

CMMI® for Small Business

**NDIA CMMI® Working Group
NDIA Systems Engineering Division**

CMMI Technology Conference

November 17, 2010

Small Business in the Defense Industry



The defense industry is critically dependent on small business for the technology and rapid innovation needed for future defense business.

“...In one of the few studies of its kind, the Pentagon’s industrial policy office in 2005 identified the critical, innovative technologies which are needed for 21st century wars and found that 35 to 45 percent of the companies supplying those key technologies had fewer than 100 employees.”

- NDIA *National Defense Magazine* (June 2010),

<http://www.nationaldefensemagazine.org/archive/2010/June/Pages/PentagonNeedsInnovativeMid-TierContractors.aspx>

However, small businesses can be challenged to compete and thrive in the defense market.

“... Only the largest firms have access to the resources and expertise to bid on the most complex programs, and it is difficult for all but the largest size to survive losing them. As a result, competition is reduced at the front end of programs, and all but eliminated in the sustainment phase.... Small businesses are largely locked out of the process or accorded contracts only on the goodwill of one of the larger firms.... The end result of this process is the gradual erosion of competition and innovation in the defense industrial base.”

-House Armed Services Committee Panel on Defense Acquisition Reform, *Findings and Recommendations* (March 2010)

<http://armedservices.house.gov/pdfs/DARFINALREPORT/DARFINALREPORT032310.pdf>

Is CMMI for Small Business?

The NDIA CMMI Working Group was tasked to investigate common questions on the applicability of CMMI to small business

- Is CMMI appropriate for small businesses?
- Is CMMI a barrier to competition in the defense market?
- What data substantiates the adoption of CMMI by small business?
- What challenges do small businesses face for adoption?
- How can acquirers use CMMI to manage their acquisition risks with small suppliers?



What is a Small Business?

There is no single definition of what constitutes a small business.

The SBA characterizes small businesses in terms of size and revenue, by domain

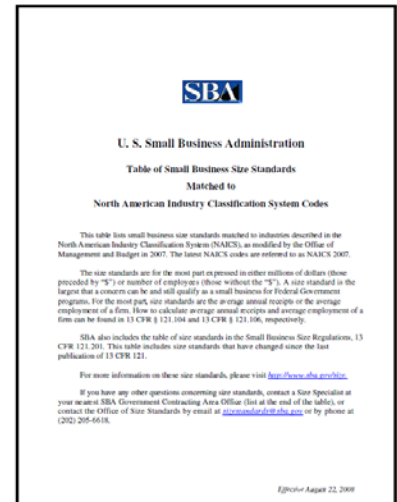
- Size standards defined by North American Industrial Classification System (NAICS)
- Typically ~250 employees, < \$25M in revenue

SEI research characterizes a small setting as:

- Small business < 100 people
- Small organization within a large organization, < 50 people
- Small project < 20 people

For this study, we did not set thresholds, but focused on employee size across a wide range of data partitions

- As small as a few people
- As large as several thousand people
- 'Small' may be in the eye of the beholder



NDIA Small Business Division

<http://www.ndia.org/Divisions/Divisions/SmallBusiness/Pages/default.aspx>

U.S. Small Business Administration size standards:

<http://www.sba.gov/contractingopportunities/officials/size/index.html>

Prior Studies and Research

Many prior initiatives have investigated CMMI for small business. Example resources include:

CMMI in Small Settings Toolkit Repository

Suzanne Garcia (SEI), Sandra Cepeda (AMRDEC SED/CSSA), Gene Miluk (SEI), Mary Jo Staley (AMRDEC SEC/CSC)

<http://seir.sei.cmu.edu/toolkit/index.html>

Improving Processes in Small Settings (IPSS)

International Process Research Consortium (IPRC)

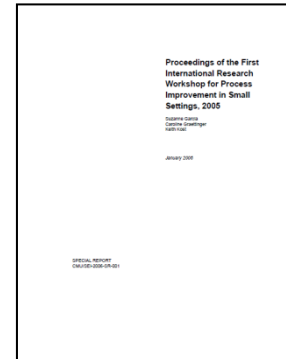
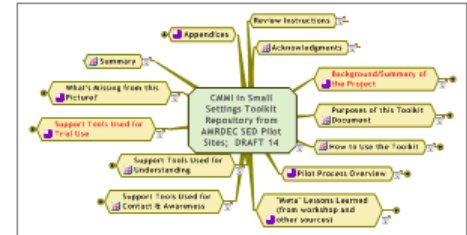
“Proceedings of the 1st International Researcher’s Workshop on Process Improvement in Small Settings”

<http://www.sei.cmu.edu/publications/documents/06.reports/06sr001.html>

“An exploratory study investigating the organizational and technical impacts of applying disciplined system development processes (CMMI™) in small to medium sized enterprises.”

Miluk, Gene. Ph.D. dissertation, Pepperdine University, 2006.

<http://gradworks.umi.com/32/24/3224161.html>

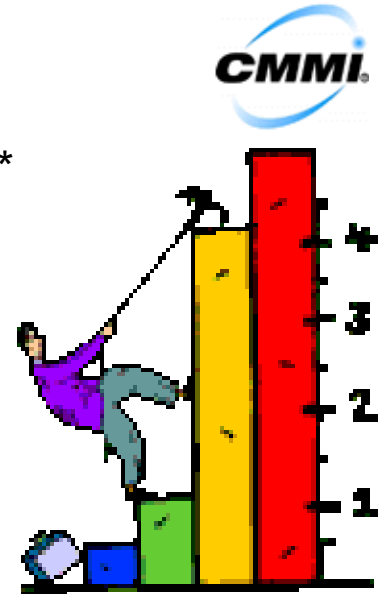


The CMMI WG conducted interviews and discussions with several of these researchers and subject matter experts.

CMMI for Small Business – Data Collection and Analysis

There are plenty of anecdotes, speculations, and opinions on the applicability of CMMI for small business – what does the data tell us?

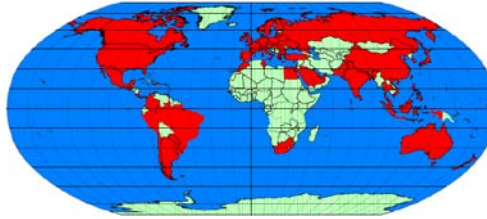
- SEI CMMI® Process Maturity Profile*
<http://www.sei.cmu.edu/cmmi/casestudies/profiles/cmmi.cfm>
- SEI Published SCAMPISM Appraisal Results (PARS)*
<http://sas.sei.cmu.edu/pars/>
- Organizational change research
Dr. Leigh Riley, leigh@acmeprocessgroup.com
- 1st International Research Workshop for Process Improvement in Small Settings
<http://www.sei.cmu.edu/library/abstracts/reports/06sr001.cfm>
- Surveys, questionnaires, ...



***Caveats:** Most CMMI data is reported and collected from appraisals based on size of the organizational unit – which may or may not be directly reflective of the size of the company overall. Other companies may also be using CMMI beyond just those conducting and reporting SCAMPI-A appraisals.

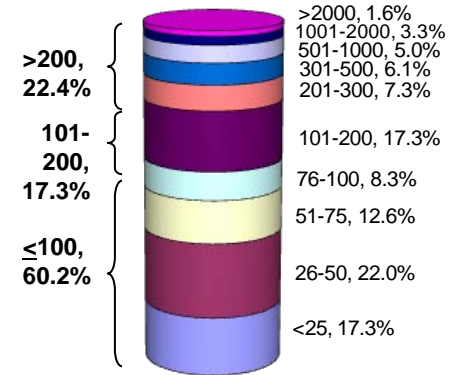
CMMI Adoption

CMMI appraisals are conducted worldwide...



	USA		Non-USA	
	Qty	%	Qty	%
Commercial In-House	425	35.2%	3354	91.8%
Contractor for Military/Government	651	54.0%	223	6.1%
Military/Government Agency	130	10.8%	76	2.1%
	1206	100.0%	3653	100.0%
	25%		75%	

...in small and large organizations and projects



Organization Size (Employees)
(4863 organizations reporting)

...in a wide range of businesses

Services (72.1%)

- Business Services
- Engineering and Management Services
- Health Services
- Other Services

Manufacturing (15.7%)

- Electronic and Electric Equipmt
- Transportation Equipment
- Instruments & Related Products
- Industrial Machinery
- Other Mfg Industries

Other (12.2%)

- Finance, Insurance, Real Estate
- Public Administration/Defense
- Transportation, Communication, Utilities

Based on primary Standard Industrial Classification (SIC) codes reported in CMMI-based appraisals.

...at all levels of process maturity

	Commercial In-House	Contractor for Military/Government	Military/Government Agency
No Rating Given	5.3%	8.0%	22.3%
Initial (ML1)	0.6%	1.4%	1.0%
Managed (ML2)	25.8%	31.5%	45.6%
Defined (ML3)	58.1%	49.3%	26.7%
Quantitatively Managed (ML4)	2.9%	1.0%	1.5%
Optimizing (ML5)	7.2%	8.9%	2.9%
	(3779 orgs)	(874 orgs)	(206 orgs)

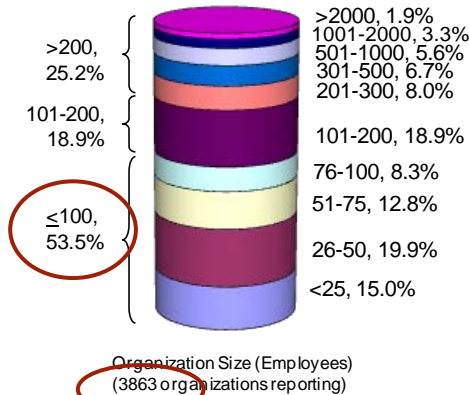
Source: SEI Process Maturity Profile, Sept 2010.

<http://www.sei.cmu.edu/cmmi/casestudies/profiles/cmmi.cfm>

Adoption Trends in Small Business

Comparison: SEI Process Maturity Profile, Sep 2009 vs. Sep 2010

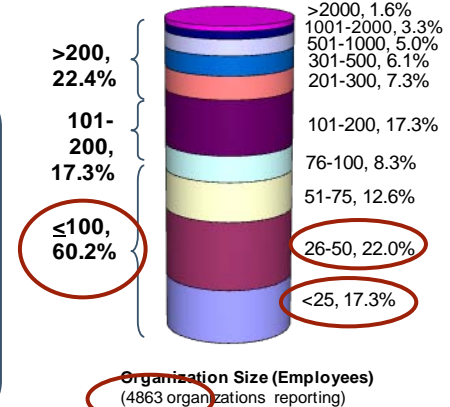
Sep 2009



Sep 2010

Greatest growth in CMMI adoption worldwide continues to be

- small
- commercial
- overseas



	Commercial In-House	Contractor for Military/Government	Military/Government Agency
No Rating Given	5.7%	8.5%	22.3%
Initial (ML1)	0.8%	1.6%	1.7%
Managed (ML2)	28.0%	31.7%	44.3%
Defined (ML3)	53.6%	46.7%	26.7%
Quantitatively Managed (ML4)	3.1%	1.4%	1.1%
Optimizing (ML5)	8.7%	10.1%	3.4%
	(2920 orgs)	(769 orgs)	(176 orgs)

	USA		Non-USA	
	Qty	%	Qty	%
Commercial In-House	354	33.6%	2566	91.3%
Contractor for Military/Government	586	55.7%	183	6.5%
Military/Government Agency	113	10.7%	63	2.2%
	1053	100.0%	2812	100.0%
	27.2%		72.8%	

	Commercial In-House	Contractor for Military/Government	Military/Government Agency
No Rating Given	5.3%	8.0%	22.3%
Initial (ML1)	0.6%	1.4%	1.0%
Managed (ML2)	25.8%	31.5%	45.6%
Defined (ML3)	58.1%	49.3%	26.7%
Quantitatively Managed (ML4)	2.9%	1.0%	1.5%
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Contractor for Military/Government	651	54.0%	223	6.1%
Military/Government Agency	130	10.8%	76	2.1%
	1206	100.0%	3653	100.0%
	24.8%		75.2%	

What's the CMMI maturity profile for small businesses?

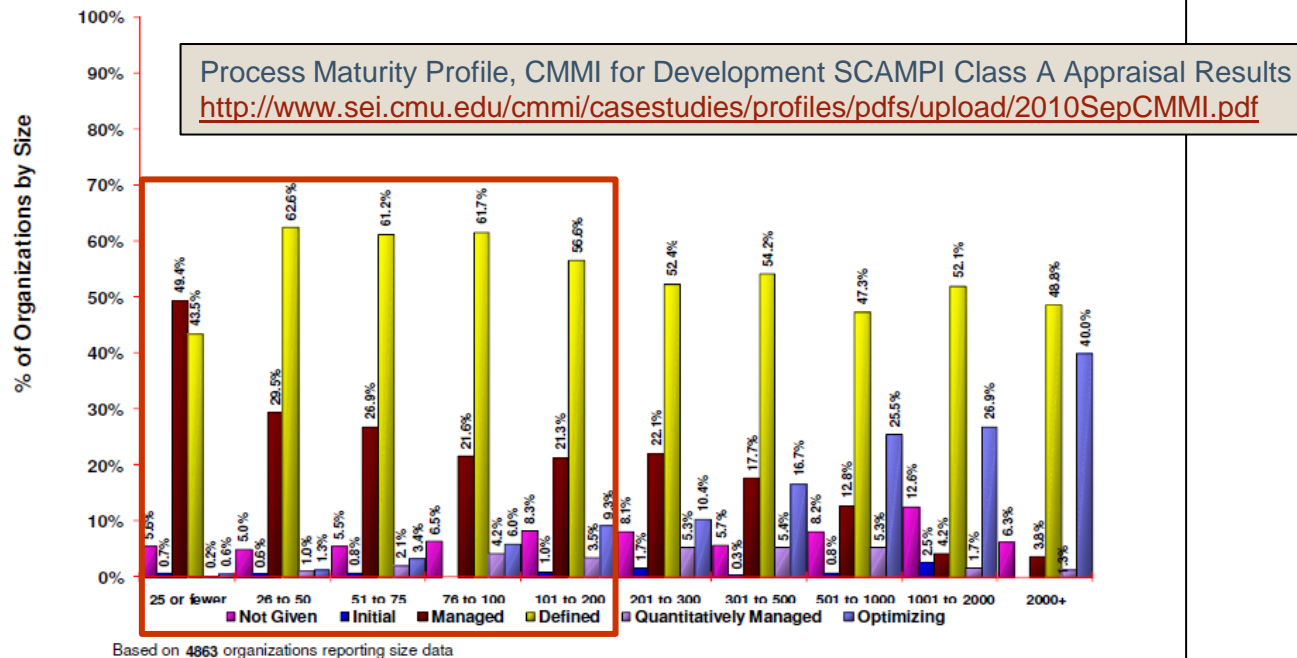


Carnegie Mellon
Software Engineering Institute CMMI® DEV v1.1/v1.2 – SCAMPI v1.1/V1.2 Class A Appraisal Results



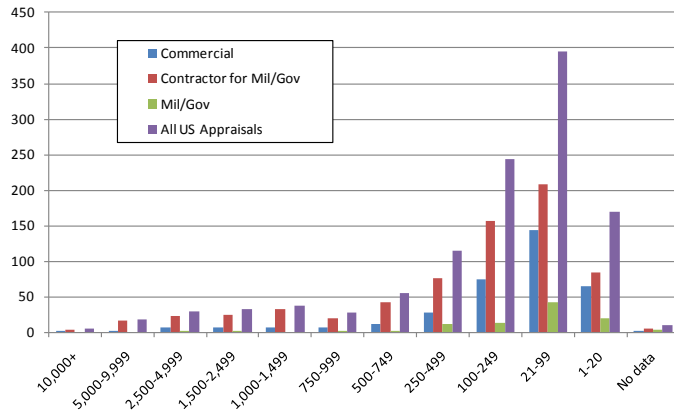
Maturity Profile by Organization Size

Based on the total number of employees within the area of the organization that was appraised



Are Small U.S. Businesses Using CMMI?

US Appraisals
Distribution by Org. Size



- U.S. organizations of all sizes are conducting SCAMPI-A appraisals, including very small organizations.
- Large % of U.S. appraisals conducted in all domains are by small organizations (<100 people) : commercial (59.5%), govt. contractors (42.3%), govt (65.6%)
- CMMI use overseas is overwhelmingly commercial. Within U.S., predominantly govt contractors (60.6%) but with significant usage in commercial industry (30.9%).

Based on data from published SCAMPI appraisal results for organizations – which could be part of a large company.

US		10,000+	5,000-9,999	2,500-4,999	1,500-2,499	1,000-1,499	750-999	500-749	250-499	100-249	21-99	1-20
	Commercial	0.3%	0.3%	1.7%	2.0%	1.7%	1.7%	3.1%	8.0%	21.1%	41.0%	18.5%
	Contractor for Mil/Gov	0.6%	2.5%	3.3%	3.5%	4.6%	2.9%	6.1%	11.0%	22.6%	30.1%	12.2%
	Mil/Gov	0.0%	0.0%	1.0%	1.0%	0.0%	1.0%	2.1%	11.5%	14.6%	44.8%	20.8%

US		10,000+	5,000-9,999	2,500-4,999	1,500-2,499	1,000-1,499	750-999	500-749	250-499	100-249	21-99	1-20	No data	Total	
	Commercial	1	1	6	7	6	6	11	28	74	144	65	2	351	31%
	Contractor for Mil/Gov	4	17	23	24	32	20	42	76	156	208	84	5	691	61%
	Mil/Gov	0	0	1	1	0	1	2	11	14	43	20	3	96	8%
All US Appraisals		5	18	30	32	38	27	55	115	244	395	169	10	1138	
%		0.4%	1.6%	2.6%	2.8%	3.3%	2.4%	4.8%	10.1%	21.4%	34.7%	14.9%	0.9%		

	Non-US	U.S.	Grand Total
Commercial/In-house	3352	352	3704
Contractor for Military/Government	206	690	896
Military/Government Agency	73	96	169
Grand Total	3631	1138	4769

	Non-US	U.S.	Grand Total
Commercial/In-house	92.3%	30.9%	77.7%
Contractor for Military/Government	5.7%	60.6%	18.8%
Military/Government Agency	2.0%	8.4%	3.5%
Grand Total	100.0%	100.0%	100.0%

Are small businesses using CMMI in the U.S. defense contracting market?

US	10,000+	5,000-9,999	2,500-4,999	1,500-2,499	1,000-1,499	750-999	500-749	250-499	100-249	21-99	1-20	No data	Total	
Commercial	1	1	6	7	6	6	11	28	74	144	65	2	351	31%
Contractor for Mil/Gov	4	17	23	24	32	20	42	76	156	208	84	5	691	61%
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All US Appraisals	5	18	30	32	38	27	55	115	244	395	169	10	1138	
%	0.4%	1.6%	2.6%	2.8%	3.3%	2.4%	4.8%	10.1%	21.4%	34.7%	14.9%	0.9%		

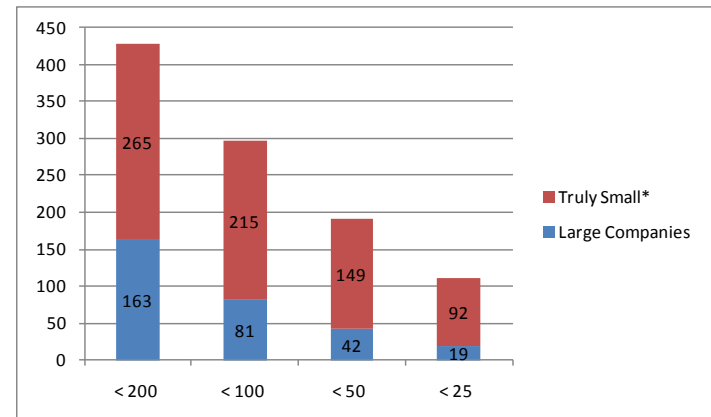
Data from SCAMPI appraisal results is for organizational units (OUs) – which could be part of a larger company. Overall company size is not available from SCAMPI results filed with SEI.

From the data set of 691 appraisals by U.S. government contractors:

- 428 were by OUs < 200 people
- Known large companies were removed from this data set
- *Best judgment is 265 appraisals (62%) were conducted by truly small companies < 200 people
- This 265 appraisals reflects 38% of the complete data set (all sizes, 691 appraisals)

Even though these reflect estimates, they substantiate significant usage of CMMI by small companies in the U.S. defense market.

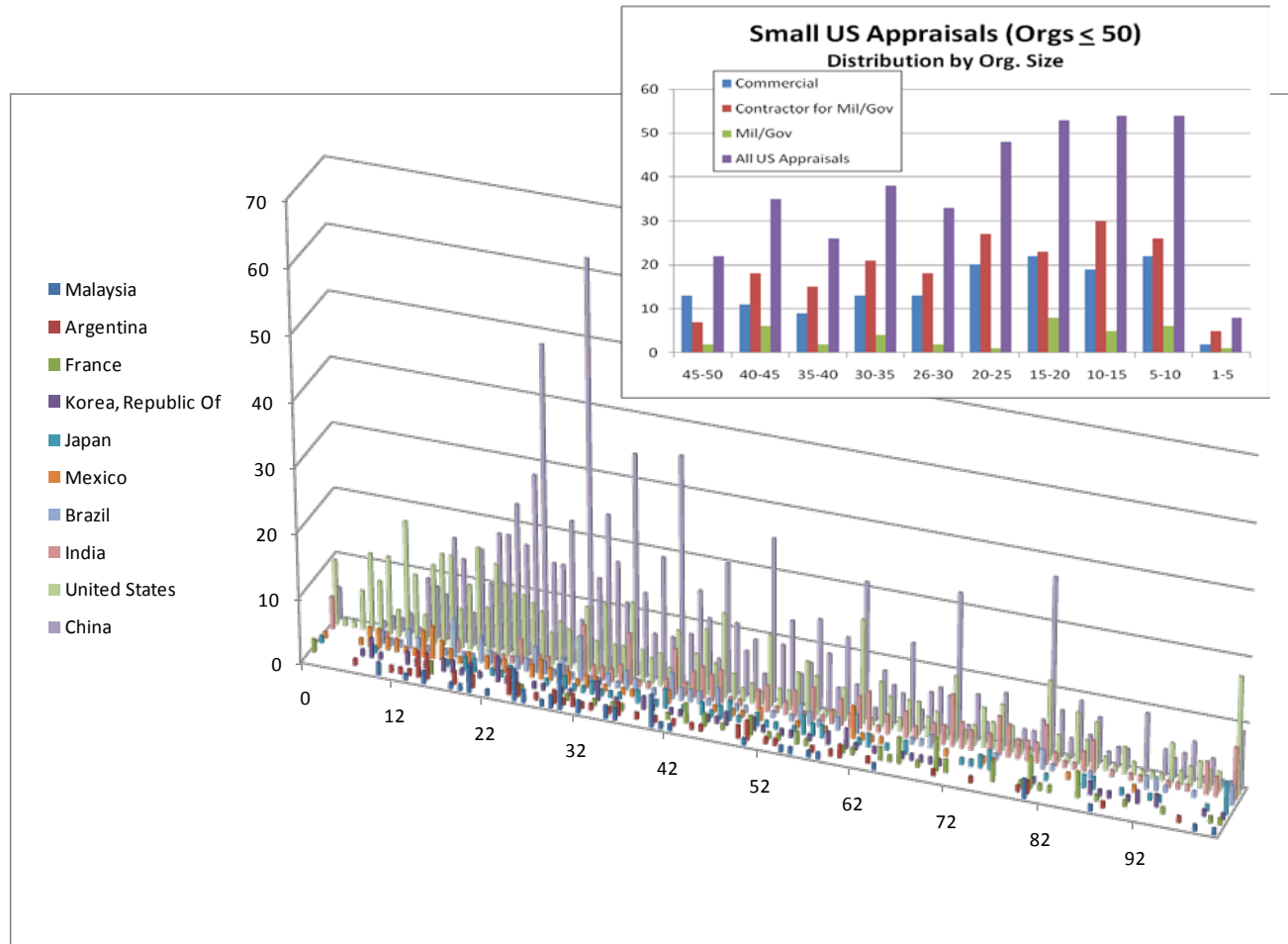
Size (Employees)	Total Appraisals	Large Companies	Truly Small*	% Truly Small
< 200	428	163	265	62%
< 100	296	81	215	73%
< 50	191	42	149	78%
< 25	111	19	92	83%



What countries conduct the most small appraisals?

Number of appraisals reported with organization size < 100

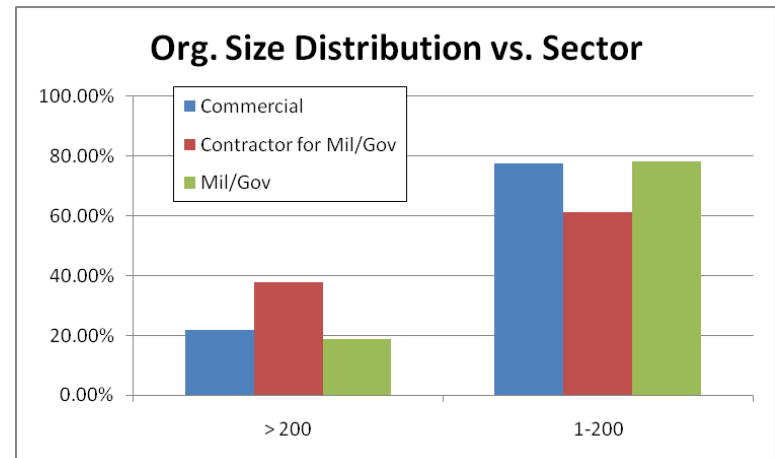
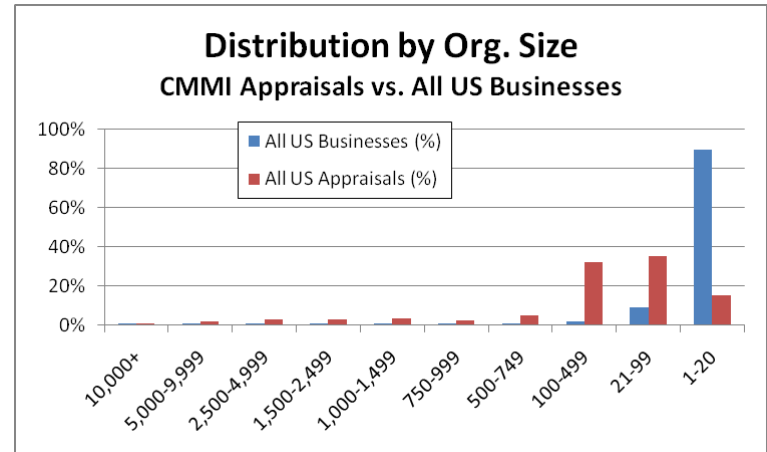
China	1161
United States	783
India	313
Spain	138
Brazil	132
Japan	115
Korea, Republic Of	102
Taiwan	100
France	93
Mexico	86
Argentina	69
Malaysia	60
Egypt	36
Thailand	36
United Kingdom	34
Colombia	34
Chile	33
Italy	27
Canada	25
Pakistan	24
Germany	20
Turkey	18
Hong Kong	14
Sri Lanka	14
Viet Nam	13
Philippines	12
Australia	11
Singapore	10



Other Observations

Under-representation of small organizations (CMMI data) relative to small US businesses overall (Census data) *may* represent a marketing opportunity

There is more proportional interest among small commercial orgs. than other orgs. ($p = 0.000$ on a χ^2 test)

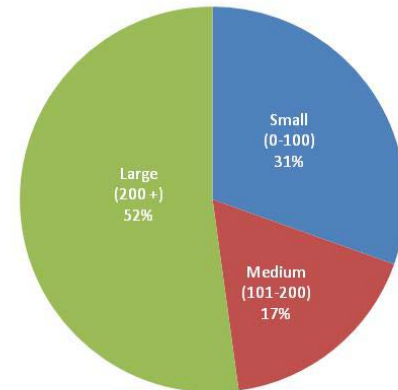


- *A Mixed Method Analysis to Refine an Organizational Change Model for Technology Organizations*, Doctoral Dissertation, University of Phoenix, Dr. Leigh Riley, 2010
- Survey and analysis of organizational change factors ensuring successful implementation of CMMI® -Dev by IT organizations
- Further analyses will be published next year as an addendum to the Protean Model®

Participant Demographics

Employment Level	Survey Participants	
	Number	Percentage
Executive	5	7%
Management	25	34%
Senior Technical	7	9%
Technical	1	1%
Process Improvement	33	45%
Other	3	4%
Total	75	100%

Organization Size



Ranking of Organizational Change Factors by Size of the Organization

Rank	Small	Medium	Large
1	Senior Leadership Support	Senior Leadership Support	Communication
2	Operational Leadership	Communication	Senior Leadership Support
3	Communication	Operational Leadership	Measuring of Progress
4	Training the Leadership	Training the Employees	Training the Employees
5	Training the Employees	Measuring of Progress	Aligning the Initiative with Strategic Goals
6	Measuring of Progress	Aligning the Initiative with Strategic Goals	Articulating the Benefits
7	Managing Initiative as a Project	Incremental Improvements	Managing Initiative as a Project
8	Aligning the Initiative with Strategic Goals	Providing Support Mechanisms	Operational Leadership
9	Providing Support Mechanisms	Managing Initiative as a Project	Providing Support Mechanisms
10	Articulating the Benefits	Training the Leadership	Training the Leadership
11	Incremental Improvements	Articulating the Benefits	Incremental Improvements
12	Involving Employees	Involving Employees	Involving Employees
13	Changing the Performance Management System	Changing the Performance Management System	Changing the Performance Management System

Factors for effective organizational change are similar across different sizes of businesses, but initiatives may have shifting priorities (e.g., tactical to strategic)

Improving Processes in Small Settings (IPSS)

- “Proceedings of the 1st International Researcher’s Workshop on Process Improvement in Small Settings”
<http://www.sei.cmu.edu/publications/documents/06.report/s/06sr001.html>
- “Improving Processes in Small Settings (IPSS): A White Paper”
International Process Research Consortium (IPRC),
Software Engineering Institute
 - Phase 1: Qualitative study
 - Phase 2: Quantitative research

Barriers to entry:

- Lacking core competencies, basic practices
- PI costs within operating budget
- Clear roles/responsibilities, flat hierarchy
- Infrastructure
- Staff culture

Reference: Applicability of CMMI to Small and Medium Enterprises
Dr. Rick Hefner and Maggie Glover. SC SPIN, April 2010.

<http://www.uces.csulb.edu/SPIN/media/ppslide/Rick%2007CMMI%20Small%20Settings%20Part%20I.ppt>

Phase-1 Results

- **CMMI SME implementation issues:**
 - Size - CMMI is considered too large by SMEs
 - Linkage to SME problems is not immediately evident
 - Lack of SME implementation knowledge, infrastructure and resources to translate process framework into value added operational processes
- **CMMI Alternative Approaches:**
 - **CMMI-SME Front-end:** Provide direct link of SME development problems to the appropriate practices in the model
 - **CMMI-SME Back-end:** Link of model components to off the shelf “whole” product solutions appropriate for SME implementation
 - *The optimum packaging for the CMMI-SME would provide “line of sight” connectivity from SME problem to model components to implementation solutions*

Pain Associated with Improving Existing Products or Developing New Products

	Average Response	Standard Deviation
Above Average “Pain”		
The time it takes to get to market / recognize revenue	7.2	2.0
Trying to accelerate corporate growth	6.7	2.2
Average “Pain”		
Development of new products or features	6.0	1.9
Capitalization / funding new product efforts	6.0	2.8
Compliance issues with partners	5.6	1.9
Quality assurance / quality control issues	5.4	2.1
Incorporating increasing systems or software into new or improved products	5.3	2.4
Historical New Product Failures	5.2	2.2
Below Average “Pain”		
ISO or QS 9000 Compliance	4.6	2.3

Supporting Small Suppliers

Acquirers (such as prime contractors) often use CMMI practices to select, manage, and support their small suppliers.

Typical uses of CMMI within CMMI WG member companies:

- CMMI maturity level requirements rarely specified to subs unless levied by external customer
- Use CMMI practices in key areas to evaluate supplier risks
- Checklists or tools used for supplier selection
- May require suppliers to follow prime contractor's processes
- Provide direct support to suppliers – training, mentoring, tools, etc.

Alignment of Processes with Subs

CMMI Process Areas			Prime	Subs	CMMI Process Areas			Prime	Subs
Level 2					Level 3 (continued)				
Requirements Management			✓	✓	Organizational Process Definition			✓	(4)
Project Planning			✓	✓	Organizational Training			✓	(4)
Project Monitoring & Control			✓	✓	Integrated Project Management for IPPD			✓	(1)
Supplier Agreement Management			✓	✓	Risk Management			✓	(1)
Measurement & Analysis			✓	✓	Integrated Teaming			✓	(1)
Product & Process Quality Assurance			✓	✓	Integrated Supplier Management			✓	(4)
Configuration Management			✓	(1)	Decision Analysis & Resolution			✓	(1)
Level 3					Organizational Environment for Integration			✓	(4)
Requirements Development			✓	(2)	Level 4				
Technical Solution			✓	✓	Organizational Process Performance			✓	(5)
Product Integration			✓	✓	Quantitative Project Management			✓	(5)
Verification			✓	(3)	Level 5				
Validation			✓	(3)	Organizational Innovation & Deployment			✓	(5)
Organizational Process Focus			✓	(4)	Causal Analysis & Resolution			✓	(5)

Notes:

- (1) Subcontractor internal processes and IPT operations integrate with prime's processes.
- (2) System requirements are allocated by prime; subcontractors develop requirements at the configuration item (CI) level.
- (3) All subcontractors integrate, verify and validate their products to the CI or subsystem level; this includes integration of software CIs into hardware CIs or line replaceable units (LRUs). Prime integrates, verifies and validates at the system level
- (4) Subcontractors follow their own CMMI-compliant business processes.
- (5) Prime is responsible team's process control and optimization.

Reference: "High Maturity System/Software Cost Estimation", Richard L. W. Welch, PhD., Northrop Grumman Integrated Systems CMMI Technology Conference, November 2007.

<http://www.dtic.mil/ndia/2007cmmi/Wednesday/4pmWelch.pdf>

Resources – Publications, briefings, social networks

Many small businesses and their consultants share their CMMI experience in publications and conference briefings.

Over 40,000 Google hits on “CMMI” “small business”

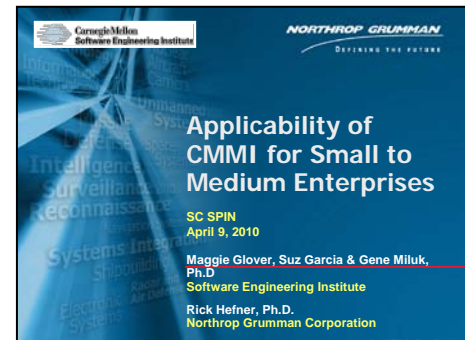
Other good resources:

- SEI – tech reports, guidance, adoption info, case studies, ...
<http://www.sei.cmu.edu/cmmi>
- NDIA CMMI Conference briefings
<http://www.dtic.mil/ndia/>
- SEI SEPG Conference briefings
<http://www.sei.cmu.edu/sepg/>
- CrossTalk articles <http://stsc.hill.af.mil/crosstalk/>
- SPIN meetings
- Newsgroups, social networks (Yahoo!, Linked In, Facebook, ...)
- RSS feeds
- Webinars - “Process Improvement at the Edges”
<http://www.sei.cmu.edu/library/abstracts/webinars/18dec2008.cfm>

There is no shortage of good people willing to help – just ask!



<http://seispin.wikispaces.com/file/view/ipss.ppt>

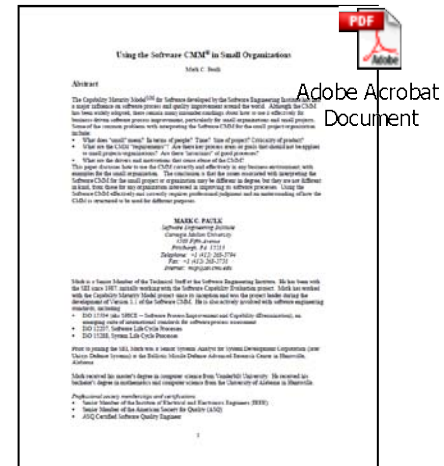


<http://www.uces.csulb.edu/SPIN/media/ppslide/Rick%2007CMMI%20Small%20Settings%20Part%20I.ppt>

Resources – Guidance for Effective CMMI Adoption

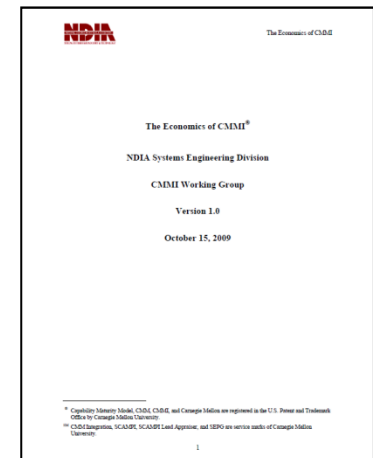
SEI Resources:

- **CMMI in Small Settings Toolkit Repository**
<http://seir.sei.cmu.edu/toolkit/index.html>
- **Reports & Technical Notes – Interpretative Guidance, ...**
<http://www.sei.cmu.edu/cmmi/casestudies/reports/>
- **CMMI Roadmaps – goal-driven process area guidance**
<http://www.sei.cmu.edu/library/abstracts/reports/08tn010.cfm>
- **Using the Software CMM in Small Organizations**
- Mark Paulk papers: SW-CMM, but still good guidance (if you can find it)



NDIA Resources:

- **The Effective Use of CMMI – NDIA position paper**
http://www.ndia.org/Divisions/Divisions/SystemsEngineering/Pages/CMMI_Working_Group.aspx
- **The Economics of CMMI – CMMI WG white paper**
http://www.ndia.org/Divisions/Divisions/SystemsEngineering/Documents/Committees/CMMI%20Working%20Group/The_Economics_of_CMMI.pdf



Consultant Resources ... and many others

Summary and Recommendations

Perceptions that CMMI is too burdensome for small businesses is not supported by data on CMMI adoption

- Greatest growth areas: small, commercial, overseas
- No evidence that CMMI is a barrier to competition

Small businesses face many of the same obstacles as large companies

- Sponsorship, commitment, resources, alignment with business objectives, ...
- Tailored processes and priorities adapted to meet the needs of the business
- Small businesses often have fewer resources to address these challenges
- But they also have advantages: agility, innovation, simplicity, institutionalization

Follow proven guidance for using CMMI effectively

- Focus on business value - *The Economics of CMMI*®
- Set performance goals, measure progress against them, use CMMI to improve
- Learn from others - take advantage of the many resources available to help

For More Information....



NDIA CMMI Working Group

http://www.ndia.org/Divisions/Divisions/SystemsEngineering/Pages/CMMI_Working_Group.aspx

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