

Use and Organizational Impact of Process Performance Modeling in CMMI High Maturity Organizations

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Selected Results from SEI Surveys

Selected results on the outcomes of using analytical methods

- Data from 2008 survey of high maturity appraisal sponsors
- Focus on issues faced with respect to the adoption & productive use of high maturity measurement & analysis practices

Question wording framed on Process Performance Baselines & Models (PPMs & PPBs)

- Because of survey focus on CMMI-based improvement

Nevertheless, the broader issue is one of appropriate use of analytical methods & the value that can be added by using them

- Don't fixate on the CMMI terminology...
- What matters for process improvement is the use of the analytical methods ... statistical modeling & otherwise
- Similar results in general population survey where reference is simply to M&A

High maturity survey replicated in 2009 with High Maturity Lead Appraisers instead of organizational representatives



Caveat: The Survey Data Do *Not* Speak for Themselves

Perceptions & expectations often differ among survey respondents

- & they probably do by maturity level

We're not claiming cause & effect

- It's statistical association at one point in time
- Cause & effect often are recursive

Proportions & strength of association sometimes vary across the distributions in both surveys

But the differences *are* consistent by maturity level & measurement practices

Results described more fully in a recent SEI Technical Report

- CMU/SEI-2008-TR-024, ESC-TR-2008-024



The Need for Evidence

A great deal of recent discussion

- What does it take to attain high maturity status?
- What can one reasonably expect to gain by doing so?

We need clarification

- Along with good examples of what has worked well and what has not

Questions center on value added by process performance modeling

- As a function of extent of use & understanding of PPMs
- As well as organizational resources & management support

Response rate: 46%



Synopsis & Implications

Evidence of considerable understanding & use of PPMs

- But also variation in responses
- The same is true for judgments about how useful PPMs have been

There is in fact room for continuous improvement among high maturity organizations.

- As in less mature organizations

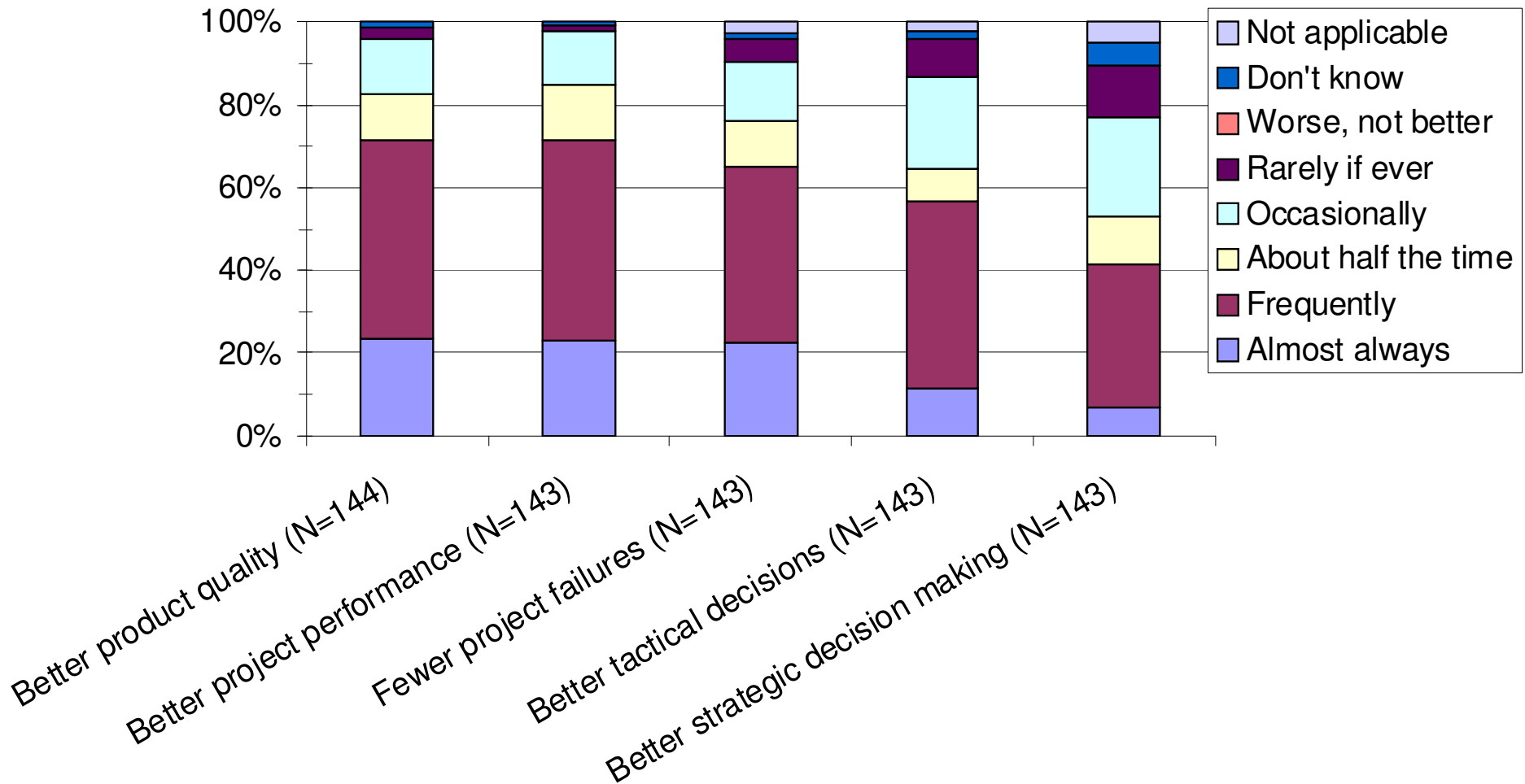
Nevertheless

- Judgments about value added by process performance modeling also vary predictably
- As a function of the understanding & reported use of the models

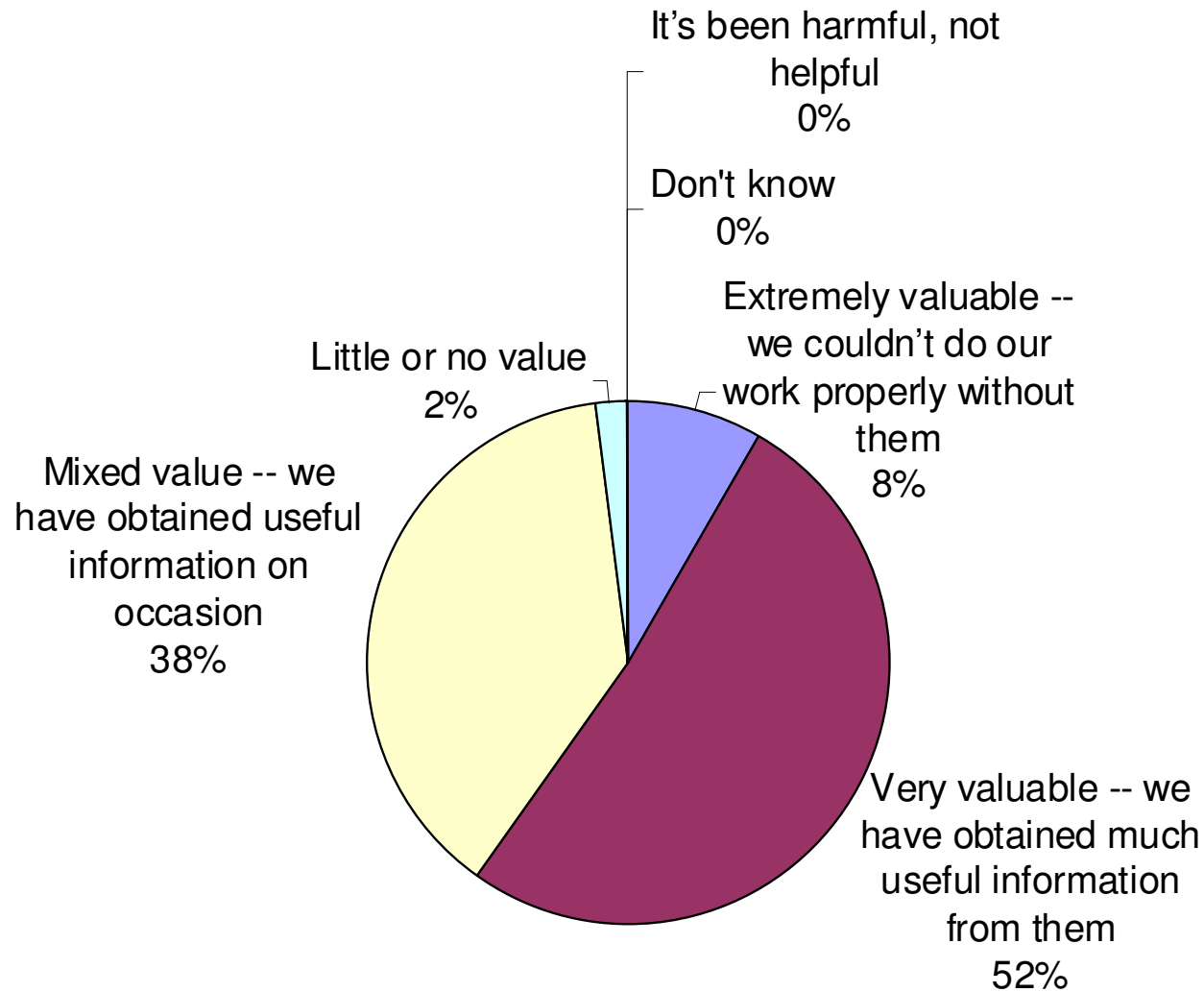
More widespread adoption & improved understanding of what constitutes a suitable process performance model holds promise to improve CMMI-based performance outcomes considerably



Following are a few statements about the possible effects of using process performance modeling. To what extent do they describe what your organization has experienced?



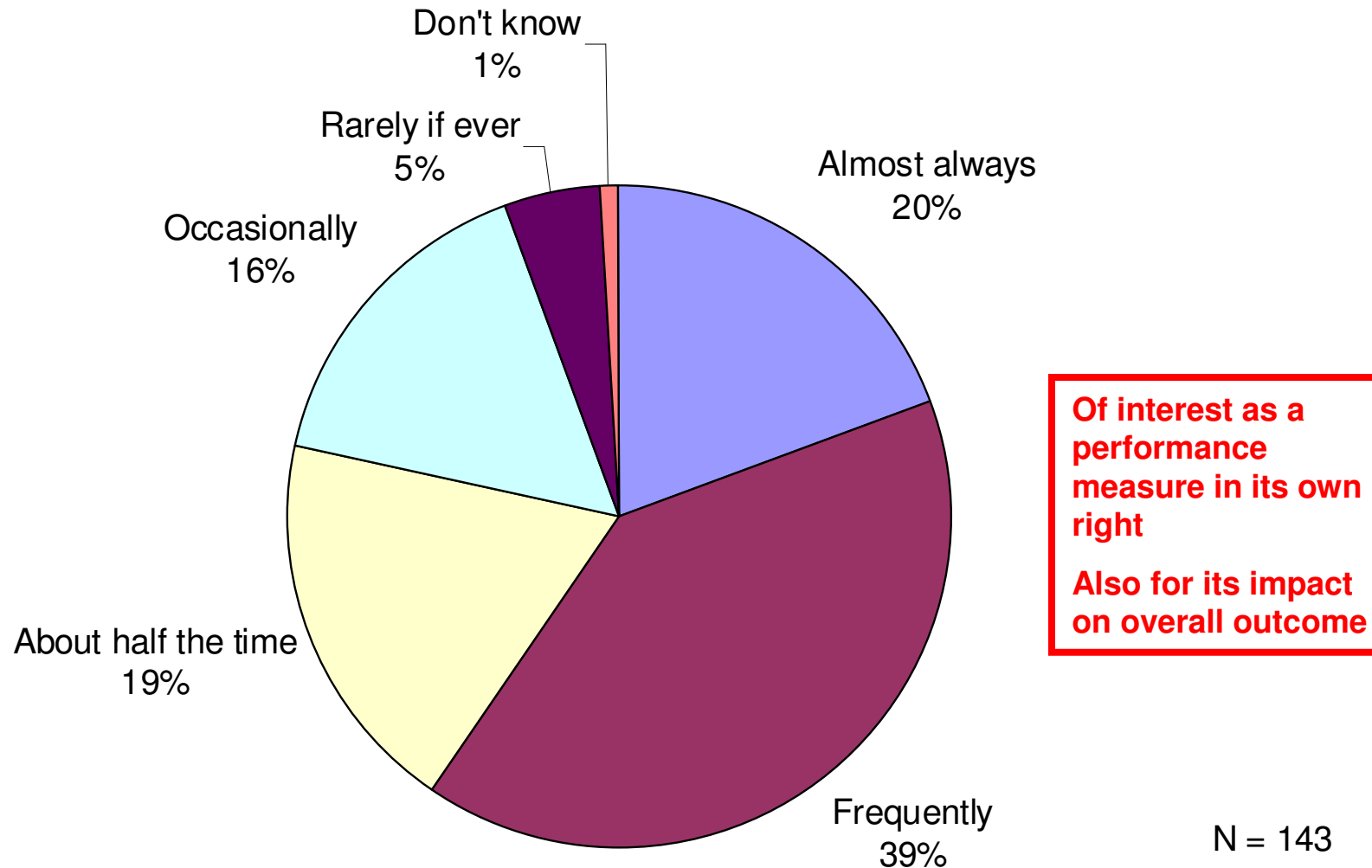
Overall, how useful have process performance models been for your organization?



N = 144



How often are process performance model predictions used to inform decision making in your organization's status and milestone reviews?



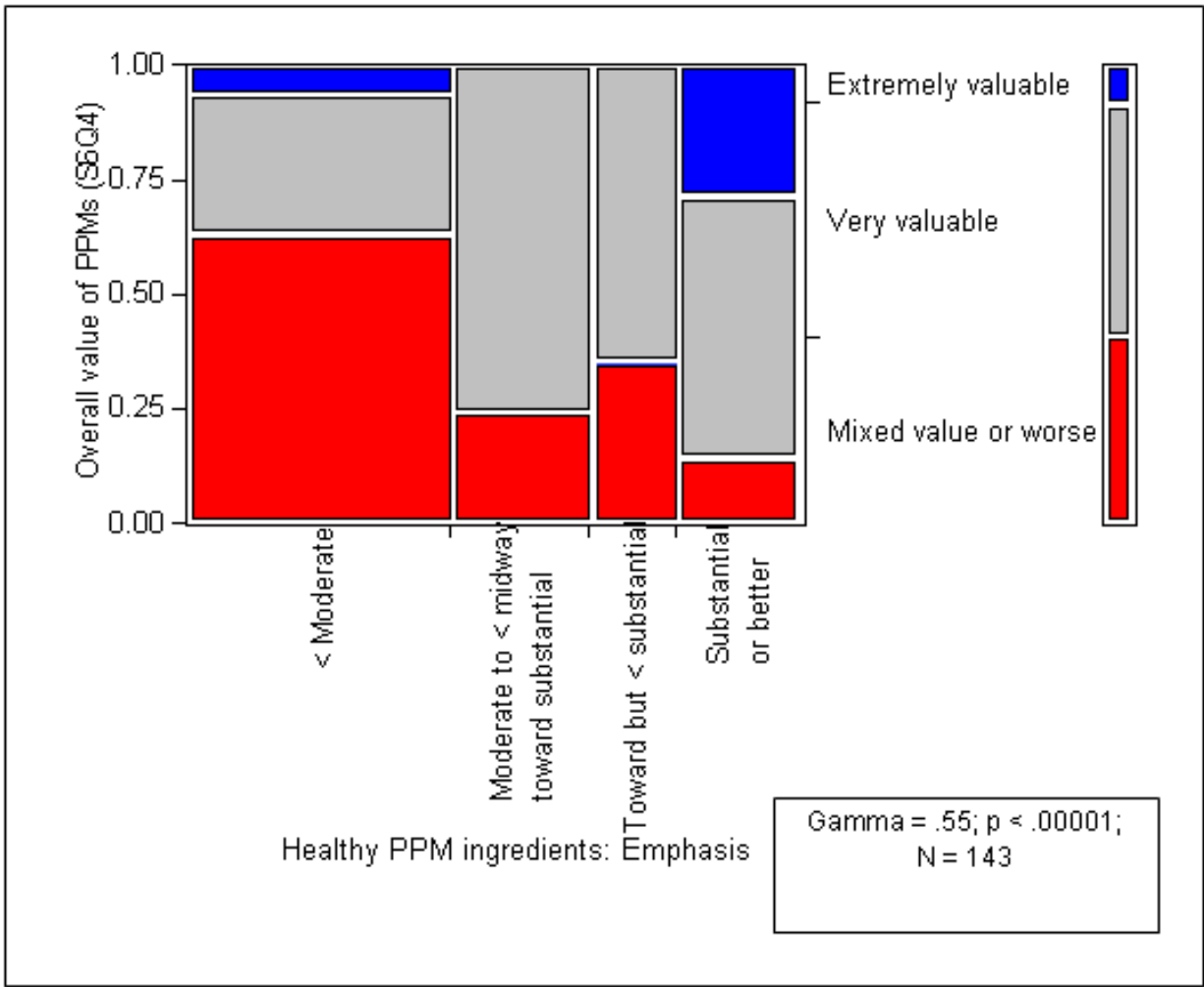
Healthy PPM Ingredients: Emphasis

How much emphasis does your organization place upon the following in its process performance modeling?

- Accounting for uncertainty and variability in predictive factors and predicted outcomes
- Factors that are under management or technical control
- Other product, contractual or organizational characteristics, resources or constraints
- Segmenting or otherwise accounting for uncontrollable factors
- Factors that are tied to detailed subprocesses
- Factors that are tied to larger, more broadly defined organizational processes



Relationship Between Healthy PPM Ingredients & Overall Value Attributed to PPMs ₁



Still room for improvement in PPM emphasis

Which does seem to pay off



Healthy PPM Ingredients: Usage

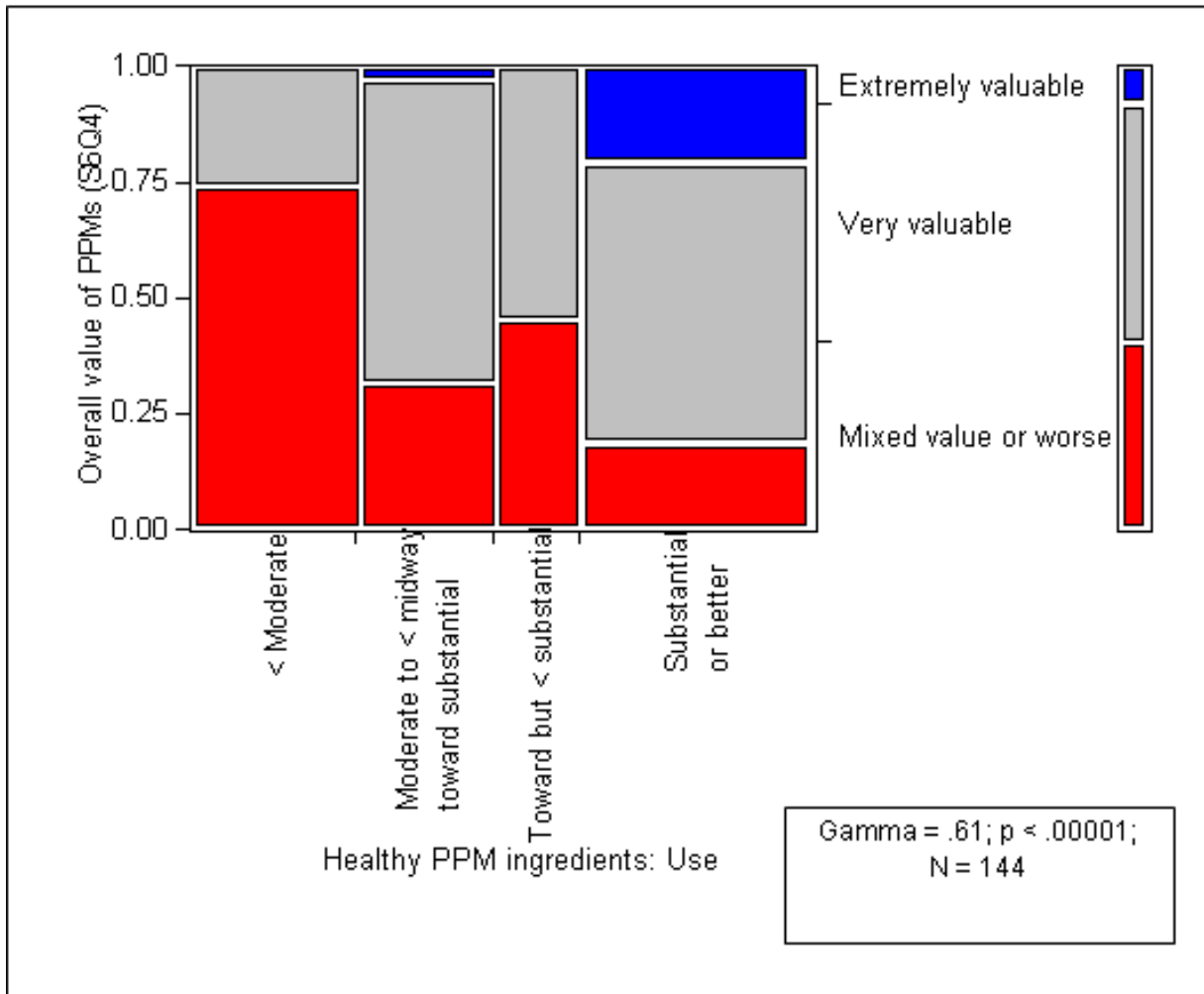
To what degree are your organization's process performance models used for the following purposes?

- Predict final project outcomes
- Predict interim outcomes during project execution (e.g., connecting “upstream” with “downstream” activities)
- Model the variation of factors and understand the predicted range or variation of the predicted outcomes
- Enable “what-if” analysis for project planning, dynamic re-planning and problem resolution during project execution
- Enable projects to achieve mid-course corrections to ensure project success

Note that values on the extremes of this & all other weighted sum measures require consistency of replies across all of the component sub questions



Relationship Between Healthy PPM Ingredients & Overall Value Attributed to PPMs ₂



More do report using PPMs for the right reasons



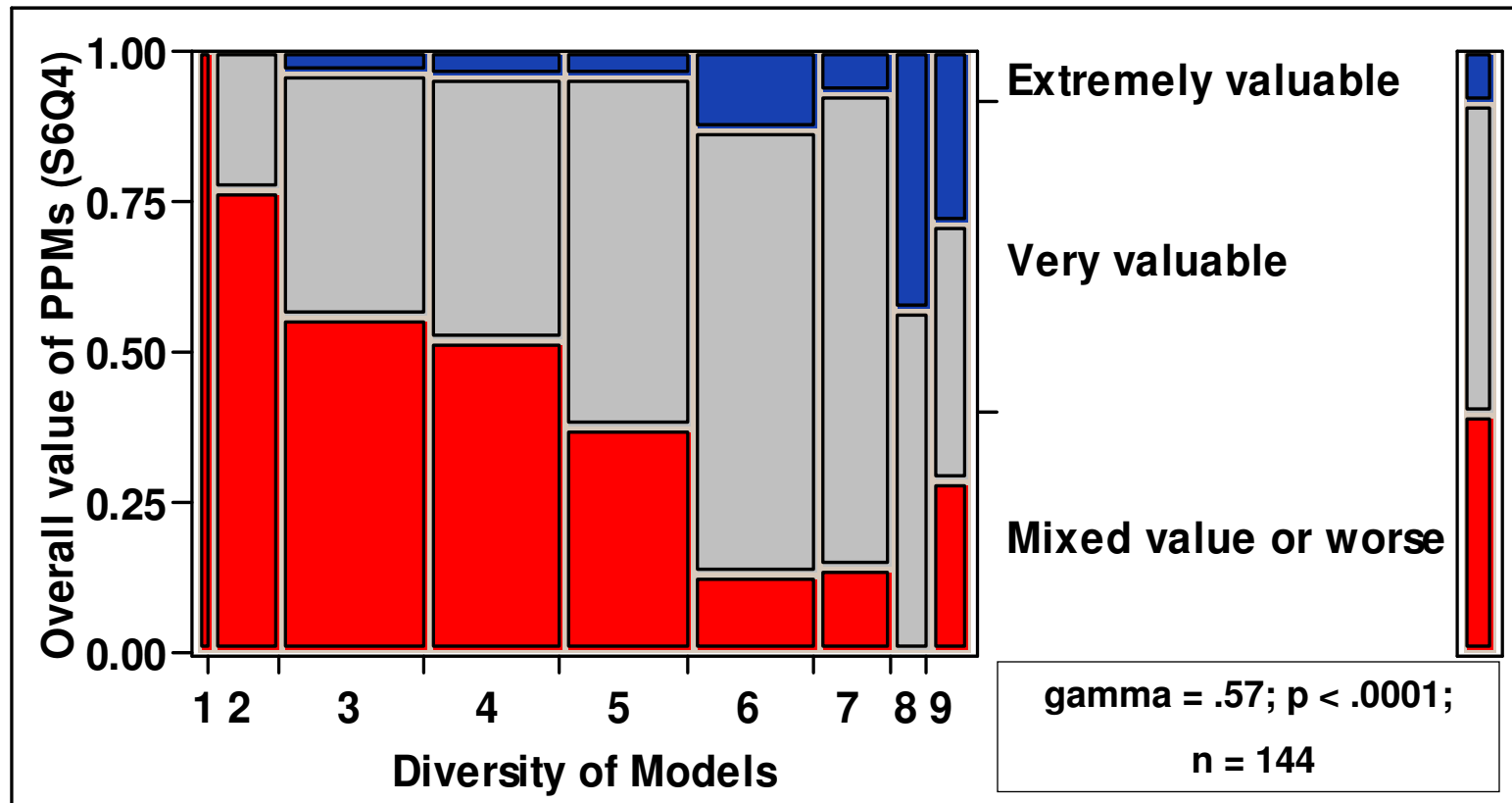
Diversity of PPMs

Which of the following product quality and project performance outcomes are routinely predicted with process performance models in your organization?

- Delivered defects
- Type or severity of defects
- Product quality attributes (e.g., mean time to failure, design complexity, maintainability, interoperability, portability, usability, reliability, complexity, reusability or durability)
- Quality of services provided (e.g., IT ticket resolution time)
- Cost and schedule duration
- Work product size
- Accuracy of estimates (e.g., cost, schedule, product size or effort)
- ROI of process improvement or related financial performance
- Customer satisfaction



Relationship Between Diversity of Models Used & Overall Value Attributed to PPMs



Use of Exemplary Modeling Approaches

Including:

- We have trouble doing process performance modeling because it takes too long to accumulate enough historical data.
- We thought we knew what was driving process performance, but process performance modeling has taught us otherwise.
- We use data mining when similar but not identical electronic records exist.
- We do real time sampling of current processes when historical data are not available.
- We create our baselines from paper records for previously unmeasured attributes.

Relatively little use, but apparent payoff when used – Gamma = .48



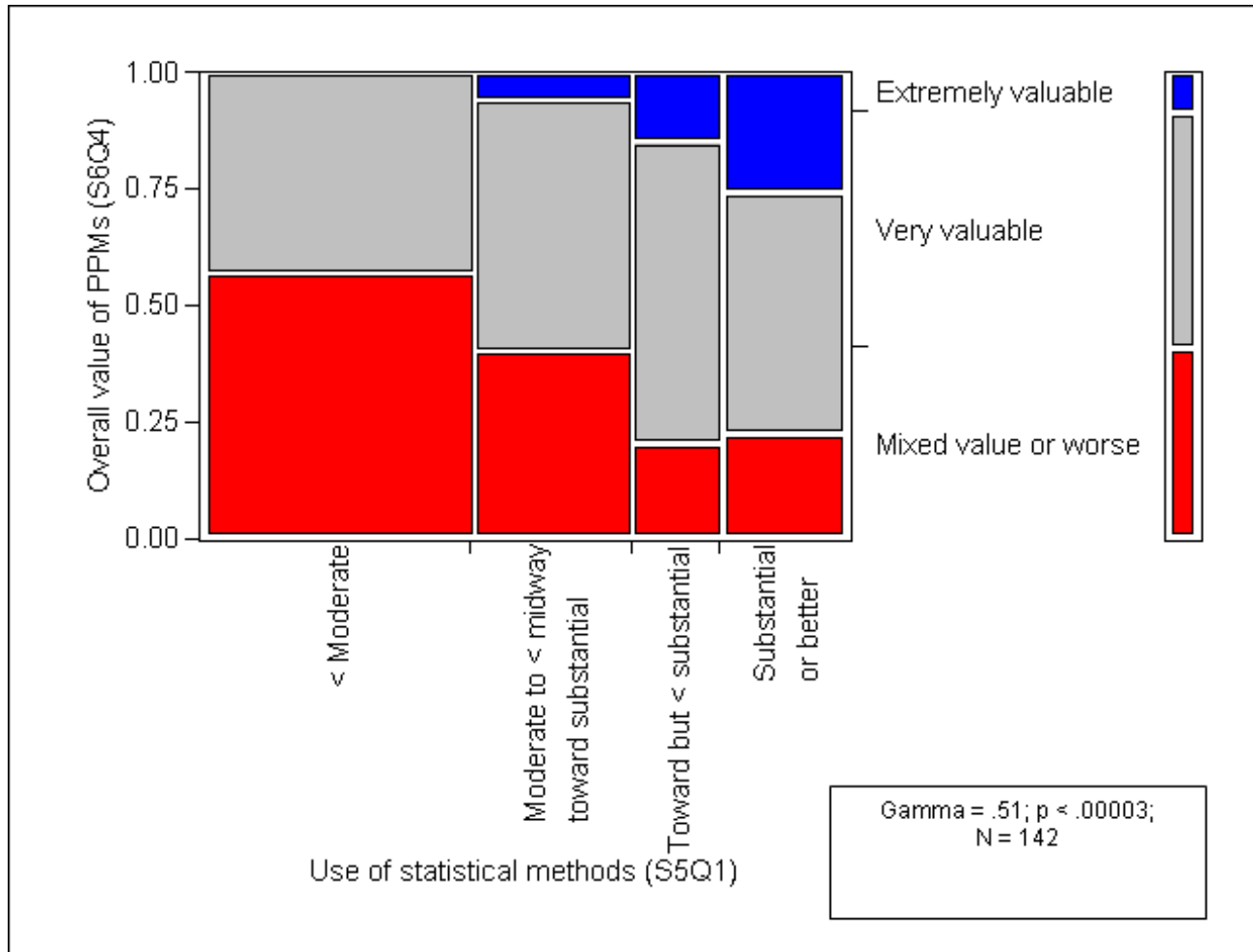
Statistical Analysis Methods

To what extent are the following statistical methods used in your organization's process performance modeling?

- Regression analysis predicting continuous outcomes (e.g., bivariate or multivariate linear regression or non-linear regression)
- Regression analysis predicting categorical outcomes (e.g., logistic regression or loglinear models)
- Analysis of variance (e.g., ANOVA, ANCOVA or MANOVA)
- Attribute SPC charts (e.g., c, u, p, or np)
- Individual point SPC charts (e.g., ImR or XmR)
- Continuous SPC charts (e.g., XbarR or XbarS)
- Design of experiments



Relationship Between Use of Statistical Methods & Overall Value Attributed to PPMs



There's room for improvement here too

Regression & ANOVA are the best individual discriminators



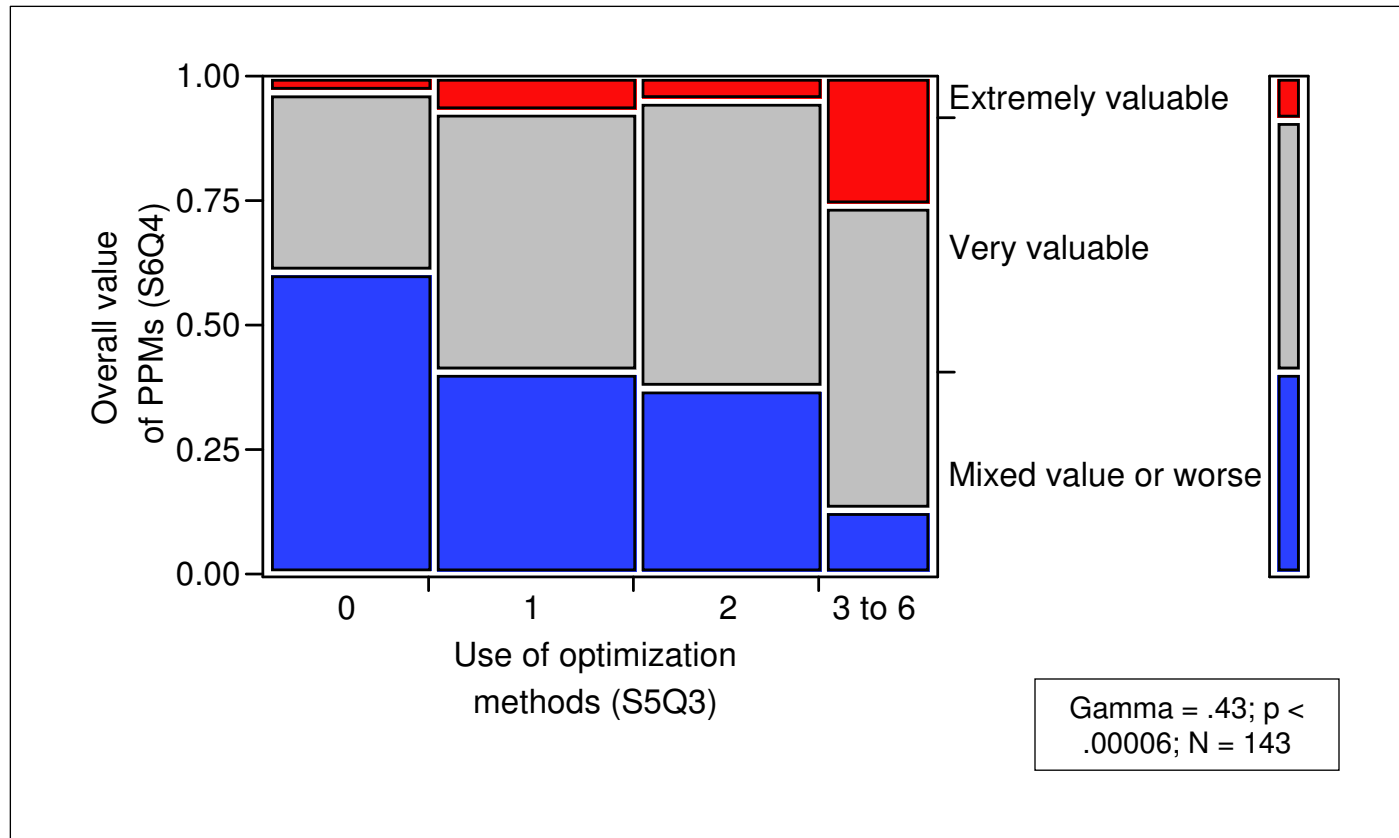
Optimization Methods

Which of the following other optimization approaches are used in your organization's process performance modeling?

- Monte Carlo simulation
- Discrete event simulation for process modeling
- Markov or Petri-net models
- Probabilistic modeling
- Neural networks
- Optimization



Relationship Between Use of Optimization Methods & Overall Value Attributed to PPMs



Methods still used less often

But the value that can be added seems to be considerable



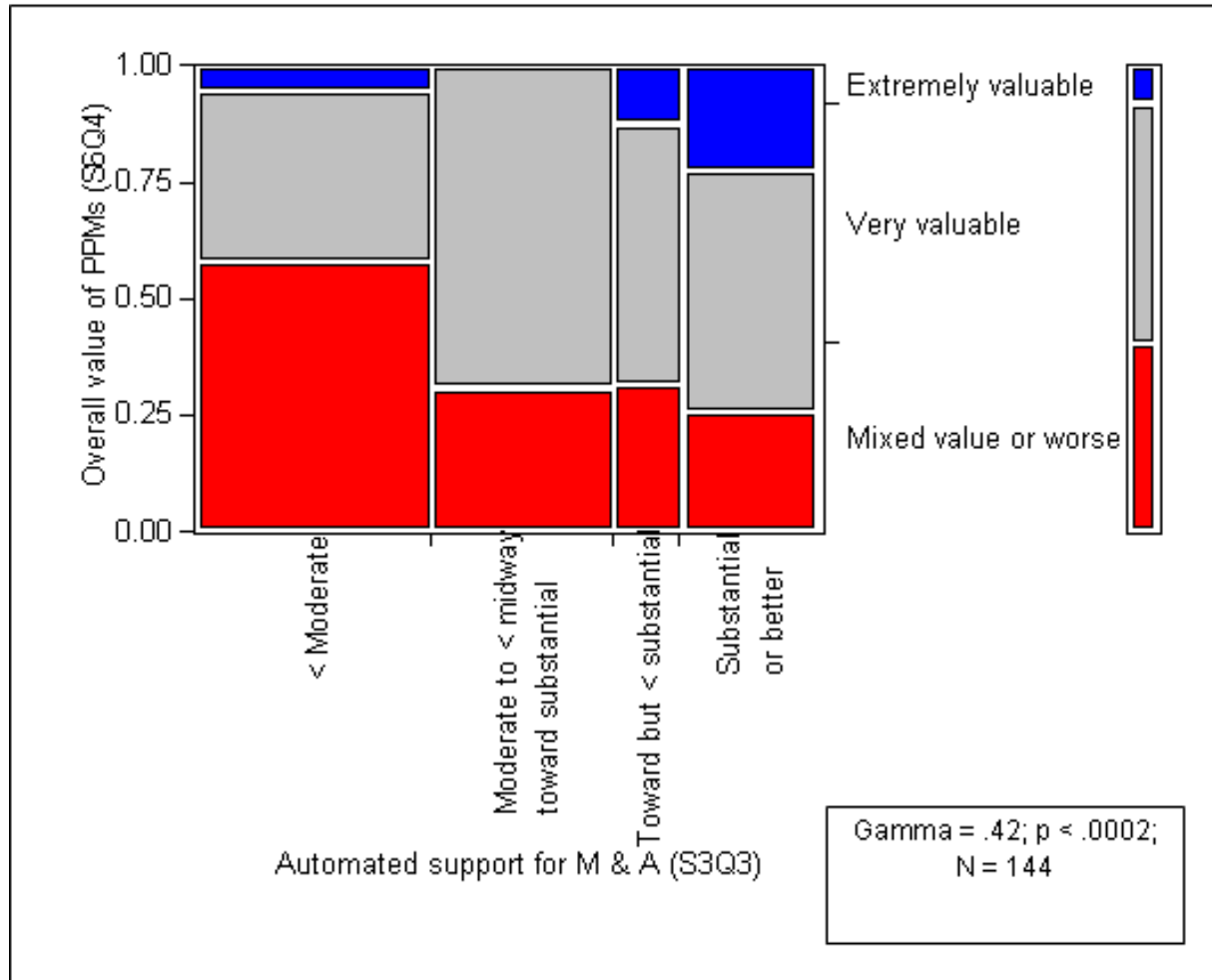
Automated Support

How much automated support is available for measurement related activities in your organization?

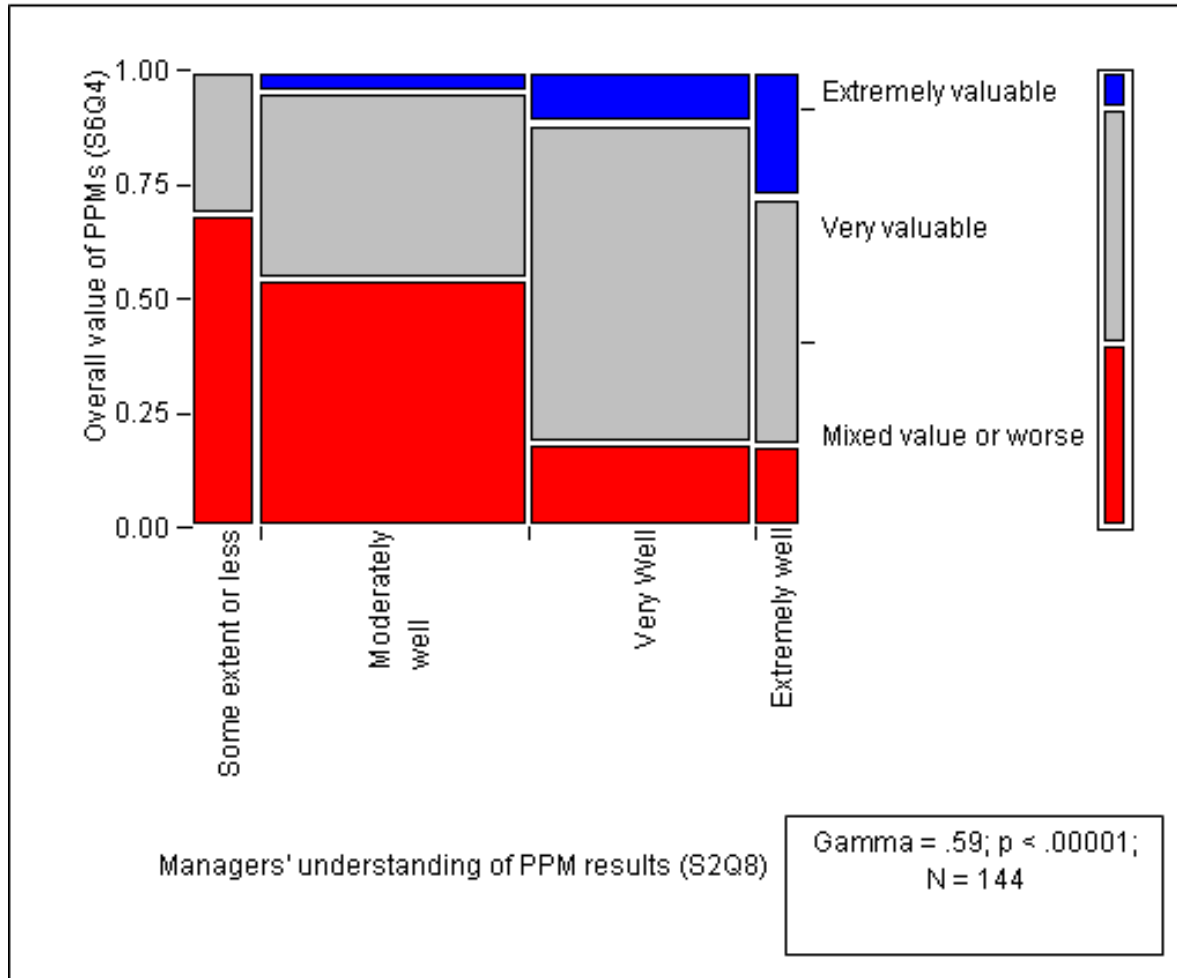
- Data collection (e.g., on-line forms with "tickler" reminders, time stamped activity logs, static or dynamic analyses of call graphs or run-time behavior)
- Commercial work flow automation that supports data collection
- Data management (e.g., relational or distributed database packages, open database connectivity, tools for data integrity, verification, or validation)
- Spreadsheet add-ons for basic statistical analysis
- Commercial statistical packages that support more advanced analyses
- Customized spreadsheets for routine analyses (e.g. for defect phase containment)
- Commercial software for report preparation (e.g., graphing packages or other presentation quality results)



Relationship Between Automated Support & Overall Value Attributed to PPMs



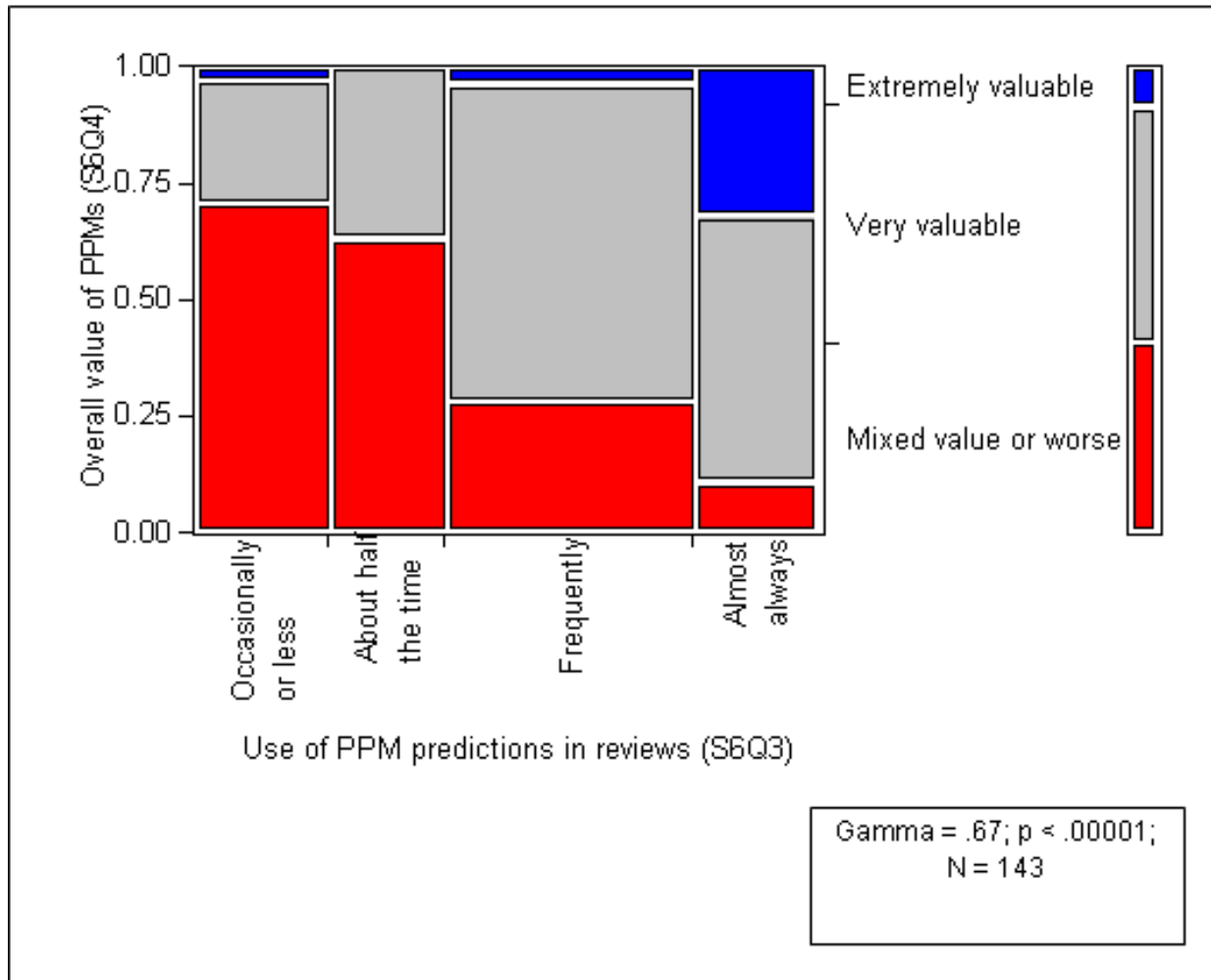
Relationship Between Managers' Understanding of Model Results & Overall Value Attributed to PPMs



How well do the managers in your organization who use process performance model results understand the results that they use?



Relationship Between Use of PPM Predictions in Reviews & Overall Value Attributed to PPMs



How often are process performance model predictions used to inform decision making in your organization's status and milestone reviews?



Stakeholder Involvement

How would you characterize the involvement of various potential stakeholders in setting goals and deciding on plans of action for measurement and analysis in your organization?

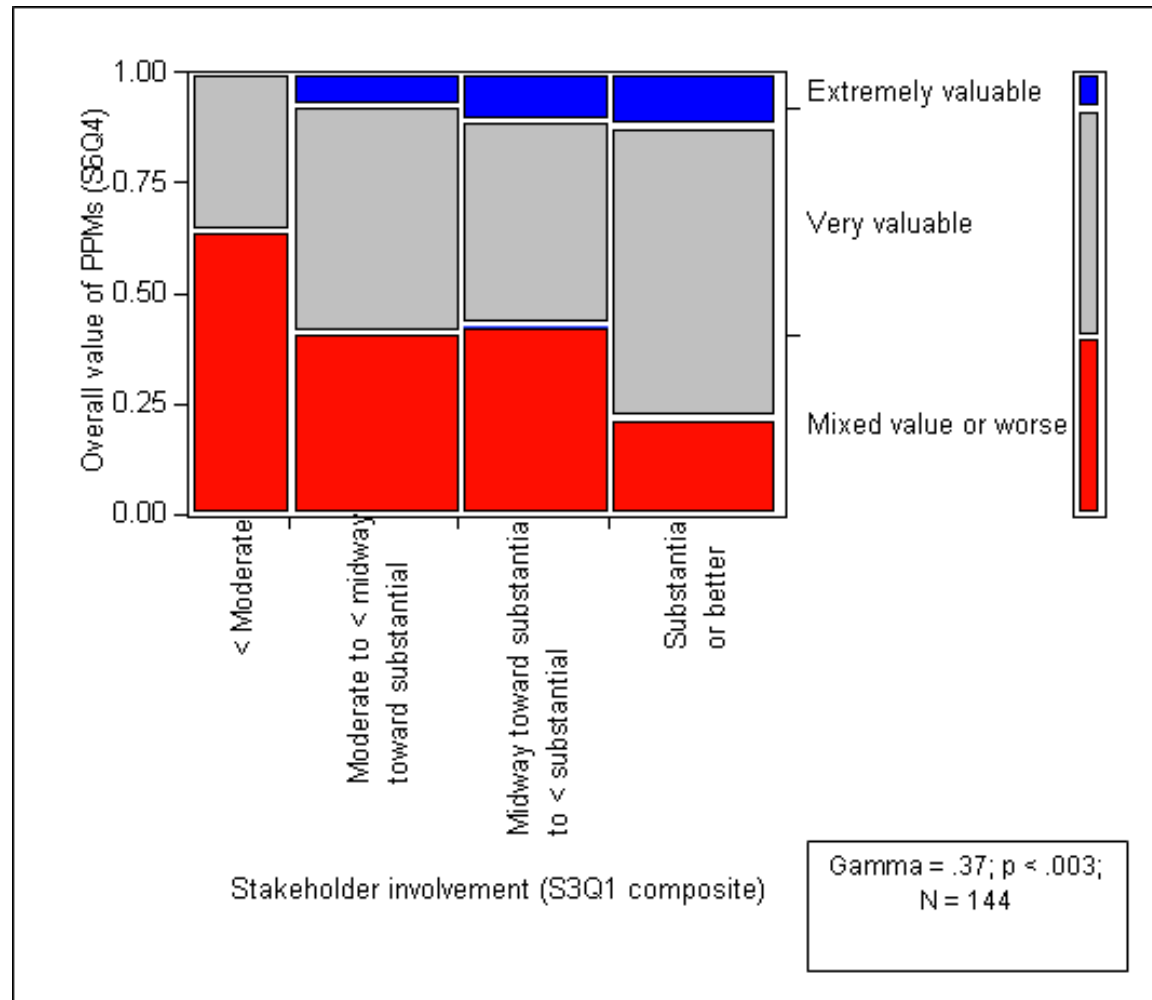
- Customers
- Executive and senior managers
- Middle managers (e.g., program or product line)
- Project managers
- Project engineers and other technical staff
- Process and quality engineers
- Measurement specialists

**As per GQ(IM)
Measurement &
Analysis SG1, SP1
As well as GP 2.7**

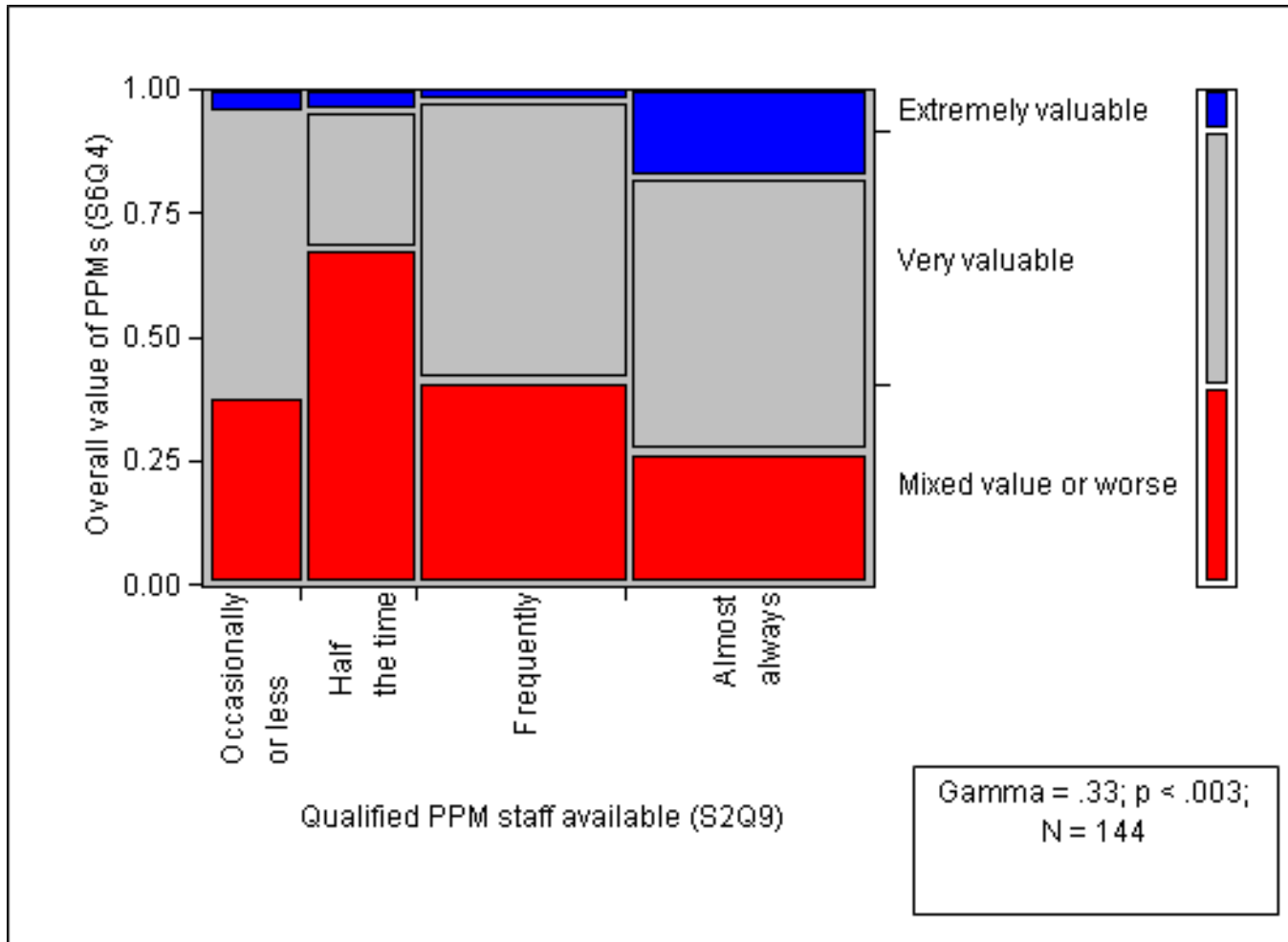
Note that values on the extremes of this & all other weighted sum measures require consistency of replies across all of the component sub questions



Relationship Between Stakeholder Involvement & Overall Value Attributed to PPMs



Relationship Between PPM Staff Availability & Overall Value Attributed to PPMs



How often are qualified, well-prepared people available to work on process performance modeling in your organization when you need them?



Technical Challenge₁

Composite measure

- Extensive interoperability • Large development efforts
- Quality attribute constraints • Requirements changes
- Requirements not well defined • Insufficient resources
- Immature technology • Little or no precedent for work
- Insufficient skills / resources

Essentially *no* direct relationship among these high maturity organizations
(Gamma = .02)

However relationships with *other* predictors of value added by PPMs *do*
differ consistently

- As a function extent of technical challenges faced in their projects



Technical Challenge₂

Stronger relationships when there are *more* technical challenges

- More likely to report value added by process performance modeling
- Including those who use PPMs the *least*

19 out of 20 comparisons – highly unlikely due to change alone

- use of process performance model predictions in reviews
- emphasis on healthy process performance model ingredients
- use of healthy process performance model ingredients
- exemplary modeling approaches
- diversity of process performance models: product quality and project performance
- use of diverse statistical methods
- use of optimization techniques
- use of automated support for measurement and analysis activities
- availability of qualified process performance modeling personnel
- management support (composite measure)



Measurement Related Training

Composite measures based largely on the duration of the training (*not* the quality)

Moderately strong relationship between **management** training & overall value attributed to PPMs – Gamma = .30

But stronger relationships with intermediate factors more directly under management control, e.g.

- *Emphasis on healthy PPM ingredients* – Gamma = .44
- *Use of diverse statistical methods* – Gamma = .43

Moderate relationship with modelers' training – Gamma = .29

- But no other direct effects
- Probably mediated by other, more important determinants of overall value



Overall Impact₁

Did exploratory data analyses to describe combined impact

- As a function of variation in response to the individual questions & composite measures
- That are most strongly associated with reported outcome of process performance modeling

Focused on various combinations looking for a parsimonious model

- Using several statistical methods

Not surprisingly, the various questions & composite measures are often associated with each other

- The inter-relationships are quite complex with mediating effects
- So it is difficult to describe the overall relationship simply



Overall Impact₂

Still, able to increase overall relationship modestly

- Gamma = .71
- Using multiple logistic regression (with non categorized measures)

Variables include:

- Use of process performance model predictions in status & milestone reviews
- Diversity of models used
- Management & Analytic Facilitators of Effective Measurement & Analysis (Exemplary modeling approaches & a similar composite measure of management support for modeling)
- Healthy PPM Ingredients: Emphasis



Summary of Results

Considerable understanding & use of PPMs

- But also variation in responses
- The same is true for judgments about how useful PPMs have been

Nevertheless

- Judgments about value added by process performance modeling also vary predictably
- As a function of:
 - Understanding & reported use of the models
 - Organizational resources & management support

More widespread adoption & improved understanding of what constitutes a suitable process performance model holds promise to improve CMMI-based performance outcomes considerably



The General Population Surveys

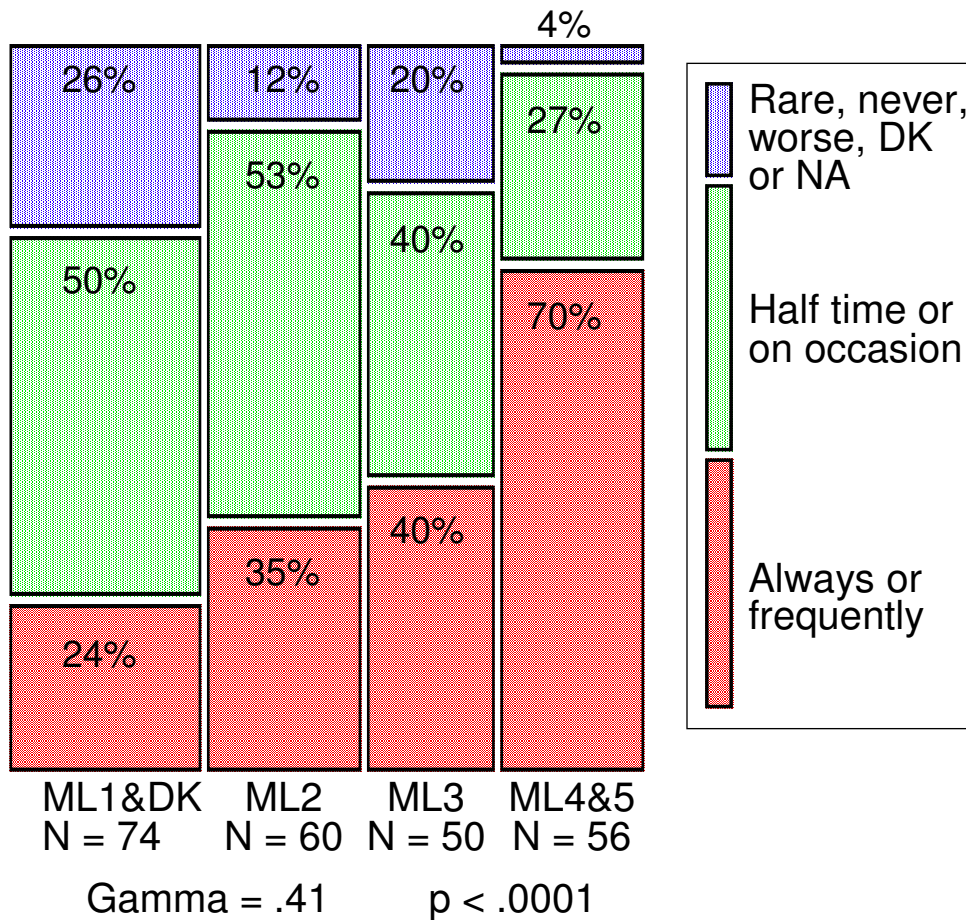
In general, how valuable has measurement and analysis been to your organization?

- Selected evidence follows.
- Response rate: 25%

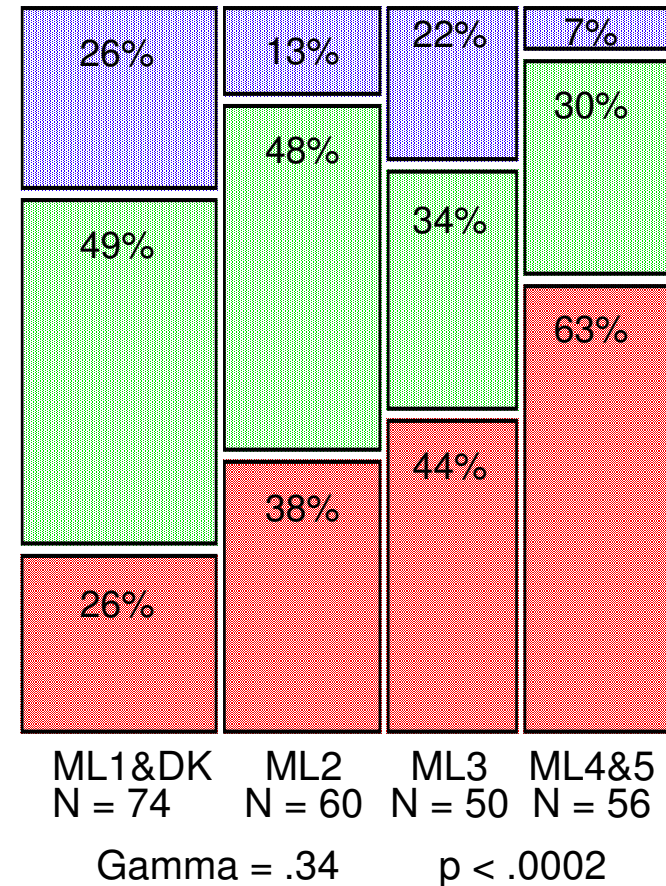


Effects of Measurement on the Organizations₁

Better Project Performance

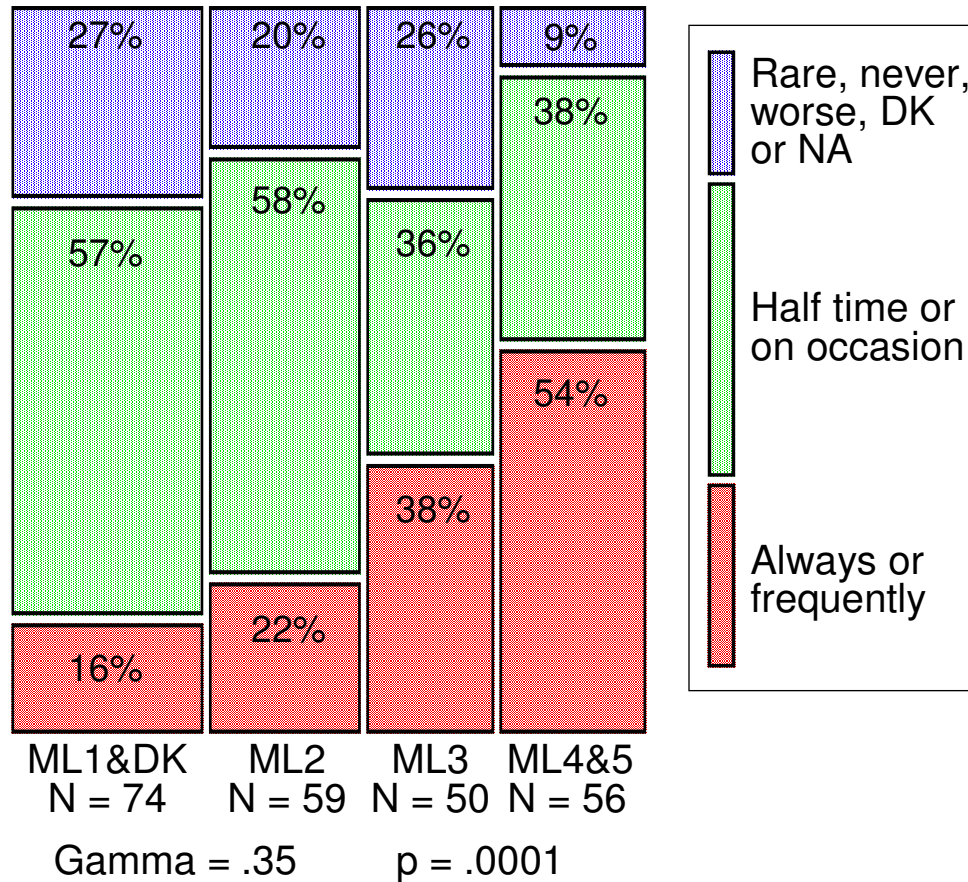


Better Product Quality

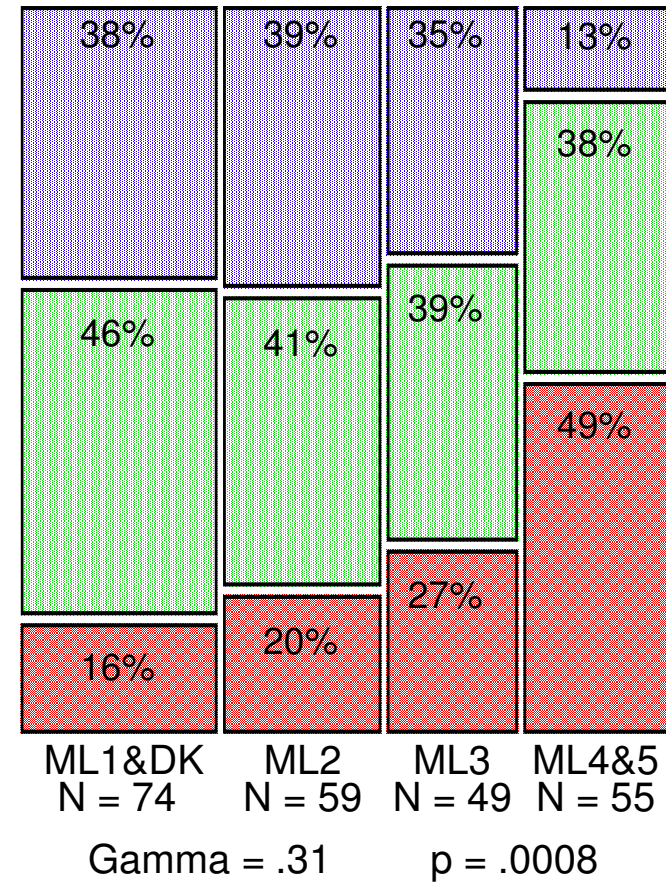


Effects of Measurement on the Organizations₂

Better Tactical Decisions



Better Strategic Decisions



Sampling Issues

Lower than desired response rates

Not surprising in relatively long questionnaires

Exacerbated by:

- Repeated contact of the same individuals for business as well as survey purposes
- Demands on time from busy executives

Considering other sampling strategies for future surveys

“State of the practice” also can refer to very different target populations

- The SEI customer base ... the broader software & systems engineering community ... or those organizations that more routinely use measurement?
- Of course, the answer depends on the purposes of the survey



Thank You for Your Attention!

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