IGLC IRELAND 2019
INTERNATIONAL GROUP FOR LEAN CONSTRUCTION
DUBLIN | IRELAND | 1ST - 7TH JULY 2019

Comparative Analysis of **Project Performance** between Different **Project Delivery Systems**

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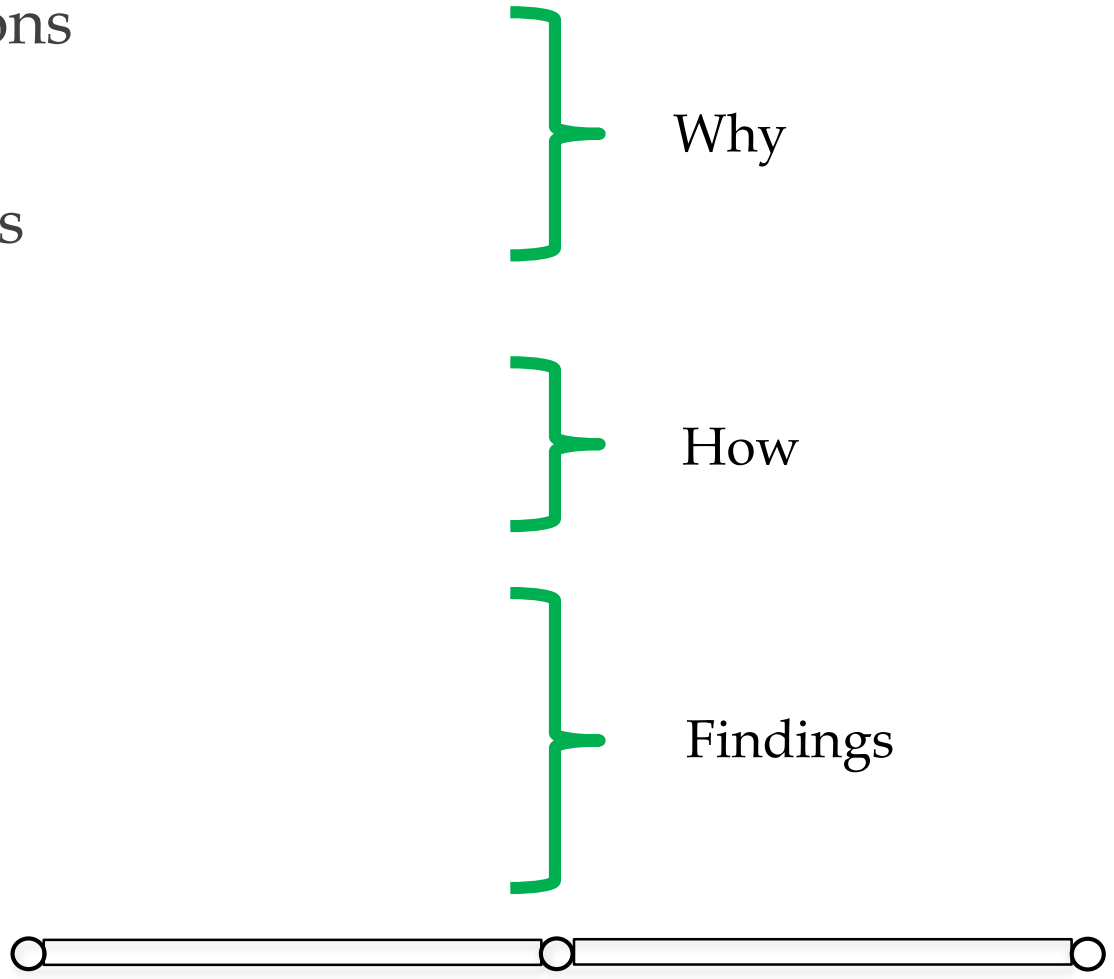
Outline

- Research Motivations
- Research Objectives
- Methodology
- Research Outputs
- Key Takeaways



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

(U.S. Bureau of Labor Statistics 2018)

Why How Findings

98% of megaprojects suffer from cost overruns or delays

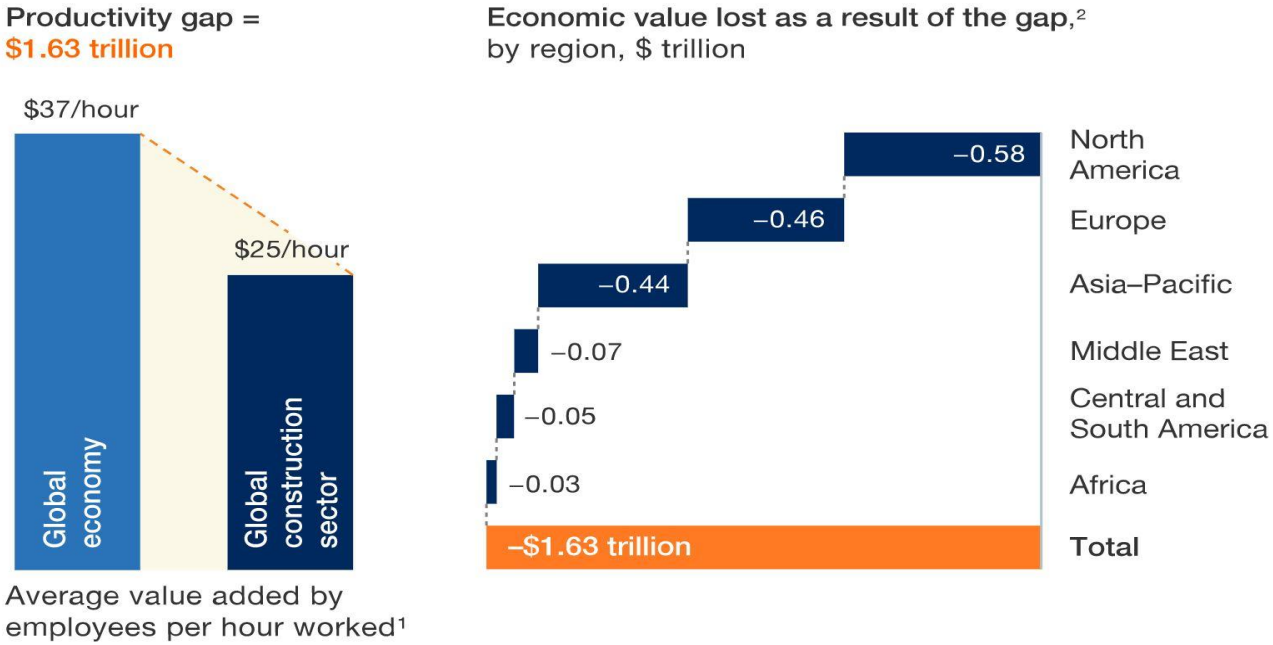
80% Average cost increase

20 Months average schedule slippage

McKinsey&Company (Changali et al. 2015)

Why How Findings

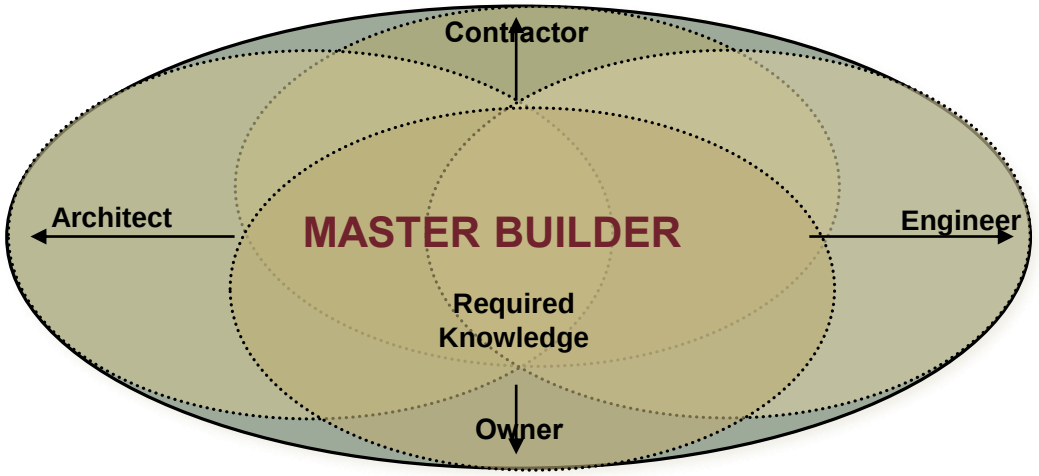
Lagging construction productivity costs the global economy $1.6 trillion a year.



[1]2015 data in real 2005 dollars.
[2]Assumes construction productivity catches up with total economy productivity and current workers are reemployed at the total economy productivity rate.

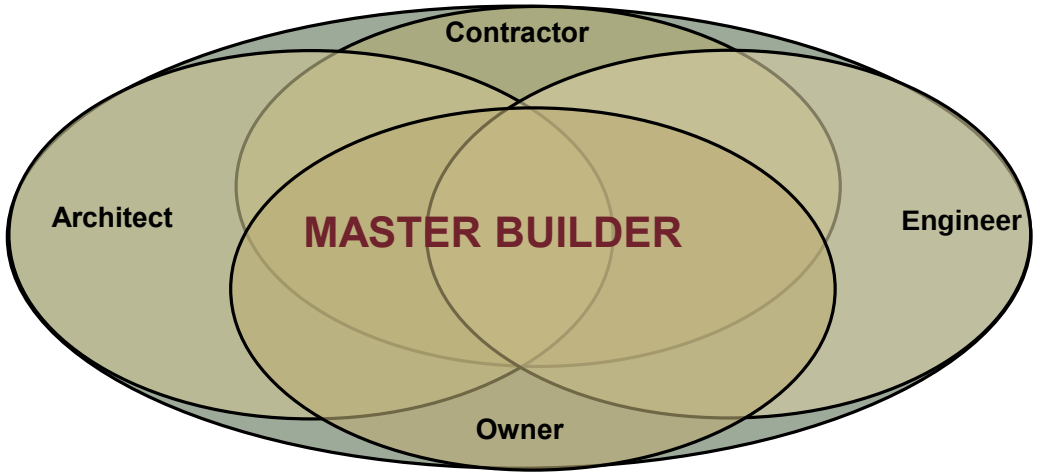
McKinsey&Company

Poor construction productivity costs the global economy **$1.63 trillion** each year



(Ibrahim and Hanna, 2016)

Why How Findings



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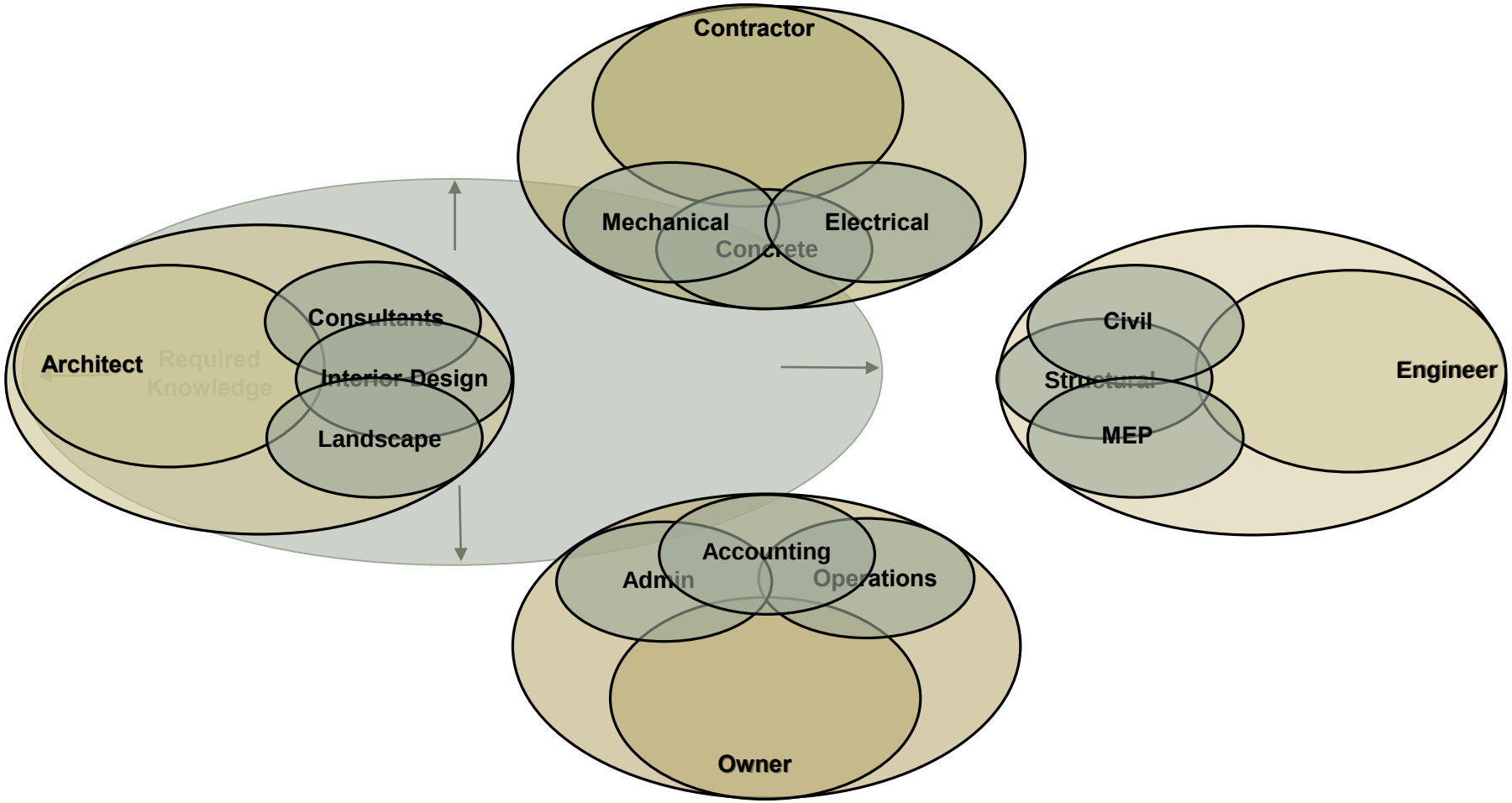
Why How Findings



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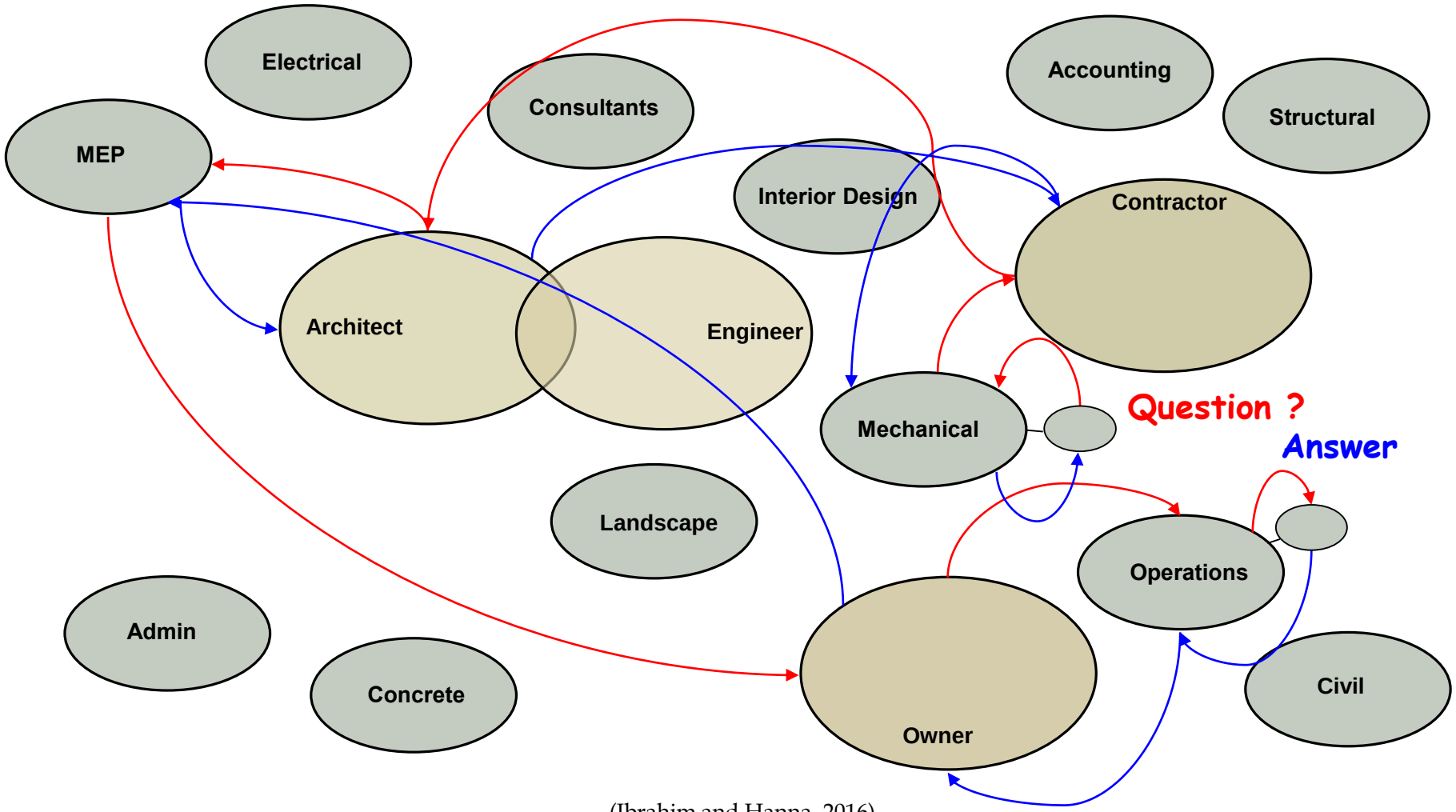

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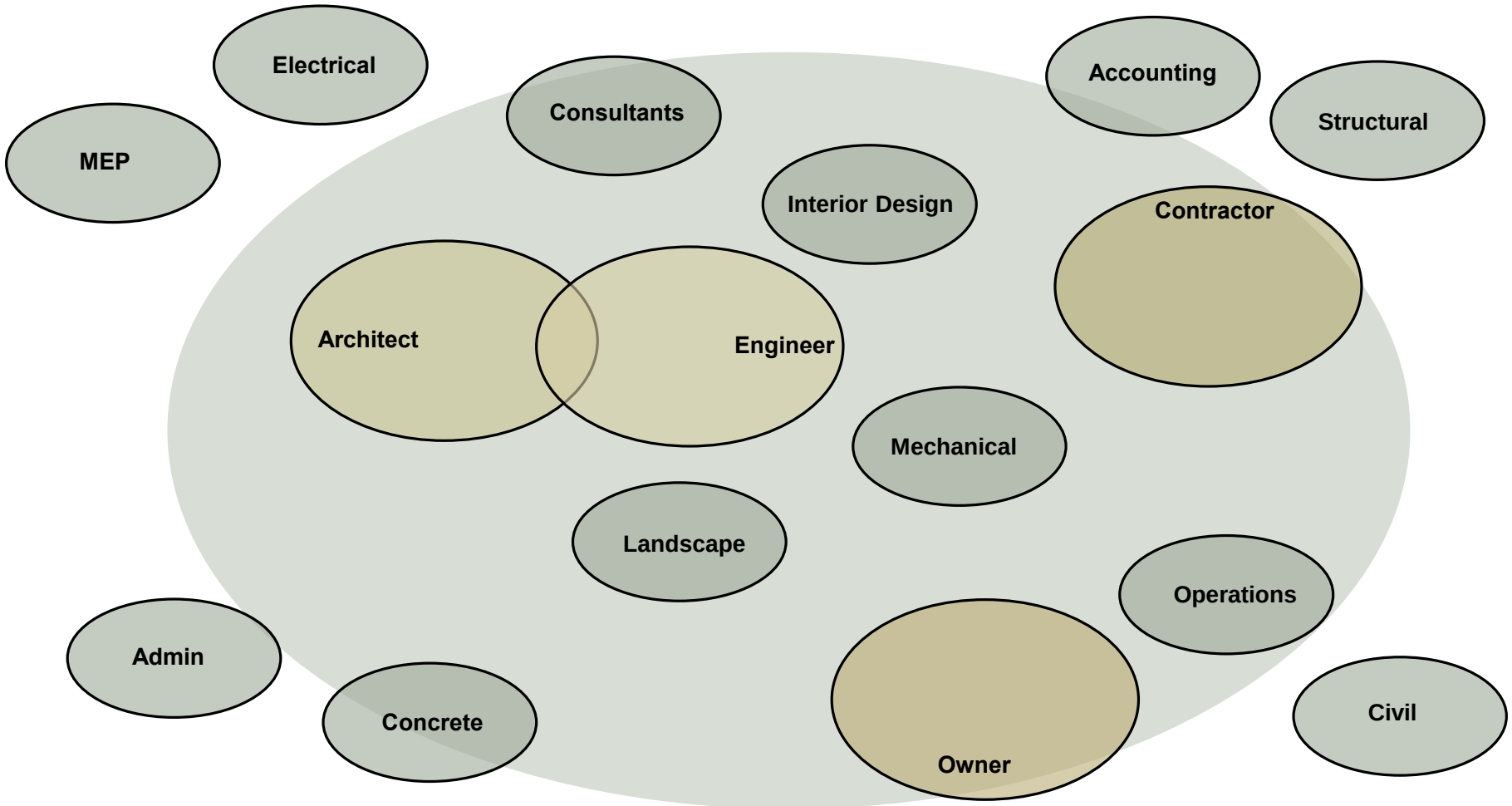
Why How Findings



(Ibrahim and Hanna, 2016)

Why How Findings

- Explore how project delivery systems (PDS) impact project performance
  - PDS defines the relationship and timing of involvement between different contracting parties (Hanna 2011)

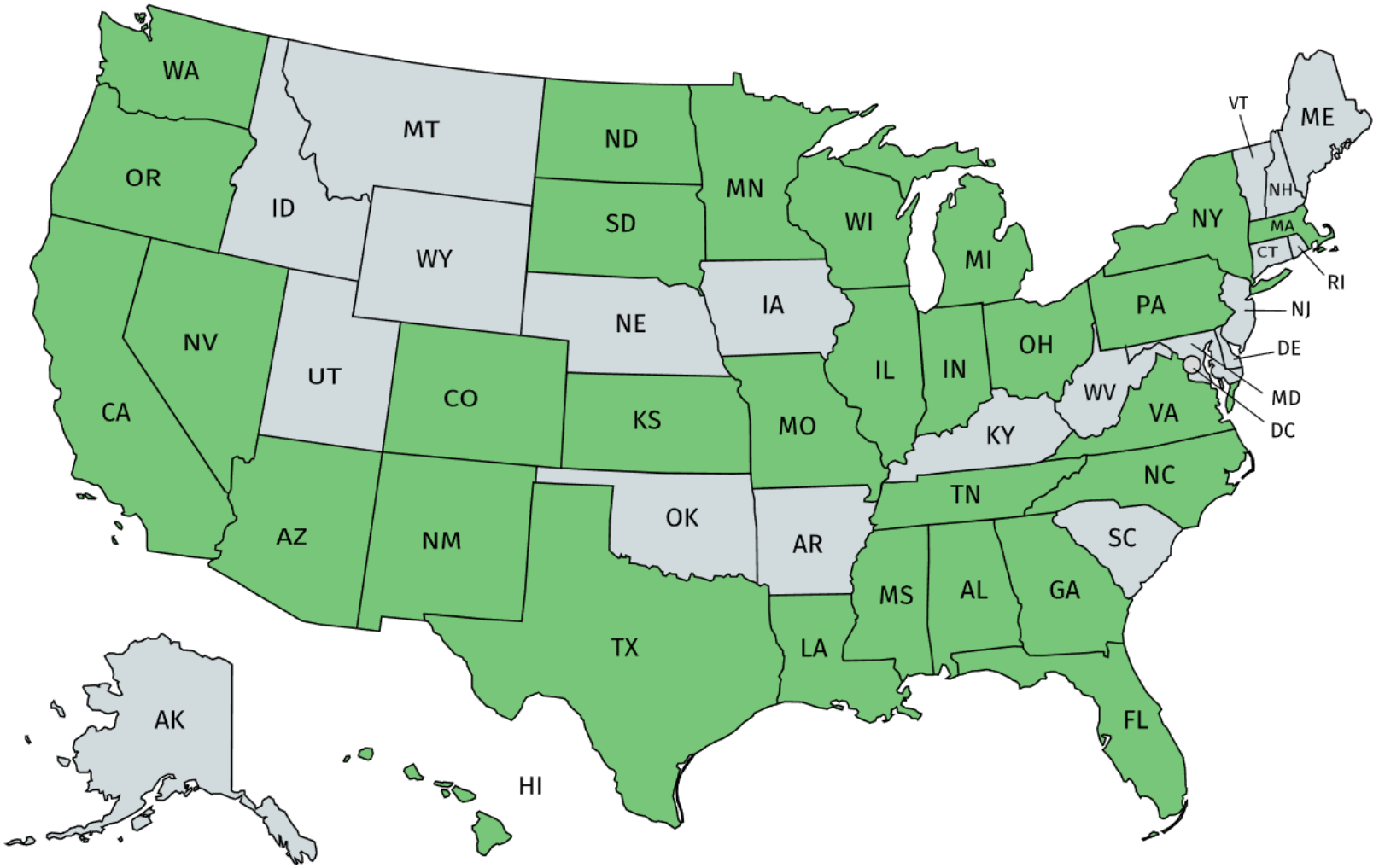
Project performance using quantitative performance metrics spanning six areas:

- Design-Bid-Build (DBB)
- Construction Management at-Risk (CMR)
- Design-Build (DB)
- Integrated Project Delivery (IPD)

  - Communication
  - Change management
  - Schedule
  - Cost
  - Quality
  - Safety

- 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



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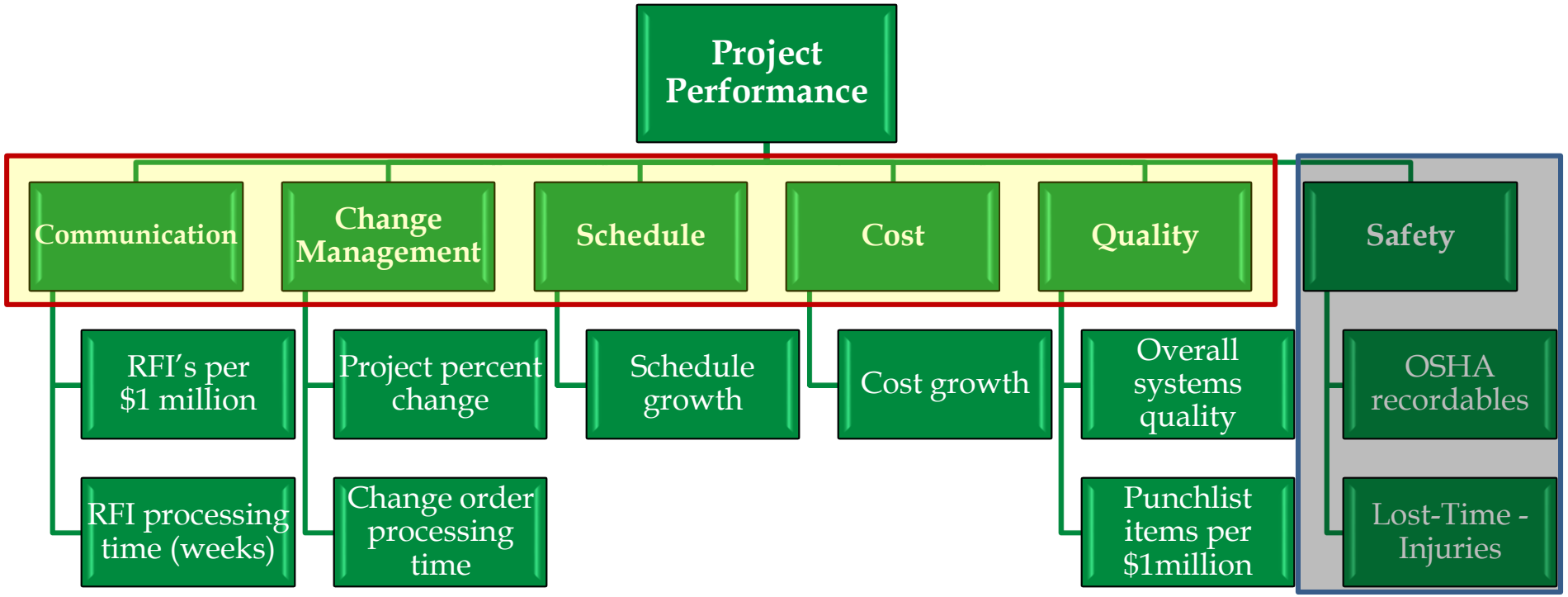
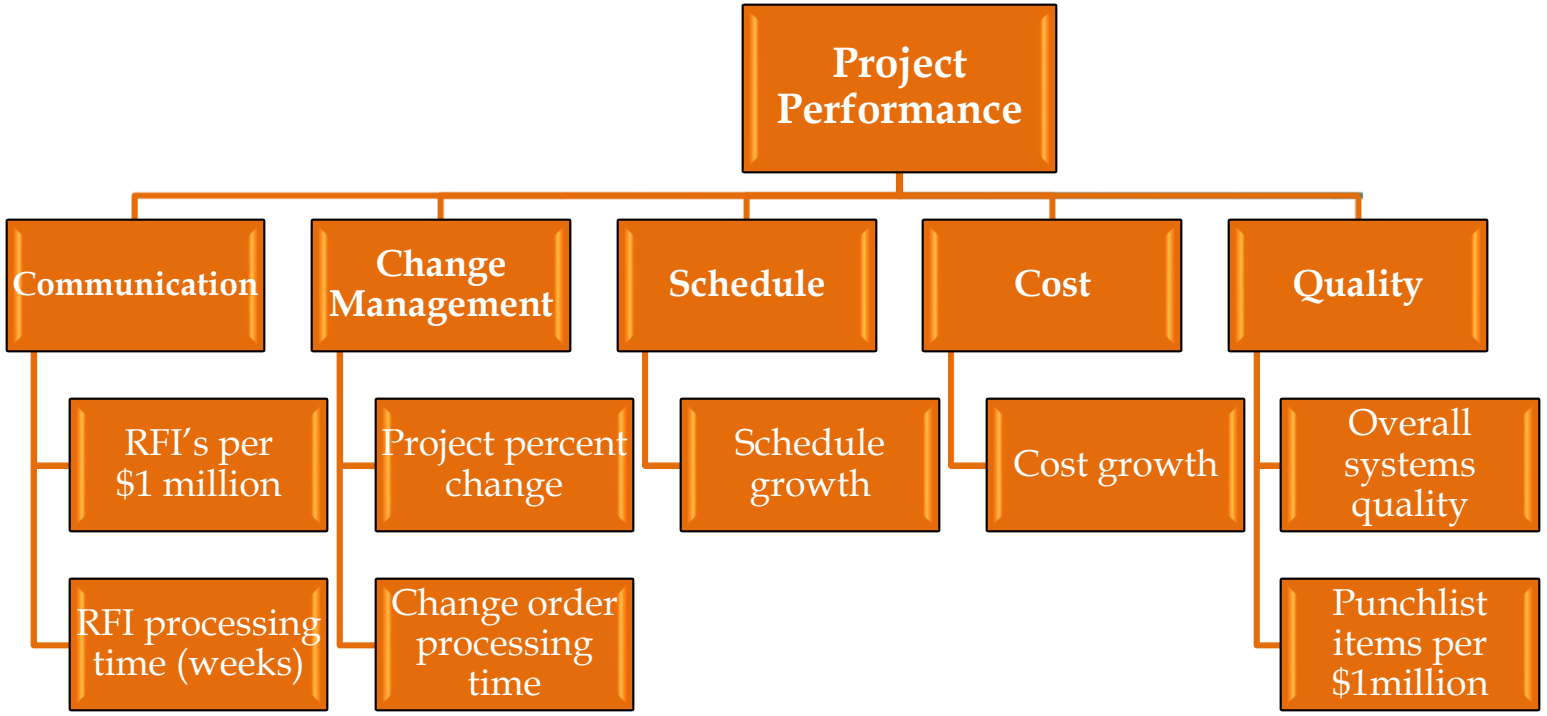


Safety performance DOES NOT differ across PDSs

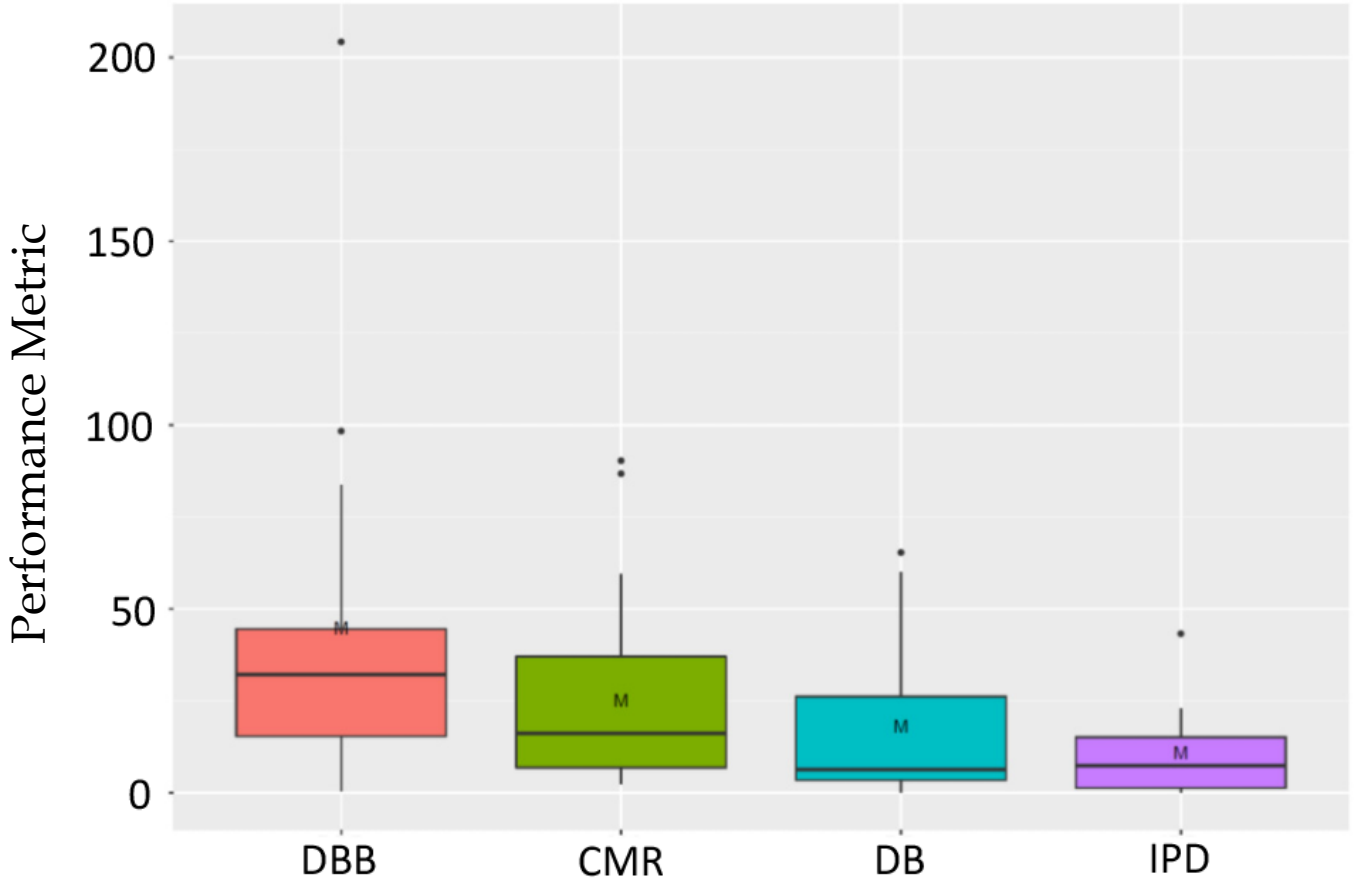
Communication, change management , schedule, cost and quality DIFFER across PDSs

Why How Findings



8 performance metrics spanning 5 areas

- Comparative box-and-whisker plots
- Checke
- Statistic
  - Examin g investigated
  - p-value nfidence level
- Statistic
  - Compa
  - p-value nfidence level

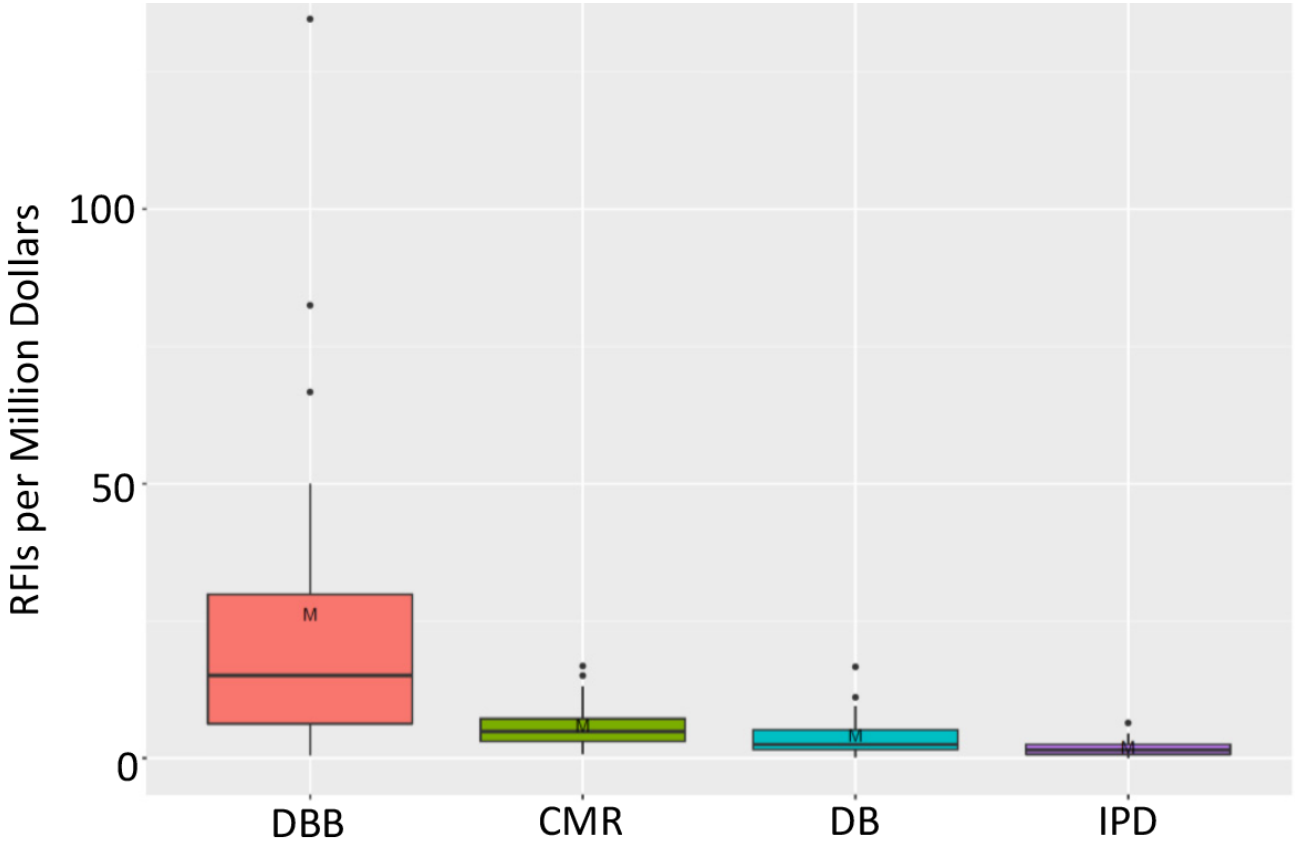


Why How Findings

Communication – RFI's per $1 Million

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

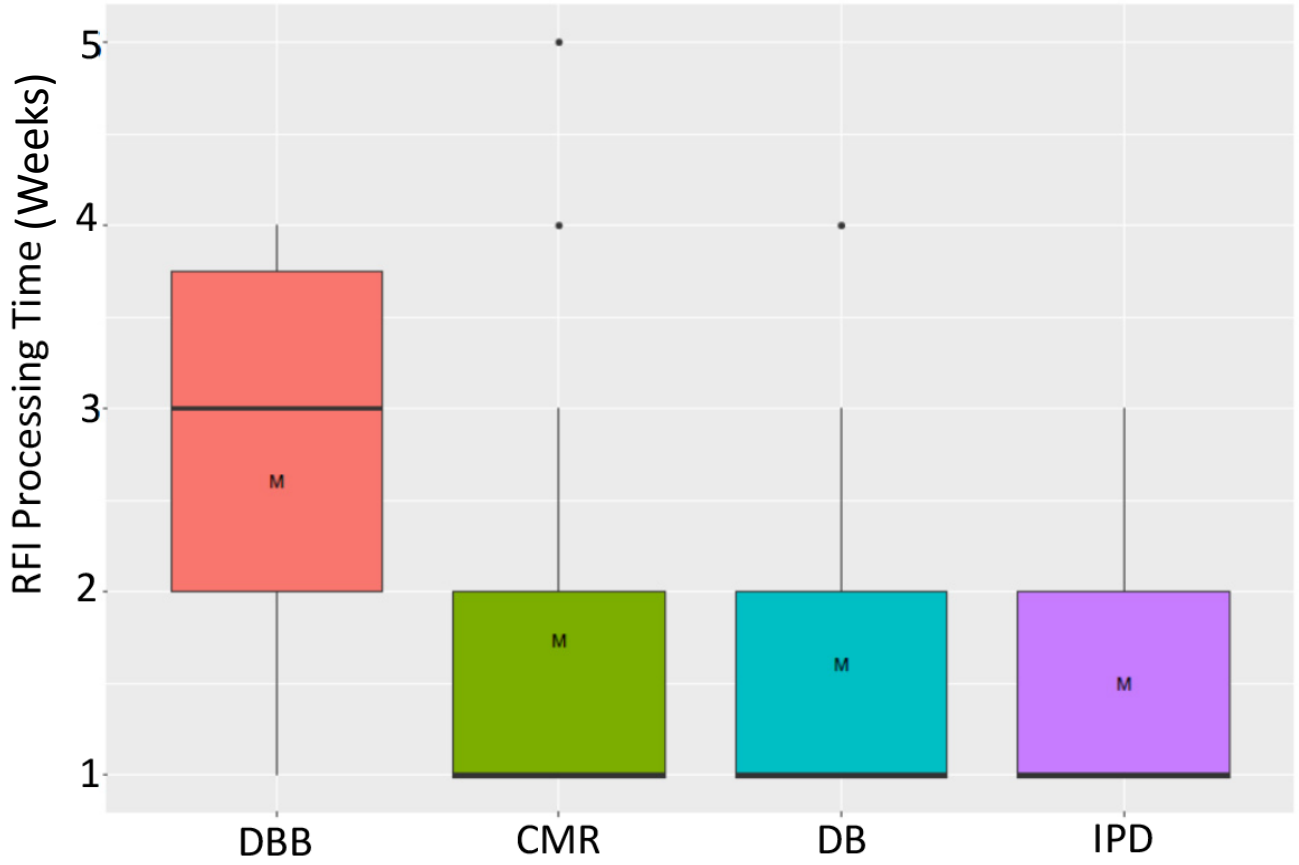
- IPD has fewer RFIs per million dollars than DBB
- DB has fewer RFIs per million dollars than DBB
- CMR has fewer RFIs per million dollars than DBB



Communication – RFI Processing Time

RFI processing time differs across PDSs

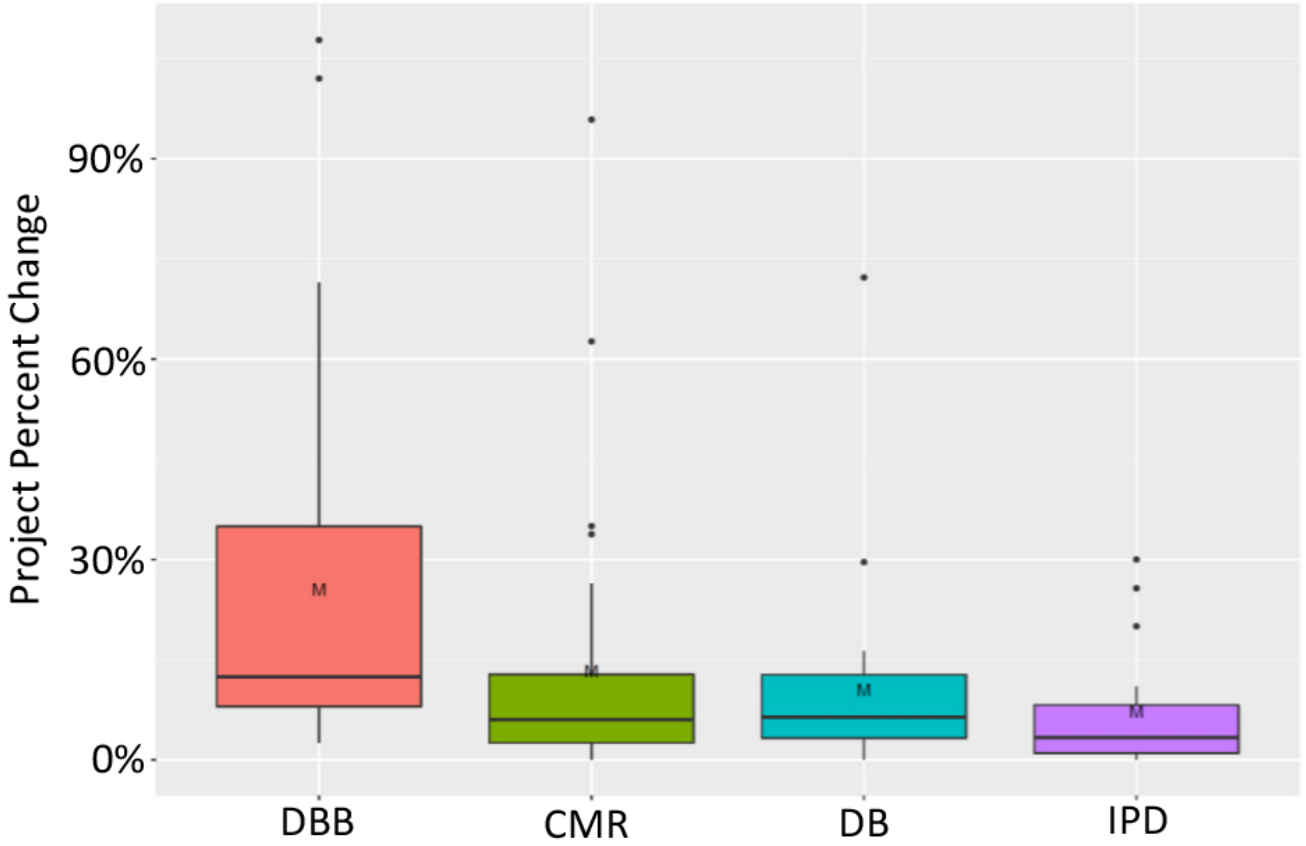
- IPD has shorter RFIs processing time than DBB
- DB has shorter RFIs processing time than DBB
- CMR has shorter RFIs processing time than DBB



Change management – Percent Change

Percent change differs across PDSs

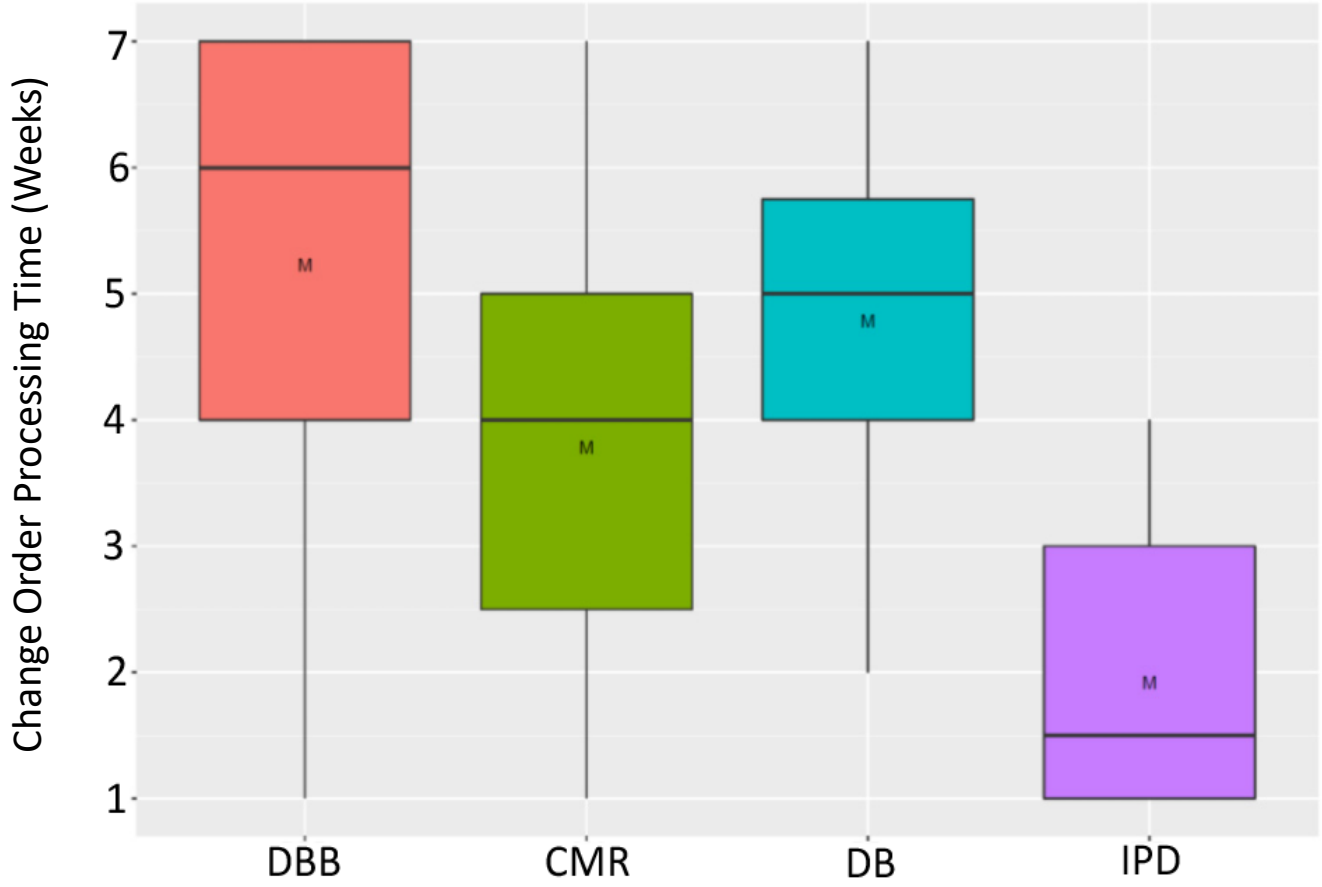
- IPD has lower percent change than DBB
- DB has lower percent change than DBB
- CMR has lower percent change than DBB



Change management – Change Order Processing Time

Change order processing time differs across PDSs

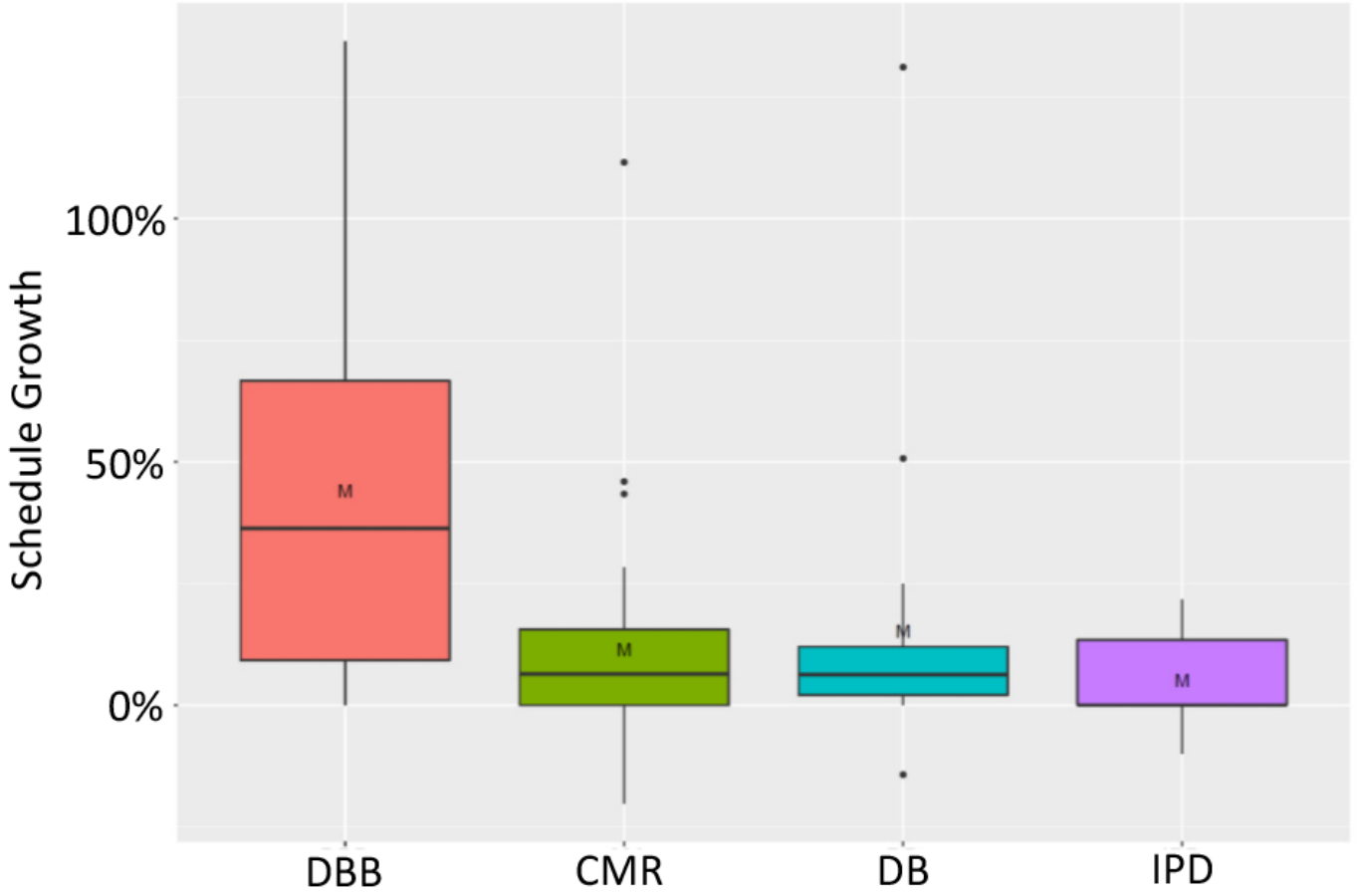
- IPD has shorter change order processing time than DBB
- IPD has shorter change order processing time than CMR
- IPD has shorter change order processing time than DB



Schedule Performance – Schedule Growth

Schedule growth differs across PDSs

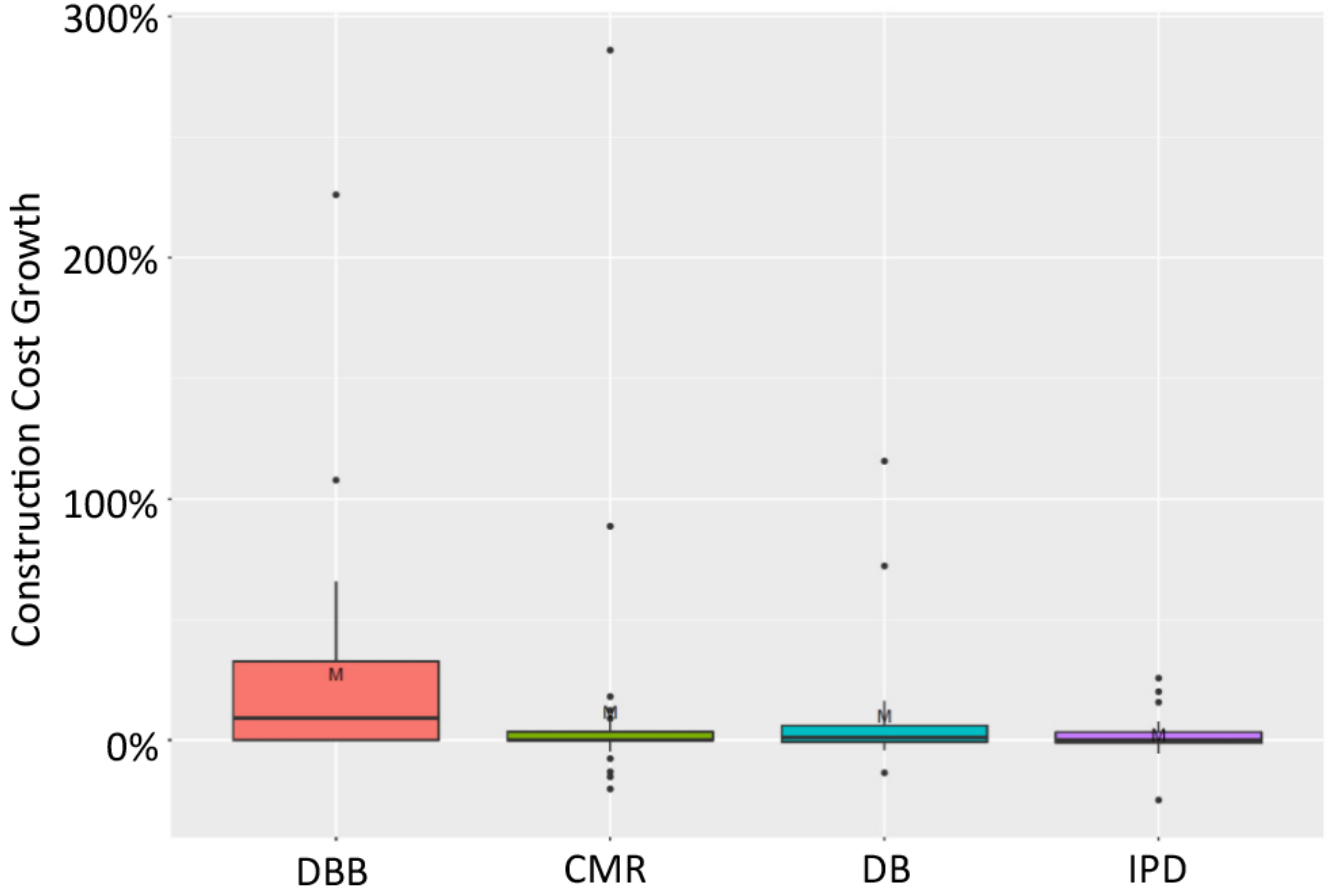
- IPD has lower schedule growth than DBB
- DB has lower schedule growth time than DBB
- CMR has lower schedule growth than DBB



Cost Performance – Cost Growth

Cost growth differs across PDSs

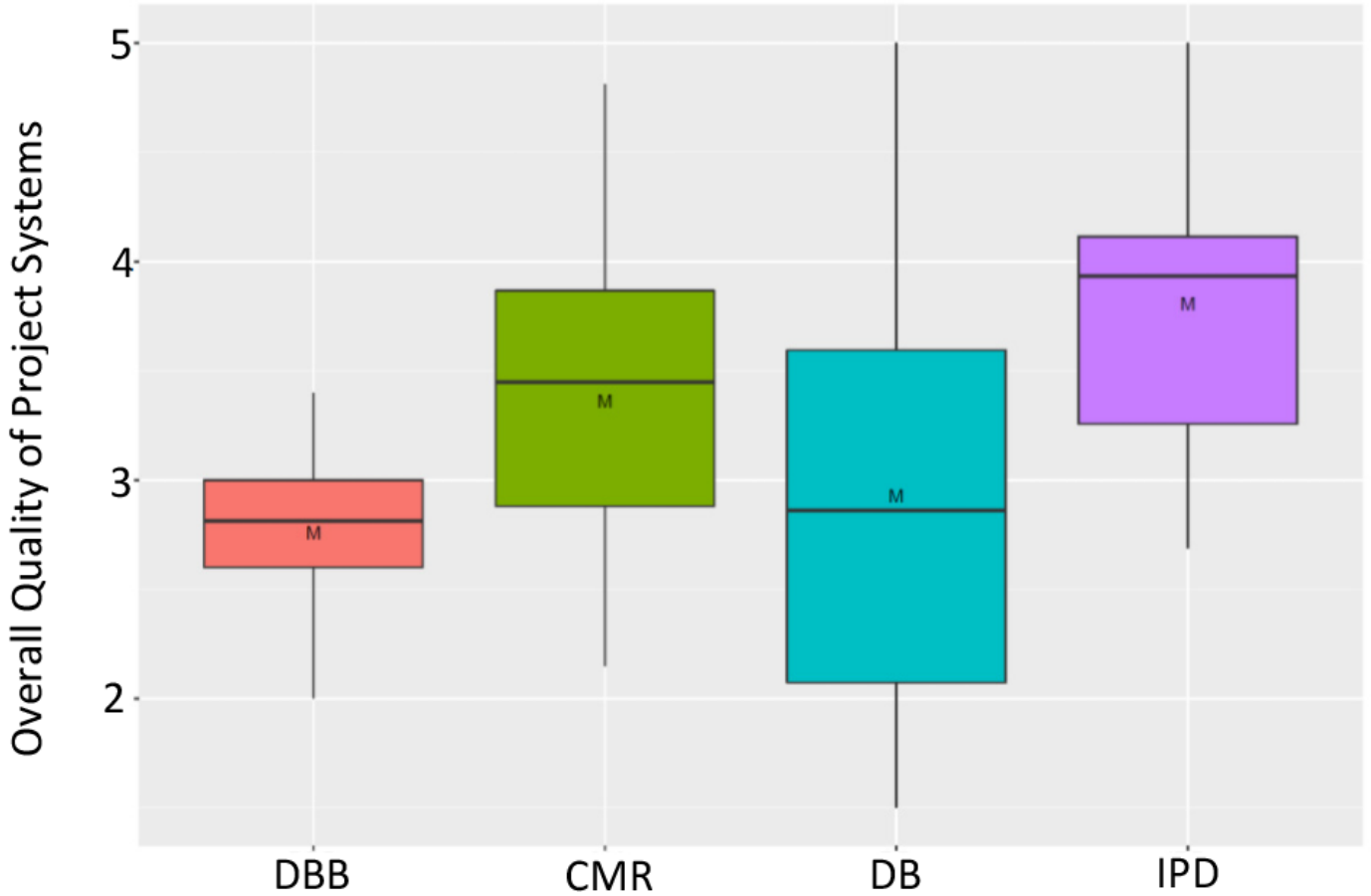
- IPD has lower cost growth than DBB
- DB has lower cost growth time than DBB
- CMR has lower cost growth than DBB



Quality Performance – Overall System Quality

Overall quality of project systems differs across PDSs

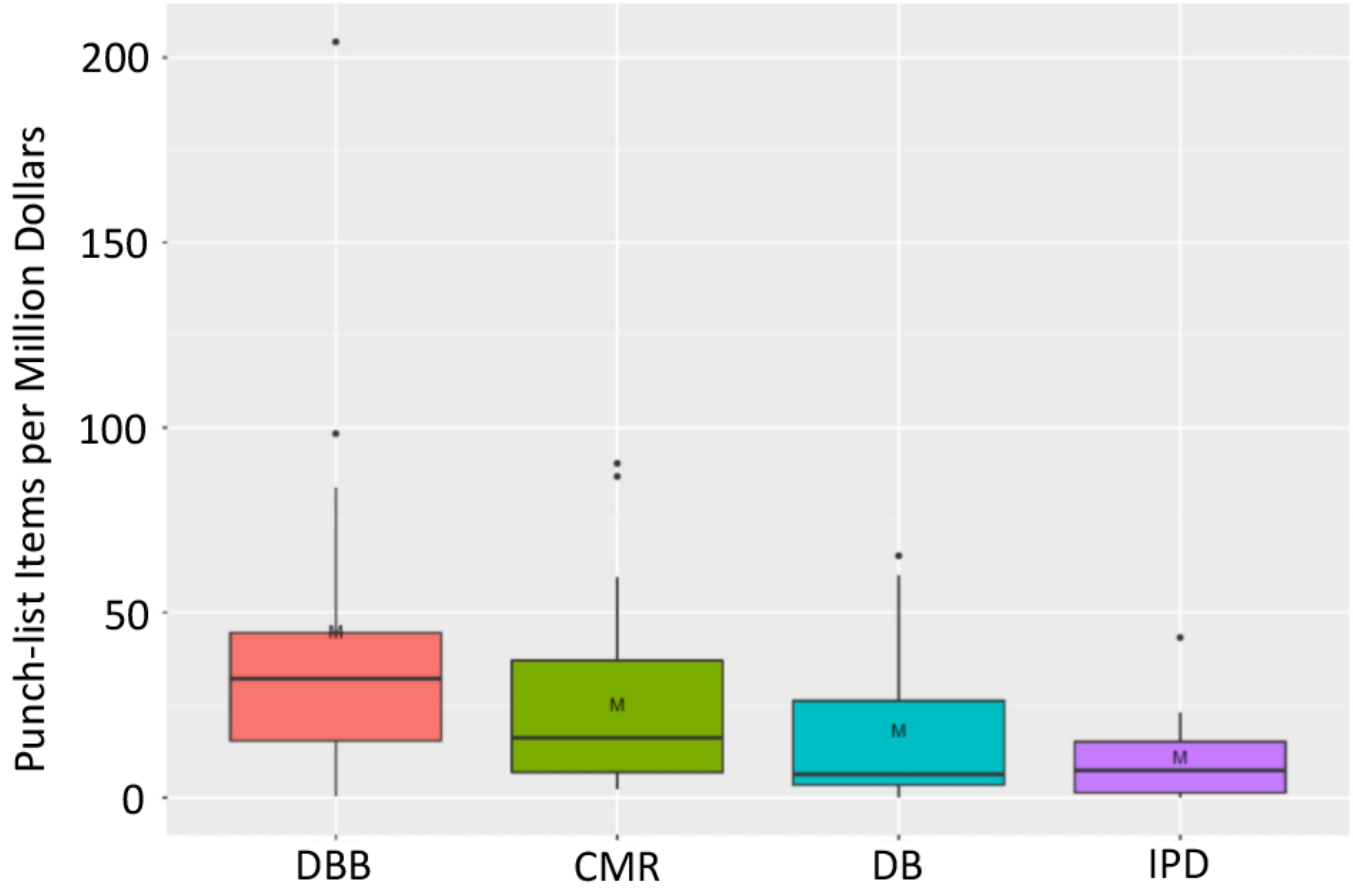
- IPD has higher overall quality of project systems than DBB
- IPD has higher overall quality of project systems than DB



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

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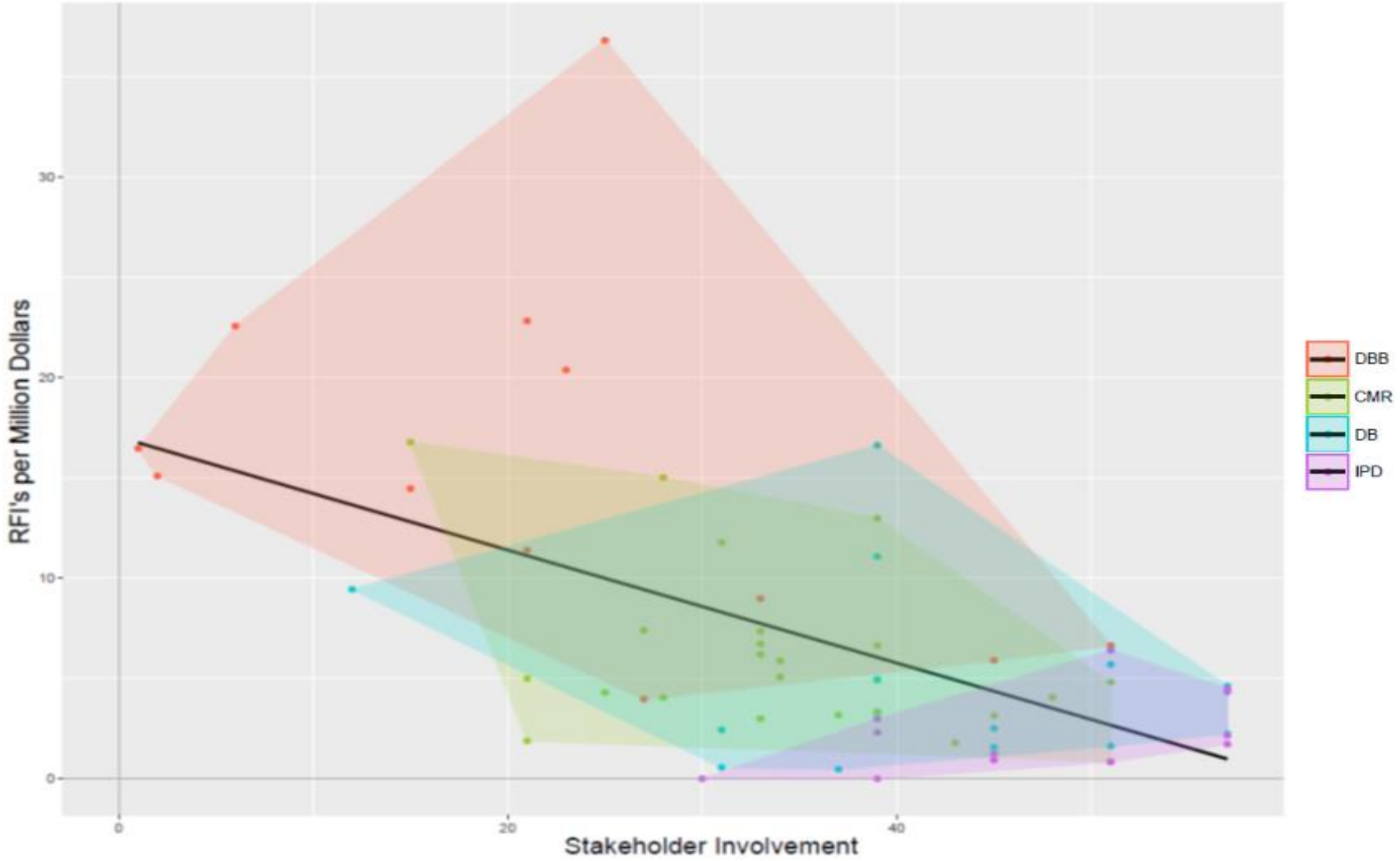
Q&A

Stakeholder Involvement:

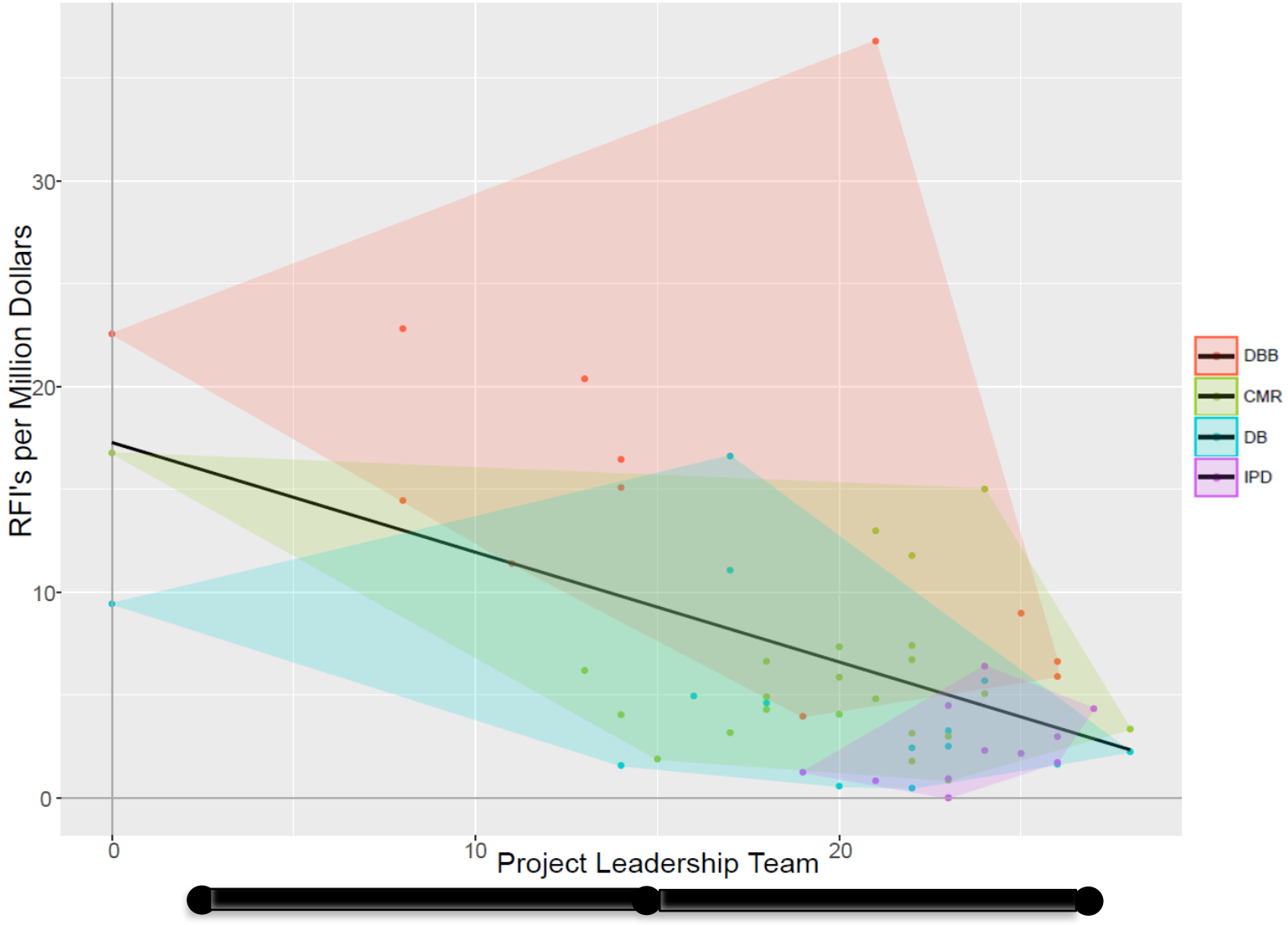
- How familiar was the contractor with the owner's objectives and expectations?
- Did the owner's staff actively participate in the construction process?
- Did the architect/engineer give adequate support during construction?
- How involved was the CM/GC in the design/preplanning stage of the project?
- How involved were the key subcontractors in the design/preplanning sage 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?

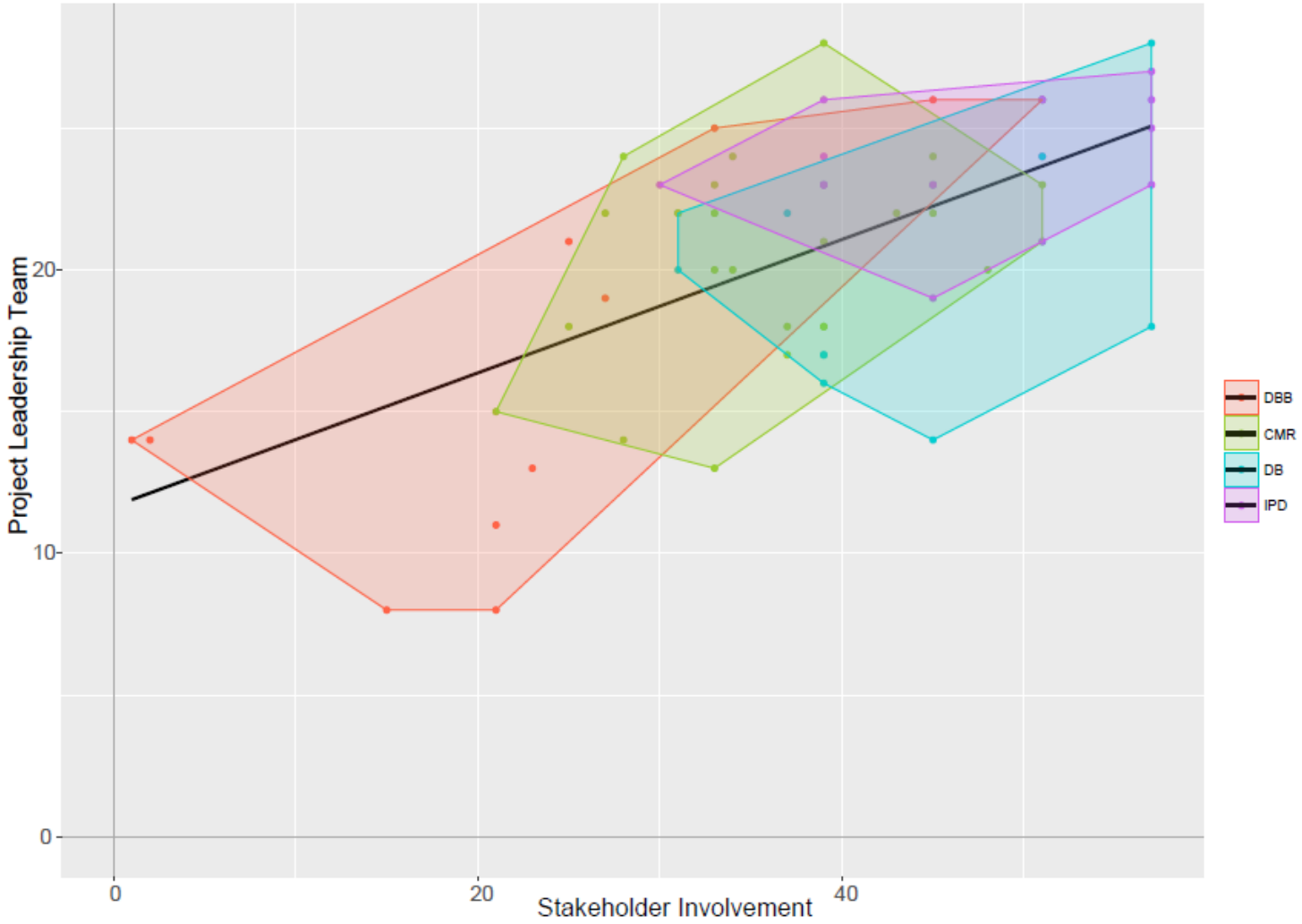


Why How Findings

Project Leadership:

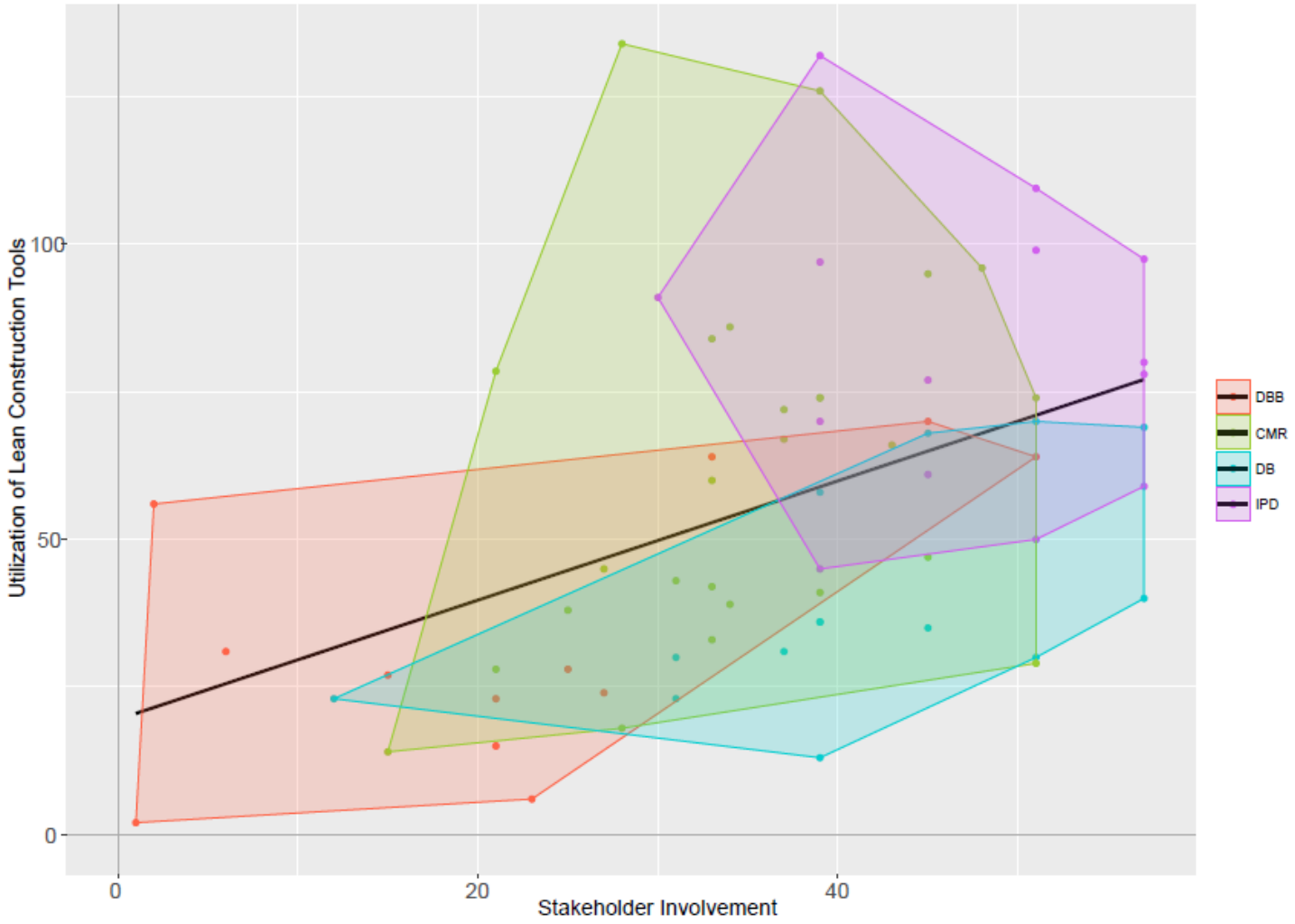
- The number of stakeholders represented in the project leadership team
- The authority of the team to make necessary decisions to manage and lead the project on daily basis
- Whether the team jointly developed project target criteria and goals
- Whether the team made decisions collaboratively
- Periodic 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

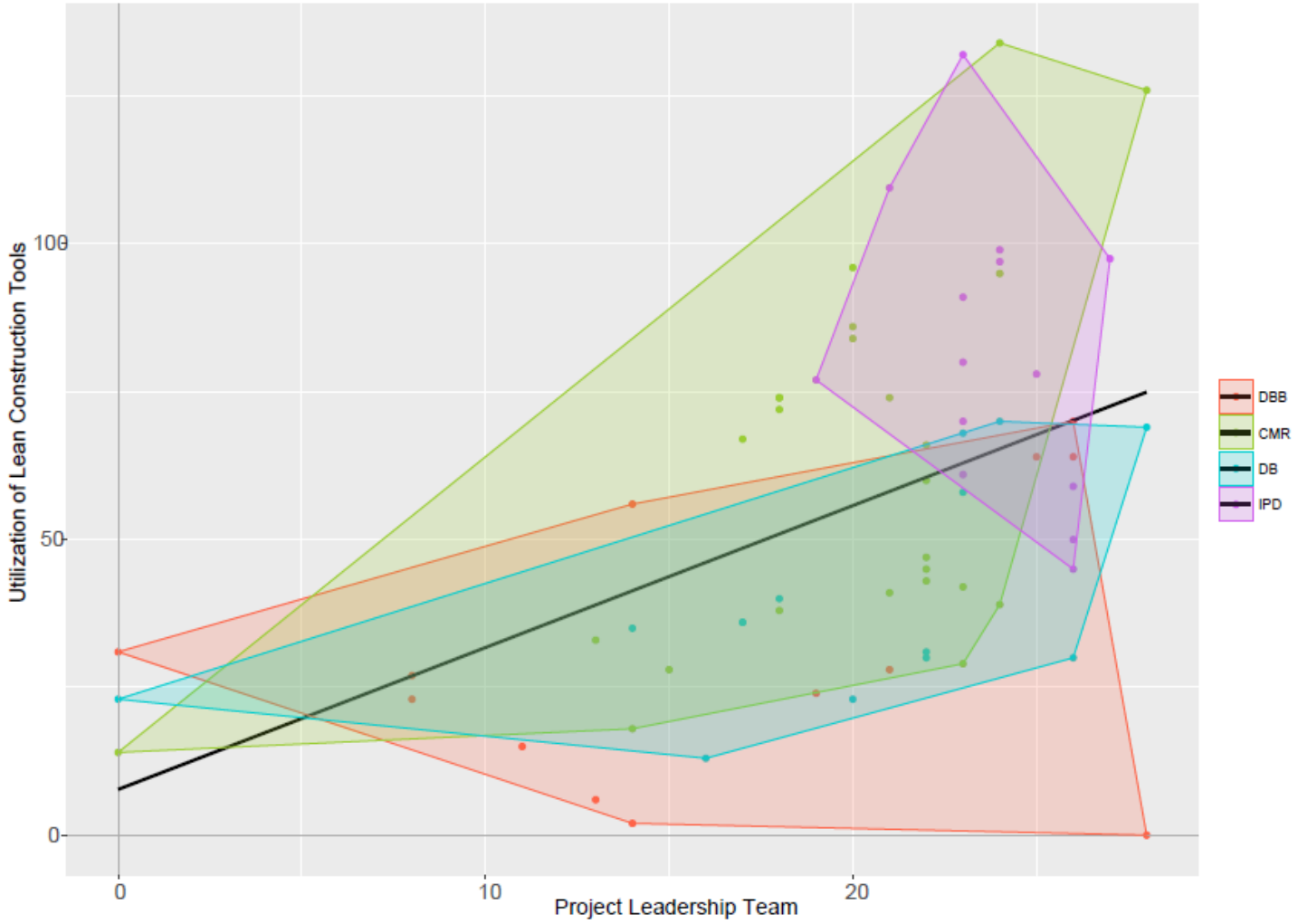

RFI's per Million Dollars
30
20
10
0
0
10
20
Project Leadership Team
DBB
CMR
DB
IPD


Project Leadership Team
20
10
0
0
20
40
Stakeholder Involvement
DBB
CMR
DB
IPD

Create a project environment that fosters collaboration to enable optimal project performance

Last Planner System (LPS) for production control
LPS: Tracking weekly commitments from the project team
LPS: Tracking reliable promises / Percent Plan Complete
5S - *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.*
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.*
Value Stream Mapping - *to clearly identify and eliminate waste throughout the project.*
Proactive dynamic Target Costing or Target Value Design
Daily Huddles – *meeting with the field crews on a daily basis to review the schedule and plan the work.*
JIT - *bulk materials are delivered just prior to installation* 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*
Point Cloud technology such as Total Station
Visual Management Devices
Mock-ups for repetitive construction systems
Project Training Sessions - *to enhance team working ability, clarify Pull Scheduling and/or Last Planner System, etc.*
Constructability reviews


Utilization of Lean Construction Tools
100
50
0
0
20
40
Stakeholder Involvement
DBB
CMR
DB
IPD


Utilization of Lean Construction Tools
100
50
0
0
10
20
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