

Benchmarking Systems Engineering Measures

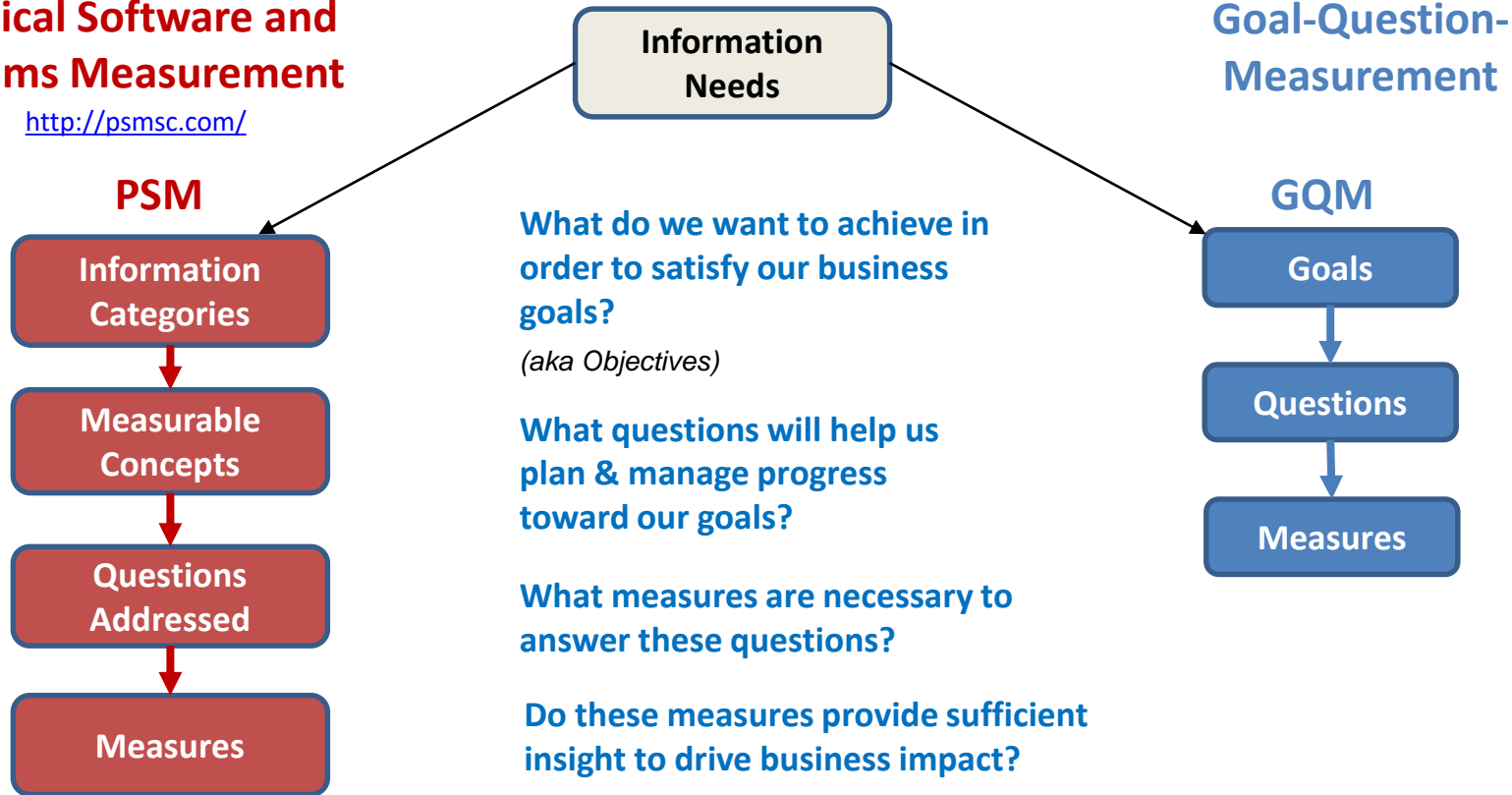
Geoff Draper (Harris Corporation)
NDIA Systems Engineering Division

NDIA Systems Engineering Conference
October 2018

What to Measure?

Practical Software and Systems Measurement

<http://psmsc.com/>



The question is not:
What metrics should I use?

Rather:
What do I want to know or learn?
Why are we collecting the data?
How do we use the data?
Do the measures facilitate driving action and results?

How effective are common SE measures in providing insight and improvement in your organizations?

Common Measurement Resources



Standards:

- ISO/IEC/IEEE 15939, Systems and software engineering – Measurement process

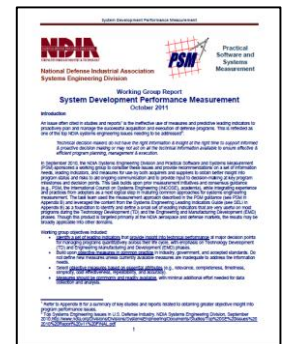
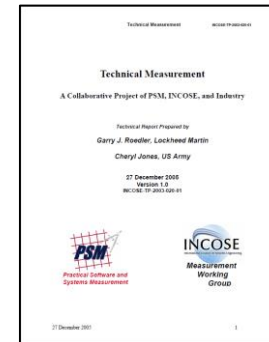
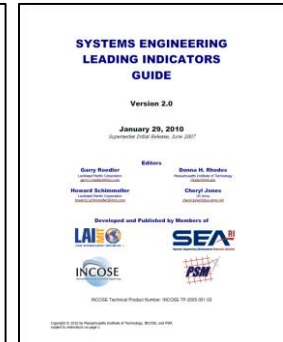
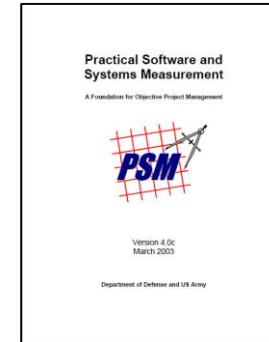
Measurement Processes:

- Practical Systems and Software Measurement (PSM)
www.psmc.com

Common industry guidance / example measures:

- Systems Engineering Leading Indicators Guide (SELI) (INCOSE, PSM, LAI, SEA)
<http://www.psmc.com/downloads/other/seli-guide-rev2-01292010-industry.pdf>
- PSM Guide (PSM)
<http://psmc.com/PSMGuide.asp>
- SE Measurement Primer (INCOSE members)
https://www.sebokwiki.org/wiki/Systems_Engineering_Measurement_Primer
- Technical Measurement Guide (INCOSE, PSM)
http://psmc.com/Downloads/TechnologyPapers/TechnicalMeasurementGuide_v1.0.pdf
- System Development Performance Measurement (NDIA, PSM)
<http://psmc.com/Downloads/Other/NDIA%20System%20Development%20Performance%20Measurement%20Report.pdf>
- Project Manager's Guide to Systems Engineering Measurement (INCOSE members)
<https://connect.incose.org/Pages/Product-Details.aspx?ProductCode=TechGuidePMGuideSoft>

The NDIA SE Division appreciates the support of INCOSE and PSM in granting permission to use example indicators in this presentation to solicit community feedback.



Example SE measures



Practical Software & Systems Measurement (PSM)
<http://www.psmc.com/>

Systems Engineering Leading Indicators Guide
<http://psmc.com/Downloads/Other/SELI-Guide-Rev2-01292010-Industry.pdf>

PM Guide to SE Measurement
<https://connect.inco.se.org/Pages/Product-Details.aspx?ProductCode=TechGuidePMGuideSoft> (members)

Issue - Category - Measure Mapping		
Common Issue Area	Measurement Category	Measures
Schedule and Progress	Milestone Performance	Milestone Dates Critical Path Performance
	Work Unit Progress	Requirements Status Problem Report Status Review Status Change Request Status Component Status Test Status
	Incremental Capability	Action Item Status Increment Content - Components Increment Content - Functions
Resources and Cost	Personnel	Effort Staff Experience Staff Turnover
	Financial Performance	Earned Value Cost
	Environment and Support Resources	Resource Availability Resource Utilization
Product Size and Stability	Physical Size and Stability	Database Size Components Interfaces Lines of Code Physical Dimensions
	Functional Size and Stability	Requirements Functional Change Workload Function Points
Product Quality	Functional Correctness	Defects Technical Performance
	Supportability - Maintainability	Time to Restore Cyclomatic Complexity Maintenance Actions
	Efficiency	Utilization Throughput Timing
Process Performance	Process Compliance	Standards Compliance Operator Errors
	Process Efficiency	Failures Fault Tolerance
	Process Effectiveness	Reference Model Rating Process Audit Findings Productivity Cycle Time Defect Containment Rework
Technology Effectiveness	Technology Suitability Impact Technology Volatility	Requirements Coverage Technology Impact Baseline Changes
Customer Satisfaction	Customer Feedback	Survey Results Performance Rating
	Customer Support	Requests for Support Support Time

Candidate Leading Indicators:

- Requirements Trends
- System Definition Change Backlog Trends
- Interface Trends
- Requirements Validation Trends
- Requirements Verification Trends
- Work Product Approval Trends
- Review Action Closure Trends
- Technology Maturity Trends
- Risk Exposure Trends
- Risk Treatment Trends
- Systems Engineering Staffing and Skills Trends
- Process Compliance Trends
- Facility and Equipment Availability
- Defect and Error Trends
- System Affordability Trends
- Architecture Trends
- Schedule and Cost Pressure

Technical Measurement Guide

http://psmc.com/Downloads/TechnologyPapers/TechnicalMeasurementGuide_v1.0.pdf

- Measures of Effectiveness (MOEs)
- Key Performance Parameters (KPPs)
- Measures of Performance (MOPs)
- Technical Performance Measures (TPMs)

Example Measurement Categories and Measures:

- Schedule
- Problem Reports and Peer Reviews
- Technical Uncertainty Reduction
- Scope Change (requirements volatility)
- Technology Readiness or Technical Maturity
- Solution Satisfies Requirement
- Technical Performance
- Counts and Stability of Elements of the System
- Reliability, Maintainability, and Availability
- Defect Containment

NDIA System Development Performance Measures

<http://www.psmc.com/Downloads/Other/NDIA%20System%20Development%20Performance%20Measurement%20Report.pdf>

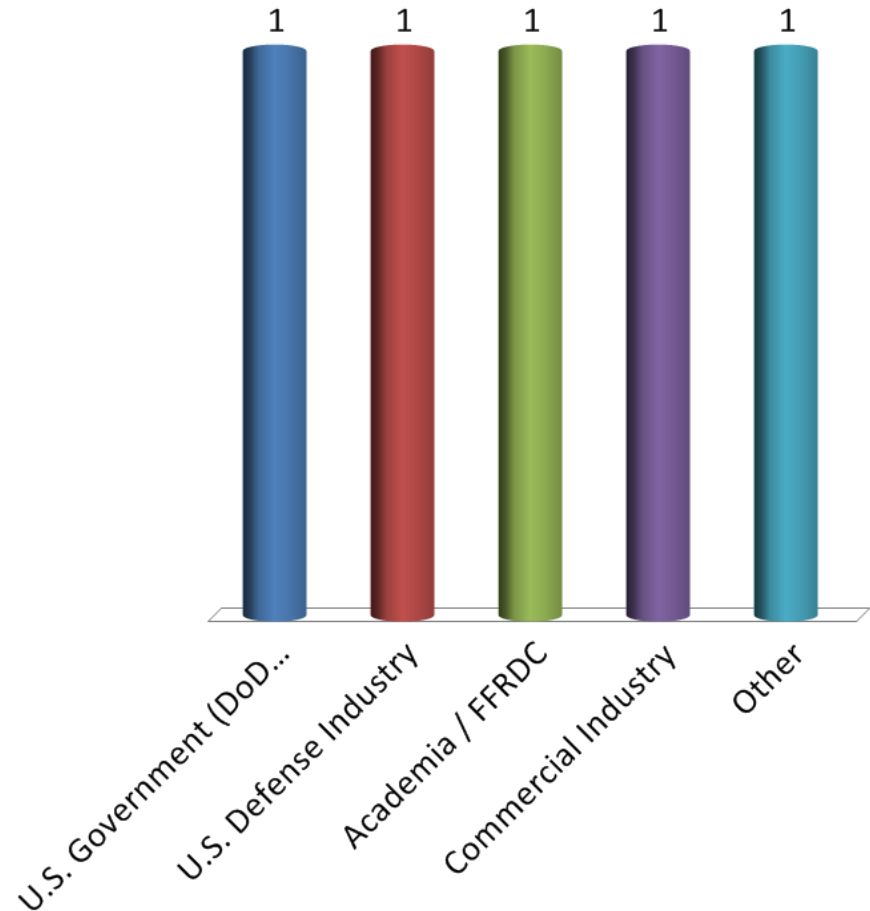
Recommended Performance Measures:

- Requirements Stability
- Stakeholder Needs Met
- Interface Trends
- Staffing and Skills Trends
- Risk Burndown
- TPM Trend (specific TPM)
- TPM Summary (all TPMs)
- Technology Readiness Level (TRL)
- Manufacturing Readiness Level (MRL)

How would you best characterize your organization?

Response Counter

1. U.S. Government (DoD, agency)
2. U.S. Defense Industry
3. Academia / FFRDC
4. Commercial Industry
5. Other



Evaluations of SE Measures

We will be seeking your feedback on several common SE measures.

Two separate evaluations are desired:

- **Usefulness:** Is the measure itself (≥ 1 indicators) useful for providing insight?
- **Effectiveness:** How effectively does your organization use it for SE?

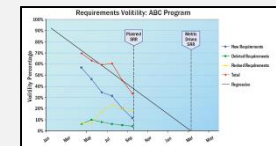
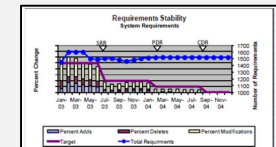
Sample of SE Measures	
Requirements Stability (Volatility)	Requirements Verification Status
Interface Status	Customer Satisfaction
Technical Performance (TPMs)	Technical Maturity (TRL)
Review Action Item Closure	Problem Report Status
Defect Containment and Defect Trends	Defect Density/Rework
Risk Status	Risk Mitigation Status
Opportunity Status	Schedule Details
Product Size / Productivity	

Example:

Is **[measure name]** a **useful** SE measure, and how **effectively** is it used to provide insight and impactful action in your organization?

1. **Very Useful**
2. **Useful**
3. **Somewhat Useful**
4. **Limited or No Usefulness**
5. **Very Effective**
6. **Effective**
7. **Somewhat Effective**
8. **Limited or No Effectiveness**

Examples:



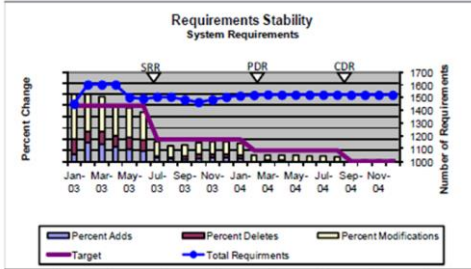
We will evaluate as many of these as we have time for!

Is Requirements Stability a **useful** SE measure, and how **effectively** is it used to provide insight and impactful action in **your** organization?

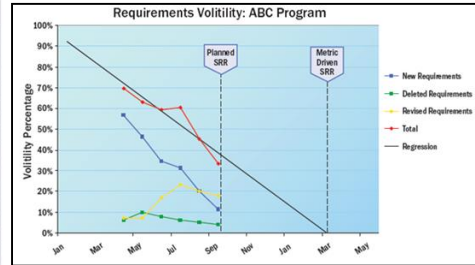
(select 2 choices, 1 from each set below; **usefulness**, **effectiveness**)

Is it a good SE measure? How much value does it actually provide to **your** organization?

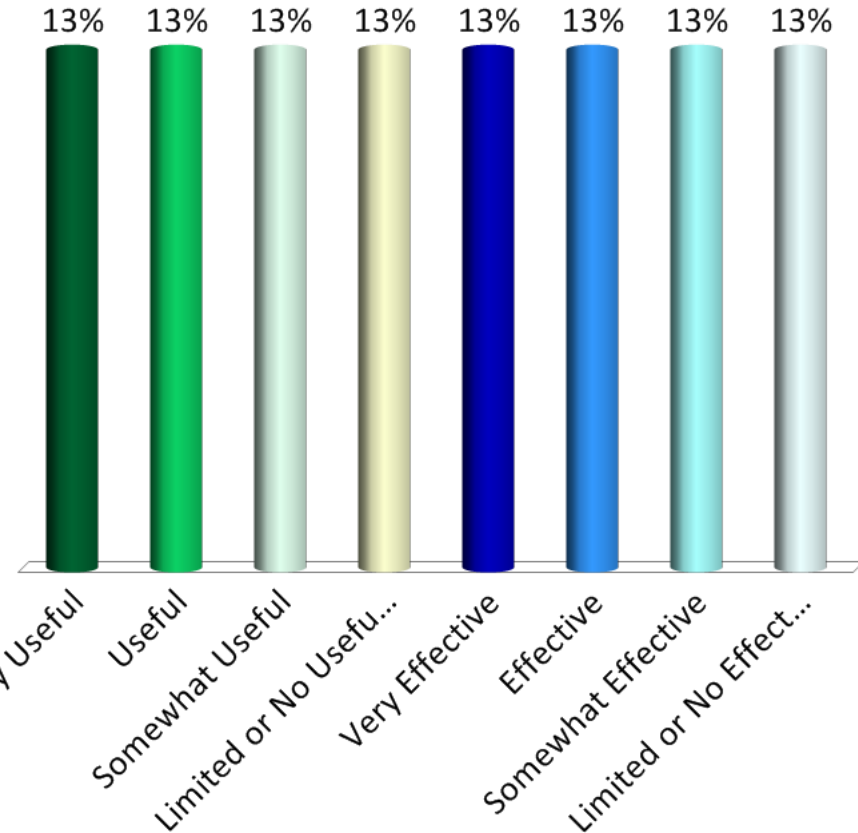
Examples: Requirements Stability, Requirements Volatility/Burndown



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SE Leading Indicators Guide



1. **Very Useful**
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3. **Somewhat Useful**
4. **Limited or No Usefulness**
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8. **Limited or No Effectiveness**

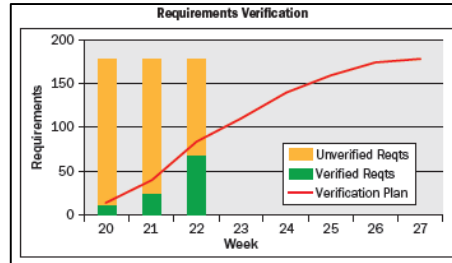
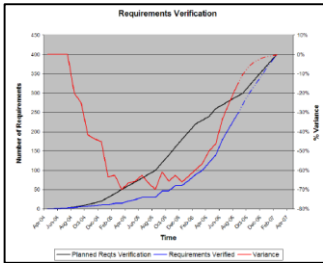
Is Requirements Verification Status a useful SE measure, and how effectively is it used to provide insight and impactful action in your organization?



(select 2 choices, 1 from each set below; usefulness, effectiveness)

Is it a good SE measure? How much value does it actually provide to your organization?

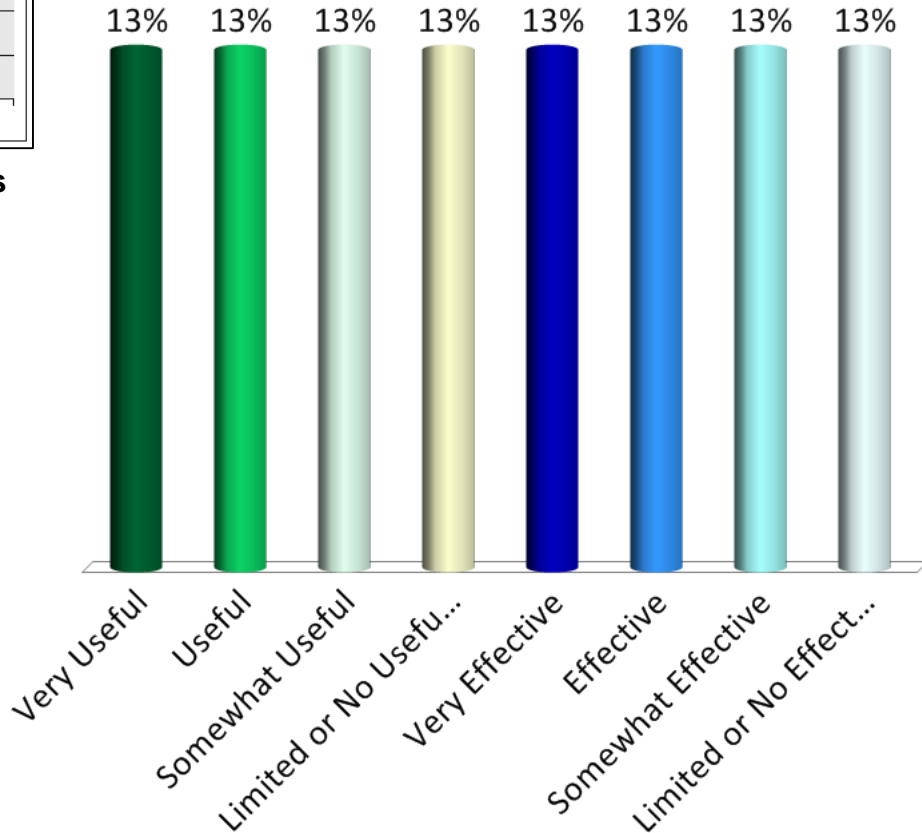
Examples: Requirements Verified (plan vs. actual)



SE Leading Indicators Guide

PM Guide to SE Measures

1. **Very Useful**
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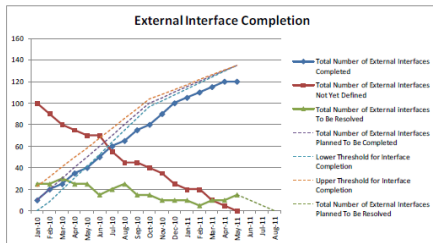


Is **Interface Status** a **useful** SE measure, and how **effectively** is it used to provide insight and impactful action in **your** organization?

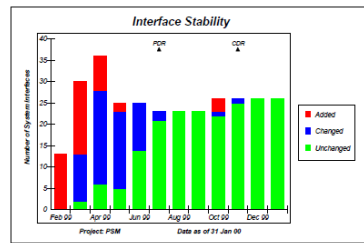
(select 2 choices, 1 from each set below; **usefulness**, **effectiveness**)

Is it a good SE measure? How much value does it actually provide to **your** organization?

Examples: Interface Completion Status, Interface Stability

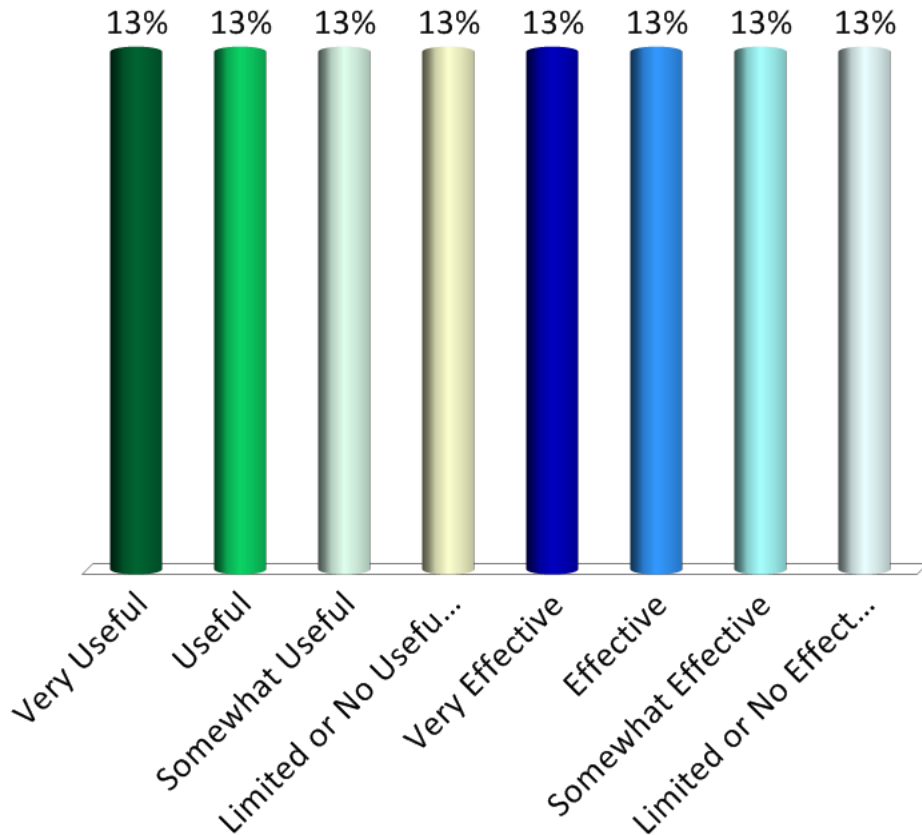


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PSM

1. **Very Useful**
2. **Useful**
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4. **Limited or No Usefulness**
5. **Very Effective**
6. **Effective**
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8. **Limited or No Effectiveness**



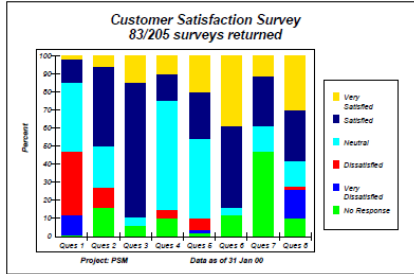
Is **Customer Satisfaction** a **useful** SE measure, and how **effectively** is it used to provide insight and impactful action in **your** organization?



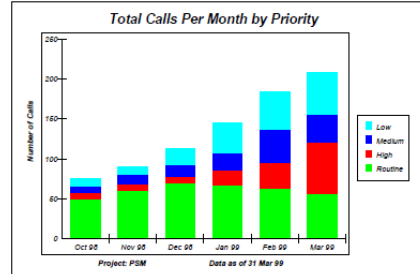
(select 2 choices, 1 from each set below; **usefulness**, **effectiveness**)

Is it a good SE measure? How much value does it actually provide to **your** organization?

Examples: Customer Surveys, Trouble Tickets

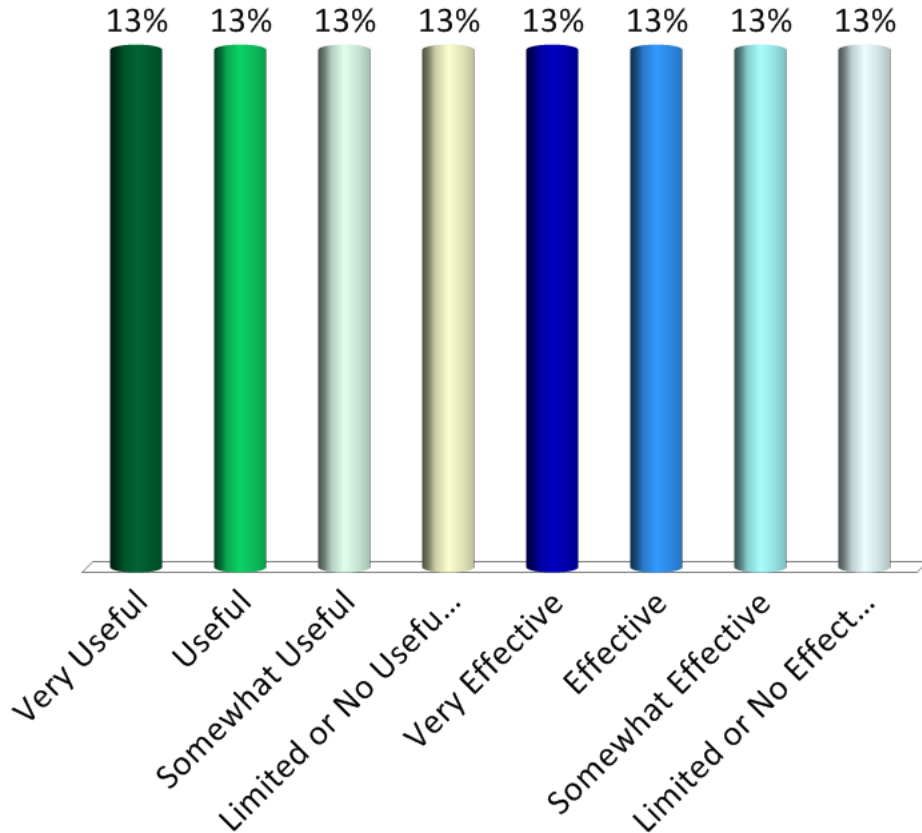


PSM



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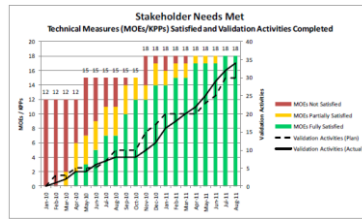
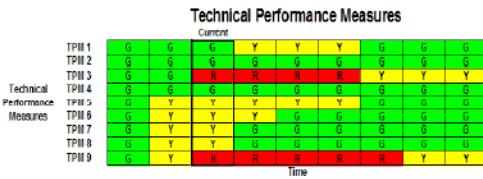


Is **Technical Performance** a **useful** SE measure, and how **effectively** is it used to provide insight and impactful action in **your** organization?

(select 2 choices, 1 from each set below; **usefulness**, **effectiveness**)

Is it a good SE measure? How much value does it actually provide to **your** organization?

Examples: TPMs, MOEs, KPPs

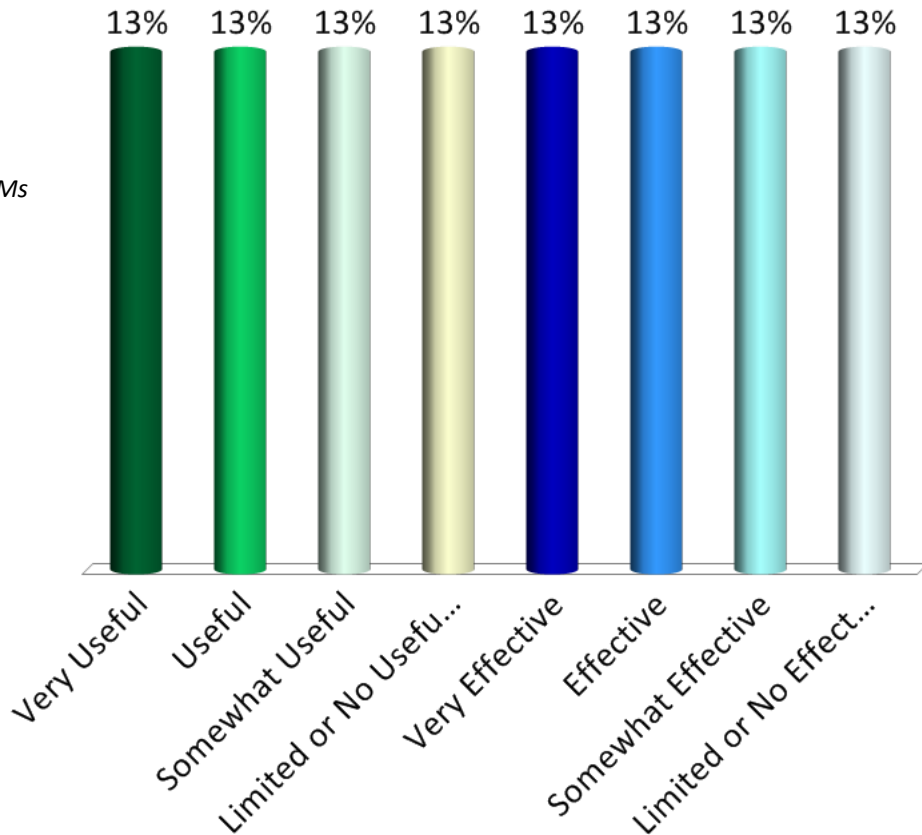


SE Leading Indicators Guide

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See also *INCOSE Technical Measurement Guide* for details of MOEs, MOPs, KPPs, TPMs

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3. **Somewhat Useful**
4. **Limited or No Usefulness**
5. **Very Effective**
6. **Effective**
7. **Somewhat Effective**
8. **Limited or No Effectiveness**



Is **Technical Maturity** a **useful** SE measure, and how **effectively** is it used to provide insight and impactful action in **your** organization?

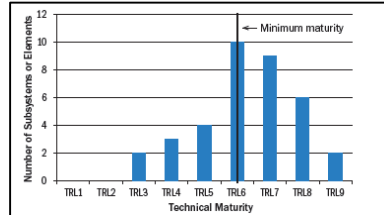


(select 2 choices, 1 from each set below; **usefulness**, **effectiveness**)

Is it a good SE measure? How much value does it actually provide to **your** organization?

Examples: Technology Readiness Level (TRL)

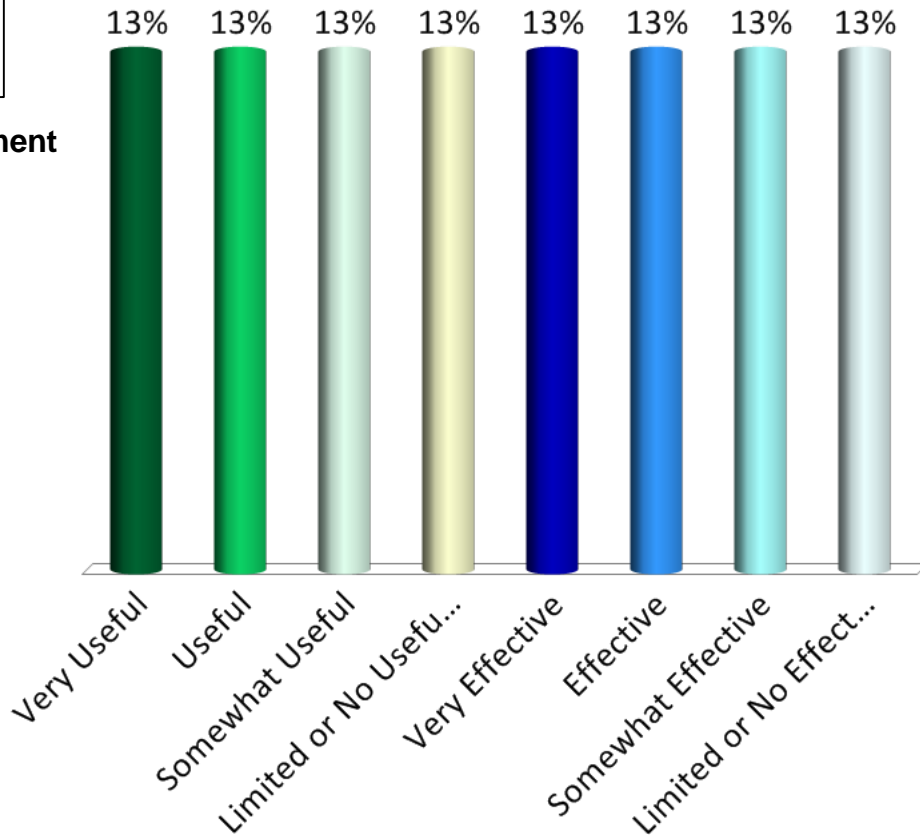
System Milestone / Technical Review	TRL (Plan)	TRL (Actual)	MRL (Plan)	MRL (Actual)	Comments / Risk Action Plan
JTR	TRL 2	TRL 3	MRL 2	MRL 2	Analysis model based on ABC study
ASR	TRL 3	TRL 3	MRL 3	MRL 3	Lab validation of ASIC mfg concept
MS A	TRL 4	TRL 3	MRL 4	MRL 3	Study funding delayed 30 d. TRA completed.
SRR	TRL 5	TRL 4	MRL 5	MRL 3	Mechanical packaging ICD validation issues. Supplier facility contention elevated.
SFR	TRL 6	TRL 5	MRL 6	MRL 5	Prototyped XYZ subsystem w/ test bed I/F. Investigating low yield on lot 6 wafer fab.
PDR / MS B	TRL 6	TRL 6	MRL 6	MRL 6	Dwgs on plan. Tin whisker fab issue ok. Productibility plan approved.
CDR	TRL 7		MRL 7		
TRR	TRL 7		MRL 8		Evaluating alternative μW feeds (risk #23).
SVR (FGA PRR)	TRL 7		MRL 8		
MS C	TRL 8		MRL 9		
FRP Decision Review	TRL 9		MRL 10		



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PM Guide to SE Measurement

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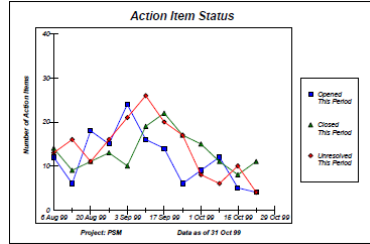
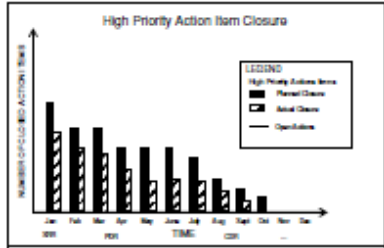


Is **Review Action Item Closure** a **useful** SE measure, and how **effectively** is it used to provide insight and impactful action in **your** organization?

(select 2 choices, 1 from each set below; **usefulness**, **effectiveness**)

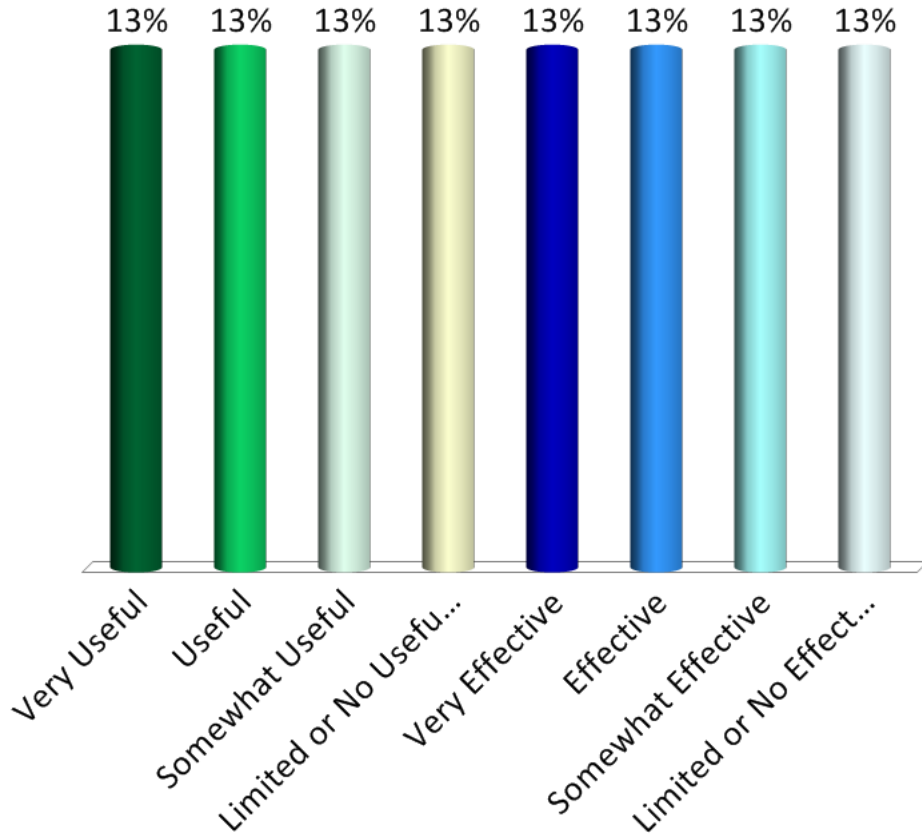
Is it a good SE measure? How much value does it actually provide to **your** organization?

Examples: Action Item Status from Reviews, Closure Aging



SE Leading Indicator Guide

PSM



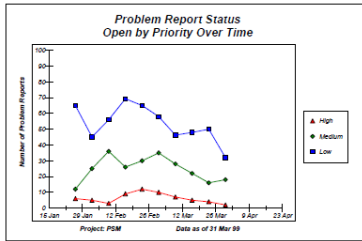
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Is **Problem Report Status** a useful SE measure, and how effectively is it used to provide insight and impactful action in your organization?

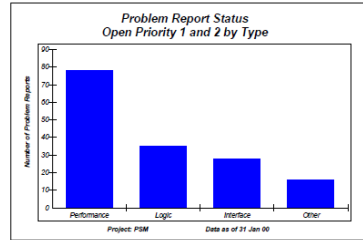
(select 2 choices, 1 from each set below; **usefulness**, **effectiveness**)

Is it a good SE measure? How much value does it actually provide to your organization?

Examples: Open/Closed Status, Prioritization, Categorization

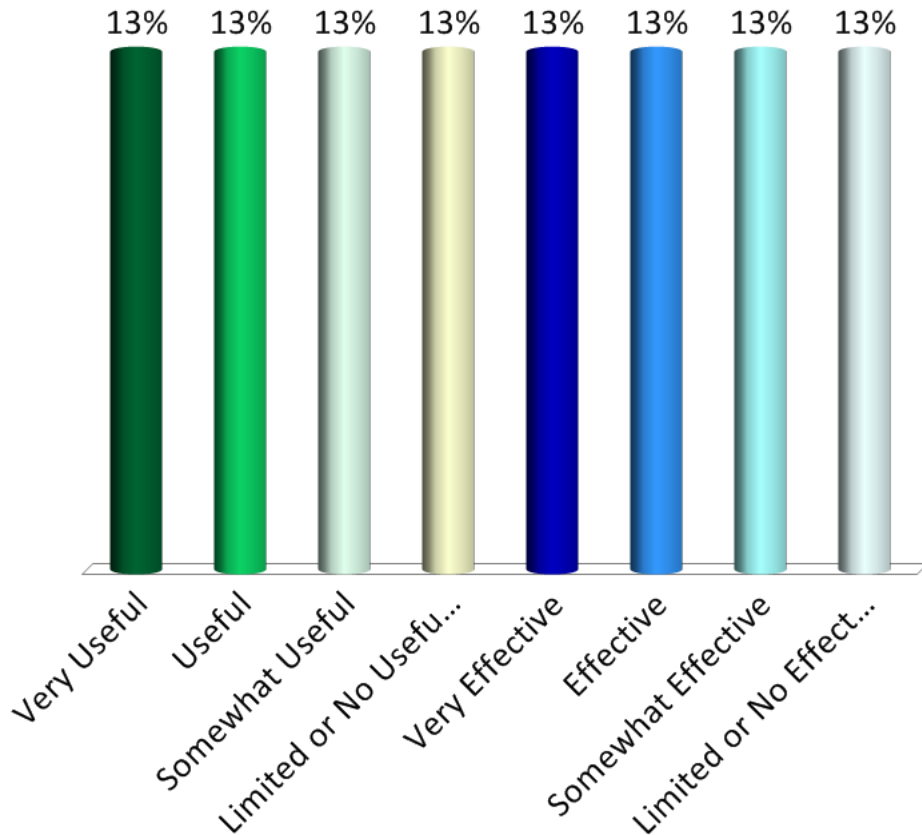


PSM



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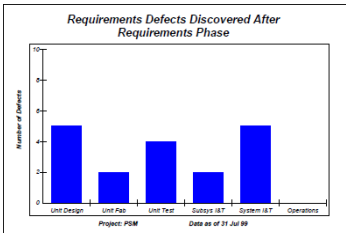


Are Defect Containment and Defect Trends useful SE measures, and how effectively are they used to provide insight and impactful action in your organization?

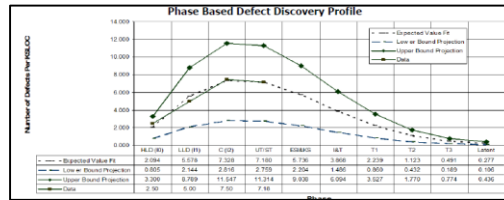
(select 2 choices, 1 from each set below; usefulness, effectiveness)

Is it a good SE measure? How much value does it actually provide to your organization?

Examples: Defect Containment, Escapes, Defect Profile (plan vs. actual)

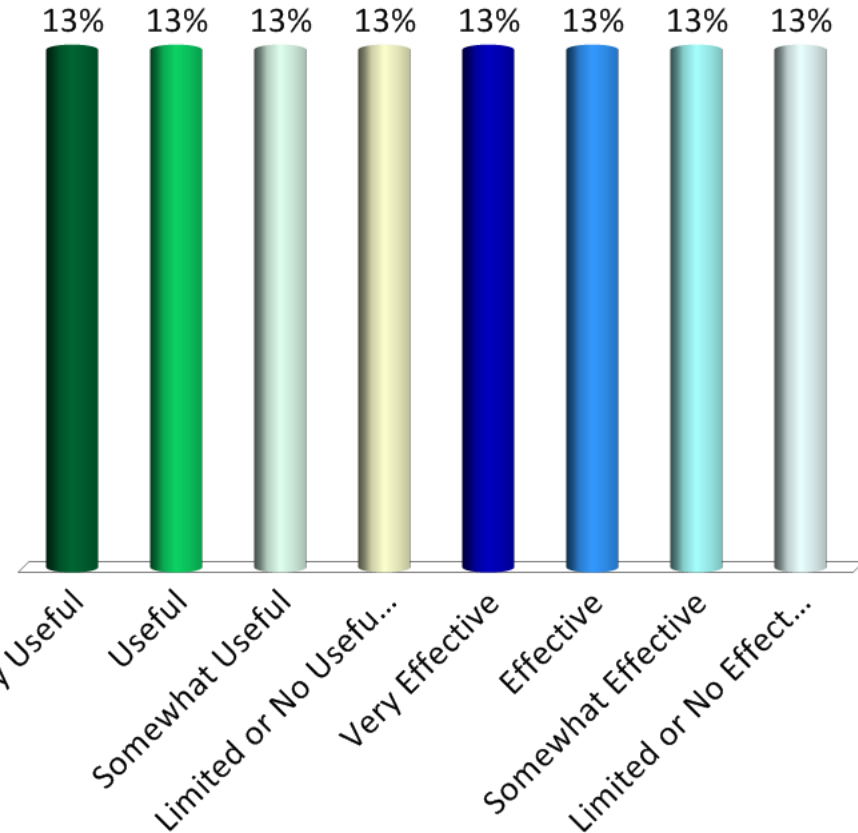


PSM



SE Leading Indicators Guide

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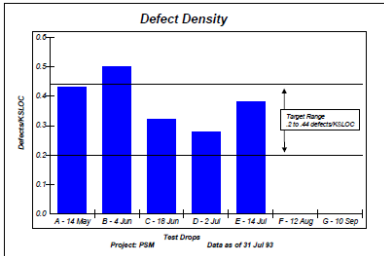


Are **Defect Density** and **Rework** useful SE measures, and how effectively are they used to provide insight and impactful action in your organization?

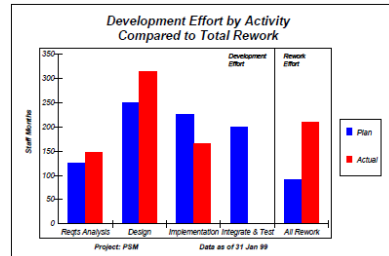
(select 2 choices, 1 from each set below; **usefulness**, **effectiveness**)

Is it a good SE measure? How much value does it actually provide to your organization?

Examples: Defects / Size, Rework Effort, COPQ

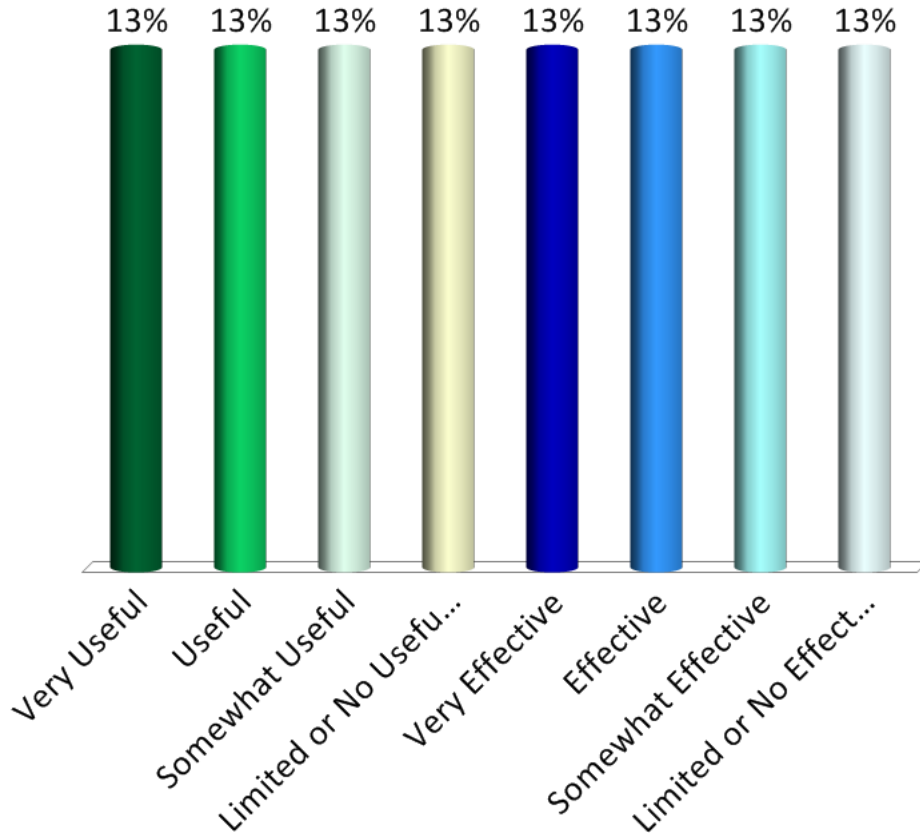


PSM



PSM

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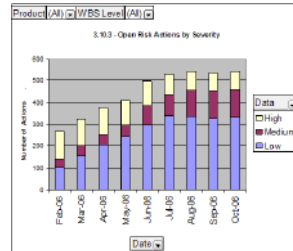
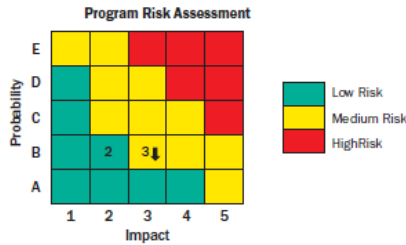


Is Risk Status a **useful** SE measure, and how **effectively** is it used to provide insight and impactful action in your organization?

(select 2 choices, 1 from each set below; **usefulness**, **effectiveness**)

Is it a good SE measure? How much value does it actually provide to your organization?

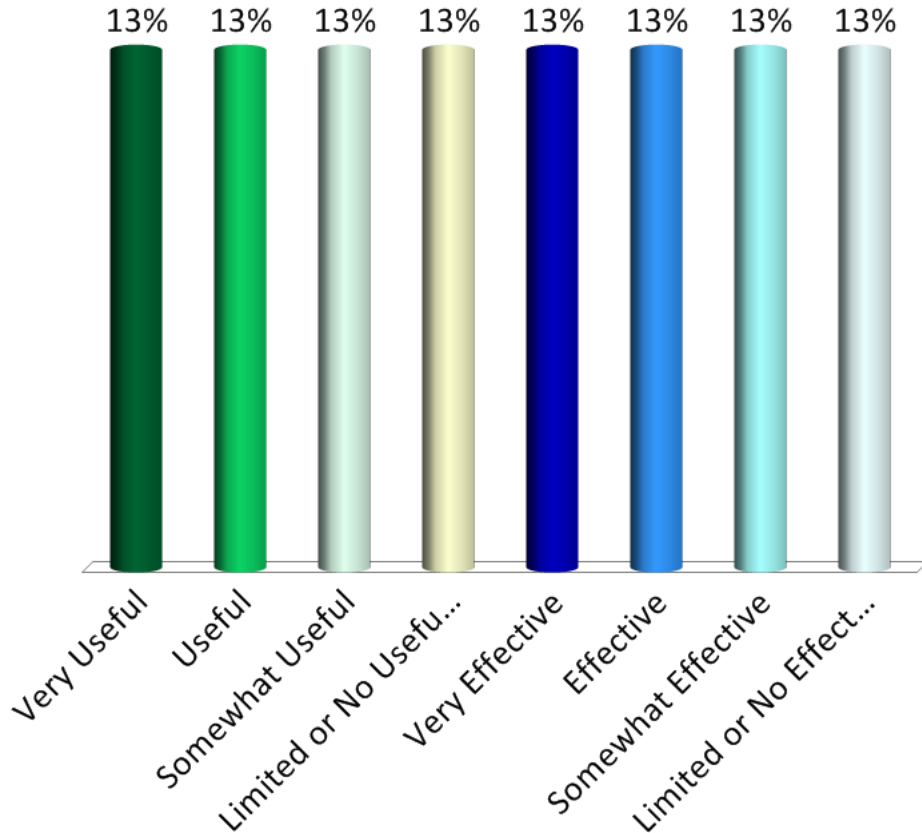
Examples: Risk Matrix, Risk Summary



DoD Risk, Issue, and Opportunity Guide

PSM

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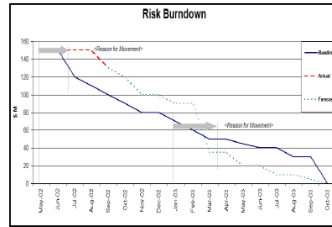
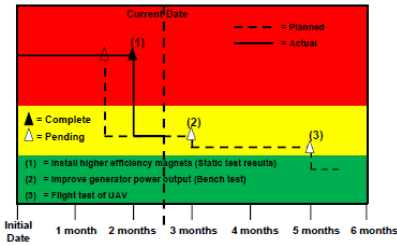


Is Risk Mitigation Status a useful SE measure, and how effectively is it used to provide insight and impactful action in your organization?

(select 2 choices, 1 from each set below; usefulness, effectiveness)

Is it a good SE measure? How much value does it actually provide to your organization?

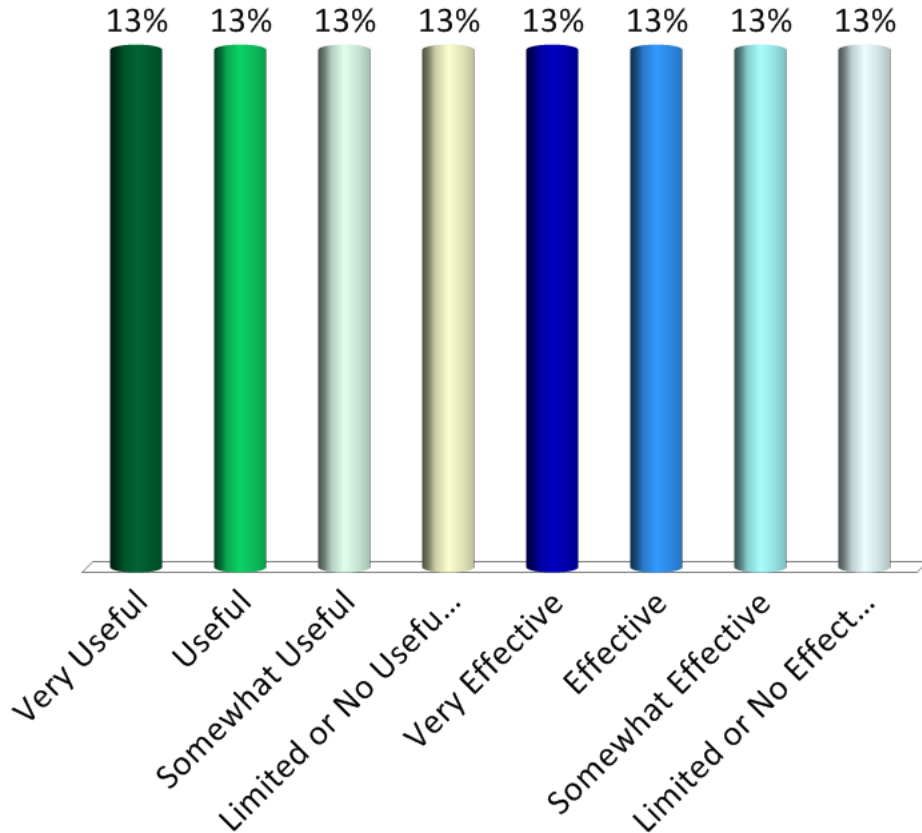
Examples: Risk Treatment Actions, Risk Burndown



DoD Risk, Issue, and Opportunity Guide

SE Leading Indicators Guide

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6. **Effective**
7. **Somewhat Effective**
8. **Limited or No Effectiveness**



Is **Opportunity Status** a **useful** SE measures, and how **effectively** is it used to provide insight and impactful action in your organization?



(select 2 choices, 1 from each set below; **usefulness**, **effectiveness**)

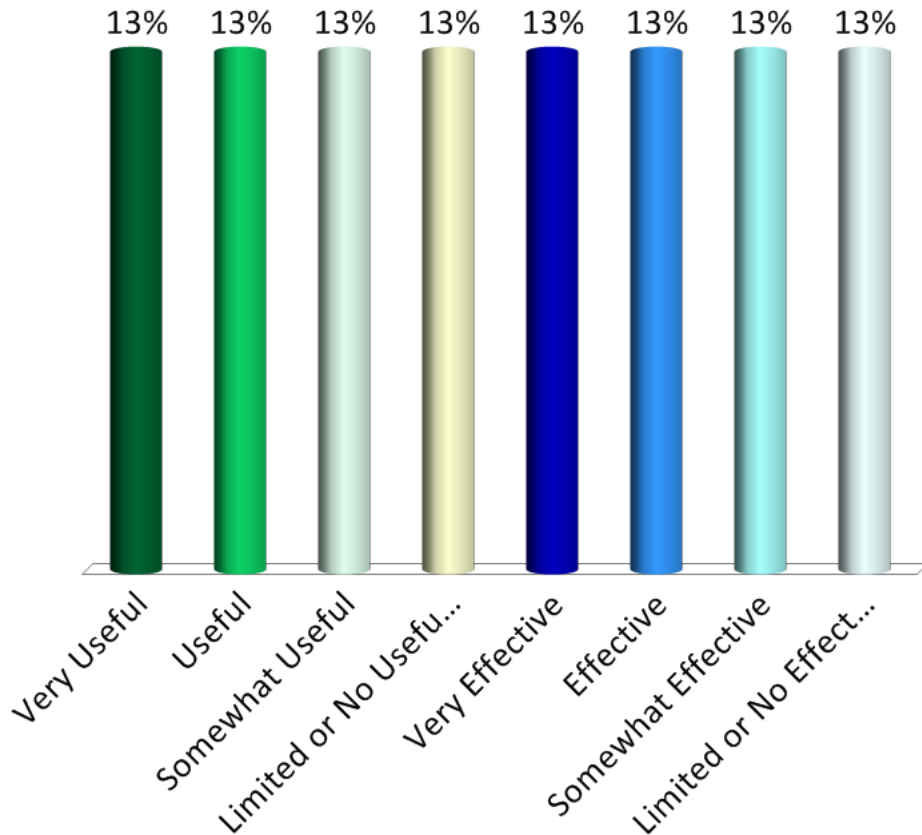
Is it a good SE measure? How much value does it actually provide to your organization?

Examples: Opportunity Register

Opportunity	Likelihood	Cost to Implement	Return on Investment				Program Priority	Management Strategy	Owner	Expected Closure
			MOI/E	Programme	OS&A	Schedule				
Opportunity 1: Procure Smith rather than Jones instead of Jones enter bid.	Med	\$3.2M		\$4M	2 month margin	4% greater	#2	Reevaluate - Summarize the mitigation plan	Ms. Jill Smith	March 2017
Opportunity 2: Summarize the opportunity activity.	Med	\$350K	\$25K	\$375 K			#3	Reject	Ms. Dana Jones	May 2017
Opportunity 3: Summarize the opportunity activity.	High	\$233K	\$0.4M	\$3.8 M	4 months less long lead time needed		#1	Summarize the mitigation plan to realize the opportunity	Ms. Kim Johnson	January 2017

Defense Acquisition Guidebook

1. **Very Useful**
2. **Useful**
3. **Somewhat Useful**
4. **Limited or No Usefulness**
5. **Very Effective**
6. **Effective**
7. **Somewhat Effective**
8. **Limited or No Effectiveness**

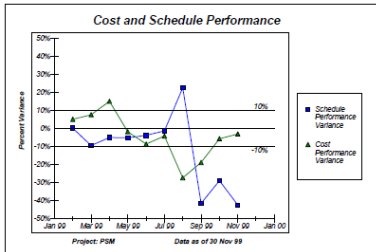


Is **Schedule Detail** a **useful** SE measure, and how **effectively** is it used to provide insight and impactful action in **your** organization?

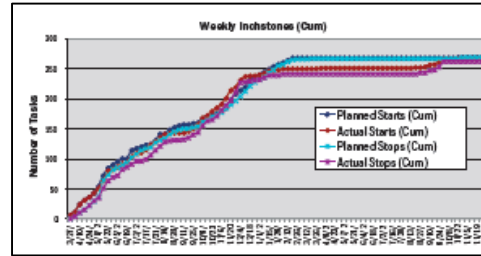
(select 2 choices, 1 from each set below; **usefulness**, **effectiveness**)

Is it a good SE measure? How much value does it actually provide to **your** organization?

Examples: Schedule Performance (SPI), Schedule Inchstones

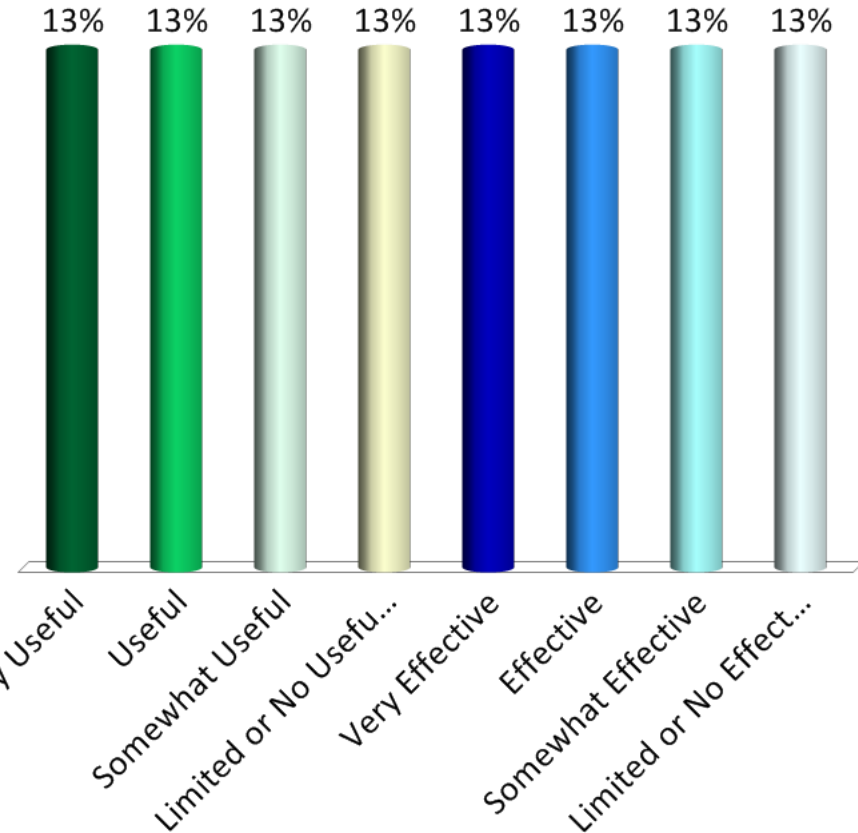


PSM



PM Guide to SE Measures

1. **Very Useful**
2. **Useful**
3. **Somewhat Useful**
4. **Limited or No Usefulness**
5. **Very Effective**
6. **Effective**
7. **Somewhat Effective**
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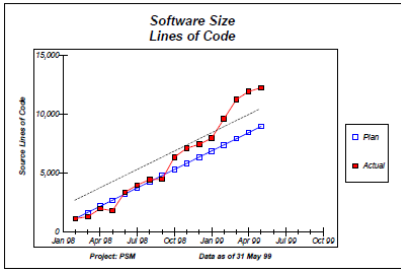


Is **Product Size / Productivity** a **useful** SE measure, and how **effectively** is it used to provide insight and impactful action in **your** organization?

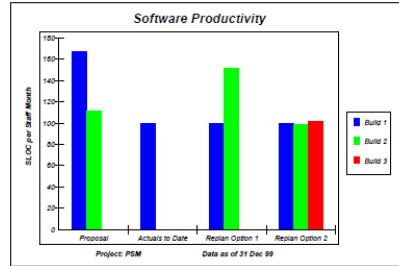
(select 2 choices, 1 from each set below; **usefulness**, **effectiveness**)

Is it a good SE measure? How much value does it actually provide to **your** organization?

Examples: Size (plan vs. actual), Productivity (qty / effort)

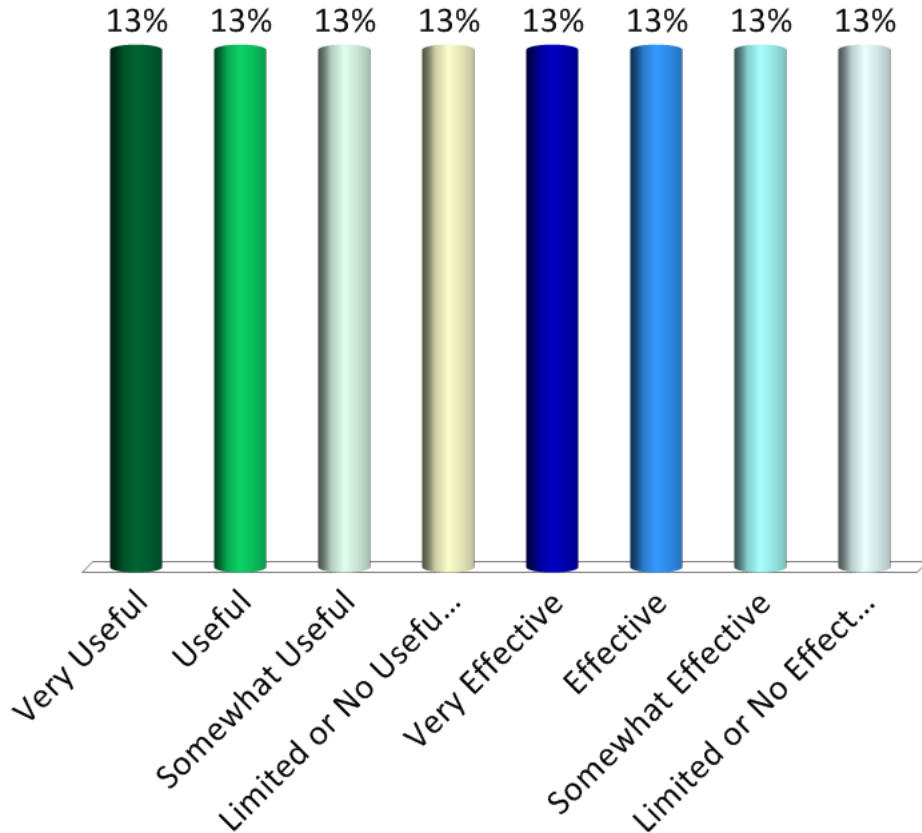


PSM



PSM

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3. **Somewhat Useful**
4. **Limited or No Usefulness**
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6. **Effective**
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Next Steps



Thank you for your input!

Slides will be posted on NDIA SE Conference DTIC site

Additional analysis of these results will be performed

- Benchmarking results by demographic
- Reporting through NDIA SE Division Meetings
<http://www.ndia.org/divisions/systems-engineering/past-events-and-proceedings/division-meetings>

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Please return the interactive voting clickers!