system identifies the primary parties taking contractual responsibility for the performance of the work. The essential elements of any project delivery system are cost, time, quality and safety. Agency CM firms are the agents of the owners to give pre-construction advice on scheduling, budgeting, value analysis and bidding and continue to assist the owners in construction phase, but doesn't take any performance risk in guaranteeing the Project cost, Project schedule or Project quality. These risks remain for someone else to take.

A common misconception is that Agency CM is a project delivery system. An Agency CM is not contractually responsible for delivering the bricks and sticks in construction. Rather responsible for management services necessary to deliver construction. Agency Construction Management is a management system based on an owner's agreement with a qualified construction management firm to provide coordination, administration and management within a defined scope of services. While Agency CM is not limited to a certain sized project, it is frequently used on large, complex projects where the owner desires to supplement its in-house staff and expertise. Any Agency CM is usually paid on hourly basis/lump sum fee/percentage of project cost. In each of these cases, the owner has certain disadvantages.

The disadvantages of Owner contracting with Agency CM on hourly CM-Fee are that the Agency CM is tempted to work hours that are not needed to maximize the fee. The Agency CM and the Owner need to carefully monitor Agency CM'S efforts Vs Results. When the Agency CM is contracted on Lump sum Fee/percentage of project cost, Agency CM is committed to provide defined services and results. It requires a thorough definition of results expected from Agency CM'S efforts and services required to attain such results prior to signing Agency CM contract. The disadvantage in this case is that the Agency CM may maximize profits by cutting corners on services at risk of not obtaining expected results.

Design-Bid-Build (D-B-B), Design-Build (D-B), and Construction Management at risk (CM at - Risk) are the three principal project delivery systems. Agency-CM can be used with any type of Project Delivery system. [1]

Design-Bid-Build (D-B-B):

1. Design and Construction are separate contracts (Versus Design-Build, where the contracts are combined)
2. The only criterion for final selection is lowest total construction cost (Versus CM at Risk, where there are other criteria in the final selection)

Design-Build (D-B):

1. Design and Construction contracts are combined (Versus both Design-Build and CM@Risk, where contracts are separate)

CM @ Risk:

1. Design and Construction are separate contracts (Versus D-B, where the contracts are combined)
2. Criteria for final selection include factors other than just lowest total construction cost(Versus D-B-B where total construction cost is the only criterion for final selection) [2]

The efficient delivery of construction projects is foundation to the success of the construction industry. To increase the probability of success, owners must choose the appropriate project delivery systems to match their project needs. Most groups agree that there is no perfect project delivery system. Every project is unique and has its own unique set of challenges. Therefore, industry consensus is that every project should be considered on a case-by-case basis to determine the most appropriate project delivery system.

Construction industry has been using D-B-B and D-B and CM at Risk project delivery systems. The most recent period has seen an increase in the use of Agency CM along with these two project delivery systems. Considerable amount of fee is paid to the Agency CM in order to improve the efficiency of the project. Is the use of Agency CM improving the quality of the project? Is the amount of fee paid to the Agency CM increasing the Project cost or decreasing the project cost? When Agency CM is used, is there any improvement in the Project time Schedule? To answer these questions, it necessitates a comprehensive investigation in to the performance of projects delivered with Agency CM and Projects delivered without Agency CM.

This study may help an owner better select a project delivery system that is most suitable between the Design-Bid- Build with Agency CM and the Design-Bid-Build without Agency CM.

This paper covers the Literature Review in brief, Research Methodology, and Data analysis, Results, Testing of Hypotheses and Conclusions.

II. OBJECTIVES OF RESEARCH :

1. To compare the Cost Growth between D-B-B Projects with Agency CM and D-B-B Projects without Agency CM
2. To compare the Time Growth between D-B-B Projects with Agency CM and D-B-B Projects without Agency CM
3. To compare the Quality Performance between D-B-B Projects with Agency CM and D-B-B Projects without Agency CM
4. To distinguish the project performance between Design- Bid- Build Projects With and Without Agency CM

III. LITERATURE REVIEW :

Many researchers put their efforts to evaluate the project delivery systems in the past.

- Fouad Mansoor Al Sinan (1986)evaluated the construction management Contracts in developing Countries.[3]
- Kyungsoon Chang (2004) suggested a proper model for best value selection in public sector Design Build projects. [4]
- Joseph A. Mannarino (2001) evaluated the Construction management delivery system. [5]
- Edmond W.M.Lam (2004) bench marked the Design- Build procurement systems in Construction. [6]
- AdetokunboA.Oyetunji and Stuart D. Anderson (2001) studied the relative effectiveness of Project Delivery and Contract Strategies. [7]
- The university of Reading Design and Build Forum using multivariate analysis techniques compared the cost, schedule and quality performance of 332 Design Build and Design Bid Build projects built in UK. [8]
- Mark D Konchar (1998) empirically compared the cost, schedule and quality performance of Construction Management at Risk, Design-Build and Design – Bid – Build delivery systems for US building projects. [9]
- Sami W. Fahmi (2005) compared the owner expectations and actual performance of the Design-Build projects. [10]
- Chuck Kluenker (2001) studied the Risk Vs Conflict of Interest – What Every Owner Should Consider When Using Construction Management and stated the disadvantages in hiring an Agency CM on hourly fee and lump sum fee was that the Agency CM might be tempted to work hours that were not needed to maximize fee. Agency CM might maximize profits by cutting corners on services at risk of not obtaining expected results. [11]
- Some research (AIA 2007, Ballard and Morris2010) consisted of opinion surveys to investigate attitudes toward specific project

delivery methods by owners who frequently procure design and construction services. [12]

- Several case studies of industry builders and clients, (Bruns,1997) such as the US Postal service, explain variations in the way project delivery systems are administered both privately and in the public sector. [13]
- Konchar and Sanvido (1998) found that DBB projects generally face 5.2% more change orders than DB projects. [14]
- Rojas and Kell (2008) studied completed construction projects and established that the degree of collaboration/Integration has a significant relationship with the team practices imposed by the project procurement approach. The research was completely survey based and made no comparison to the cost benefits achieved on projects based on level of integration and type of delivery system. [15]
- Aditi Kulkarni, Zofia K.Rybhowski, and James Smith (2012) through cost comparison of collaborative and IPD-like project delivery methods versus competitive Non-Collaborative Project delivery methods concluded that collaborative project delivery systems produce a more reliable cost outcome for public owners. [16]

Despite substantial efforts in the past to evaluate the project delivery systems, there is no study conducted to compare the quantifiable cost, schedule and quality performance of Design-Build and Design- Bid-Build project delivery systems with Agency CM and Without Agency CM.

However the scope of this paper is limited to present a comparison of cost, schedule and quality attributes between the Design-Bid-Build (D-B-B) projects where Agency CM was used and the Design-Bid-Build (D-B-B) projects where Agency CM was not used.

IV. RESEARCH METHODOLOGY:

This study developed and utilized a data collection instrument (Questionnaire) to obtain project specific data, which was used to measure the Project Cost Growth, Project Time Growth and Project Quality scores. The data was collected from various contractors, Agency CMs, representatives of Owners.

The results were used to compare the Cost Growth, Time Growth and Quality Scores and to test several hypotheses to measure the Performance of Design-Build projects With Agency CM and Design- Build Projects without Agency CM.

PERFORMANCE METRICS:

Though various performance metrics were used by previous researchers to describe the performance of the project delivery process, this study considered only three most important metrics namely, Cost, Time, and Quality.

Cost Growth

This metric provides an indication of the growth of the project costs over the initial award cost of Project.

Cost growth = (Final Project Cost – Award Cost)/Award Cost *100

Where Award Cost is the Construction Contract Cost including the Agency CM‘s fee

Final project cost is the final cost of construction including Agency CM’s fee.

Time Growth

This performance metric provides an indication of the growth of schedule (Project Time Duration) over the Initial Planned Duration of the Project.

Time growth = (Actual Duration-Planned duration)/Actual duration*100

Quality Measure

Quality was defined as the degree to which the facility met the expected facility requirements. Quality was measured in six areas. Each was a measure of the actual performance versus the facility user’s or owner’s expectations of the referenced building. The maximum scores against which the quality scores measured were based on the importance of the criteria.

To distinguish the Project performance between the Design– Bid- Build Projects (D-B-B) with Agency CM and the Design- Bid- Build Projects (D-B-B) without Agency CM, the two independent populations’ means were compared to test the hypothesis.

TESTING OF HYPOTHESES

Comparing Two Independent Populations’ Means of D-B-B Projects with Agency CM and D-B-B Projects without Agency CM:

Assumptions:

1. The observations in D-B-B project delivery method without Agency CM are independent of the observations in
   D-B-B project delivery method with Agency CM.
2. The two sampled populations are normally/approximately normally distributed.
3. The standard deviations of the two populations are nearly equal.

Cost Growth

Hypotheses

Null Hypothesis:

The mean Cost growth of D-B-B projects with Agency CM is at least equal to the mean Cost growth of D-B-B projects without Agency CM.

$\mu 1 \geq \mu 2$ where $\mu 1$ = mean Cost growth of D-B-B projects with Agency CM.

$\mu 2$ = mean Cost growth of D-B-B projects without Agency CM

Alternate Hypothesis:

The mean Cost growth of D-B-B projects with Agency CM is less than the mean Cost growth of D-B-B projects without Agency CM.

$\mu 1 < \mu 2$

Time Growth/Schedule Growth

Hypotheses:

Null Hypothesis:

The mean Time growth of D-B-B projects with agency CM is at least equal to the mean Time growth of D-B-B projects without Agency CM.

$\mu 1 \geq \mu 2$ where $\mu 1$ = mean Time growth of D-B-B projects with Agency CM.

$\mu 2$ = mean Time growth of D-B-B projects without Agency CM

Alternate Hypothesis:

The mean Time growth of D-B-B projects with agency CM is less than the mean Time growth of D-B-B projects without Agency CM.

$\mu 1 < \mu 2$

Quality Performance

Hypotheses:

Null Hypothesis:

The mean quality score of D-B-B projects with agency CM is at most equal to the mean quality score of D-B-B projects without Agency CM.

$\mu 1 \leq \mu 2$ where $\mu 1$ = mean Quality Score of D-B-B projects with Agency CM.

$\mu 2$ = mean Quality Score of D-B-B projects without Agency CM

Alternative Hypothesis:

The mean quality score of D-B-B projects with agency CM is greater than the mean quality score of D-B-B projects without Agency CM.

$\mu 1 > \mu 2$

Using SPSS comparing means, t-test was conducted at 0.05 significance level to test the above hypotheses.

V. ANALYSIS AND RESULTS

Data related to Cost, Schedule and Quality from 200 projects of which 100 D-B-B projects with Agency CM, and 100 D-B-B projects without Agency CM were initially collected and entered in to EXCEL spreadsheet. Using the formulae the Cost Growth, Time Growth of projects were calculated and tabulated against each project. For measuring the Quality, the subjective evaluation of quality performance for difficulty in project start up was transformed to the scale of 10, 5 and 1 respectively for low, Medium and High. For number and magnitude of callbacks the scale was 10, 5, 1 for none, a few, many respectively. For operating/maintenance cost of the building was 10, 5, 1 for none, a few, many respectively. Similarly the quality performance related to quality of envelop/roof/structure/foundation, quality of interior space/layout and quality of environmental system to meet the expectations was transformed to the scale of 5,8,10 respectively for the lowest, average and the highest. The quality scores were tabulated against each project. SPSS was used for data analysis.

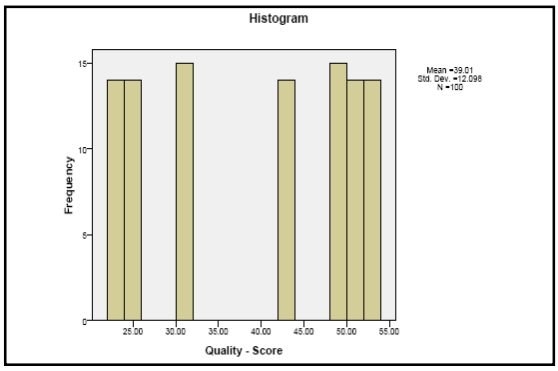

Figure 1: Quality Scores Histogram for DBB Projects with Agency CM

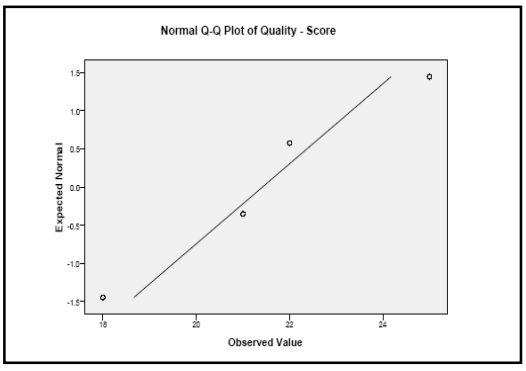

Figure 4: Normal Q-Q Plot of Quality Scores for DBB Projects without Agency CM

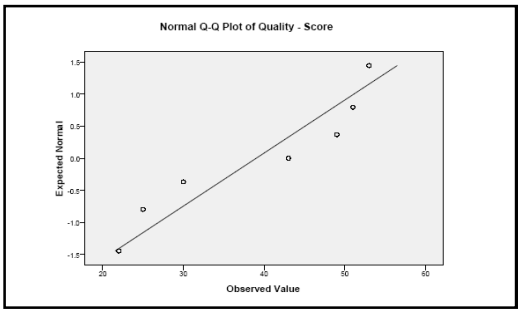

Figure 2: Normal Q-Q Plot of Quality Scores for DBB Projects with Agency CM

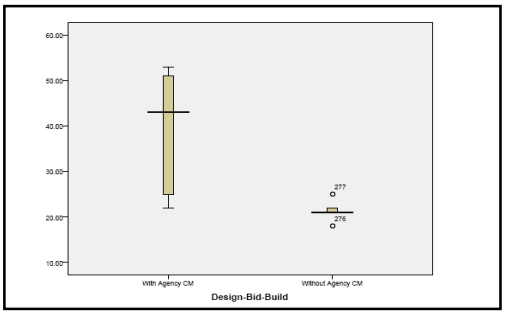

Figure 5: Quality Scores for DBB Projects with and without Agency CM

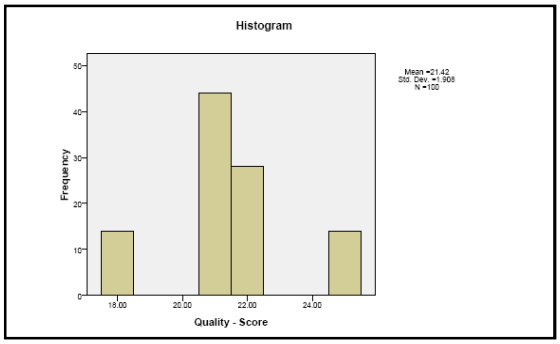

Figure 3: Quality Scores for DBB Projects without Agency CM

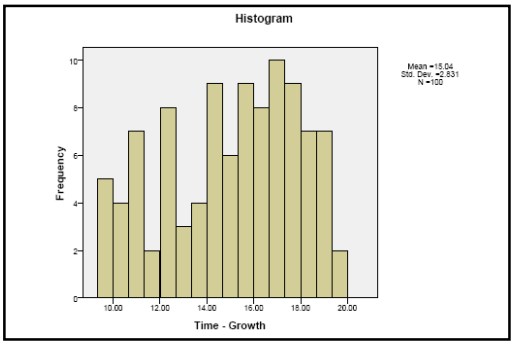

Figure 6: Time Growth Histogram for DBB Projects with Agency CM

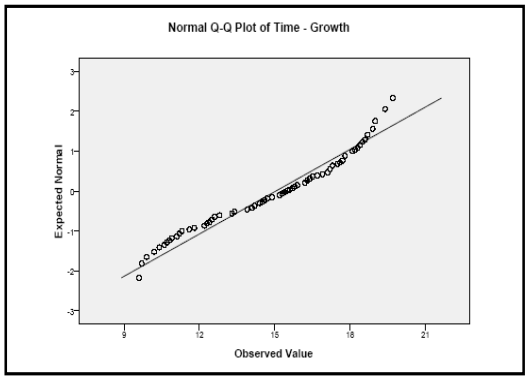

Figure 7: Normal Q-Q Plot of Time Growth for DBB Projects with Agency CM

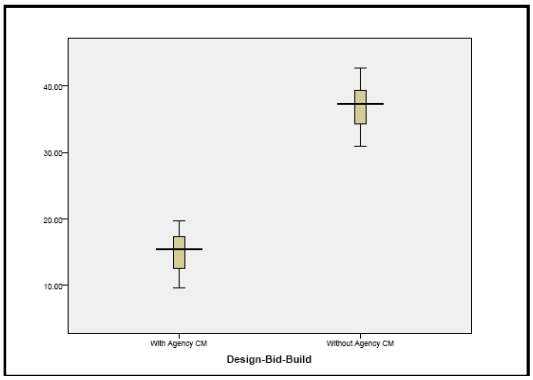

Figure 10: Time Growth for DBB Projects with and without Agency CM

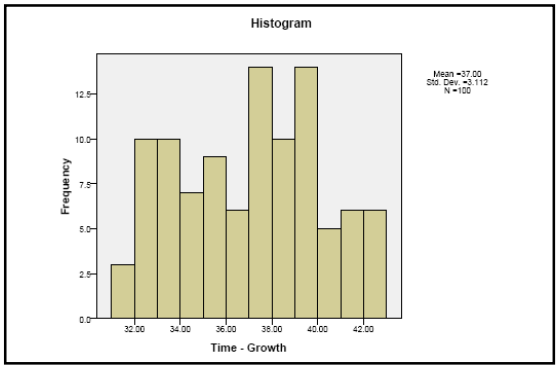

Figure 8: Time Growth Histogram for DBB Projects without Agency CM

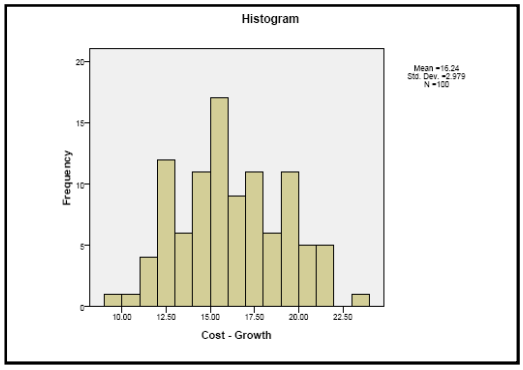

Figure 11: Cost Growth for DBB Projects with Agency CM

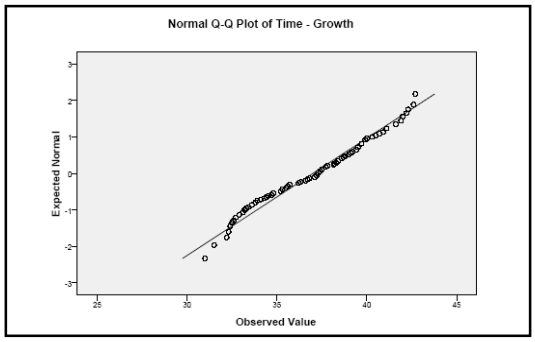

Figure 9: Normal Q-Q Plot of Time-Growth for DBB Projects without Agency CM

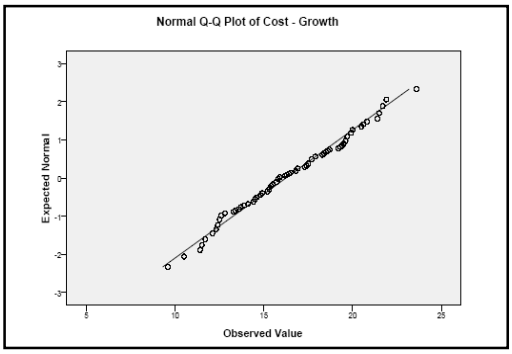

Figure 12: Normal Q-Q Plot of Cost Growth for DBB Projects with Agency CM

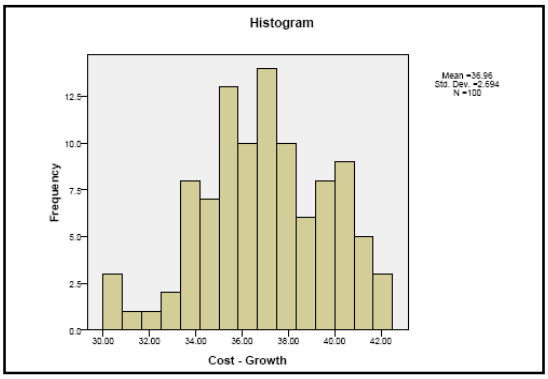

Figure 13: Cost Growth Histogram for DBB Projects without Agency CM

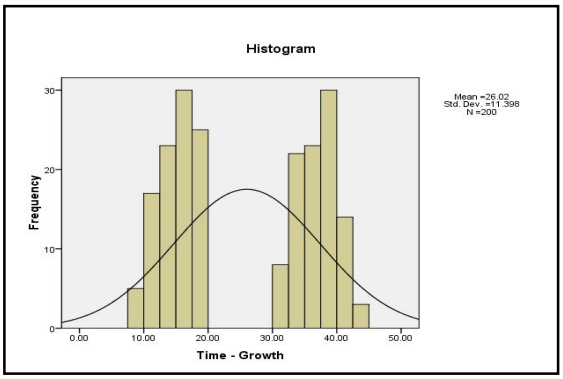

Figure 16: Frequency Distribution of Time Growth in Design- Bid-Build Projects

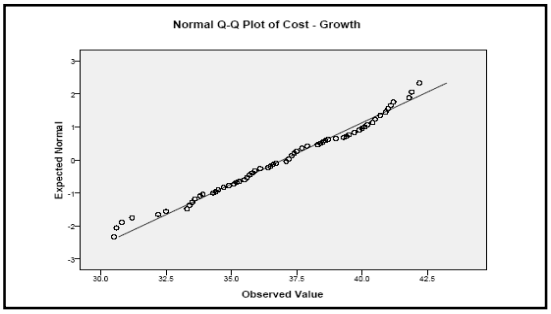

Figure 14: Normal Q-Q Plot of Cost Growth for DBB Projects without Agency CM

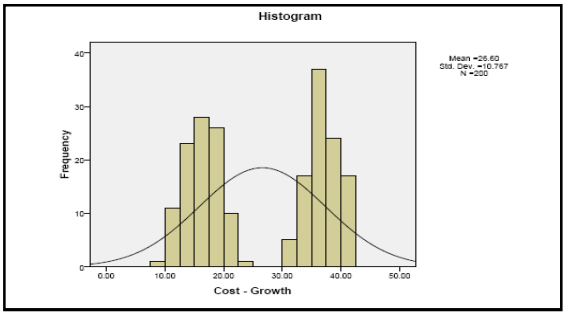

Figure 17: Frequency Distribution of Cost Growth in Design-Bid-Build Project

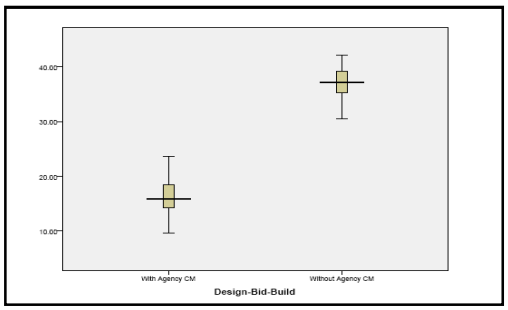

Figure 15: Cost Growth for Design-Bid- Build Projects with and without Agency CM

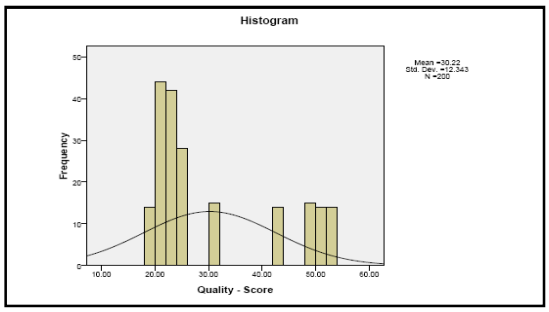

Figure 18: Frequency Distribution of Quality Scores in Design-Bid-Build Projects

Design-Bid- Build Quality Score

Table-1: Quality Scores- Case Processing Summary and Descriptive Statistics of Design-Bid-Build (D-B-B) Projects with and Without Agency CM

Design-Bid-Build

Case Processing Summary

		Cases					
		Valid		Missing		Total	
	Design-Bid-Build	N	Percent	N	Percent	N	Percent
Quality - Score	With Agency CM	100	100.0%	0	.0%	100	100.0%
	Without Agency CM	100	100.0%	0	.0%	100	100.0%

Descriptives

	Design-Bid-Build			Statistic	Std. Error
Quality - Score	With Agency CM	Mean		39.0100	1.20977
		95% Confidence Interval for Mean	Lower Bound	36.6096	
			Upper Bound	41.4104	
		5% Trimmed Mean		39.1778	
		Median		43.0000	
		Variance		146.353	
		Std. Deviation		1.2097E1	
		Minimum		22.00	
		Maximum		53.00	

Descriptives

	Design-Bid-Build			Statistic	Std. Error
Quality - Score	With Agency CM	Range		31.00	
		Interquartile Range		26.00	
		Skewness		-.233	.241
		Kurtosis		-1.696	.478
	Without Agency CM	Mean		21.4200	.19079
		95% Confidence Interval for Mean	Lower Bound	21.0414	
			Upper Bound	21.7986	
		5% Trimmed Mean		21.4111	
		Median		21.0000	
		Variance		3.640	
		Std. Deviation		1.90788	
		Minimum		18.00	
		Maximum		25.00	
		Range		7.00	
		Interquartile Range		1.00	
		Skewness		.125	.241
		Kurtosis		.325	.478

Table 2: Test of Normality of Performance Metrics of DBB Projects' Quality Scores with and without Agency CM

Tests of Normality

		Kolmogorov-Smirnov [a]			Shapiro-Wilk		
	Design-Bid-Build	Statistic	df	Sig.	Statistic	df	Sig.
Quality - Score	With Agency CM	.226	100	.000	.825	100	.000
	Without Agency CM	.273	100	.000	.827	100	.000

a. Lilliefors Significance Correction

Design-Bid- Build Time Growth:

Table-3: Time Growth – Case Processing Summary and Descriptive Statistics of Design –Bid- Build (D-B-B) Projects with and Without Agency CM.

Design-Bid-Build

Case Processing Summary

		Cases					
		Valid		Missing		Total	
	Design-Bid-Build	N	Percent	N	Percent	N	Percent
Time - Growth	With Agency CM	100	100.0%	0	.0%	100	100.0%
	Without Agency CM	100	100.0%	0	.0%	100	100.0%

Descriptives

	Design-Bid-Build			Statistic	Std. Error
Time - Growth	With Agency CM	Mean		15.0440	.28307
		95% Confidence Interval for Mean	Lower Bound	14.4823	
			Upper Bound	15.6057	
		5% Trimmed Mean		15.1089	
		Median		15.4500	
		Variance		8.013	
		Std. Deviation		2.83065	
		Minimum		9.60	
		Maximum		19.70	
		Range		10.10	

Descriptives

	Design-Bid-Build			Statistic	Std. Error
Time - Growth	With Agency CM	Interquartile Range		4.92	
		Skewness		-.359	.241
		Kurtosis		-1.006	.478
	Without Agency CM	Mean		36.9985	.31115
		95% Confidence Interval for Mean	Lower Bound	36.3811	
			Upper Bound	37.6159	
		5% Trimmed Mean		36.9872	
		Median		37.3000	
		Variance		9.682	
		Std. Deviation		3.11152	
		Minimum		31.00	
		Maximum		42.70	
		Range		11.70	
		Interquartile Range		5.08	
		Skewness		-.030	.241
		Kurtosis		-1.001	.478

Table 4: Test of Normality of Performance Metrics of DBB Projects' Time Growth with and without Agency CM

Tests of Normality

		Kolmogorov-Smirnov a			Shapiro-Wilk		
	Design-Bid-Build	Statistic	df	Sig.	Statistic	df	Sig.
Time - Growth	With Agency CM	.096	100	.023	.948	100	.001
	Without Agency CM	.070	100	.200*	.968	100	.016

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Design-Bid- Build Cost Growth

Table-5: Cost Growth – Case Processing Summary and Descriptive Statistics of Design –Bid- Build (D-B-B) Projects with and Without Agency CM.

Design-Bid-Build

Case Processing Summary

		Cases					
		Valid		Missing		Total	
	Design-Bid-Build	N	Percent	N	Percent	N	Percent
Cost - Growth	With Agency CM	100	100.0%	0	.0%	100	100.0%
	Without Agency CM	100	100.0%	0	.0%	100	100.0%

Descriptives

	Design-Bid-Build			Statistic	Std. Error
Cost - Growth	With Agency CM	Mean		16.2400	.29792
		95% Confidence Interval for Mean	Lower Bound	15.6489	
			Upper Bound	16.8311	
		5% Trimmed Mean		16.2122	
		Median		15.8500	
		Variance		8.875	
		Std. Deviation		2.97915	
		Minimum		9.60	
		Maximum		23.60	

Descriptives

	Design-Bid-Build			Statistic	Std. Error
Cost - Growth	With Agency CM	Range		14.00	
		Interquartile Range		4.30	
		Skewness		.118	.241
		Kurtosis		-.633	.478
	Without Agency CM	Mean		36.9640	.26938
		95% Confidence Interval for Mean	Lower Bound	36.4295	
			Upper Bound	37.4985	
		5% Trimmed Mean		37.0322	
		Median		37.2000	
		Variance		7.256	
		Std. Deviation		2.69378	
		Minimum		30.50	
		Maximum		42.20	
		Range		11.70	
		Interquartile Range		4.00	
		Skewness		-.213	.241
		Kurtosis		-.382	.478

Table 6: Test of Normality of Performance Metrics of DBB Projects' Cost Growth with and without Agency CM

Tests of Normality

		Kolmogorov-Smirnov [a]			Shapiro-Wilk		
	Design-Bid-Build	Statistic	df	Sig.	Statistic	df	Sig.
Cost - Growth	With Agency CM	.065	100	.200*	.986	100	.358
	Without Agency CM	.057	100	.200*	.982	100	.185

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Design-Bid- Build Projects – T- Test

Table7: Group Statistics of Cost Growth, Time Growth and Quality Score
In D-B-B Projects with and without Agency CM

Group Statistics

	Design-Bid-Build	N	Mean	Std. Deviation	Std. Error Mean
Time - Growth	With Agency CM	100	15.0440	2.83065	.28307
	Without Agency CM	100	36.9985	3.11152	.31115
Cost - Growth	With Agency CM	100	16.2400	2.97915	.29792
	Without Agency CM	100	36.9640	2.69378	.26938
Quality - Score	With Agency CM	100	39.0100	12.09766	1.20977
	Without Agency CM	100	21.4200	1.90788	.19079

Table 8: T-Test Independent Sample Test for Cost Growth, Time Growth and Quality Scores in D-B-B Projects with and Without Agency CM.

Independent Samples Test

		t-test for Equality of Means			
				95% Confidence Interval of the Difference	
		Mean Difference	Std. Error Difference	Lower	Upper
Time - Growth	Equal variances assumed	-21.95450	.42064	-22.78402	-21.12498
	Equal variances not assumed	-21.95450	.42064	-22.78406	-21.12494
Cost - Growth	Equal variances assumed	-20.72400	.40164	-21.51605	-19.93195
	Equal variances not assumed	-20.72400	.40164	-21.51610	-19.93190
Quality - Score	Equal variances assumed	17.59000	1.22472	15.17483	20.00517
	Equal variances not assumed	17.59000	1.22472	15.16132	20.01868

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Time - Growth	Equal variances assumed	1.013	.315	-52.193	198	.000
	Equal variances not assumed			-52.193	196.254	.000
Cost - Growth	Equal variances assumed	1.596	.208	-51.598	198	.000
	Equal variances not assumed			-51.598	196.026	.000
Quality - Score	Equal variances assumed	588.424	.000	14.362	198	.000
	Equal variances not assumed			14.362	103.921	.000

Cost Growth

The mean Cost growth in D-B-B projects without Agency CM =36.96 (Table-7)

The mean Cost growth in D-B-B projects with Agency CM = 16.24 (Table-7)

T-test for Equality of means (Table-8) illustrates that at 95% confidence interval of the difference, there is significant difference in means of Cost growth of D-B-B projects with Agency CM and Cost growth of D-B-B projects without agency CM. Hence the null hypothesis, "the mean Cost growth of D-B-B projects with Agency CM is at least equal to the mean Cost growth of D-B-B projects without agency CM" is rejected. The alternate hypothesis, "the mean Cost growth of D-B-B projects with Agency CM is less than the mean Cost growth of D-B-B projects without Agency CM" cannot be rejected.

Time Growth

The mean Time growth in D-B-B projects without agency CM=37 (Table-7)

The mean Time growth in D-B-B projects with agency CM= 15.04 (Table-7)

T-test for Equality of means (Table-8) illustrates that at 95% confidence interval of the difference, there is significant difference in means of Time growth of D-B-B projects with Agency CM and Time growth of D-B-B projects without agency CM. Hence the null hypothesis, "the mean Time growth of D-B-B projects with Agency CM is at least equal to the mean Time growth of D-B-B projects with Agency CM" is rejected and the alternate hypothesis "the mean Time growth of D-B-B projects with Agency CM is less than the mean Time growth of D-B-B projects without Agency CM cannot be rejected.

Quality Performance

The mean Quality Score in D-B-B projects with Agency CM=39.01(Table-7)

The mean Quality Score in D-B-B projects without Agency CM=21.42(Table-7)

T-test for Equality of means (Table-8) illustrates that at 95%Confidence Interval of the difference, there is significant difference in means of Quality Score of D-B-B projects with Agency CM and Quality Scores of D-B-B projects without Agency CM. Hence the null hypothesis, "the mean quality score of D-B-B projects with Agency CM is at most equal to the mean quality score of D-B-B projects without Agency CM" is rejected. The alternate hypothesis, "the mean quality score of D-B-B projects with Agency CM is greater than the mean quality scores of D-B-B project without Agency CM", cannot be rejected.

VI. CONCLUSION

The study of performance evaluation of Design-Bid-Build (D-B-B) Projects with Agency CM and Without Agency CM shows that the Cost Growth and Time Growth are more in the case of Design- Bid-Build Projects where Agency CMs are not used than the Design-Bid- Build Projects where Agency CMs are used. The quality performance of the D-B-B Projects with Agency CM is also found to be better than the D-B-B projects without Agency CM. Though the remuneration payable to the Agency CM as a monthly fee, Lump sum Fee or as a percentage of the project has a conflict of interest of the Project Time Growth, and Project Cost Growth, this study suggests that the Owners/Clients may select the Design-Bid-Build project Delivery System with Agency CM compared to Design-Bid- Build Project Delivery system without Agency CM, despite the considerable amount of fee required to be paid to Agency CM firms.

VII. ACKNOWLEDGEMENTS:

The Authors wish to thank particularly the General Contractors, A/Es, and representatives of the Clients/Owners for providing the project data and extending cooperation for successful completion of this research.

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