Improving Enterprise Decision-Making: The Benefits of Measure Commonality

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Agenda

- The Motivation for Improvement
- Research Concept & Questions
- The Case Study
  - Background
  - Research Design
  - Findings
  - Insights, Reflections, and Impacts
- Answering the Research Questions & Future Work

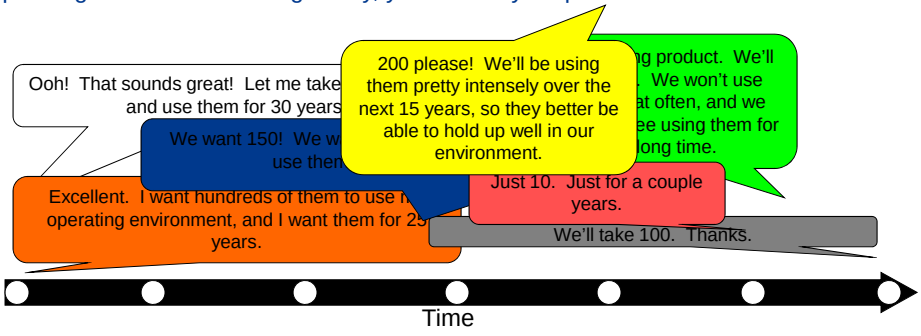
The Motivation for Improvement

Research Concept & Questions

LEAN ADVANCEMENT INITIATIVE

…but first, CONGRATULATIONS!

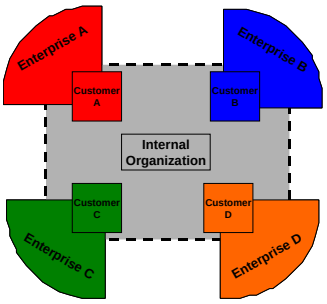
You have successfully developed a product for a big customer with a production contract spanning decades! As time goes by, you market your product to even more customers:



How do you manage, and make internal decisions on, external data, to better improve the product?

Motive for Improvement:
The Burning Platform

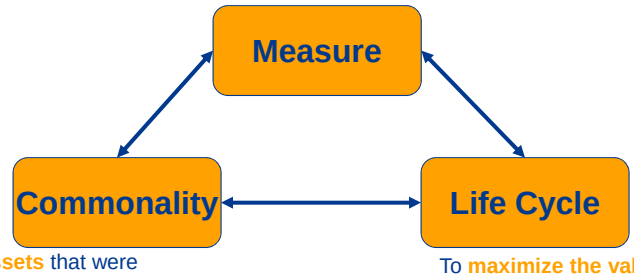
- Each external stakeholder (customer) is unique
  - Values, strategic objectives
  - Different uses of same product
  - Different sets of performance measures
  - Capabilities (technology, knowledge)
  - Leadership involvement
  - Rules and regulations
- Potential results
  - Misallocation of improvement money
  - Lack of customer communication
  - Increased time to make decisions



How does one improve this program?

Research Concept:
Commonalizing External Performance Measures

A measure is something quantifiable that is used to **help drive a decision** (Blackburn, 2009)



The **reuse of assets** that were specifically developed to **meet the needs of other products** (Boas, 2008)

To **maximize the value** of a product, while **containing its impact on cost** to manufacturer, the user and the society **to a minimum** (Prasad, 2000)

Associating Measures with Commonality

- **Commonality**: the reuse of ~~assets~~ measures that were previously developed to meet the needs of another ~~product~~ customer and, in some cases, from the reuse of ~~assets~~ measures that were specifically developed to meet the needs of multiple ~~products~~ customers (Boas, 2008)
- Lots of literature of commonality in product development, but not in measures
  - Specifically, external measure commonality

Research Concept: Commonalizing External Performance Measures

Do the right job … by tracking the product or service performance measures that stakeholders value, and basing the right decisions off of them

Do the job right … by using an optimal number of common measures at the right phase in the operating life cycle for all customers

(Drucker, 1963)

Research Questions

- Can the concept of commonality be applied towards measures?
- How efficient and effective is commonalizing measures in assessing performance?
- How do measures change over an operating life cycle?

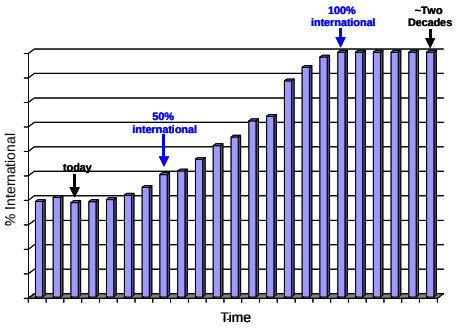
The Connection to Lean Thinking

The Case Study

LEAN ADVANCEMENT INITIATIVE ™

The Case Study:
Background

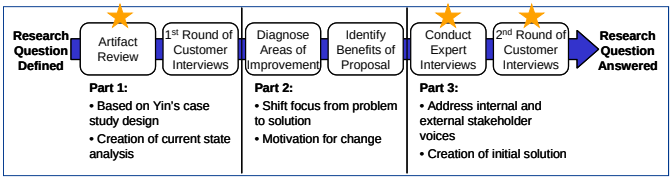
- Technical product; operating for decades, will continue to operate for decades
- Originally developed for large, domestic customer
- Product marketing led to contracts with other unique customers (all international)
- Soon, only international customers will operate the product
- Frustratingly harder to manage, and make the right decisions to improve, the 2500+ product line as ONE product



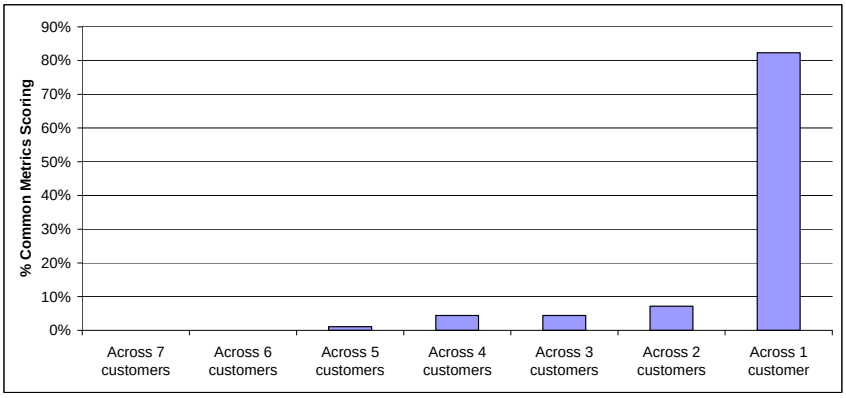
100% international (non-primary) customers over next ~20 years

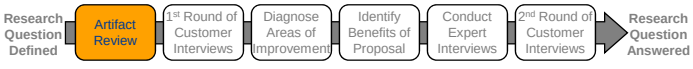
The Case Study:
Research Design

- **Mixed-method**: qualitative and quantitative data
- **Triangulation**: use of three data sets (three different viewpoints) within same research problem dimension
  - Artifact review (historical data): quantitative
  - Expert interview data: qualitative and quantitative
  - Customer interview data: qualitative and quantitative

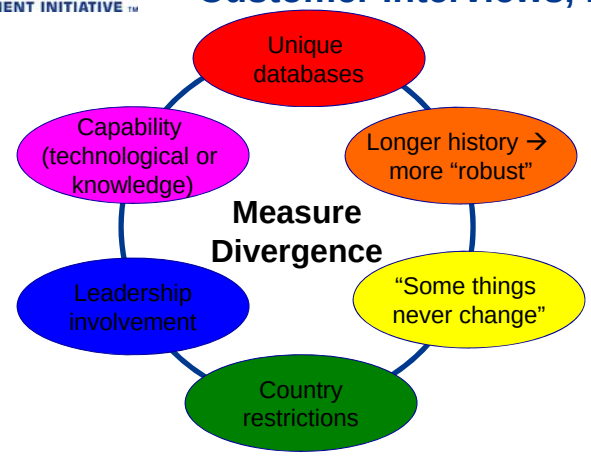


The Case Study:
Artifact Review





The Case Study:
Customer Interviews, Round 1



Research Question Defined → Artifact Review → 1st Round of Customer Interviews → Diagnose Areas of Improvement → Identify Benefits of Proposal → Conduct Expert Interviews → 2nd Round of Customer Interviews → Research Question Answered

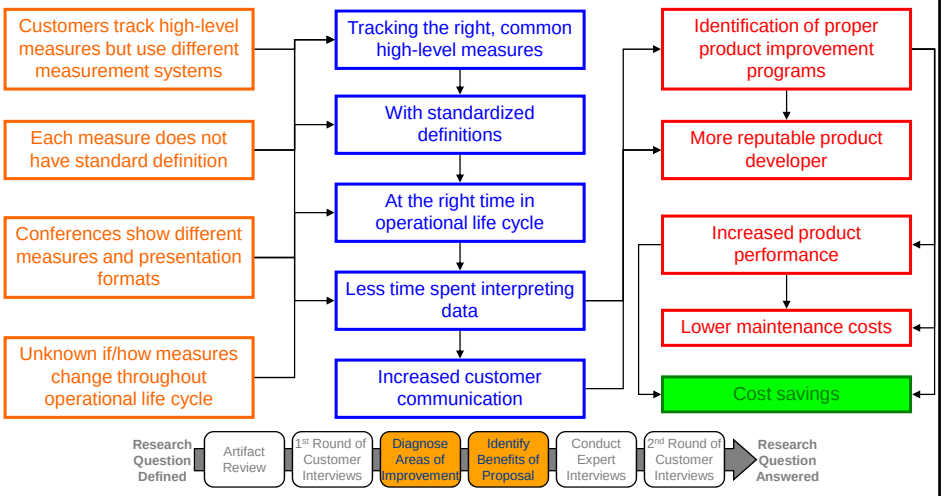
The Case Study:
Customer Interviews, Round 1

- ☑ Common performance and measure definitions
- ☑ Increased customer information sharing and communication
- ☑ Best-in-class initiatives (to use for other product lines)
- ☑ Easier to determine root causes for adverse performance
- ☑ Budget planning purposes

- ⊘ Adoption to change
- ⊘ Export control issues
- ⊘ Lack of "uniqueness"

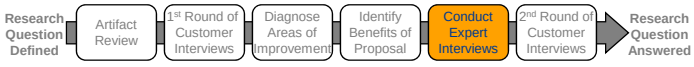
Research Question Defined → Artifact Review → 1st Round of Customer Interviews → Diagnose Areas of Improvement → Identify Benefits of Proposal → Conduct Expert Interviews → 2nd Round of Customer Interviews → Research Question Answered

The Case Study:
The Tie to the Bottom Line



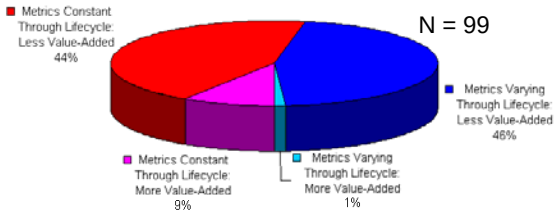
The Case Study:
Expert Interviews

- Eleven experts spanning component design, safety, and project
- Recommended measures satisfy voice of customer AND individual responsibilities
- Total of 99 recommended measures (45% reduction from historical data)
- 5 measures >50% agreement, total 10 measures >25% agreement

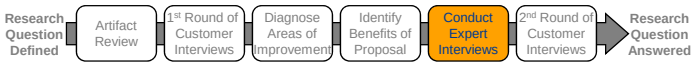


The Case Study:
Expert Interviews

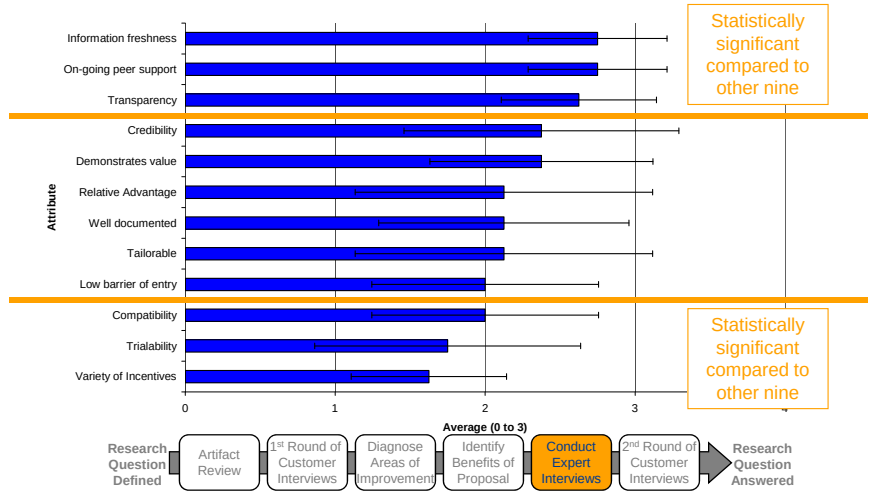
- Of the 99 recommended measures, 53% should be measured throughout the life cycle, and 47% should be measured at different points throughout the lifecycle



- 90% of the most "value-added" (ie – top ten) measures should be recorded throughout the product's life cycle

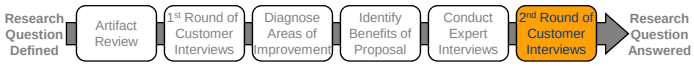


The Case Study:
Expert Interviews (n = 8)



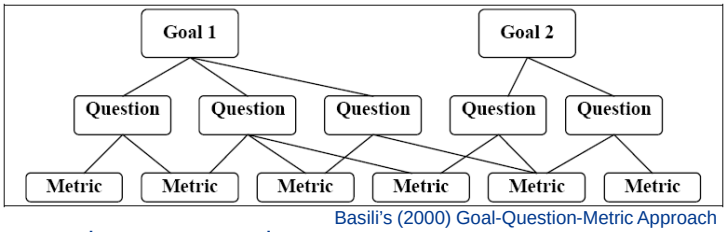
The Case Study:
Customer Interviews, Round 2

- Small sample size, n = 4 customers interviewed
  - 4 customers represent >80% of product population
- Measure generation: "what five to ten [product] performance measures do you consider most important to address your job's CTQ's?"
- Total of 28 recommended measures. Total of:
  - 100% customer agreement = 1 measure
  - 75% customer agreement = 3 measures
  - 50% customer agreement = 8 measures
  - 25% (individual) customer agreement = 28 measures



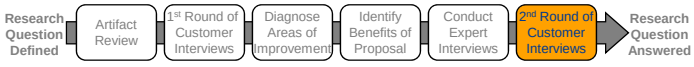
The Case Study:
Customer Interviews, Round 2

- The issue lies in the Question/Metric (Measure)!

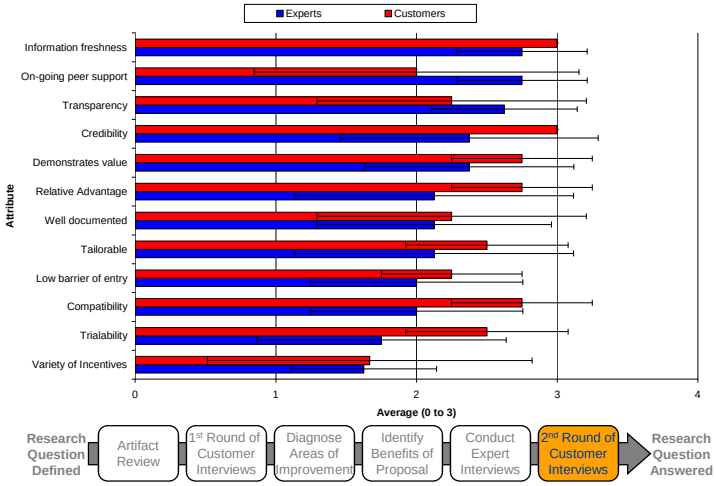


Basili's (2000) Goal-Question-Metric Approach

- Customers share same goal
- Yet the question (how to characterize the goal) and metric/measure (quantitative data that addresses question) vary

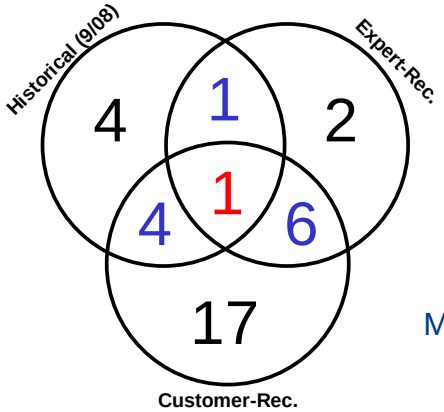


The Case Study:
Customer Interviews (n = 4), Round 2



The Case Study:
Findings

Total Interactions for Data Sets



Totals for Individual Data Sets

Measure Set	Total
Historical	10
Expert	10
Customer	28
Historical / Expert	18
Historical / Customer	33
Customer / Expert	31
All 3	35

Maybe measure commonality can exist – look deeper into results

The Case Study:
Findings

		Measure Population Set			
		Historical Expert Customer	Historical Expert	Historical Customer	Expert Customer
Overall	Total Number of Measures in Set	35	18	33	31
	Number of Shared Measures	1	2	5	7
	Percentage	3%	11%	15%	23%
Number of Measures in Agreement with "X" Number of Customers	0 Customers	0	1	0	0
	1 Customer	1	1	4	4
	2 Customers	0	0	1	1
	3 Customers	0	0	0	1
	4 Customers	0	0	0	1

"goodness"

Measure commonality **CAN** exist!

The Case Study:
Recommendations

1. Engage leadership
2. Generate common list of measures, with standard set of definitions
3. Create a "pull" database system
4. Use common templates for measure presentations during product conferences
5. Be patient, be energetic, be supportive

The Case Study:
Recommendation 1

- Engage leadership
  - Tie common measures to bottom-line measures
  - Predict benefits over time (quantitative)
  - Include examples of success (Nike, CAST)

The Case Study:
Recommendation 2

- Generate common list of measures, with standard set of definitions
  - Begin with this research as a starting point
  - Great venue to start discussions: product conferences
  - Make sure the right stakeholders are in the room
  - Follow the goal-question-metric approach
  - Perform "measure audit" to identify measure alignment, false alarms, and gaps

The Case Study:
Recommendation 3

- Create a “pull” database system
  - Integrated project team between IT, customers, and developers to create a user-friendly system to place data into, and pull data from
  - Opportunity to understand the customer technological capabilities and challenges
  - Aim for a self-sustaining database (addresses an adoption attribute)
  - Still a barrier for this case study is export control; unsure at moment how to work through this.

The Case Study:
Recommendation 4

- Use common templates for measure presentations during product conferences
  - Base template information off of the current common measures between customers and experts
  - This can be used as interim step while adopting a measure commonality decision-making model – if improvements are seen during conferences using a common template, this is a good starting point

The Case Study:
Recommendation 5

- Be patient, be energetic, be supportive
  - This adoption process will NOT happen overnight! Could take 1-2 years, at minimum
  - Don't lose faith! Need the right leadership supporting the process, understand expected outcomes, and continuously engage stakeholders
  - Continuously improve model so it becomes a best-in-class initiative across the industry

Insights, Reflections, and Impacts

- The importance of the voice of the customer
- The link between measures and strategic planning
- A new PMS framework
- The importance of adoption
- Business strategy creation

Insights, Reflections, and Impacts

- The importance of the voice of the customer
  - Highlighted in the case study by:
    - Common measure sets (Venn Diagram reference)
    - Adoption attribute assumptions
    - Recommendation of IPT
- Understanding VOC → "co-creation" of VOC

*"In this co-creation process, **the firm and the customers do the asking, listening, observing, and experimenting**: that is, the firm and the customers engage in learning. The subject of study is customer needs/wants and firm needs/wants. **The process results in the firm and customers knowing more about the needs/wants of the customer and the firm**. Finally, after the process is complete, the firm and the customers figure out the goods and services that will be developed (or performed) by the firm and those that will be developed (or performed) by the customers."*

-- Jaworksi and Kholi (2006)

Insights, Reflections, and Impacts

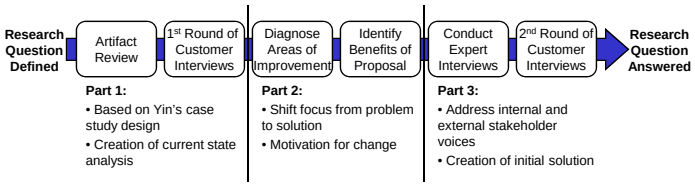
- The link between measures and strategic planning

Measure Set	Total # Measures	Top # Measures	Top Measure Criteria	Remaining Measures
Historical	181	10	>=50% customer agreement	171
Expert	99	10	>=25% expert agreement	89
Customer	28	8	>=50% customer agreement	20

Are any of these necessary to make the right decisions?

Insights, Reflections, and Impacts

- A new PMS framework
  - Common measure creation through a "pre-audit"
  - External stakeholder (customer) as primary data source
  - Individual instead of group input



Insights, Reflections, and Impacts

- The importance of adoption

Adoption Attribute	Expert	Customer
Top Three	**Information Freshness** **Ongoing Peer Support** Transparency	**Information Freshness** Credibility
Bottom Three	**Variety of Incentives** Compatability Trialability	**Variety of Incentives** **Ongoing Peer Support** Low Barrier of Entry

There is some alignment already: information freshness in top three, variety of incentives in bottom three

But still, gaps between experts and customers … need to align!

Insights, Reflections, and Impacts

- Business strategy creation
  - Strategy 1: sell product to potential buyers with "optimal list of performance measures"
    - Another data set in comparing "apples to apples"
    - Provides the customer with a "starting point"
  - Strategy 2: offer performance measures as part of "remote diagnostics" package
    - Customer does not need to worry about additional resources to record the measure data
    - Developer has access to customer data all the time

Answering the Research Questions

Future Work

Answering the Research Questions

- Can the concept of commonality be applied towards measures?
  - YES!
  - Results of data analysis:
    - Historical/Expert = 11%
    - Historical/Customer = 15%
    - **Expert/Customer = 23% (!!!)**

Answering the Research Questions

- How efficient and effective is commonalizing measures in assessing performance?
  - Qualitatively: measure commonality improves both
    - Effectiveness
      - All customers tracking the right things of which to base decisions
    - Efficiency
      - All customers tracking the same things
      - Less time needed to interpret data and make decisions

Answering the Research Questions

- How do measures change over an operating life cycle?
  - Based off of expert interviews
    - 53% of all measures should be tracked across entire life cycle
    - 47% of all measures should be tracked during varying phases of life cycle
    - TOP TEN MEASURES: 90% of these measures should be tracked across entire life cycle

Future Work

- How much commonality is too much commonality?
- Quantitative benefits of measure commonality
  - "You can save 'X' million dollars over 'Y' years…"
- Expand the knowledge!
  - More aerospace case studies
  - Studies in other fields
  - Perhaps a study that focuses on organizational performance rather than product performance

Questions?

- Thank you! Any questions?
- Are there any audience members who have tried to work through this issue?
  - Any recommended best practices?
- Contact information:
  - ahf9@mit.edu or alissa.h.friedman@gmail.com

Backup

Blackburn's (2009) PMS Framework Typology

Structural	Procedural	Both
Strategic Measurement & Reporting Technique (Cross et al., 1988)	A Framework for Design & Audit (Medori, 2000)	The Balanced Scorecard (Kaplan et al., 1992)
The Performance Prism (Neely et al., 2001)	A Framework for Factors Affecting Evolution (Kennerly et al., 2003)	Extended Enterprise Balanced Scorecard (Structural) and Procedural Frameworks (Folan et al., 2005)
European Foundation for Quality Management – EFQM (Jackson, 2001)	Define-Measure-Analyze-Implement-Control (De Feo et al., 2005)	-
PSM's Measurement Contstruct (McGarry et al., 2001)	GQM (Basili et al., 1994)	-
Value Stream Mapping (Murman et al., 2002)	Steps to Metric Selection	-

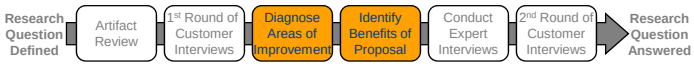
Structural = typology-based
Procedural = methodology for establishing the system
Both = structural and procedural

Mahidhar's (2005) strengths and weakness of PMS frameworks

Performance Measurement Framework	Strengths	Weaknesses
Strategic measurement and reporting technique (SMART)	• Integrates strategic objectives with operational performance measures. • Aggregates financial and non-financial measures across various functions and business units.	• Does not capture measures with respect to all stakeholder values • Does not provide any mechanism to identify causal relationships between measures across functions or levels. • Does not explicitly integrate the concept of continuous improvement. • May promote local optimization due to functional approach
The Balanced Score card	• Scorecard approach to integrate strategic, operational, and financial measures. • Focus on linkages and strategy maps • Most widely accepted	• The linkages between the measures are presumed and unidirectional. • Explicitly focuses on customers but leaves other stakeholders implicit. • No deployment system that breaks high-level goals down to the sub-process level .
European Foundation for Quality Management	• Contains self assessment tests • Focuses not only on the results, like the balanced scorecard, but also on the drivers of success	• Enterprise performance management is broader than quality management. • Loosely defined framework with no supporting process of implementation.
The Performance prism	• Has a much more comprehensive view of different stakeholders (e.g. investors, customers, employees, regulators and suppliers) than other frameworks. • Provides visual map causal relationship map of measures for individual stakeholders.	• It offers little about how the causal relationships between the performance measures are going to be realized. • There is little or no consideration is given to the existing systems that companies may have in place.
A Framework for design and audit	• Provides detailed implementation guidelines. It can be used both to design a new performance measurement system and to enhance an existing performance measurement system . • It also contains a unique description of how performance measures should be realized.	• The performance measurement grid provides basic design for the performance measurement system, and the grid is only constructed from six categories. • The causal relationships among the measures is not explained.
A Framework of factors affecting evolution	• Provides a systematic process of assessing the existing performance measurement system and adapting to the changing internal and external environment • Design against people, process, system , technology	• Does not consider stakeholders as one of the factors affecting the measurement system.

The Case Study:
Diagnose Improvement Areas, Identify Commonality Benefits

Improvement Opportunity	Benefits of Metric Commonality	Tie to the Bottom Line
Customers track similar high-level metrics but use different measurement systems.	Tracking the same high-level metrics will reduce variation in what is analyzed. Less variation in data means more accurate assessments of the data. Less time will be needed to interpret the data, as well as more clarity of what root causes drive the high-level metric behavior. Communication between customers will increase. Identification of the right corrective actions will be recommended.	Cost savings.
Each tracked metric does not have a common definition across all customers.	Less metric variation and uncertainty reduction in data interpretation. Less time will be needed to interpret data.	Cost savings.
Conference presentations show varied metric information using varied presentation formats.	If the same information and same formats are used, then less time and effort is needed to interpret the data presented. The communalization of what is presented will allow the customers to better share information between other customers, initiating a "best in class" work flow, as well as an increase in universal product knowledge. The program manager can also use this information better to determine what improvement programs should be implemented to improve the product's performance.	Performance improvement should decrease maintenance costs.
Lack of understanding in how metrics change over the course of the product's operation.	Tracking the right metrics at the right time leads to a better understanding of product performance throughout its lifecycle, and therefore improvement money can be spent on the right programs at the right time.	Increased performance and decreased maintenance costs.



Customer Interview Questions (Round 1)

- What is your [enterprise's] process of recording raw metric data (types or numbers of databases used)?
- How did the current [product] metric recording process come to fruition? How was it developed, how have things changed along the way, and how much influence into the system did you have vs. [the product developer's] influence?
- What are your methods of recording data (spreadsheets and databases vs. observations, field reps to record information, etc.)?
- How long have you been recording [product] metrics?
- How would [product] metric standardization benefit the way you run your [enterprise]? What improvements would you like to see currently in your system?
- What are your concerns in standardizing [product] metric data?
- What [product] metrics does your [enterprise] track outside of [product] data?
- Do your [product] metrics measure your key processes? What are your key processes?
- Are your strategic objectives driven by your [product] metrics? What are your strategic objectives?
- How often are [product] metrics assessed and re-evaluated?

Expert Interview Questions

LEAN ADVANCEMENT INITIATIVE ™

Objective:
Generate a list of expert developed optimum performance metrics for the [product], spanning [product] lifecycle phases. Employees are to address the questions below; Alissa will take all responses and combine to generate one list of "recommended" metrics from the "experts."

Expert Typology:
What do you consider your area of expertise?

How comfortable are you in calling yourself an expert in this area?

How comfortable are you in calling yourself an expert in this area on [product]?

How many years have you been working (or worked) in your area of expertise?

How many years have you been working (or worked) in your area of expertise on the [product]?

Defining the Voice of the Customer:
Not elaborated upon so as to conceal identity of organization. There were two definitions of the voice of the customer (defined internally).

** NOTE: standard definitions would need to be established for the answers below, but not enough time is allotted in this interview period to review definitions **

Addressing the Voice of the Customer via [Product] Metrics through a Life Cycle:
What [product] performance measures do you believe are most effective in [addressing VOC #1] when the [product] is first entered into service?

What [product] performance measures do you believe are most effective in [addressing VOC #1] when the [product] is in the middle of its operating life (prime production)?

What [product] performance measures do you believe are most effective in [addressing VOC #1] when the [product] is preparing to be phased out?

What [product] performance measures do you believe are most effective in [addressing VOC #2] when the [product] is first entered into service?

What [product] performance measures do you believe are most effective in [addressing VOC #2] when the [product] is in the middle of its operating life (prime production)?

What [product] performance measures do you believe are most effective in [addressing VOC #2] when the [product] is preparing to be phased out?

Addressing Role of the Developer via [Product] Metrics through a Life Cycle:
What [product] performance measures do you believe are most effective in [helping you better do your job] when the [product] is first entered into service?

What [product] performance measures do you believe are most effective in [helping you better do your job] when the [product] is in the middle of its operating life (prime production)?

What [product] performance measures do you believe are most effective in [helping you better do your job] when the [product] is preparing to be phased out?

Effectiveness of Metric Commonality:
What do you believe is the optimal percentage of common [product] performance metrics across all customers that would result in maximum efficiency of understanding [product] performance?

What is your confidence interval of your answer above?

Motivating Factors for Commonalizing Metrics:
What data would you need to see to convince yourself that metric commonality is the right approach to managing [product] performance?

How much customer / developer interaction do you believe is necessary to determine these measures? What other stakeholders do you believe would need to be involved in this process?

What incentives or incentive structures should be in place to motivate the concept of metric commonality across customers?

Other:
I asked you what else you believe is important to the customer outside of [VOC #1 and VOC #2]. What [product] performance measures would you think should be in place to track this parameter?

Are there other programs you have worked on that you believe have a strong framework in determining proper [product] performance metrics? How successful do you believe those other programs are?

Do you have other comments or concerns you would like to discuss?

Valerdi and Blackburn Modified Adoption Questions

LEAN ADVANCEMENT INITIATIVE ™

	Must-Be	One-Dimensional	Attractive
Well documented You are provided with documentation and training on how to adopt metric commonality principles for your enterprise.	☐	☐	☐
Trialability You can pilot the recording of the common metric set and, depending on its success, can implement this model as more of a standard.	☐	☐	☐
Low barrier of entry The transition between the way you record metrics now and the proposed way you should record metrics is not overly complex.	☐	☐	☐
Transparency There is easy access, as a product community, to this common metric data.	☐	☐	☐
Demonstrates value There is a clear link between this new model and its assumed value (higher performance and lower maintenance costs).	☐	☐	☐
Variety of Incentives The use of the new model includes personal incentives, or increases your job performance.	☐	☐	☐
Tailorable There is still opportunity for the metrics to be customized for your enterprise's particular needs.	☐	☐	☐
Information freshness The recorded data is updated at a predetermined periodic basis so that it continues to help drive decisions.	☐	☐	☐
Relative Advantage It has an advantage over the current metric recording process	☐	☐	☐
Compatibility It is compatible with your enterprise's current operating environment.	☐	☐	☐
On-going peer support It is a supported system (such as support provided through knowledgeable field representatives or IT experts if an IT-enabled system is developed).	☐	☐	☐
Credibility It is based on a method, approach, tool, or standard that has already proven itself to be valuable	☐	☐	☐

Customer Interview Questions (Round 2)

Section 1:
What are your job's largest critical-to-qualities (CTQ's)?

How does tracking [product] performance integrate with your business objectives?

How did you create the list of [product] performance metrics you currently track?

What do you do with the [product] metrics once you record them?

Section 2:
What five to ten [product] performance metrics do you consider to be most important to address your job's CTQ's? Why?

Open discussion on data review (not listed in thesis)

Section 3:
From your standpoint, what are advantages and disadvantages to adopting metrics that other customers already use?

What sort of data would you want to see that would convince yourself that commonalizing metrics would benefit your [enterprise]?

What would improve, or incentivize, adoption of metric commonality?

Open discussion on adoption survey (Appendix C)

Are there other attributes we did not review that you believe should be considered when trying to adopt the model of metric commonality?