

# Globally Distributed Software Development Project Performance: An Empirical Analysis

Narayan Ramasubbu

School of Information Systems  
Singapore Management University

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# America's pain, India's gain

Economist

## Outsourcing Debate Enters Political Arena

Information Week

## SAP puts its eggs in India basket

Economic Times

## Microsoft Courts Offshore Outsourcers

Information Week

## Outsourcing Debate Tainted by Myths, Misconceptions

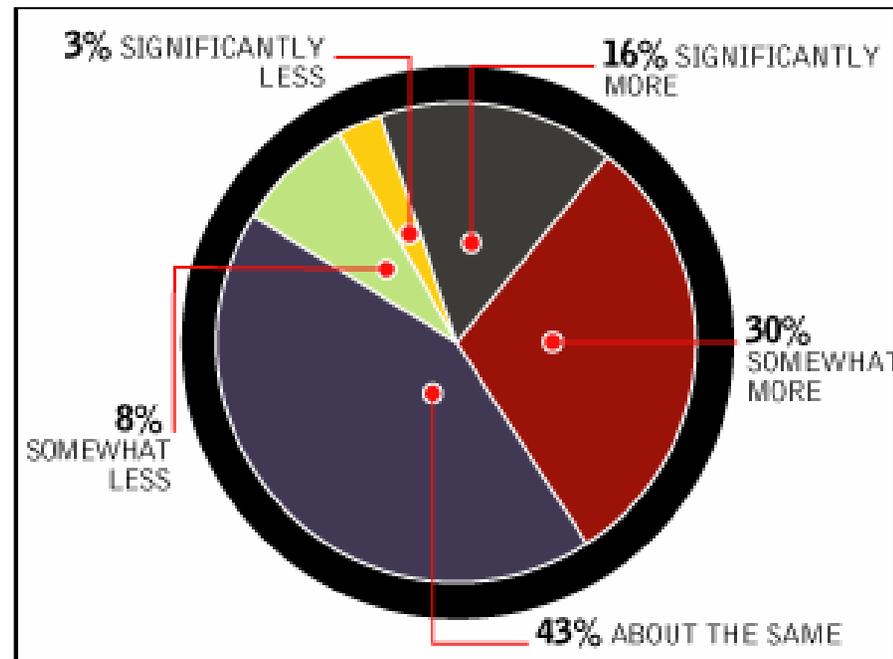
FoxNews

## Outsourcing Debate Driven by Cost, Agility

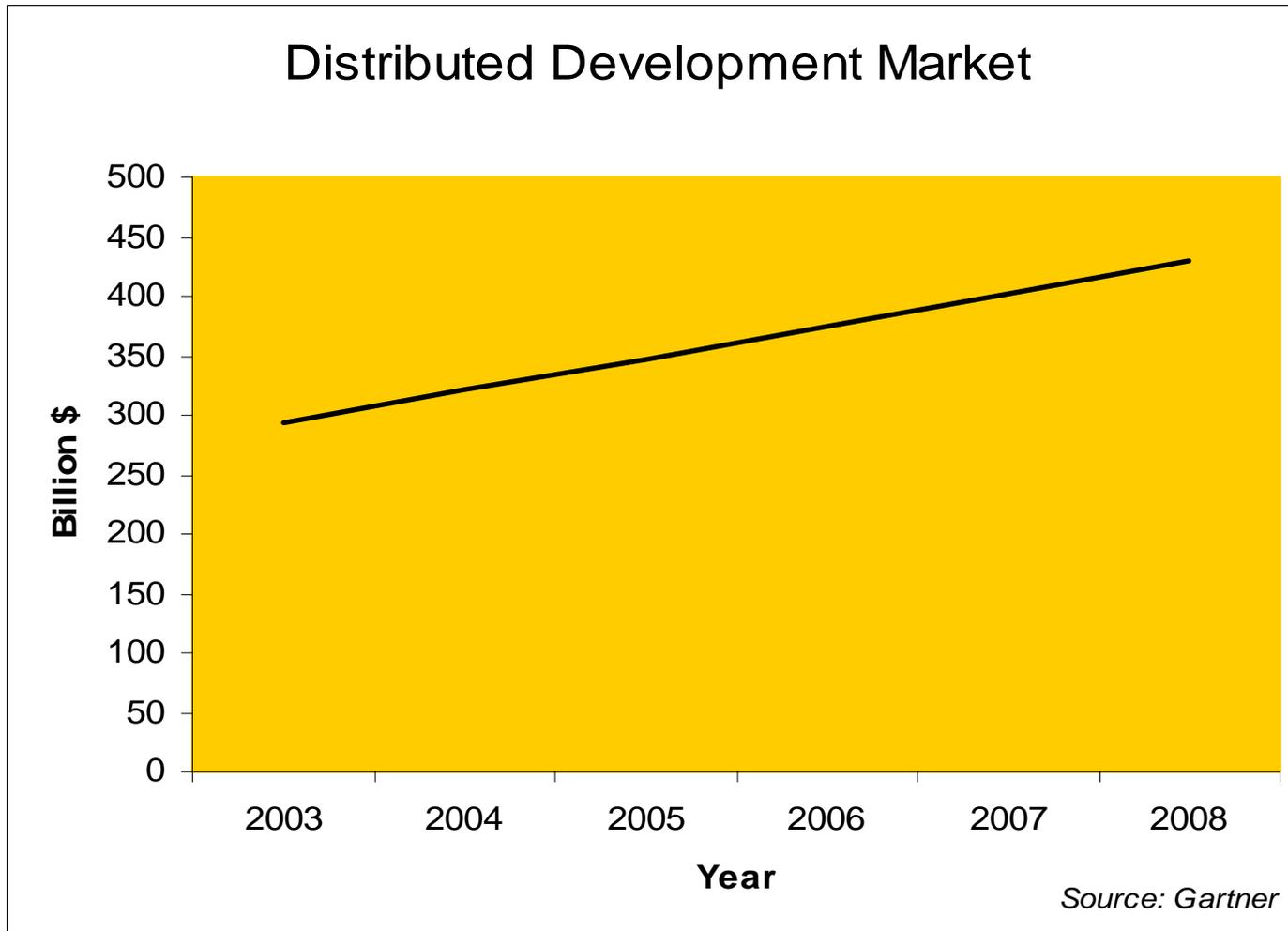
Computer World

# Offshore Dependence

- Distributed software development becoming pervasive
  - \$ 12.5 billion trade with India
  - \$ 5 billion trade with China
  - \$ 475 million trade with Russia
  - Labor shortage
  - Cost difference
  - Strategic regional presence
  - (Carmel 1999, Carmel & Agarwal 2002)



Source: Information Week



- By 2008, 56% of all IT expenditure will be on collaborative application development
- Cost reduction expectation as the No. 1 propeller (*CIO survey*)

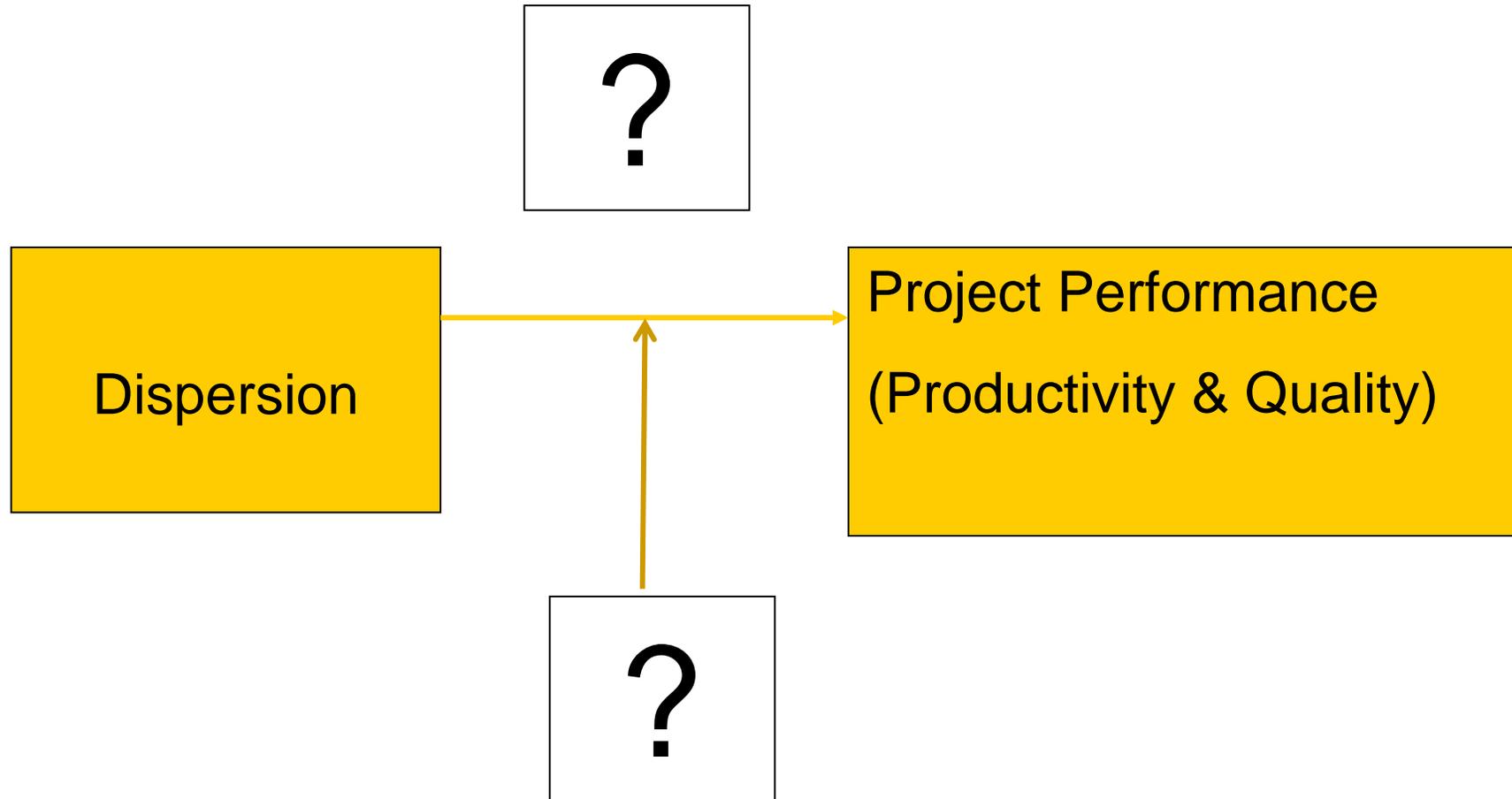
# Practitioner's Experience

- “Expected cost reductions did not lead to lower costs in the long term” (*CIO survey, Gartner*)
- “There were a lot of bumps; there were help-desk tickets piling up on the floor” (*CIO, Boeing*)
- “I don’t think we’re saving money – whether we get better service is arguable too” (*CIO, Beverage company*)
- “Savings because of difference in labor rates quickly disappeared” (*Forrester CIO survey*)
- “Almost everyone has a problem. The culprit is often a bad process at home.” (*Lance Travis, HP & AMR*)

# Nuggets from Academic Research

- Distributed development is negatively associated with
  - Productivity and Cycle time (*Herbsleb and Mockus 2003*)
  - Planning and control capability (*Herbsleb, Paulish and Bass 2005*)
  - Knowledge management capability (*Cramton 2001, Sarker et al 2005*)
  - Trust and team cohesiveness (*Jarvenpaa and Leidner 1999, Warkentin, Sayeed and Hightower 1997*)

# Dispersion and Performance



# Scope of our study

- Development projects
  - Business applications
- Role of structured processes
  - High rate of adoption among distributed development practitioners
  - Largest number of CMMI-level 5 companies in India

# Role of structured processes

- Structured approach treats software development tasks as processes that can be measured, controlled and improved using process models
  - *CMM, ISO 9001, Trillium, Bootstrap, etc*

# Quality Management Approaches

- Categorization of quality activities

Prevention	Appraisal	Failure
Training Technical Business Process Configuration management Planning & Scheduling	Requirement, specification and design peer reviews Inspections Status reviews	Unit Testing Integration Testing System Testing Bug tracking and correction Intermediate builds

# Competing Views

## Pros

- Enforces discipline
- Enhances predictability
- Facilitates control
- Evidence from co-located settings
- *Humphrey 1989, Krishnan & Kellner 1999, Harter et al 2000, 2003*

## Cons

- structuration stymies improvisation and creativity (*Aaen 2003*)
  - Lacks social aspects, posits mechanistic view of firms (*Ngwenyama and Nielsen 2003*)
- “.....the hierarchical structures of the CMM work processes with their explicitly defined role responsibilities and strict management control are contradictory to building trust upon which a development culture thrives...”*

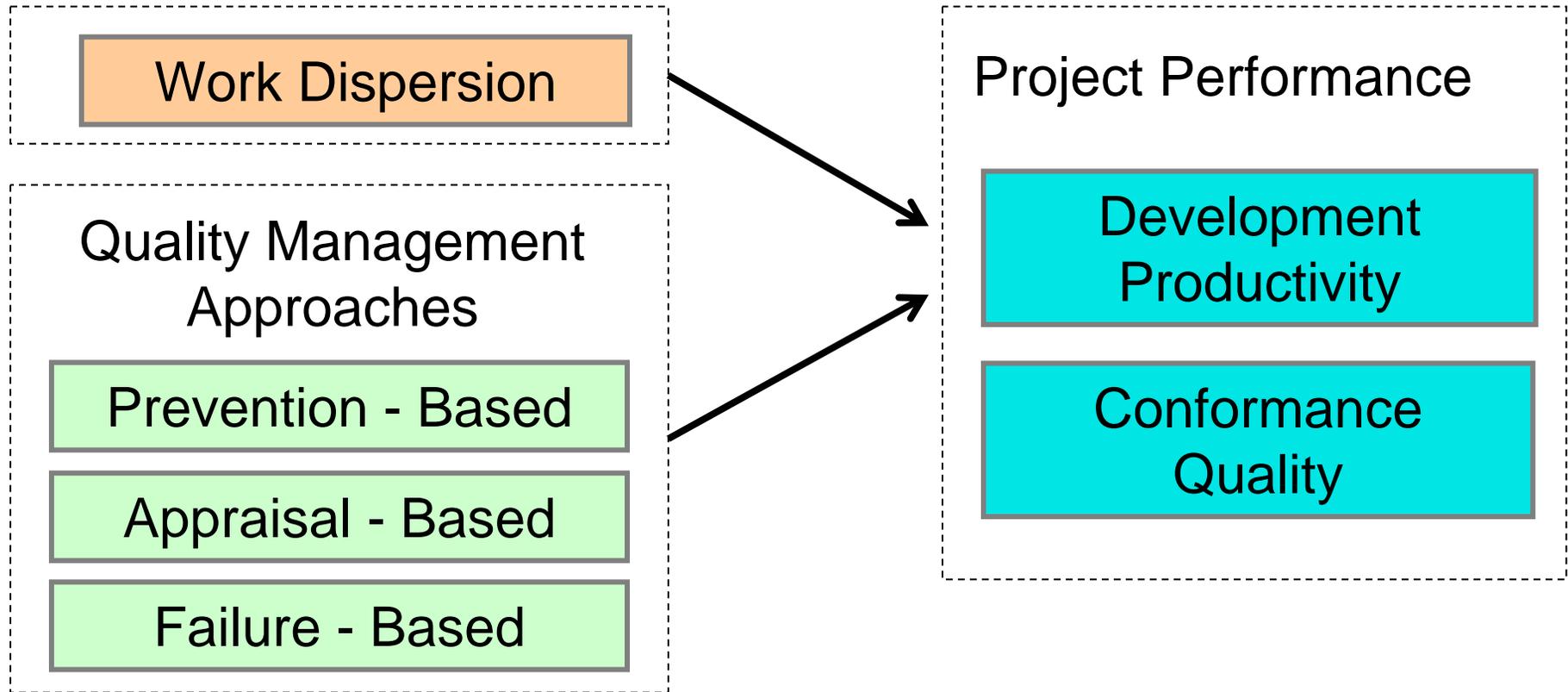
# Research Questions

1. To what extent does “dispersion” in software tasks affect software productivity and quality?
2. To what extent can investments in structured software engineering processes mitigate the effect of dispersion?
3. What are the relative effects of individual quality management practices in improving distributed project performance?

# Research Approach

- 2 year Field Study at a large global software firm
  - Data from 42 projects tracked from start to finish
  - Dispersion between USA and India
  - CMMI Level 5 process maturity
  - People Management Level 5 (PCMM)

# Research Model



## Control Variables

*Team Size, Code Size, Code Reuse,  
Upfront Investment, Design Rework*

# Empirical Models

1. *Development productivity* =  $f$  {conformance quality, work dispersion, defect prevention, task appraisal, failure costs, reuse, team size, project duration}
2. *Conformance quality* =  $f$  {development productivity, work dispersion, defect prevention, task appraisal, failure costs, code coverage, code size, team size, project duration}

# Results: Hypothesis Tests

HYPOTHESIS	PARAMETER	EFFECT ON PRODUCTIVITY	EFFECT ON QUALITY
1 A, B	Dispersion	- (-)	- (-)
2 A,B	Prevention	+ (+)	NS (+)
3 A,B	Appraisal	+ (+)	NS (+)
4 A,B	Failure-based	NS (-)	+ (+)
5 A, B	Relative Returns	Appraisal > Failure	Failure > Appraisal

# Detailed Results

Models →	Parameter	(1)	(2)	(3)	(4)
Dependent Variable →		Development Productivity	Conformance Quality	Development Productivity	Conformance Quality
Development Productivity	$\beta_1$	----	2.03*** (0.002)	----	2.02*** (0.002)
Conformance Quality	$\beta_2$	- 0.374*** (0.000)	----	- 0.382*** (0.000)	-----
Integration effort due to work dispersion	$\beta_3$	- 0.196*** (0.004)	- 0.404*** (0.013)	-0.152* (0.066)	-0.515** (0.018)
Aggregate Work Sharing (% onsite / total)	$\beta_3$	----	----	- 0.243 (0.332)	0.469 (0.449)
Defect Prevention	$\beta_4$	0.177* (0.075)	0.235 (0.259)	0.153 (0.134)	0.283 (0.183)
Task Appraisal	$\beta_5$	0.404*** (0.006)	0.496 (0.147)	0.380** (0.011)	0.522 (0.126)
Failure	$\beta_6$	0.2 (0.192)	0.746* (0.072)	0.256 (0.118)	0.744* (0.071)
Reuse	$\beta_7$	0.942*** (0.000)	--	0.942*** (0.000)	---
Team Size	$\beta_8$	- 0.443*** (0.004)	1.652** (0.022)	-0.429*** (0.005)	1.58** (0.025)
Project duration	$\beta_9$	- 0.344*** (0.002)	0.852** (0.031)	- 0.317*** (0.006)	0.824** (0.034)
Code Size	$\beta_{10}$	----	-2.36*** (0.000)	----	-2.36*** (0.00)
Code Coverage	$\beta_{11}$	----	- 0.463 (0.210)	----	-0.599 (0.142)
Constant	$\beta_0$	-3.962***	11.312***	-3.43***	10.56***
Centered R - squared		0.663	0.564	0.66	0.57
F		11.23*** (0.00)	4.79*** (0.000)	9.71*** (0.000)	4.24*** (0.000)

# Questions Revisited

1. *Does “dispersion” affect software productivity and quality?*
  - *Significant effect on productivity. Secondary effect on quality*
2. *Effect of structured software engineering processes on dispersion?*
  - *Quite a bit. These processes really do help*
3. *Relative effects of individual QMAs?*
  - *Productivity: Appraisal > Failure >>> Prevention*
  - *Quality: Failure > Prevention >>> Appraisal*

# Limitations of Study

- *Only project-level aggregate data*
  - *No task-level analysis*
  - *Cultural and human factors not considered*
- *Unclear how generalizable the results are*
  - *Non CMM level 5 firms*
  - *Non custom business application development*

# Qualitative Insights - 1

## The problem of task variance:

“.....my contract says my office time is flexible. Sometimes I spend all my time at office browsing the internet, chatting with friends and doing personal stuff because my colleagues at onsite have not responded. Other times I go home late continuously for a more than a week and I do not get time to spend with my family; it is frustrating.....”

*[Interview Transcript, Senior Software Engineer]*

# Qualitative Insights - 2

## The problem of project management ambiguity:

“.....when I travel to my onsite and stay for few months it is not clear to me if my onsite manager passes on all information about my achievements to my offshore manager. Though my onsite manger monitors my task, it is my offshore manager who decides my annual bonus. Some times I feel I am at a disadvantage as compared to my offshore colleagues....”

*[Interview Transcript, Development Programmer ]*

# Qualitative Insights - 3

## The problem of mutual knowledge:

“.....I had worked on the customer’s system from offshore for more than a year. But I never fully understand why my onsite coordinator initiated so many change requests for my work even after we had discussed its design before hand. Only when I visited onsite, I fully understood the production mechanism and end users’ expectation. That’s when I realized how different our views of the system where. I wish I can pass on this experience to my offshore colleagues; but it is not easy.....”

*[Interview Transcript, Development Programmer]*

# Looking Forward

- Follow up study
- What are the key processes necessary for *managing* distributed software development?

Maturity Level	Key Process Areas
Level 0: No-process level	
<b>Level 1: Initial level</b>	Trust and belief
	Communication skills
	Distributed technology infrastructure
	Team structure
	Cultural awareness
	Remote people management
	Shared goal setting
	Tailoring of goals
Budgeting and cost ownership	



Maturity Level	Key Process Areas
<b>Level 2 : Consolidation level</b>	Division of labor
	Integrated tool environment
	Project management consistency
	Functional ownership
	Knowledge management
	Management communication channel



Maturity Level	Key Process Areas
<b>Level 3 : High productivity level</b>	Performance management
	Complexity management
	Managerial span
	Infrastructure for social development
	Competency management
	Innovation management
	Best Practices
	Contractual stability
	Strategic Significance

- Thank you !
- Questions, Comments and Feedback welcome

[nramasub@smu.edu.sg](mailto:nramasub@smu.edu.sg)

Contact Information:

<http://www.sis.smu.edu.sg/faculty/infosys/nramasub.asp>