Building a Business Case for Systems Engineering

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Who Pulls it All Together ?

The Systems Engineer

Required skills

- Global system-wide perspective
- Full life-cycle perspective
- Forward-looking
- Multidisciplinary technical knowledge
- Fact-based decision-making
- Multi-tasking

Tasks Performed *

- Requirements Development
- Requirements Management
- Trade Studies
- System Architecture Development
- Interface Management
- Configuration Management
- Project Planning
- Project Monitoring and Control
- Risk Management
- Product Integration Planning and Oversight
- Verification Planning and Oversight
- Validation Planning and Oversight

How likely is project success if these activities are not done well?

* Some tasks are done in partnership with the Project Manager

The Importance of System Engineering

GAO-09-362T - Actions Needed to Overcome Long-standing Challenges with Weapon Systems Acquisition and Service Contract Management

- "costs … of major defense acquisition programs increased 26 percent and development costs increased by 40 percent from first estimates"
- "programs … failed to deliver capabilities when promised—often forcing warfighters to spend additional funds on maintaining legacy systems"
- "current programs experienced, on average, a 21-month delay in delivering initial capabilities to the warfighter"

Why?

"… managers rely heavily on assumptions about system requirements, technology, and design maturity, which are consistently too optimistic. These gaps are largely the result of a lack of a disciplined systems engineering analysis prior to beginning system development …

The Problem

It is difficult to justify the costs of SE in terms that project managers and corporate managers can relate to.

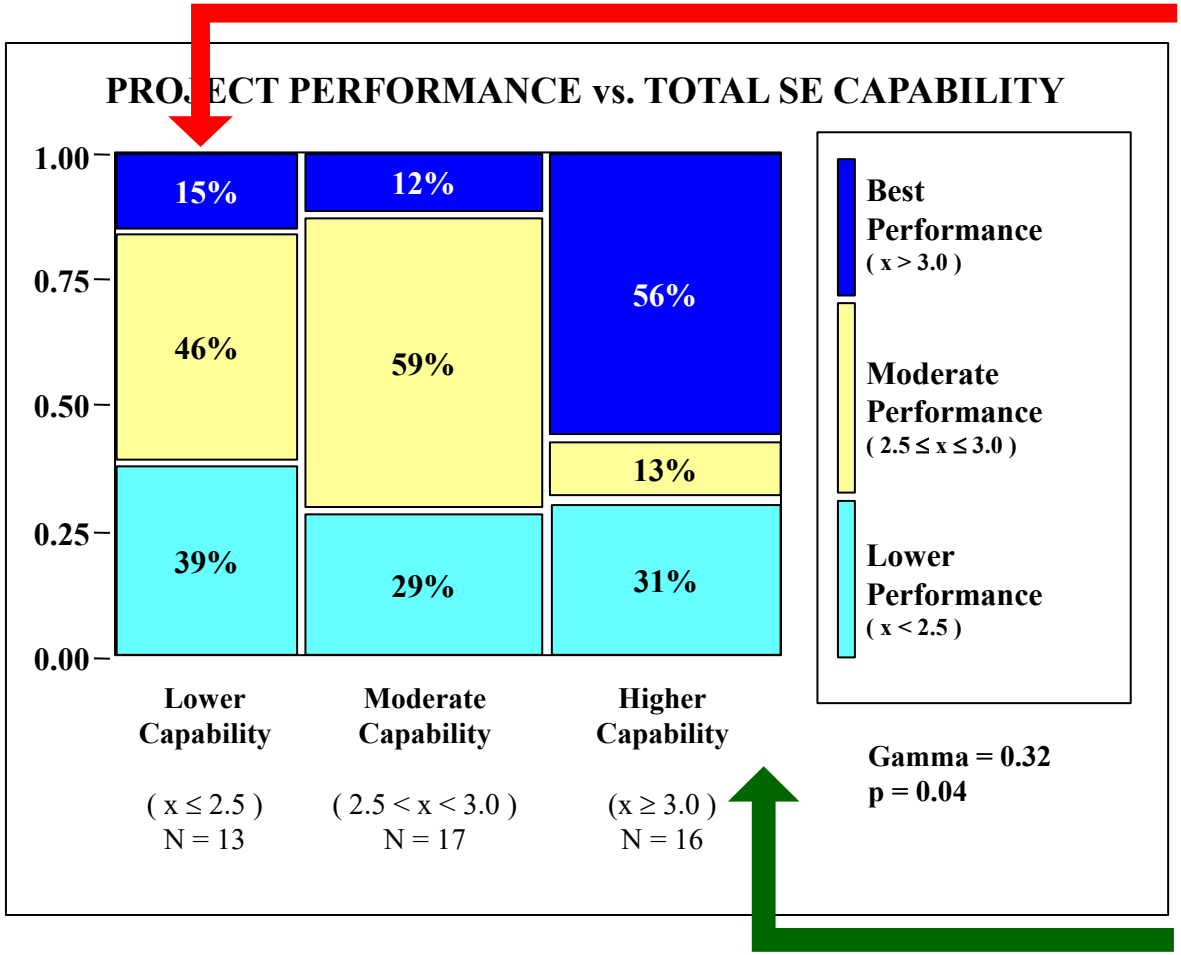
- The costs of SE are evident
  - Cost of resources
  - Schedule time
- The benefits are less obvious and less tangible
  - Cost avoidance (e.g., reduction of rework from interface mismatches)
  - Risk avoidance (e.g., early risk identification and mitigation)
  - Improved efficiency (e.g., clearer organizational boundaries and interfaces)
  - Better products (e.g., better understanding and satisfaction of stakeholder needs)

We need to quantify the effectiveness and value of SE by examining its effect on project performance?

The Solution

Obtain quantitative evidence of the costs and associated benefits of Systems Engineering activities via a survey of development projects

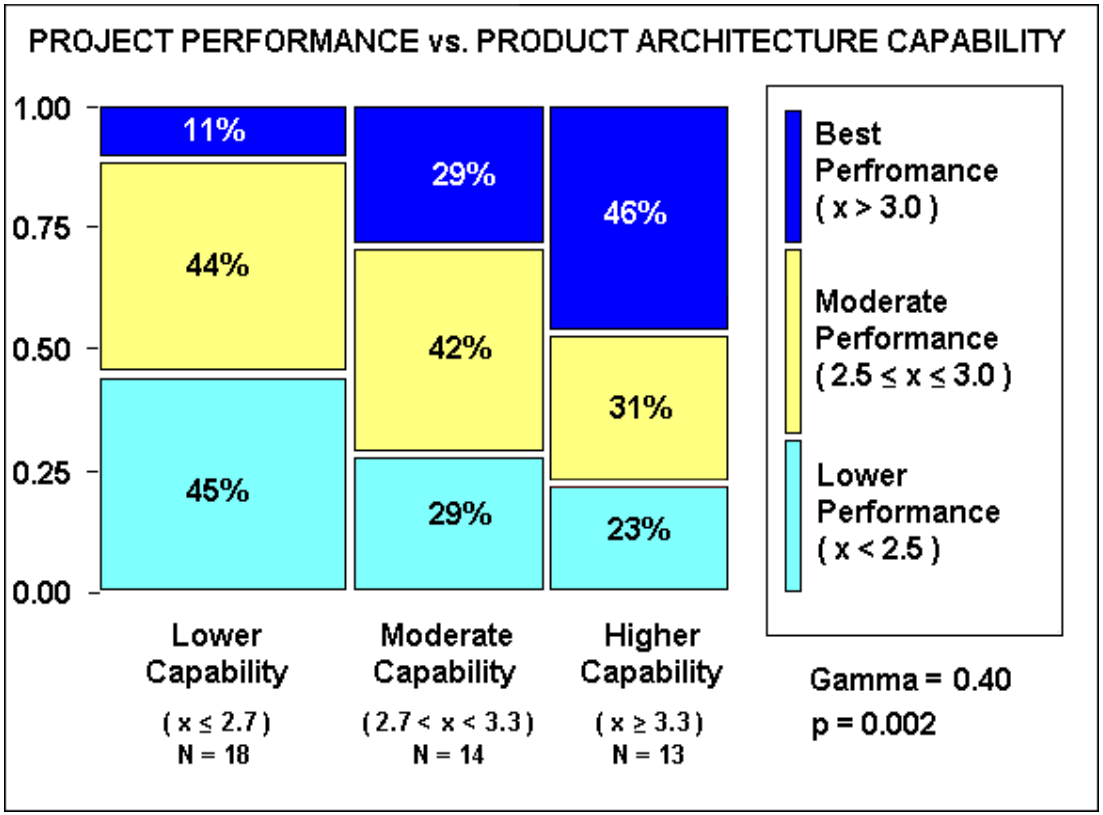
The Bottom Line [1]



For the projects that did the least SE, only 15% delivered the best project performance.

For the projects that did the most SE, 56% delivered the best project performance

Product Architecture Capability vs. Project Performance

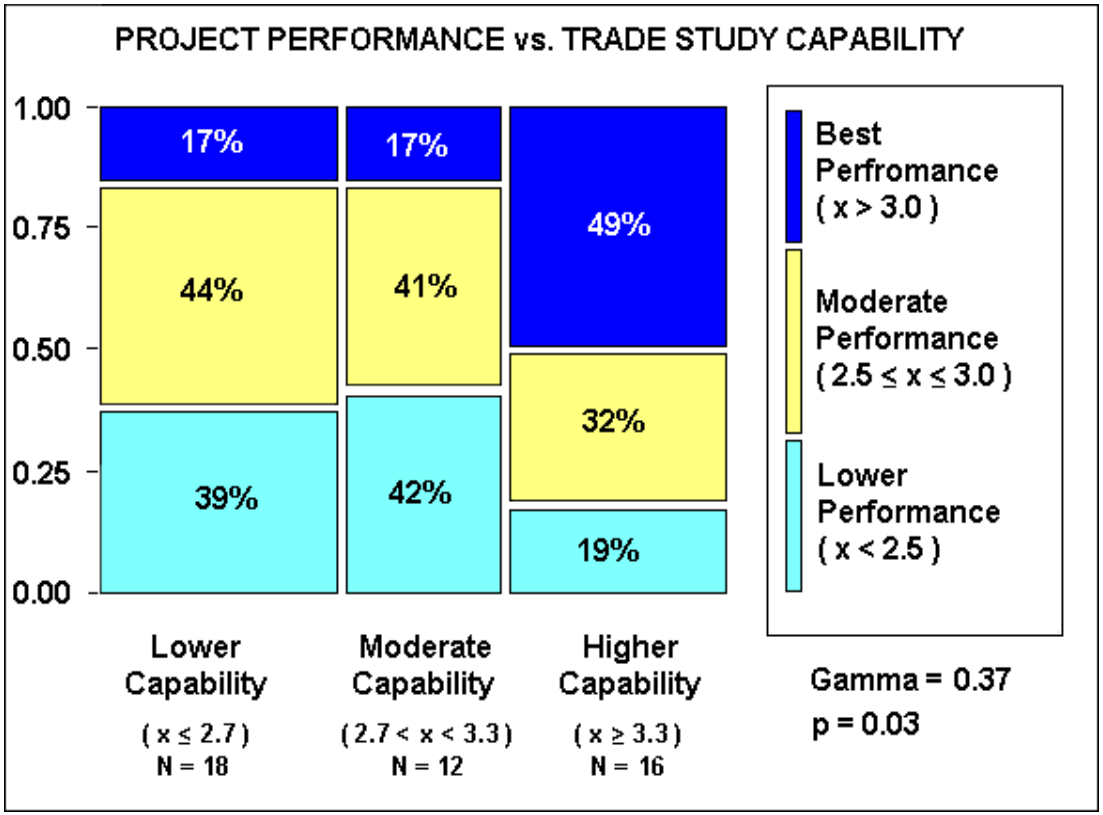


Product architecture assessment examined

- High-level product structure documentation
  - Including multiple views
- Interface Descriptions

Better Product Architecture has a "Moderately Strong / Strong" positive relationship with Better Performance

Trade Study Capability vs. Project Performance

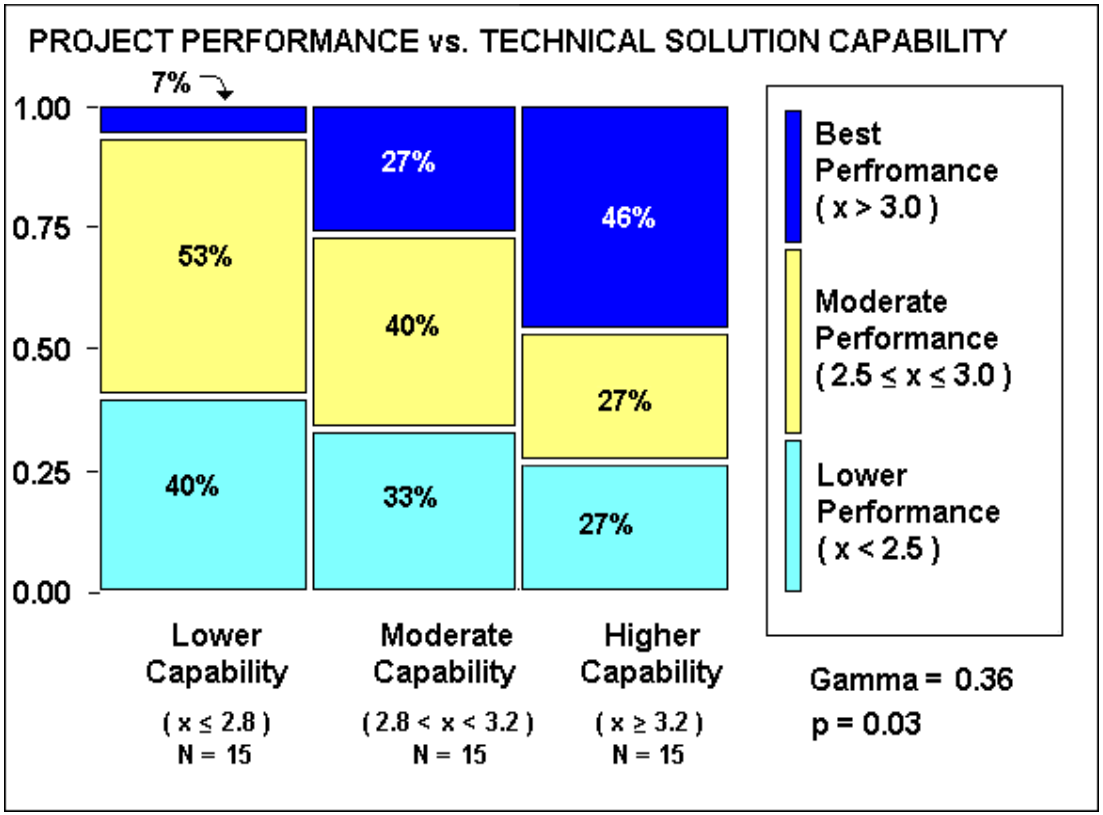


Trade Study assessment examined

- Documentation of Trade Study selection criteria
- Documentation or Trade Study results
- Stakeholder involvement

Better Trade Studies have a "Moderately Strong / Strong" positive relationship with Better Performance

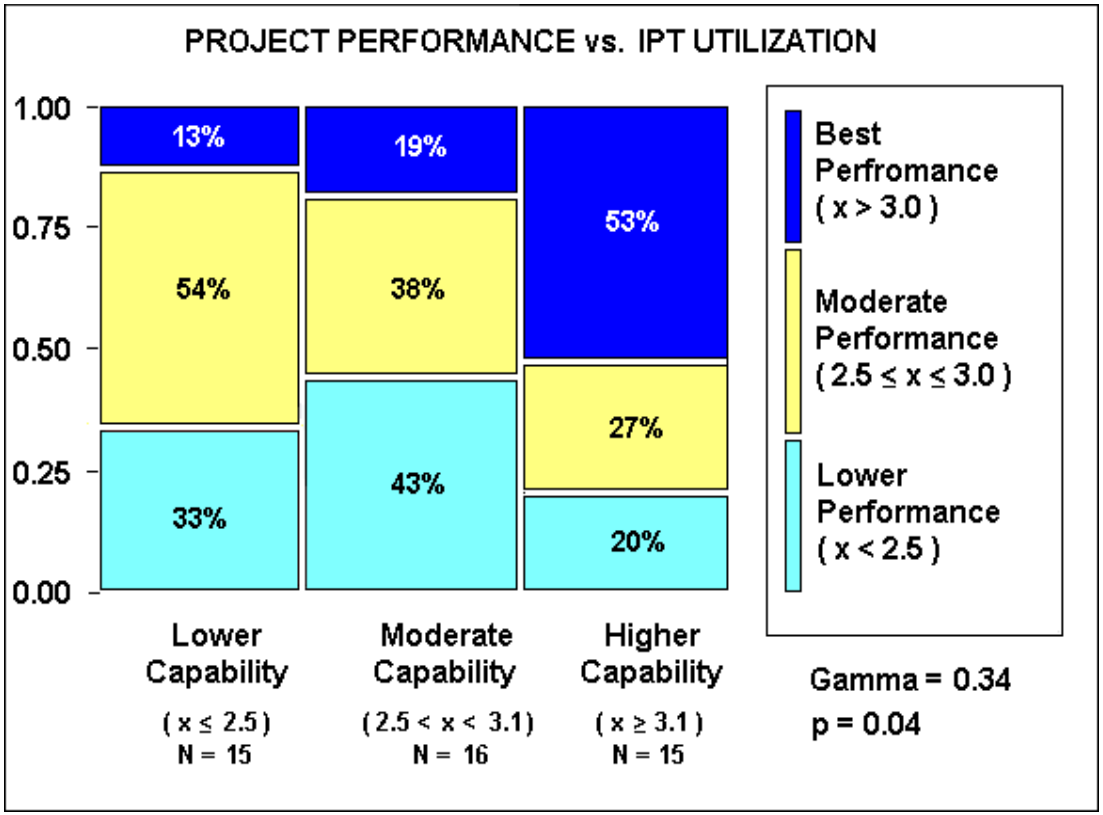
Technical Solution Capability vs. Project Performance



Technical Solution performance is the combination of both Product Architecture and Trade Study performance

Better Technical Solution processes have a "Moderately Strong" positive relationship with Better Performance

IPT Utilization vs. Project Performance

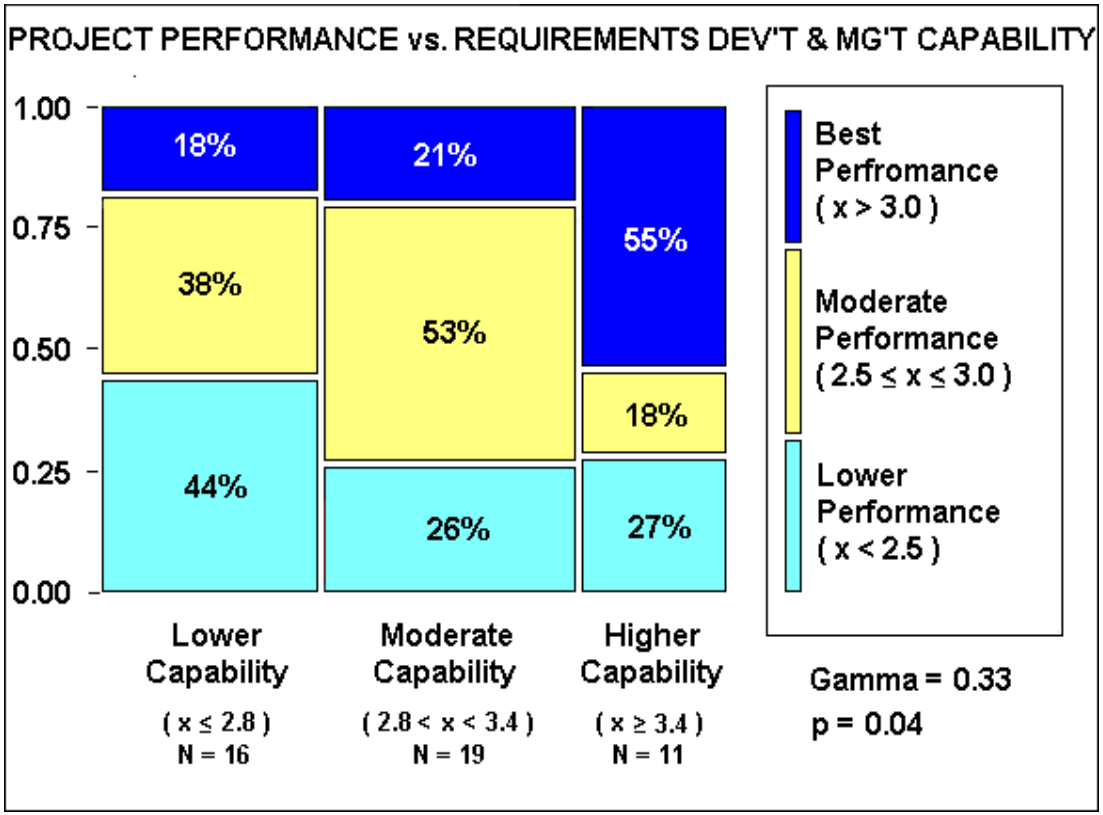


IPT (Integrated Product Team) assessment examined

- Effective IPT Usage on Project
- Supplier participation
- IPT for Systems Engineering
- SE Representation on each IPT

Better IPT Deployment has a "Moderately Strong" positive relationship with Better Performance

Requirements Development & Management vs. Project Performance

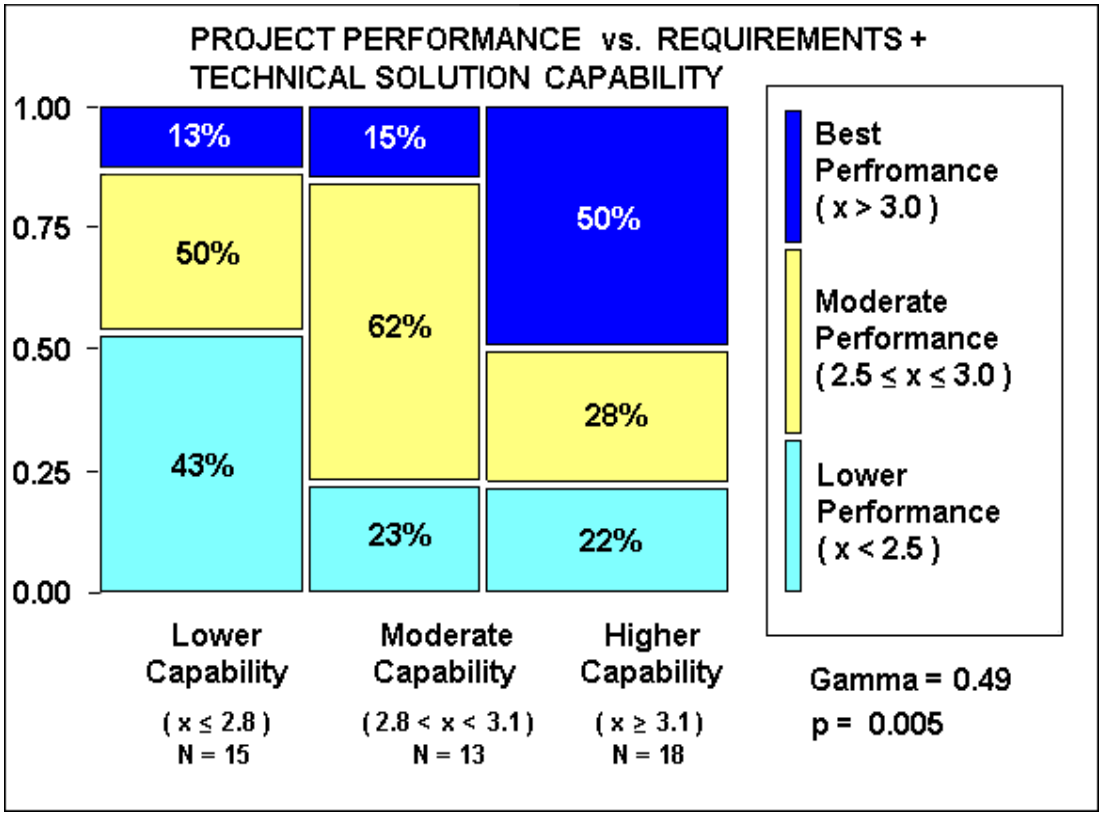


Requirements assessment examined

- Customer & derived requirements lists
- Hierarchical allocation to system elements
- CONOPs, scenarios, and Use cases
- Criteria for authorization of req'ts providers and acceptance of req'ts
- Change control process
- Traceability to Stakeholder needs

Better Requirements Development and Management has a "Moderately Strong" positive relationship with Better Performance

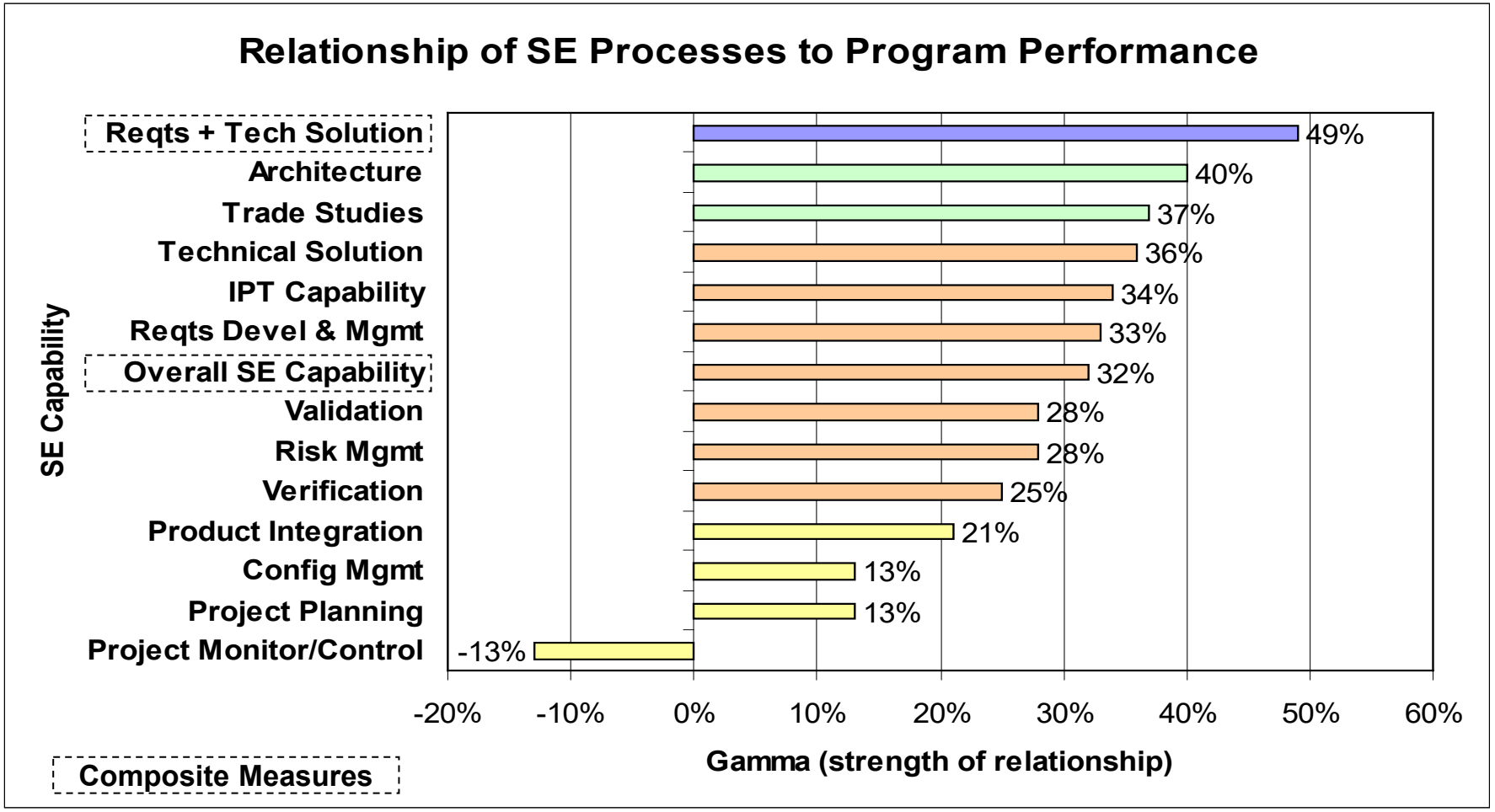
Requirements + Technical Solution Capability vs. Project Performance



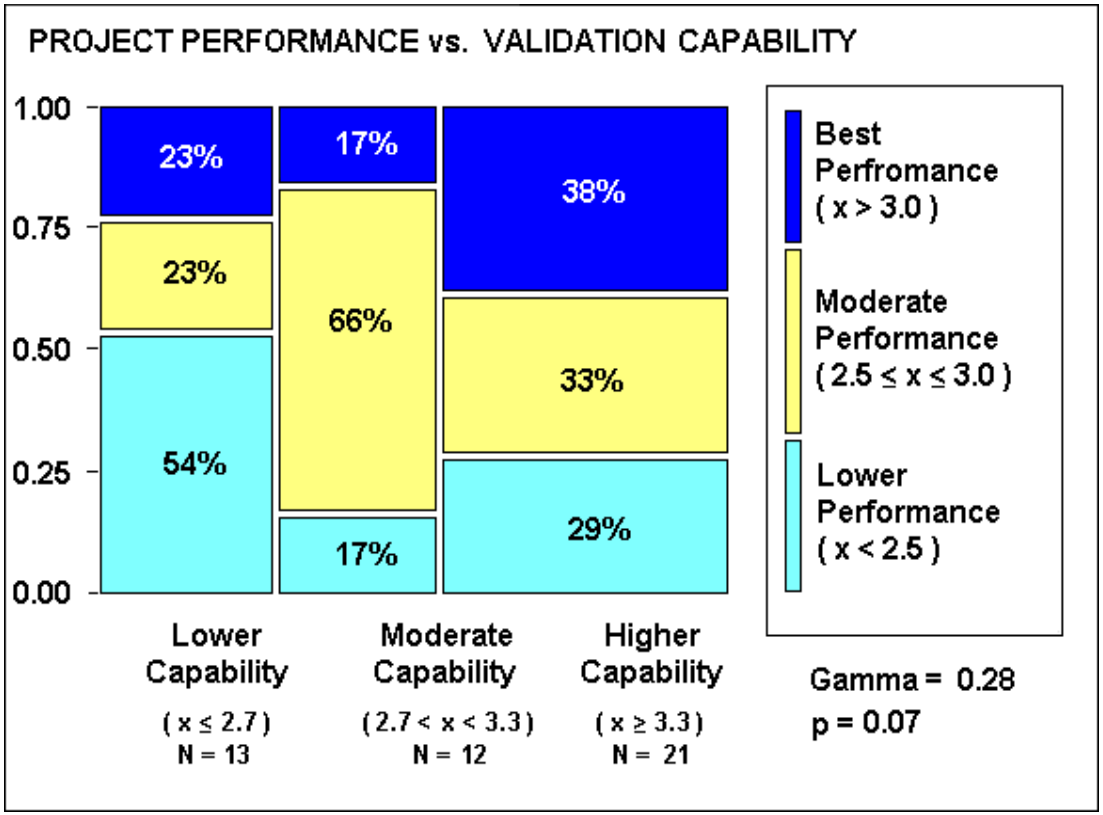
When looking at the impact of COMBINED SE activities, we see even stronger relationships

Better Requirements Dev't & Mg't and Better Technical Solution processes have a "Strong" positive relationship with Better Performance

Summary of Relationships



Validation vs. Project Performance

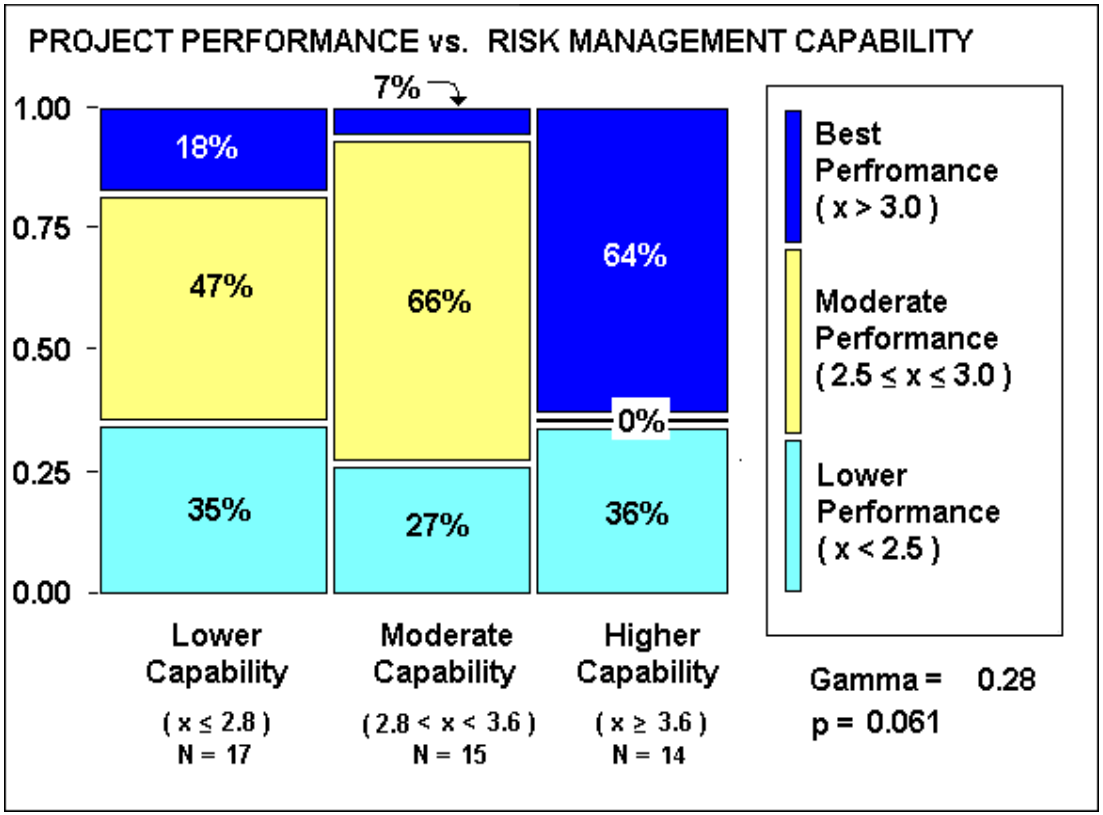


Validation assessment examined

- Validation Procedures
- Documented Acceptance Criteria
- List of items under Configuration Management

Better Validation capabilities have a "Moderately Strong" positive relationship with Better Performance

Risk Management vs. Project Performance

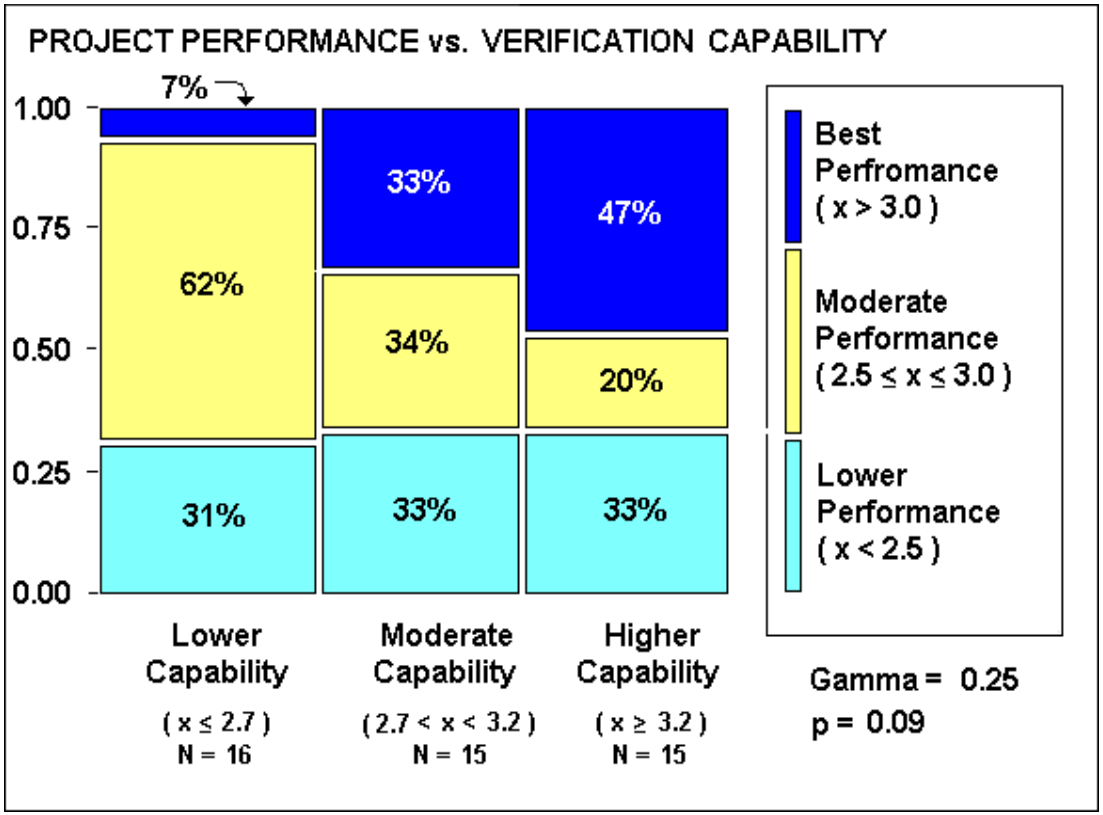


Risk Management assessment examined

- List of Risks
- Risk Mitigation Plans
- Monitoring and Reporting of Risks and Mitigation Plans
- Integration with Project Decision Making
- Integration with IMS

Better Risk Management has a "Moderately Strong" positive relationship with Better Performance

Verification vs. Project Performance

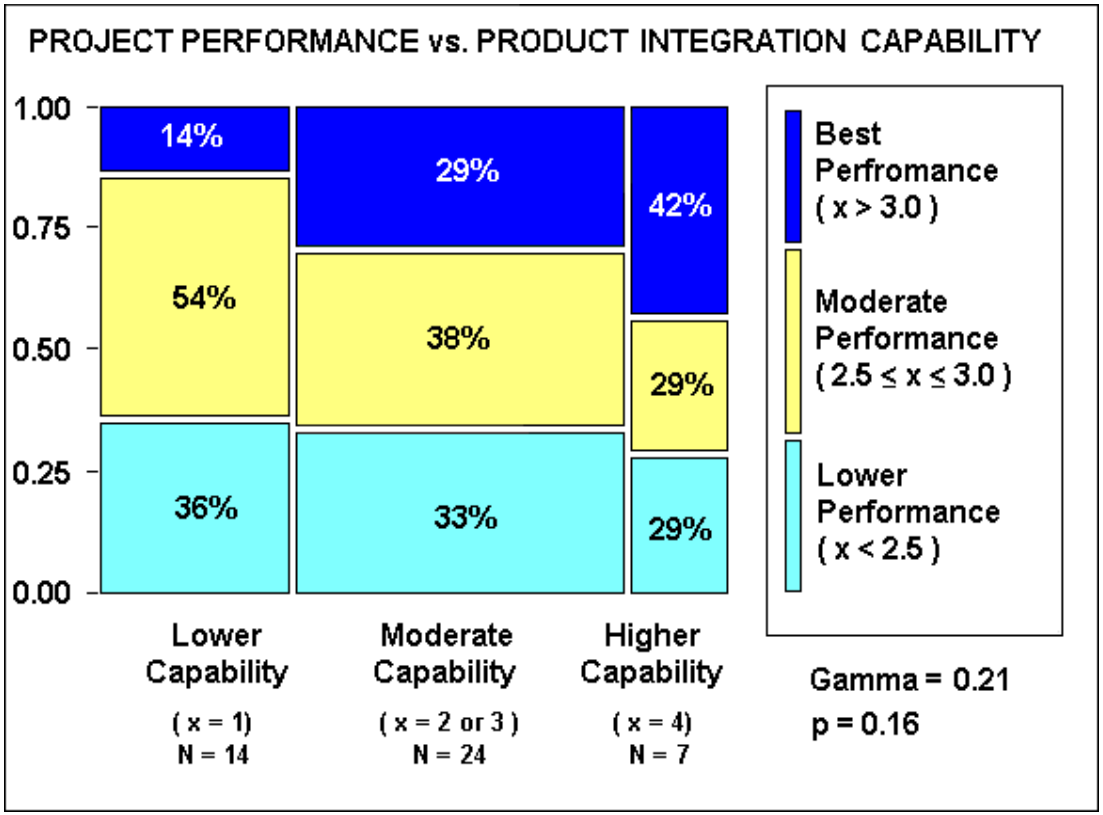


Verification assessment examined

- Verification Procedures
- Documented Acceptance Criteria
- Documented Technical Review Process
- Documented non-advocate reviews

Better Verification capabilities have a "Moderately Strong" positive relationship with Better Performance

Product Integration vs. Project Performance

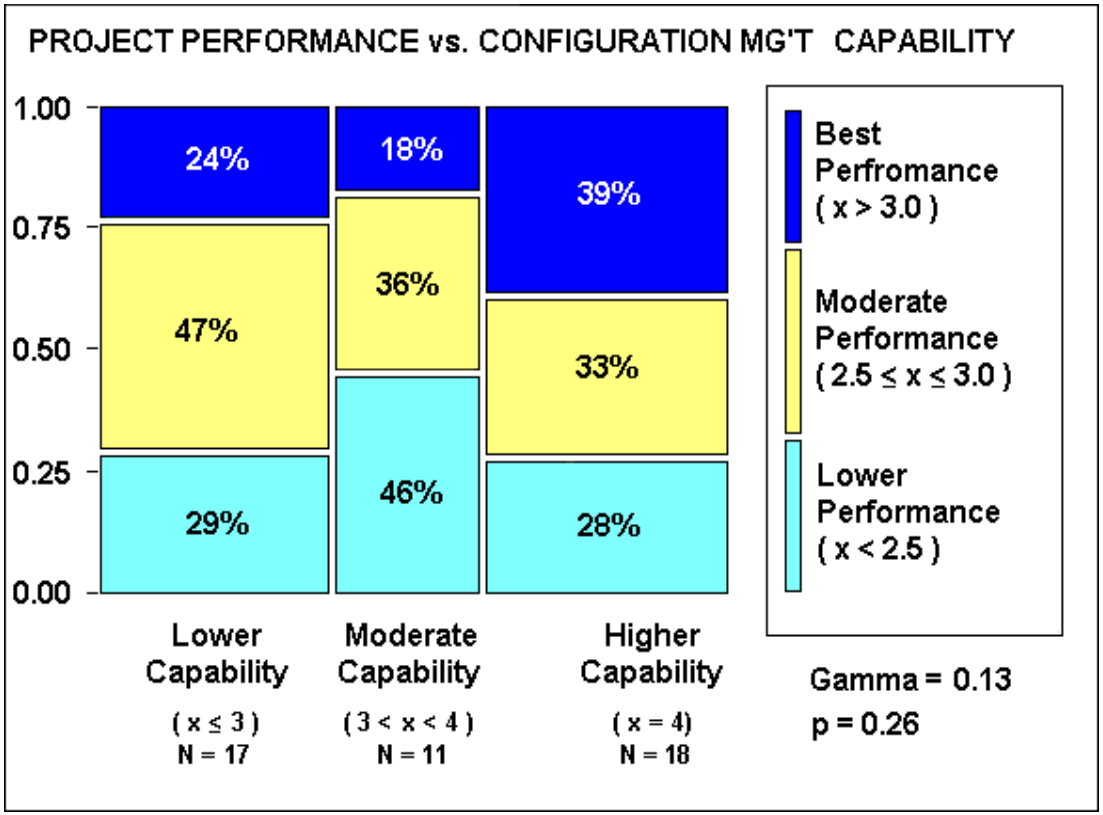


Product Integration assessment examined

- Documented Integration Process
- Documented Integration Criteria

Better Product Integration capabilities have a "Weak" positive relationship with Better Performance

Configuration Mg't vs. Project Performance

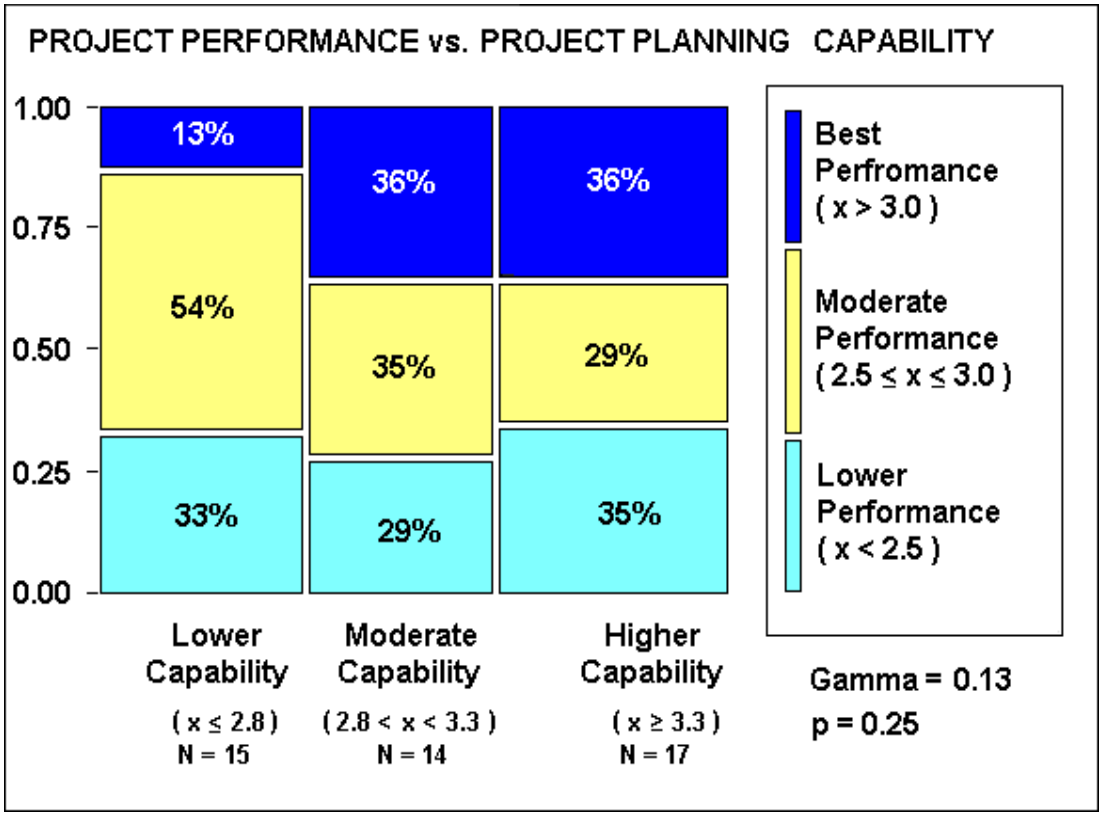


Product Integration assessment examined

- Change Control Board Charter
- Records of requested and implemented changes
- Configuration Baselines

Better Configuration Management capabilities have a "Weak" positive relationship with Better Performance

Project Planning vs. Project Performance

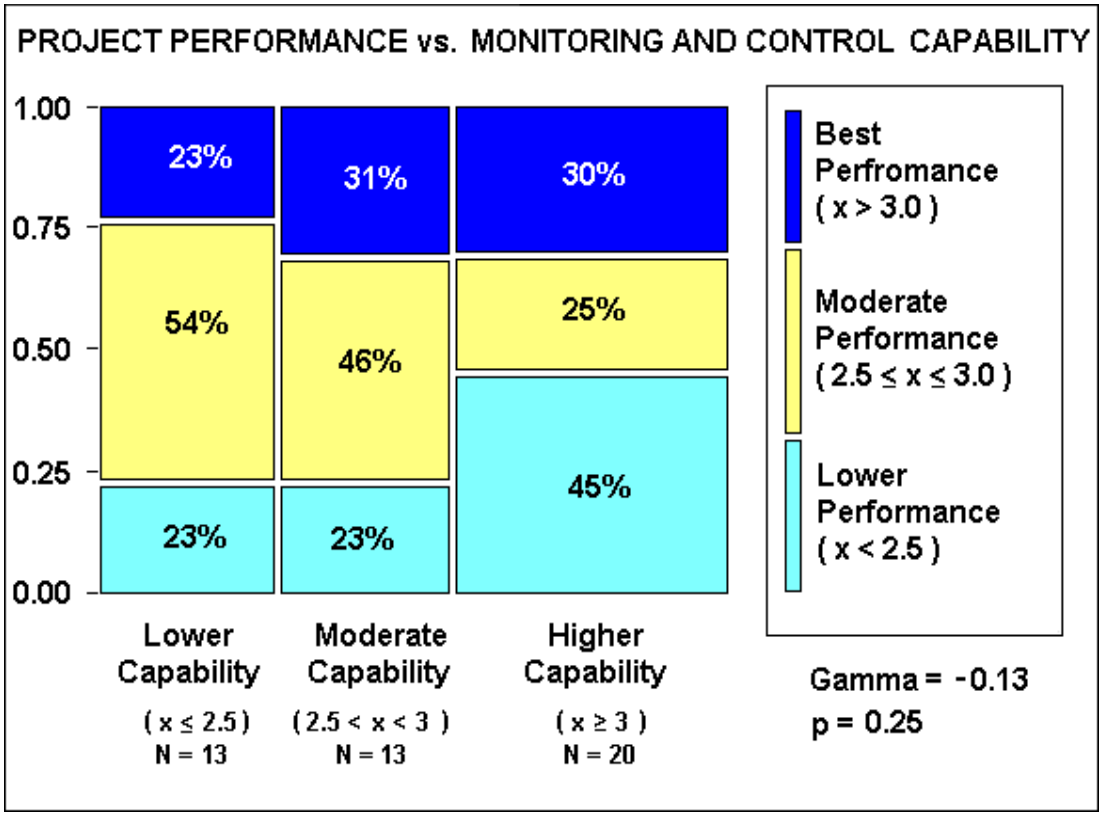


Project Planning assessment examined

- Project Planning Processes
- Work Breakdown Structure
- Technical Approach
- IMP and IMS
- Plan for technical reviews
- Systems Engineering Plan

Better Project Planning capabilities have a "Weak" positive relationship with Better Performance

Project Monitoring vs. Control and Project Performance

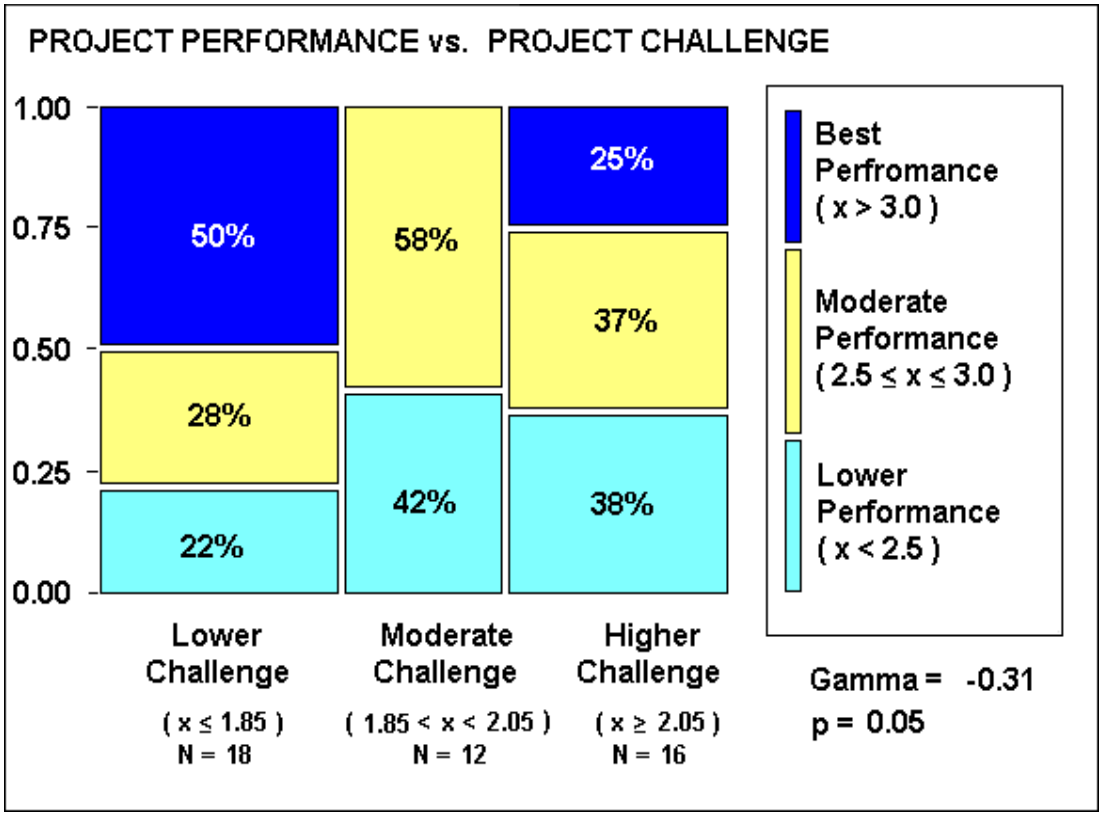


Project Planning assessment examined

- SE Costing and Tracking
- Cost and Schedule Baselines
- EVMS Data
- EVMS Data from Suppliers
- Defined Thresholds for SPI and CPI variance

Better Project Monitoring and Control capabilities have a "Weak" negative relationship with Better Performance

Project Challenge vs. Project Performance



Project challenge factors:

- # of Life cycle phases
- Project characteristics (e.g., size, effort, duration, volatility)
- Technical complexity
- Teaming relationships

More Challenging Projects do not perform as well.

Relating Project Performance to Project Challenge and SE Capability