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Comparative Evaluation of Efficiency Across Distributed Project Organizations: A Stochastic Frontier Analysis

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Outline

I. Motivation

The Larger Program of Research

Designing Work Within and Between Organizations

(Sinha and Van de Ven 2005)

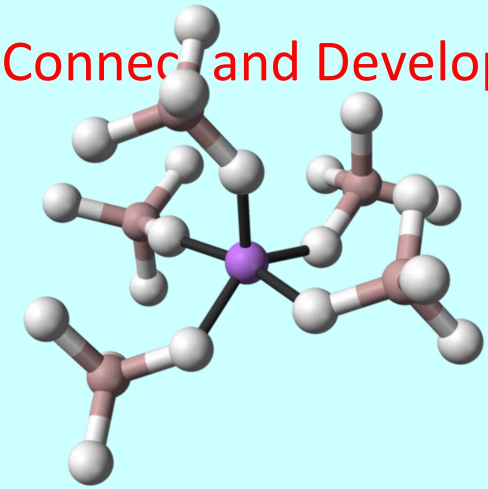
Health Care Supply Design: Toward Linking the Development and Delivery of Care Globally

(Sinha and Kohnke 2009)

I. Motivation

Fundamental shifts in the organization of technology projects

"Connect and Develop Approach"



"For every P & G researcher there were 200 scientists or engineers elsewhere in the world who were just as good"
(Huston and Sakkab, HBR 2006)

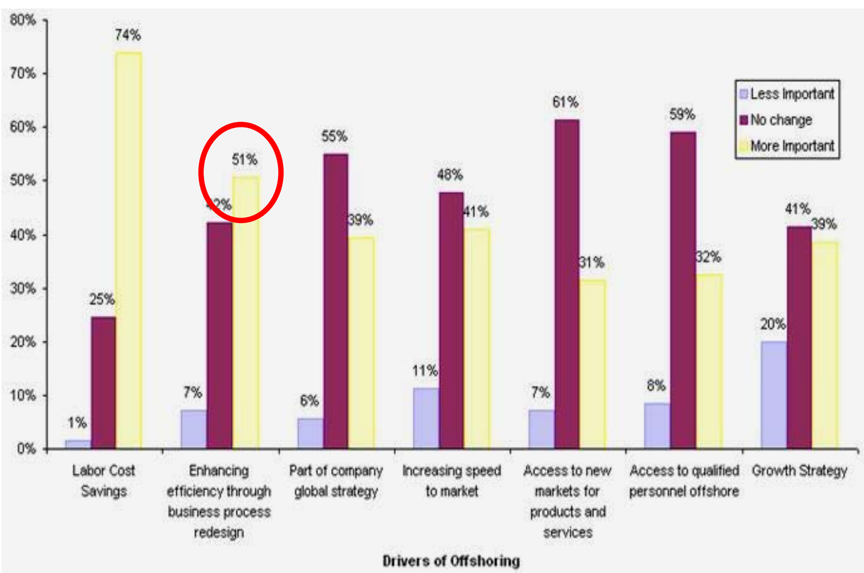
9 out of top 10 biggest R & D spenders have an offshore R&D centre.
(Booz Allen & Hamilton, 2005)

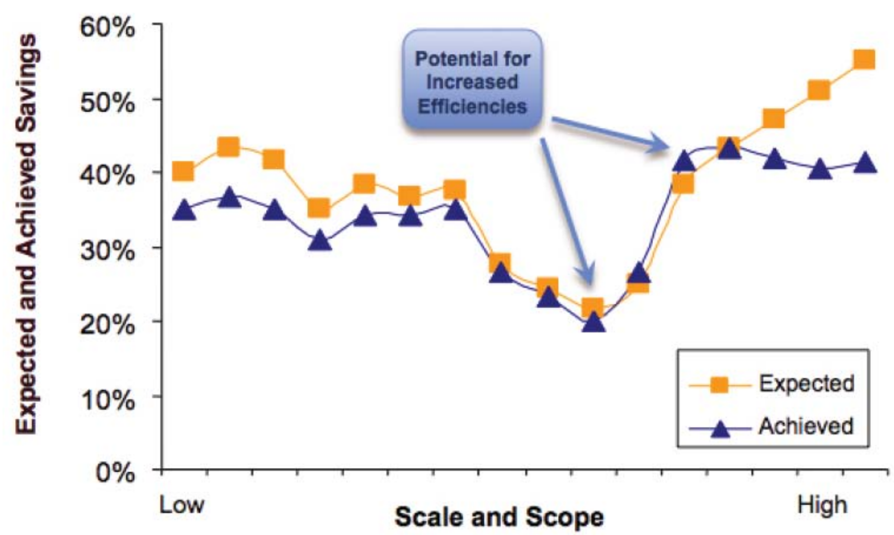
I. Motivation

Growing Importance of Project Efficiency in Offshoring Decisions

"While cost savings have been discussed extensively in the academic literature and in the media, efficiency in offshoring has taken heightened significance in the current worldwide economic slump"

— Lewin et al., (2009) in "Getting Serious about Offshoring in a Struggling Economy"





Source: Duke University/The Conference Board Offshoring Research Network 2007/8 U.S. Survey

I. Motivation – Focus on Project "Efficiency"

- Significant gap between *expected* and *actual* gains
  - Duke University's CIBER 2007 Offshoring Study
  - Deloitte 2007 Financial Services Offshoring Study
  - AT Kearney 2007 Offshoring Study

- Sourcing decisions are often taken at the top management level

  (Williamson, 1985; Holmstrom and Milgrom, 1994)

- Operational risk factors regarding project execution are not known during the initial stages

  (Gerwin and Ferris, 2004; Novak and Eppinger, 2002)

Identifying the enablers and barriers of project execution is critical for improving efficiency of distributed project organizations

I. Motivation – Focus on Project "Efficiency"

Technical Efficiency: Ability of a project to obtain maximum attainable outputs from a set of inputs (Farrell, 1957)

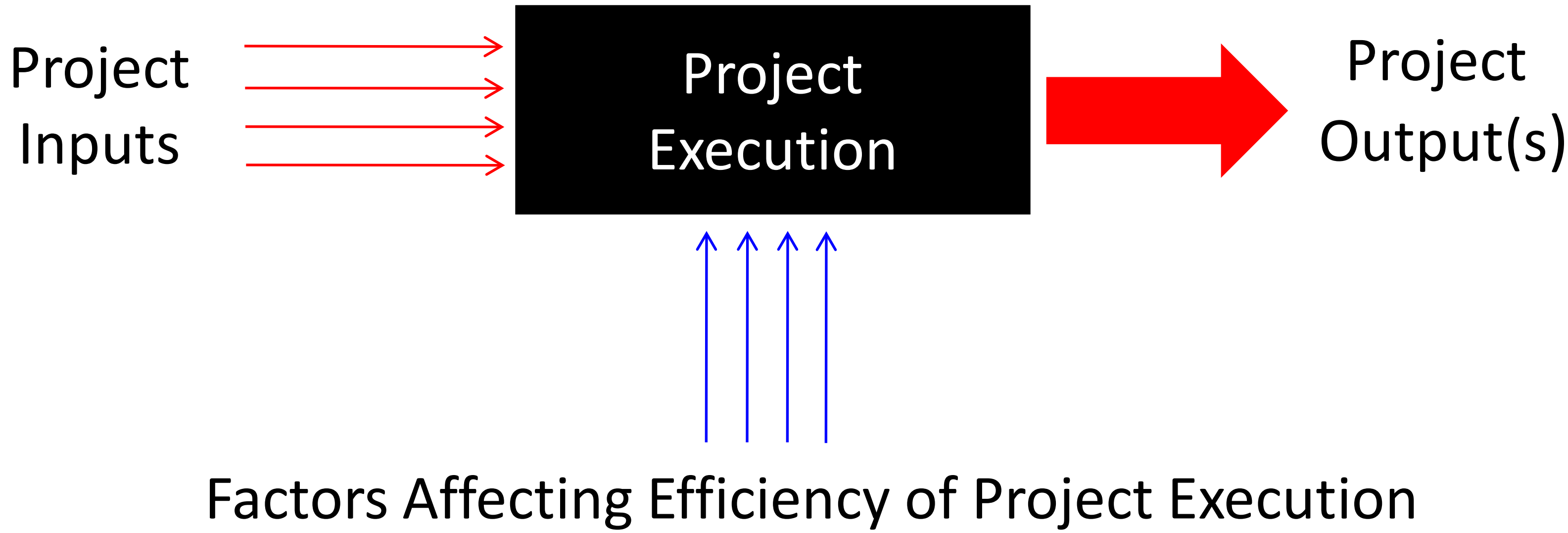
Studies of Project Efficiency are Uncommon

- Standard econometric models ignore heterogeneity among projects and assume that all projects are fully efficient (Coelli et al., 2005).
- Deterministic analytical models frequently specify project capabilities as set of *isoquants* on production frontiers (Nelson, 1982).
- Studies often confound project performance metrics (e.g., cost, budget) with project efficiency (Faraj and Sproull, 2000; Sobrero and Roberts, 2001).

These assumptions *do not* reflect the reality of technology project execution!

I. Motivation – Focus on Project "Efficiency"

Project Execution – An Economic Production Process



Research Questions

- How does the efficiency of distributed project organizations compare with those that are not distributed?
- What are the key project execution factors affecting the efficiency of projects?

II. Conceptual Foundation

Factors Affecting Efficiency of Project Execution

Structural Factors
long-range, strategic

Infrastructural Factors
operational, project management

(Hayes and Wheelwright, 1984)

Structural factor

- Project Organization Type

Infrastructural factors

- Face-to-face interaction
- Risk Management Planning
- Agile Management Planning
- Employee Turnover

Technical Efficiency

II. Conceptual Foundation

Project Organization Types

	INTRA-FIRM	INTER-FIRM
INTER-COUNTRY	**Offshoring**	**Offshore-Outsourcing**
INTRA-COUNTRY	**Insourcing**	**Outsourcing**

(Tanriverdi et al., 2007; Eppinger and Chitkara, 2006; Metters, 2008)

Insourcing	Design of Motorola's **Razr** phone
Outsourcing	**Lucent Technologies** contract **Borland** for developing automatic testing equipment. Both firms are located in US
Offshoring	**Microsoft** central R & D at Redmond, WA collaborates with Microsoft India Development Centre
Offshore-Outsourcing	**AVIVA**, a leading provider of life insurance products in UK contracts **TCS** for designing a partner management system

II. Conceptual Foundation – Hypotheses

- Technology projects require collective action from project client and project team (Wheelwright and Clark, 1992)
- Cultural differences across firm and country boundaries; difficulties in establishing common ground for exchanging business and technical information (Armstrong and Cole, 2002; Crampton, 2001)
- Potential for rework is high in distributed project organizations (Hightower and Sayeed, 1996)

HYPOTHESIS 1: Technical efficiency of distributed project organizations (Outsourcing, Offshoring, and Offshore-Outsourcing) is *less than* that of Insourcing project organization.

II. Conceptual Foundation – Hypotheses

Face-to-Face Interaction

- Cultural differences between a project client and the project team creates difficulty in information processing (Armstrong and Cole, 2002; Crampton, 2001)

- Insourcing project organizations with limited face-to-face interaction may encounter dynamics similar to distributed project organizations (Fiol and O' Connor, 2005)

- Face-to-face interaction can prevent conflicts, help both sides revisit their assumptions and reduce downstream rework (Kirkman et al., 2004; Hinds and Mortensen, 2005)

HYPOTHESIS 2: Face-to-face interaction is *positively* associated with the technical efficiency of a project.

II. Conceptual Foundation – Hypotheses

Traditional project management assumes

- predictable and sequential workflow
- project's technical and business requirements are well understood

Agile Project Management

- is a highly iterative and incremental process (Chin, 2004)
- involves continuous evaluation of requirement changes thereby reducing costly downstream rework (Augustine et al., 2005)
- utilizes prioritized resource deployment strategy that targets "bottlenecks" in a timely fashion (Thomke and Reinertsen, 1998)

HYPOTHESIS 3: Agile project management is *positively* associated with the technical efficiency of a project.

II. Conceptual Foundation – Hypotheses

Project risks can arise from many factors—e.g., unrealistic schedules and budgets, continuous requirement changes, lack of relevant knowledge (Sakthivel, 2007; Pich et al., 2002; Miller and Lessard, 2000)

Risk Management Planning

Extent to which project risks are identified at the beginning of the project, factored into requirements estimates and managed during the course of the project (Loch et al., 2006; Chapman and Ward, 1997)

- helps link potential threats to possible actions (Barki, 1993)
- facilitates a shared perception of the project among its participants (Lyytinen et al., 1998)

HYPOTHESIS 4: Risk management planning is *positively* associated with the technical efficiency of a project.

II. Conceptual Foundation – Hypotheses

Employee turnover has been a subject of considerable research in the management (Ton and Huckman, 2008; Glebbeeck and Bax, 2004).

Employee Turnover

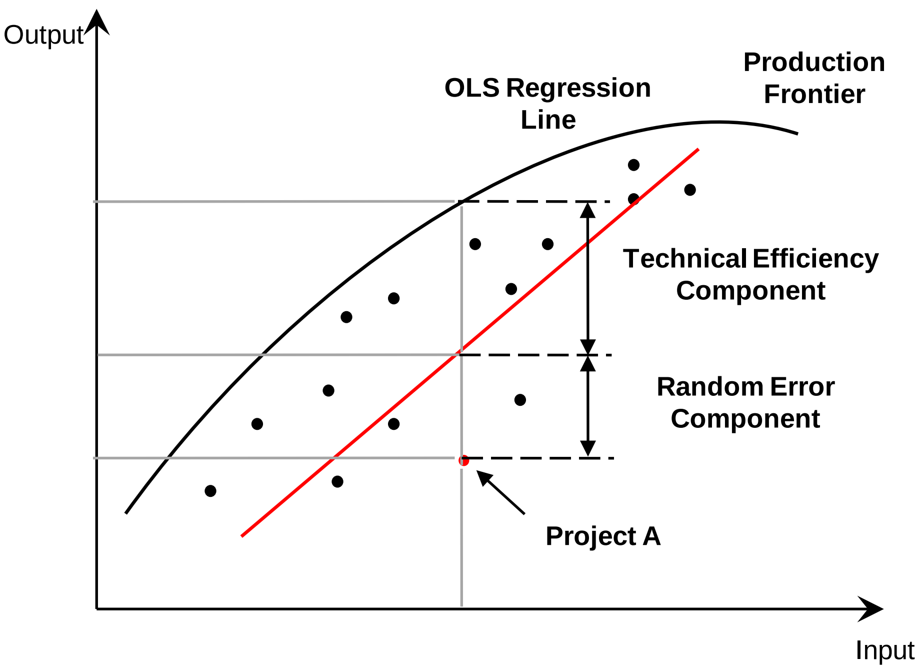
- A major challenge in distributed project organizations (Duke University/Booz Allen Hamilton Offshoring Research Network 2006 Survey)
- Impacts operating performance negatively due to disruption of existing routines (Bluedorn, 1982; Dalton and Todor, 1979)
- Loss of accumulated experience (Abelson and Baysinger, 1984)
- Set-up cost in hiring and training replacements (Osterman, 1987)

HYPOTHESIS 5: Employee turnover is *negatively* associated with the technical efficiency of a project.

III. Methodological Foundation

Stochastic Frontier Analysis

(Aigner et al., 1977; Meeusen and van der Broeck, 1977)



Technical Efficiency

(Farrell, 1957)

$$TE_i = \frac{\text{Observed Output}_i}{\text{Maximum Attainable Output}_i} = e^{-U_i}$$

$$\ln Y_i = f(X_i, \beta) + (V_i - U_i)$$

Distributional Assumptions

- Ui – i.i.d. with one-sided distribution (half-normal or truncated-normal)
- Vi – i.i.d. with two-sided normal distribution

III. Methodological Foundation

Estimation using Battese and Coelli (1995) approach

Stochastic Production Function

$$ln\, Y_i \;=\; \beta_o + \sum_n \beta_n ln(X_{ni}) \;+\; (V_i - \;U_i) \qquad \text{——} \qquad (1)$$

Technical Efficiency Function

$$U_i \;=\; \delta_o + \sum_k \delta_n Z_{ni} \;+\; W_i \qquad \text{——} \qquad (2)$$

IV. Research Design

- Data collected using web based survey
- Broad scope, captures several facets of project management

  - Project Organization Choice
  - Technological Uncertainty
  - Requirements Uncertainty
  - Architectural Uncertainty
  - Project Management Style
  - Past Experience
  - Risk Management
  - Knowledge Sharing
  - Agile Practices
  - Face to Face Interaction
  - Design-Interface Misalignment
  - Conflict (internal, external)
  - Shared Context
  - Team Diversity
  - Contract Type

Pilot testing (Dec 2006)

- Project Management Institute (PMI) chapter
- Project Management Yahoogroups
- Academic experts

Data collection (Feb – June 2007)

Survey e-mailed to members of

- PMI – Information Systems Group
- PMI – New Product Development Group

worldwide associations of project management professionals

IV. Research Design

Overall Sample Characteristics   Sample Size: 830 Projects

Project Organization Type	Frequency	%
Insourcing **[IN]**	454	54.7
Outsourcing **[OUT]**	168	20.2
Offshoring **[OFF]**	71	8.6
Offshore-Outsourcing **[OFFOUT]**	137	16.5
Total	830	100

72% respondents – Project Managers

Mean Project Team Size – 27.5 members

Mean PM Experience – 11.5 years

Mean Total Experience – 21.2 years

Responses spanned more than 26 industries

- Agriculture
- Advertising
- Aerospace
- Agriculture Equipment
- Automobile
- Banking
- Construction
- Consulting
- Consumer Electronics
- Consumer Goods
- Defense
- E-commerce
- Education
- Energy
- Entertainment
- Healthcare
- Heavy machinery
- Information technology
- Insurance
- Manufacturing
- Media & Entertainment
- Medical Devices
- Pharmaceutical
- Retail and Distribution
- Semiconductors
- Telecom
- Transport
- Travel
- Utility

IV. Research Design – Estimation Approach

Step 1: Test for Technical Efficiency Component in the Production Function

$$ln\, Y_i = \beta_o + \sum_n \beta_n ln(X_{ni}) + (V_i - U_i)$$

Output Variable

Project Performance: Adherence to Cost, Schedule, Quality, Technical Performance, Overall Satisfaction

Input Variables

Budget
Duration
Team Size
Past Experience
Technological Uncertainty
Requirements Uncertainty
Architectural Uncertainty

Control Variables

Project Type: Product, Software, Infrastructure
Respondent PM experience
Respondent role : Team member, Project or Senior manager
Respondent affiliation : Client , Vendor, External Consultant
Industry : IT, Banking, Insurance, Healthcare, Manufacturing
Project team location : North America

IV. Research Design — Estimation Approach

Chi-square (χ2) test of negative skewness of the residuals will indicate the presence of Technical Efficiency component (Kumbhakar and Lovell, 2000)

		Output Variable: lnProjectPerformance
		Model 1
Input Variables	lnBudget	.017
	lnDuration	-.013
	lnTeamSize	-.007
	lnPastExperience	.049
	lnTECHUNC	-.327**
	lnREQUNC	.008
	lnARCHUNC	.069*
Variance Parameters		
	σ_v	.145
	σ_u	.396
Test for technical efficiency Ho: No technical efficiency component		χ^2 = 65.36**
Log-likelihood Function		-80.667
Sample size (n)		745

Presence of Technical Efficiency Component

V. Results – Technical Efficiency Model

Step 2: Jointly estimate Production Function and Technical Efficiency Function

$$U_i = \delta_o + \sum_k \delta_n Z_{ni} + W_i$$

Output Variable: lnProjectPerformance		
		Model 2
Technical Efficiency Variables	Oustoucing **[OUT]**	-.227†
	Offshoring **[OFF]**	-.525**
	Offshore Outsourcing **[OFFOUT]**	-.644**
	FacetoFace	.070*
	RiskManagement	.188**
	AgileManagement	.178**
	EmployeeTurnover	-.158**
Variance Parameters		
	σ_v	.165
	σ_u	.382
Log-likelihood Function		7.288
Sample size (n)		704

Significant negative effects of OUT, OFF, OFFOUT Project Organization Types on Technical Efficiency

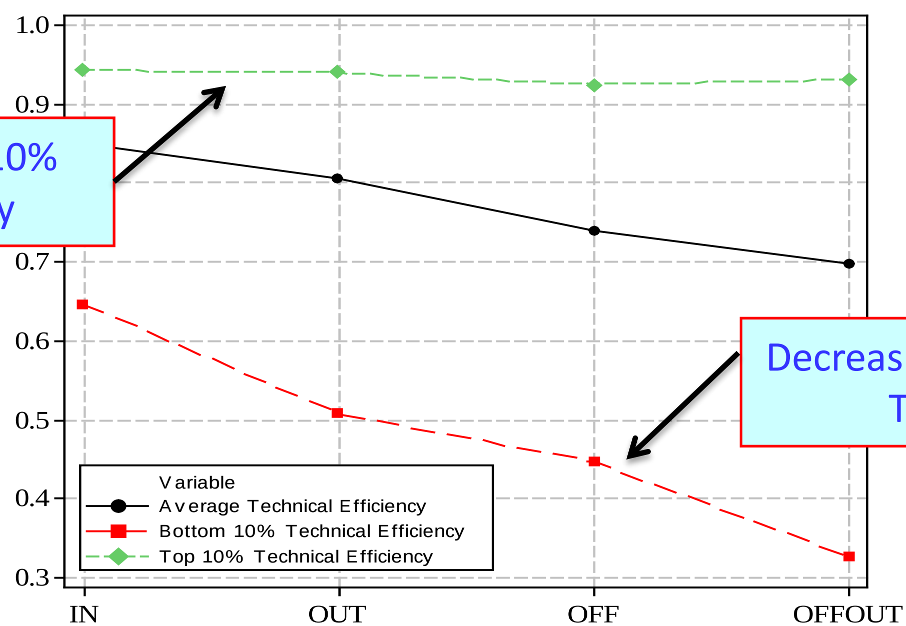
Hypothesis 1 : Supported

Significant positive effects of Face-to-Face Interaction, Risk Management Planning, Agile Management, and negative effects of Employee Turnover on Technical Efficiency

Hypotheses:
2, 3, 4, and 5 Supported

V. Results: Variation Across Project Organization Types

Project Organization Type	N	Top 10% Technical Efficiency	Average Technical Efficiency	Bottom 10% Technical Efficiency
Insourcing **[IN]**	378	0.943	0.850	0.647
Outsourcing **[OUT]**	152	0.940	0.807	0.508
Offshoring **[OFF]**	54	0.925	0.740	0.447
Offshore-Outsourcing **[OFFOUT]**	120	0.931	0.698	0.327



Similar levels of Top 10% Technical Efficiency

Decreasing levels of Bottom 10% Technical Efficiency

V. Conclusion—Key Findings

- How does the efficiency of distributed project organizations compare with those that are not distributed?

Technical efficiency of Outsourcing, Offshoring, and Offshore-Outsourcing project organizations are significant lower compared to Insourcing project organization

- What are the key project execution factors affecting the efficiency of projects?

Risk Management Planning
Agile Management Planning
Face-to-Face Interaction

Enablers of Technical Efficiency in a Project

Employee Turnover

Barrier to Technical Efficiency in a Project

VI. Contributions

Contributions to Academeme	Contributions to Practice

Growing Focus on project efficiency as a key driver of sourcing decisions in the current economy
(Lewin et al., 2009)
 	
▪ Provides a rigorous methodological apparatus—Stochastic Frontier Analysis (SFA)—to measure and diagnose project efficiency.
 	
▪ Compares and contrasts differences in project efficiency across project organization types and identifies the *enablers* and *barriers* of project efficiency.
	▪ Highlights the unfulfilled potential of Offshoring and Offshore-Outsourcing projects to provide greater benefit to both client and vendor firms.
	
	▪ Identifies key project execution factors impacting project efficiency:
	  ▪ Risk Management Planning
	  ▪ Agile Management Practices
	  ▪ Face-to-face Interaction
	  ▪ Employee Turnover

Thank You!

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