Comparative Analysis of Project Performance between Different Project Delivery Systems

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Outline

- Research Motivations

- Research Objectives

- Methodology

- Research Outputs

- Key Takeaways

Why

How

Findings
Value of construction put in place in the United States (2017):

$1,262,784,000,000

(U.S. Census Bureau 2017)

Number of employees in the US construction industry (2018):

7,173,000

98% of megaprojects suffer from cost overruns or delays

80% Average cost increase

20 Months average schedule slippage

McKinsey&Company (Changali et al. 2015)
Poor construction productivity costs the global economy $1.63 trillion each year.

Lagging construction productivity costs the global economy $1.6 trillion a year.

<table>
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<tr>
<th>Productivity gap</th>
<th>Economic value lost as a result of the gap, $ trillion</th>
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<tbody>
<tr>
<td>$1.63 trillion</td>
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$37/hour
$25/hour

Global economy
Global construction sector

Average value added by employees per hour worked¹

-0.58
-0.46
-0.44
-0.07
-0.05
-0.03

- $1.63 trillion

North America
Europe
Asia–Pacific
Middle East
Central and South America
Africa
Total

¹2015 data in real 2005 dollars.
²Assumes construction productivity catches up with total economy productivity and current workers are reemployed at the total economy productivity rate.

McKinsey&Company
(Ibrahim and Hanna, 2016)
(Ibrahim and Hanna, 2016)
Required Knowledge

Architect

Contractor

Mechanical

Electrical

Concrete

Consultants

Interior Design

Landscape

Owner

Accounting

Admin

Operations

Engineer

Civil

Structural

MEP

Operations

Admin

Accounting

Owner

Architect

Interior Design

Landscape

Consultants

Why

Findings

(Ibrahim and Hanna, 2016)

How

(Ibrahim and Hanna, 2016)
(Ibrahim and Hanna, 2016)
Project performance using quantitative performance metrics spanning six areas:

- Communication
- Change Management
- Schedule
- Design-Bid-Build (DBB)
- Construction Management at-Risk (CMR)
- Design-Build (DB)
- Cost
- Integrated Project Delivery (IPD)
- Quality
- Safety

Explore how project delivery systems (PDS) impact project performance.

PDS defines the relationship and timing of involvement between different contracting parties (Hanna 2011).
• Comprehensive survey to collect project data

• Industry collaborators provided data from 109 projects
  • 28% DBB projects
  • 32% CMR projects
  • 23% DB projects
  • 17% IPD projects
Safety performance **DOES NOT** differ across PDSs

Communication, change management, schedule, cost and quality **DIFFER** across PDSs
Why

How

Findings

8 performance metrics spanning 5 areas

Project Performance

Communication
  - RFI’s per $1 million
  - RFI processing time (weeks)

Change Management
  - Project percent change
  - Change order processing time

Schedule
  - Schedule growth

Cost
  - Cost growth

Quality
  - Overall systems quality
  - Punchlist items per $1 million

Why Findings

15
• Comparative box-and-whisker plots
• Checked normality and homoscedasticity
• Statistical analysis #1
  - Examines whether PDS impact the performance metric being investigated
  - \( p \)-value < 0.05 \( \rightarrow \) statistically significant difference at 95\% confidence level
• Statistical analysis #2
  - Compares each pair of PDSs
  - \( p \)-value < 0.05 \( \rightarrow \) statistically significant difference at 95\% confidence level
Communication – RFI’s per $1 Million

Number of RFI’s per $1 million differs across PDSs

- **IPD** has fewer RFIs per million dollars than **DBB**
- **DB** has fewer RFIs per million dollars than **DBB**
- **CMR** has fewer RFIs per million dollars than **DBB**
RFI processing time differs across PDSs

- **IPD** has shorter RFIs processing time than **DBB**
- **DB** has shorter RFIs processing time than **DBB**
- **CMR** has shorter RFIs processing time than **DBB**
Change management - Percent Change

Percent change differs across PDSs

- **IPD** has lower percent change than **DBB**
- **DB** has lower percent change than **DBB**
- **CMR** has lower percent change than **DBB**
Change management - Change Order Processing Time

Change order processing time differs across PDSs

- IPD has shorter change order processing time than DBB
- IPD has shorter change order processing time than CMR
- IPD has shorter change order processing time than DB
Schedule Performance - Schedule Growth

Schedule growth differs across PDSs

**IPD** has lower schedule growth than **DBB**

**DB** has lower schedule growth time than **DBB**

**CMR** has lower schedule growth than **DBB**
Cost Performance – Cost Growth

Cost growth differs across PDSs

- IPD has lower cost growth than DBB
- DB has lower cost growth time than DBB
- CMR has lower cost growth than DBB
Quality Performance – Overall System Quality

Overall quality of project systems differs across PDSs

- **IPD** has **higher** overall quality of project systems than **DBB**
- **IPD** has **higher** overall quality of project systems than **DB**
Quality Performance - Punchlist Items per $1 million

Number of punchlist items per $1 million differs across PDSs

- IPD has fewer punchlist items per $1 million than DBB
- DB has fewer punchlist items per $1 million than DBB
The choice of PDS can significantly **impact performance** spanning five areas:

- Communication
- Change management
- Schedule
- Cost
- Quality
Post-hoc statistical test showed that:

- IPD outperformed DBB in the 8 performance metrics
- DB outperformed DBB in 6 performance metrics
- CMR outperformed DBB in 5 performance metrics
- IPD outperformed CMR in 1 performance metrics
- IPD outperformed DB in 2 performance metrics

Create a project environment that fosters collaboration to enable optimal project performance
Stakeholder Involvement:

- How familiar was the contractor with the owner’s objectives and expectations?
- Did the owner’s staff actively participate in the construction process?
- Did the architect/engineer give adequate support during construction?
- How involved was the CM/GC in the design/preplanning stage of the project?
- How involved were the key subcontractors in the design/preplanning stage of the project?
- Did the project team have a formal risk review process to identify and accept project risks before starting construction?
- Did the key subcontractors participate in the risk assessment process?
Key takeaways

Why

Findings

How
Project Leadership:

- The number of stakeholders represented in the project leadership team
- The authority of the team to make necessary decisions to manage and lead the project on a daily basis
- Whether the team jointly developed project target criteria and goals
- Whether the team made decisions collaboratively
- Periodic project reviews were performed
- Frequency of team meetings during the planning phase
- Frequency of team meetings during the construction phase
- Frequency of team meetings during the commissioning phase
- If lessons learned were captured by the team
Create a project environment that fosters collaboration to enable optimal project performance
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<th>Key takeaways</th>
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<td>Last Planner System (LPS) for production control</td>
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<td>LPS: Tracking weekly commitments from the project team</td>
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<td>LPS: Tracking reliable promises / Percent Plan Complete</td>
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<td>SS - A policy that requires cleanliness, organization and orderly storage and movement plans. Gang boxes, tools and consumable supplies should be stocked and organized so that no time is spent searching for or retrieving common tools or materials.</td>
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<td>Set-Based Design - Set-Based Design requires carrying forward multiple alternatives to allow more time for analysis, only narrowing alternatives at the last responsible moment.</td>
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<td>Value Stream Mapping - to clearly identify and eliminate waste throughout the project.</td>
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<td>Proactive dynamic Target Costing or Target Value Design</td>
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<td>Daily Huddles – meeting with the field crews on a daily basis to review the schedule and plan the work.</td>
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<td>JIT - bulk materials are delivered just prior to installation</td>
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<td>If utilized, indicate whether it was Site Warehouse (long batches for a long period), Minor Storage (short batches for a short period), or Material Off Truck</td>
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<td>Point Cloud technology such as Total Station</td>
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<td>Visual Management Devices</td>
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<td>Mock-ups for repetitive construction systems</td>
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<td>Project Training Sessions - to enhance team working ability, clarify Pull Scheduling and/or Last Planner System, etc.</td>
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<td>Constructability reviews</td>
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