UNDERSTANDING HOW INTEGRATED PROJECT DELIVERY IMPROVES PROJECT SUCCESS FROM AN OWNER'S PERSPECTIVE

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ABSTRACT

The success of a project depends on how different project aspects are managed to deliver the end product. Determination of project management – represented in project delivery system – and the criteria that define the end product – success criteria – are both owner driven.

Within this proposed research, owners' needs – or success criteria – in new capital projects are sought to create a list of performance metrics against which project success will be measured. Moreover, the level of integration within different project delivery systems is measured to test whether the more integrated projects would lead to more successful projects from the owner's perspective. Project delivery systems included in the study represent a spectrum from conventional delivery systems such as design-bid-build (DBB) to the more innovative integrated project delivery (IPD). The concentration in the data collection is on integration and collaboration tools and initiatives within each system along with project performance outcomes. A thorough literature review was done and both a preliminary list of success criteria and performance measures from owners' perspective, and a data collection tool were developed.

Keywords: Integrated Project Delivery, IPD, Owners, Success Criteria, Collaboration

1. INTRODUCTION

The success of a project depends on how different project aspects are managed to deliver the end product. Determination of project management – represented in project delivery system – and the criteria that define the end product – success criteria – are both owner driven. Therefore, selecting the project delivery system decision by the owner at the inception of a project could determine how that project will perform. The premise of this research is that construction project success depends substantially on the delivery system by which the project is designed and constructed. Furthermore the main hypothesis to be tested is that better project management leads to more integration among project participants, and that more integration among project participants in a delivery system leads to higher success chances for that project. All of this is being measured from an owner's perspective.

The modern construction industry – from the start of the twentieth century – has known number of project delivery systems: starting with the traditional design-bid-build (DBB), passing through the construction management system in its both forms agent (CM-Agent) and at risk (CM-R), and ending up with the design-build (DB) project delivery system. Each system has its own advantages and disadvantages. Yet, with this variety of project delivery systems, the construction industry still faces a lot of challenges. A study by the Construction Industry Institute / Lean Construction Institute in 2004 concludes that as much as 57% of time, effort and material investment in construction projects are wasted and regarded as non-value adding to the final product, as compared to only 26% in the manufacturing

world (Kenig et al. 2010). The notion that such an amount of resources spent in constructing capital projects ends up wasted is very discouraging to an owner who is about to make a substantial investment in a capital project.

The chronic problems in the construction industry have driven the efforts of finding new solutions in alternative project delivery systems. A newly evolved project delivery system has been gaining momentum in the construction industry since 2005: the Integrated Project Delivery (IPD) system.

IPD has created a paradigm shift in the construction industry by revolutionizing the contractual agreement of the contracting parties in a construction project from transactional to relational contracts. Conventionally, construction contracts take the form of transactional contract where an owner usually signs separately with either the designer or builder, and the contract terms statically govern the exchange of services and money between the contract parties. The contractual agreement in IPD is a relational agreement. The agreement joins a minimum of the owner, design professional, and builder, where risk and reward are shared and stakeholder success is dependent on project success (AIA - California Council 2007). Currently, the number of firms adopting IPD is on the rise and more high profile projects are being executed using this new delivery system (AIA and University of Minnesota 2012)

Integrating the efforts of project participants is indeed the essence of IPD (AIA - California Council 2007). Integration – which sometimes is interchangeably used with collaboration – is integrating resources, efforts, and information among project participants as early as possible in the execution of a construction project. It could be found as small as voluntary acts among project participants, and it could also be found as extreme as contractual obligation. The lower end of these integration efforts could be found in the traditional project delivery systems such as the DBB and CM-R. The higher end could be found in IPD system.

Within the proposed research, what will be tested is the level of integration within each project delivery system, and whether the more integrated projects would lead to more successful construction projects according to owners' success criteria. This paper reports what was done in this research to date, namely the literature review, the data collection tool (survey) development, and a brief description of the data collected so far.

2. LITERATURE REVIEW

2.1 What is success in construction in general?

Project Success as a subject has been very well served in the literature. However, from the literature, the one main attribute that can be associated with project success is the fluidity of its definition and how it depends on addressing the different needs of project stakeholders. Many studies found in the civil engineering and construction management literature recognize the importance of addressing the different perspectives of stakeholders in the success of construction projects (Sanvido et al. 1992; Munns and Bjeirmi 1996; Chan et al. 2001; Collins and Baccarini 2004; Hughes et al. 2004; Shokri-Ghasabeh and Kavousi-Chabok 2009).

2.2 What is success to owners?

With different participants come different goals or milestones to achieve. However, these goals and milestones all converge to achieve the ultimate goals of a project solely set by owners. Different studies were found in the civil engineering and the construction management literature discussed what owners consider as success criteria or as performance metrics for a successful project.

Sanvido et al. (1992) in their study titled Critical Success Factors for Construction Projects used literature review and brainstorming sessions with the research team to establish lists of success criteria for project participants including owners. The list for owners' project success criteria established was: the project completed on schedule and on budget, functions for intended use by satisfying users and customers, the final product to be as envisioned, quality of workmanship and final product, the project to

be aesthetically pleasing, return on investment, building must be marketable, and minimize aggravation during building design and construction phases. This list was produced with no priorities or ranking.

Songer and Molenaar (1996) conducted a study to address owners' attitudes toward the design-build (DB) project delivery system. From a thorough literature review, the authors extracted a list of seven DB selection factors: establish cost, reduce cost, establish schedule, shorten duration, reduce claims, project size and complexity, and constructability and innovation.

These two previous studies are examples of several similar studies found in the literature that talked about owners' requirements in construction projects and what they considered as success criteria or performance measurements (Chua et al. 1999; Bowers et al. 2003; Collins and Baccarini 2004; CURT 2005; and Del Puerto et al. 2008).

Table 1 summarizes what was found in the literature in this regard. Meeting Cost, Schedule and Quality requirements have been at the forefront of those owners' success criteria. This table represents a basis for further research to determine current owners' success criteria. In order to optimize the use of owners' resources on their projects, their priorities need to be well understood.

Table 1: Owners' Success Criteria from Literature Review

Success Criteria	Sanvido et al. (1992)	Songer & Molenaar (1996)	Chua et al. (1999)	Bowers et al. (2003)	Collins & Baccarini (2004)	CURT (2005)	Del Puerto et al. (2008)	Tally
Meet cost requirements	●	●	●	●	●	●	●	7
Meet schedule requirements	●	●	●	●	●	●	●	7
Quality (of final product and workmanship)	●		●	●		●	●	5
Customers/ users satisfaction	●			●	●	●		4
Meet specification	●		●		●			3
Reduced claims	●	●		●				3
Efficient project management efforts				●	●			2
Innovation		●					●	2
Constructability		●	●					2
Reliability (of construction process)				●		●		2
Meet business plans	●			●				2
Safety				●		●		2
Functions well (for intended use)	●							1
3rd parties satisfaction					●			1
Project team satisfaction					●			1
Good suppliers' service			●					1
Productivity						●		1
Minimize risk				●				1
Reputation/ Social gains	●							1
Aesthetically pleasing	●							1

2.3 The Effect of Project Delivery System on Project Outcomes

Baccarini (1999) divided project success into two separate components: project success which is what the owners are looking for as a final product, and project management success. Baccarini also states that project management success does influence product success.

A second step in the literature review after revealing owners' success criteria is to study the relationship of these outcomes to how construction projects are managed. The best available frame to encompass all the project management activities and processes in a construction project is the Project Delivery System. The Construction Management Association of America (CMAA) dubs the owner's

choice of a project delivery system as the most important decision in a construction project (CMAA 2008). Table 2 summarizes the existing studies in the literature that link the effect of a project delivery system to project outcomes. The studies in the table are ordered chronologically. The comparison in the table included the project delivery systems compared, the type of data collected whether hard data or opinions, the number of projects used for the study, whether the data was collected from public or private sector projects, and whether these projects were domestic (i.e. in the US) or foreign.

Table 2: Studies Linking Project Delivery System Performance to Project Outcomes found in the Literature

	Zeitoun & Oblerlender (1993)	Pocock & Liu (1996)	Molenaar & Songer (1998)	Sanvido & Konchar (1998)	Chan, Ho, & Tam (2001)	Thomas et al. (2002)	Ibbs et al. (2003)	Ling et al. (2004)	Debella & Ries (2006)	Rojas & Kell (2008)	Hale et al. (2009)	Molenaar et al. (2009)	Korkmaz et al. (2010)	Cho & Ballard (2011)
Systems Compared														
DBB	●	●		●		●	●	●	●	●	●	●	●	
DB	●	●	●	●	●	●	●	●			●	●	●	
CMR				●						●		●	●	
CMA	●													
Other		●					●		●					●
IPD														●
Data Collected														
Quantitative	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Qualitative	●		●	●	●			●				●	●	
Project Sector														
Public	●	●	●	●	●	●		●	●	●	●	●	●	
Private	●			●		●		●				●	●	
Projects Location														
US	●	●	●	●		●	●		●	●	●	●	●	
Foreign					●	●	●	●						
Number of Projects	106	209	122	351	19	617	67	87	94	297	77	92	40	49

The literature review revealed a gap to be filled in the literature and that is: no study was found that included comparing project delivery systems with their outcomes from merely an owner's perspective. Moreover, the literature review laid a good foundation for the steps to follow to arrive at this research's objectives as it is explained in the methodology section.

3. OBJECTIVES OF THE STUDY

There are three main objectives to be tackled in this study.

The first objective is to determine owners' success criteria in new capital projects. Owners' success criteria stem from their needs. And their needs change constantly for different reasons such as resources availability or economy. Therefore, these current needs have to be addressed and associated as possible with measurable metrics. Cost, time, and quality, have been historically the most acknowledged/measured metrics in construction projects. In addition, recently, high performance/efficiency and innovation have also emerged as popular metrics (Del Puerto et al. 2008; Molenaar et al. 2009). Therefore, the first objective for this study is to investigate owners' success criteria, especially the non-traditional ones. A prioritized list of these success criteria will be formulated.

The second objective is to investigate the relationship between integration – as explained in the introduction above – in a project delivery system and project success. The main theme to be investigated in this research is the level of integration/ collaboration among project participants' efforts and experiences. After knowing the owners' success criteria, a logical step to follow is to investigate the relationship between integration in the project delivery system and project success. At the same time, investigate the different project delivery systems to find the best one to nurture and support integration among project participants. The best way to investigate this matter is to measure the outcome of projects executed with different project delivery systems, then compare these outcomes with owners' success criteria. The comparison will be done empirically using quantitative and qualitative measures.

A third objective of this study is to determine the project delivery systems that lead to more project success to owners. After determining owners' success criteria, and after analyzing the results of investigating the relationship between integration within a project delivery system and project outcomes, recommendations can be given to what project delivery systems lead to more success to owners.

This paper presents the results of the on-going effort under this study comprised of the literature review, the development of the data collection tool (survey) to be used for this study, and brief description of the data collected to date.

4. METHODOLOGY

The procedure proposed to arrive at the proposed objectives should include several steps as in Figure 1.

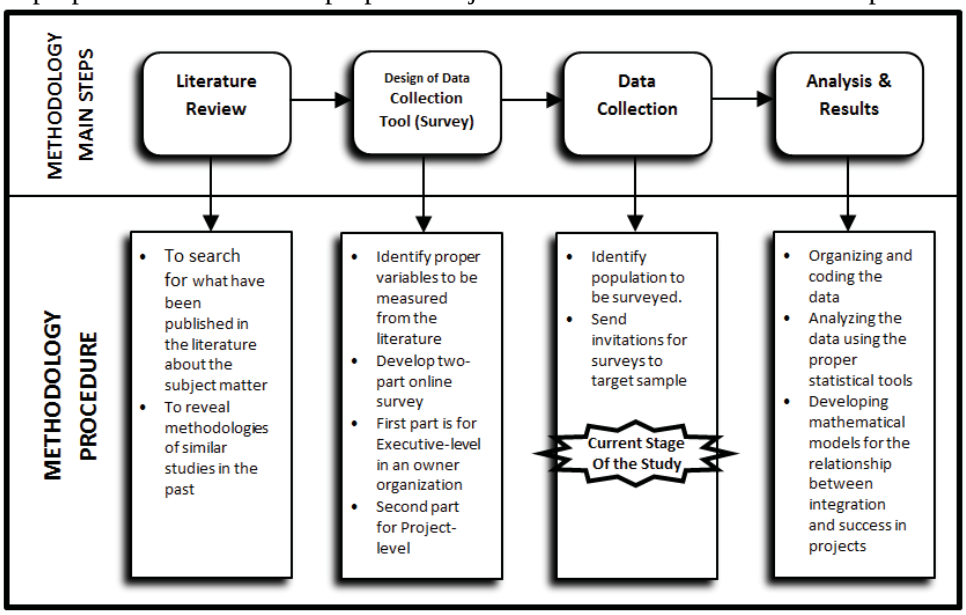

Figure 1: Methodology Steps of the Study

The first step in the process is the literature review. Two main tasks frame the literature review effort of this study. The first is to know what has been published about the subject matter of this study, and the second is to know what methodologies were followed in similar studies. Moreover, literature review presented a good start for the following step which is the development of the data collection tool (survey) through knowing what to ask for and how to ask for it. Details of what was found in the literature can be found in section 2 of this paper.

The development of the survey follows the literature review. This step included assigning the proper questions for the data to be collected for both quantitative and qualitative measures, determining the dependent and independent variables, verifying and testing the survey, and determining the subjects (organizations) to be surveyed. Details about the development of the survey can be found in a following section.

The data collection step which is currently in progress focuses on collecting data from owner organizations through a web-based survey that had been developed specifically for this purpose. Also, the future steps in this study are the data analysis and validation. Details about data collection, analysis and validation can be found in following sections.

Moreover, these proposed procedures are built around a major assumption about the subject of this study: IPD has newly emerged as a construction project delivery system compared to other conventional project delivery systems, only since 2005, and the number of IPD projects available to study is limited. Therefore, this methodology is proposed within the perspective of acquiring the information of very limited number of projects.

5. DEVELOPMENT OF DATA COLLECTION TOOL (SURVEY)

After exploring the literature, two main findings were found: a preliminary list of what owners consider as success in construction projects, and a list of variables in project management processes to be measured in the survey. Moreover, through the publications of professional organizations such as the American Institute of Architects (AIA) that documented lessons learned from IPD projects (AIA 2007; AIA and University of Minnesota 2012) more variables specific to integration/collaboration and innovation in projects were added to the list of variables. Finally, similar studies that developed similar data collection tools (Sanvido and Konchar 1998; Korkmaz et al. 2010) also help in designing the survey for this study.

5.1 Variables Selection

According to Sanvido and Konchar (1998) and Korkmaz et al. (2010), two types of variables in project delivery process can affect project outcomes: *Independent and Control variables*. In addition, the required project outcomes should be the *Dependent variables*. The data collection tool for this study is divided into two parts: part one is called "The Executive-Level Survey", and part two is called "The Project-Level Survey".

The intention behind the executive-level survey is to confirm and enhance what was found in the literature about owners' success criteria for project outcomes at the company and executive level. It is also intended to provide an up-to-date status of knowledge, experience, satisfaction level of construction owners with the current project delivery systems, and finally any obstacles that stand in the way of implementing new methods in construction project delivery. This part of the study's survey is filled – once – by someone in an executive-level in a construction owner organization due to the macro-level of information it requires about an organization, its vision on strategic plans and its perspective on success of long-term goals.

The purpose of the second part of this study's survey, the project-level survey, is to collect quantitative and qualitative data about specific projects executed by construction owner organizations. The survey data includes all types of variables: Dependent, Independent and Control variables. This part of the study's survey should be filled by a project-level person such as a project manager or project engineer due to the specific information it requires about projects. Unlike the executive-level survey, the project-level survey can be filled for as many projects as an organization can provide.

The literature helped in establishing a list of owner's success criteria, which will be treated as dependent variables. The list of project outcomes established include six metrics to be measured: cost, schedule, quality, sustainability, claims, and safety.

The independent variables are variables that take place during the process of a project delivery which an owner and a project management team can have control over. All the independent variables revolve around integration and collaboration in the project and fall under these four main sections: project delivery system, project management team integration and characteristics, project management techniques, and innovations.

Finally, control variables represent the circumstances surrounding the project and some project characteristics which could affect the project performance. Such variables are project type, construction type (new, renovation or expansion), project size, location, complexity, and regulatory constraints. Table 3 summarizes all three types of variable and lists examples of each.

Table 3: Summary of Variable in the Study

Variable Type	Definition	Examples (Not Conclusive)
Dependent	Variables representing the outcome of a construction project and are believed to be affected by both the independent and control variables.	• Schedule • Cost • Quality • Claims • Safety
Independent	Variables that take place during the process of project delivery and which the owner and the project management team can have control over. The variables revolve around integration and collaboration in the project in four main areas: 1. Project delivery system 2. Management team integration and characteristics 3. Management techniques 4. Innovation	• Use of team setting • Team members stage of involvement • Team decision making process • Jointly developed project goals and mile-stones • Contractual collaboration • BIM use • Lean tools used • RFI Processing Period • Dispute resolution process
Control	Variables representing the uncontrollable circumstances surrounding the project which could affect the project performance.	• Project type • Construction type • Project size • Project location • Project complexity

5.2 Survey Development

After gathering and establishing a preliminary list of metrics and variables to be measured, survey questions were formulated within two parts: the executive and the project level surveys. Once the survey was formulated it was presented to an academic panel for verification. After that, and with the help of a professional organization that represents construction owners, the Construction Users Roundtable (CURT), the survey in its two parts was presented to a panel of professionals who are owner representatives for further screening and verification. The main points that guided the screening process included: the reality of the questions being asked, and whether the information being asked is available in company and project records and the time it takes to fill out these surveys. Finally, both the executive and project surveys were transferred to web-based surveys.

6. DATA COLLECTION

Due to the specific population targeted in this study (i.e. owners), the research team launched the web-based surveys to the targeted population with the help of CURT.

Currently, there is an on-going effort for collecting data from construction owners through this study's web-based surveys. To date, four executive-level surveys and ten project-level surveys have been collected. The preliminary results of these surveys will be presented in the following section.

7. DATA ANALYSIS AND RESULTS

Once the proper amount of data is gathered, the analysis process will begin for both the quantitative and qualitative data. Both statistical and logical analysis of the data will be used. Potential statistical analysis to be used for the anticipated kind of data beside the descriptive statistics would be multivariate regression analysis utilizing the dependent, independent, and control variables explained in the data collection tool section. Another potential statistical tool to be used is the principal component analysis

through which independent variables are merged and simplified to smaller number that describe the sought objectives better.

The next step that comes after that should be the validation of the results. Projects that have been executed using innovative project delivery methods with emphasis on integration, especially DB and IPD, will be targeted as case studies to showcase and validate the study hypotheses and meet the objectives of this research.

7.1 Preliminary Results

To date, four complete responses were collected through this study's executive-level survey that represent the opinion and perspective of four executives in their construction owner organizations, and ten complete responses through the project-level survey that represent ten different constructed projects.

The preliminary results from the executive-level survey showed that all four organizations responded to the survey are in the industrial/manufacturing business. The predominant project delivery system they still use is the DBB. Their priorities for success outcomes from construction projects appear in Figure 2 where Safety is in the first place as top priority, then comes the schedule, quality, and budget.

The preliminary results from the project-level survey showed that the project delivery systems used are DBB for three projects, DB for one project, CM-Agent for one project, IPD for one project, and four projects have used other categorizations of delivery systems. The project types of the subject projects are industrial facilities in six projects, heavy industry in two projects, infrastructure in one project, and an unknown type of one project.

The graph in Figure 3 is extracted from the Project-Level Survey and shows a trend, albeit weak, between the cost variance – as a project delivery outcome – and the level of integration within each project. Although safety was the top rated project outcome from the executive survey responses, safety data were missing from the project-level survey responses. Therefore, cost variance was chosen as a project outcome for this sample comparison. Moreover, the level of integration was calculated by coding the answers from a group of questions in the survey that revealed integration effort and initiatives in a project, and then summing the scores of all these questions. A list of the questions used for the integration scale is found in Table 4. With more surveys collected and more complete set of data, which is what the research team is working on currently, trends will be more clear and informative and a variety of statistical analysis as discussed in section 6 above will be employed.

Table 4: Independent Variables Used for the Integration Scale within Projects

• Number of team members	• Jointly developed project goals
• Time of involvement for each member	• Existence of contractual collaboration
• Intervals between team meetings	• BIM use
• Quality of team communication	• Liabilities waived among project participants
• Quality of team chemistry	• Risk/Reward balance
• Owner's commitment to team	• Use of multi-party contract
• Use of predefined decision making process	• Incentivize collaboration method
• Existence of co-location to manage the project	• Number of lean tools used

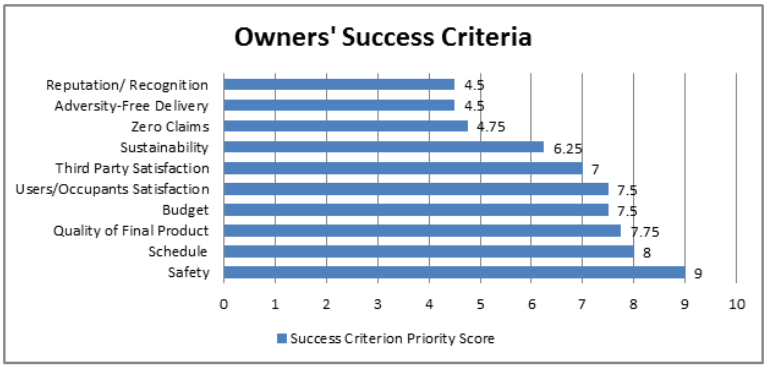

Figure 2: Owners' Success Criteria

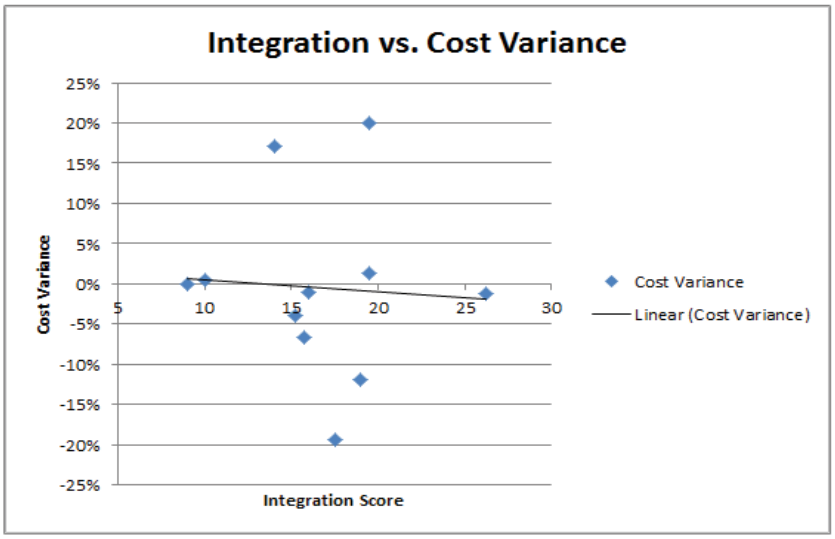

Figure 3: Trend of Cost Variance vs. Integration in the Sample Projects

8. CONCLUSION AND FUTURE WORK

Within this proposed study, owners' success criteria in new capital projects are sought to create a list of performance metrics against which project success will be measured. Moreover, the level of integration within different project delivery systems is measured to test whether the more integrated projects would lead to more successful projects from an owner's perspective. The study will compare a full spectrum of project delivery systems, from conventional delivery systems such as design-bid-build (DBB) to the more innovative integrated project delivery (IPD).

This paper presents the results from a thorough literature review performed for this study. It also explains the development of this study's data collection tool (survey). In addition, a description of the proposed analysis for the collected data is explained. And finally, a preliminary result of the data collected to date is presented.

Four outcomes are expected at the end of this study. First outcome is a prioritized list of owners' success criteria for their capital projects. Second outcome is a survey to collect the sought data for this study. A third outcome is a quantitative relationship between the level of integration in a project and the level of success associated with it represented in a mathematical model. Finally, a fourth outcome should be the determination of the project delivery systems that better cater to current owners' success criteria.

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