A Multidimensional Performance Model for Consolidating Balanced Scorecards

Alain Abran

STC IT Conference 2005, Ottawa, April 6-7, 2005
Agenda

- Introduction
- Balanced Scorecards - BSc
  - Structure & Challenges
- Measurement & Information Models
- ISO 9126 Multi-Dimensional Quality Models
- Functional Size Measures in a BSc
- Integration of multi-dimensional representations
Introduction

Balanced Scorecards = Performance Measurement Framework

Conceptually: very attractive
  - Strong appeal to business executives

Operationnally: very challenging
Introduction

Then, why is it not more widespread in organizations, and in software organisations in particular?

– People reluctance?

– Organizational reluctance?
Introduction

- Widespread recognition of benefits of measures
  - Hundreds of measures proposed to the software industry

- Why is there so limited usage in practice?
Introduction

Again:

– People reluctance?

– Organizational reluctance?
Introduction

Research Lab. in Software Engineering

Focus:
- Measurement for decision-making
- Measurement as a technology

Approach:
- Which pieces of the measurement technology puzzle are missing?
Introduction

What is missing for implementation?

– Has the measurement technology really been tested?
– Is it ready for the practitioners?
– Can it be improved before deployment?
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Most common approach to measurement in software:

Goal – Question - Metrics (GQM)
GQM Approach

Goal

Definition

Question

Metric

Interpretation

Implicit Models

Q1 Q2
M1 M2 M3

Q3 Q4
M4 M5 M6 M7

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GQM - one of the most well-known and used measurement approaches for establishing a measurement program

GQM - a technique to derive measures for project control starting from high-level goals, passing through the decomposition in several questions to answer.

Author: Victor Basili in the early ‘80s

(NASA Goddard Space Flighth Center)

Main measurement object: software projects
GQM Approach

Limitations

- Limited scope – a project at a time
  - … re-inventing the wheels most of the time
- How to figure out the organizational view?
- How to leverage the business models?
Balanced Sc –

- A multidimensional framework for “translating (organisational) strategy into action” at all levels of an enterprise, by linking objectives, initiatives and measures to an organization’s strategy

Authors: Kaplan & Norton (HBS) in the early ‘90s

- originating from the method: Tableau de Bord
  - turn of 20th century

Main measurement object:

- The whole organization / a Business Unit
ÉCOLE DE TECHNOLOGIE SUPÉRIEURE

BSc Framework

CUSTOMER

"To achieve our vision, how should we appear to our customer?"

Vision and Strategy

FINANCIAL

"To succeed financially, how should we appear to our shareholders?"

INTERNAL BUSINESS PROCESS

"To satisfy our shareholders and customers, what business processes must we excel at?"

LEARNING & GROWTH

"To achieve our vision, how will we sustain our ability to change and improve?"

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SPI is not a goal in itself, but a mean to achieve business goals more effectively

**Basic Management need:** align internal processes and activities to business objectives

- to maintain business competitiveness (Porter’s Value Chain)

**Strategic Management basic principles:**
- Alignment of processes & strategic business goals
- Identification & application of measures for an overall business unit
- Performance management
BSc in the Software field

Two versions of the BSc for the software field developed in the last few years:

- Balanced IT Scorecard (BITS) by the European Software Institute (ESI)
- AIS BSc by the Advanced Information Services Inc. (AIS)

Commonalities: both frameworks support 5 perspectives, adding the “People/Employee” one
Financial:
How do our software processes and SPI add value to the company?

• Customer:
How do we know that our customer (int/ext) are delighted?

• People:
Is the people issues (competence, satisfaction and retention) properly managed to implement a sustainable improvement program?

• Process:
Are our software development processes performing at levels sufficient enough to meet customer expectations?

• Infrastructure & Innovation:
Are the technology and organisational infrastructure issues being addressed to implement a sustainable improvement program?
Data Presentations Tools using BSc framework
OLAP Cubes manipulation

- Based on an assumption that data is available
- Most take for granted that the information models are available and mastered
- No automated causal-impact linkages
BSc Technology
Challenges

For software organizations:

- Adequate and relevant measures for each perspective:
  - Definitions
  - Data collection
  - Normalization

- Analysis models for software organizations
- Integrating models that can map to business models of performance
- Techniques for multi-dimensional models
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ISO 15939 Implementation

Data Analysis

- Data Collection
  - Measurement Method
    - Attributes
  - Base Measure
    - Measurement Function
      - Derived Measure
        - Analysis Model
          - Indicator
            - Interpretation
ISO 9126 Quality Characteristics

External and Internal Quality

- Functionality
  - Suitability
  - Accuracy
  - Interoperability
  - Security
  - Functionality Compliance

- Reliability
  - Maturity
  - Fault Tolerance
  - Recoverability
  - Reliability
  - Compliance

- Usability
  - Understandability
  - Learnability
  - Operability
  - Attractiveness
  - Usability Compliance

- Efficiency
  - Time
  - Behavior
  - Resource Utilization
  - Efficiency
  - Compliance

- Maintainability
  - Analyzability
  - Changeability
  - Stability
  - Testability
  - Maintainability Compliance

- Portability
  - Adaptability
  - Installability
  - Co-existence
  - Replaceability
  - Portability
  - Compliance
• Assumes that any software quality requirement can be a function of many variables (characteristics), linked in several ways among themselves

• The highest level of its tree structure is given by quality characteristics

• The lower one, by measurable quality attributes
Multi perspectives To obtain a more complete and exhaustive assessment: multiple concurrent viewpoints from several stakeholders

Example: the “organolectic analysis” for wine evaluation takes into account three weighted concurrent criteria for determining the final quality value:

- visual (20%)
- smell (28%)
- taste (52%)
Multiple viewpoints
ISO 9126
Quality Models

Process

Software Product

Effect of Software Product

Process Quality

Internal Quality Attributes

External Quality Attributes

Quality in use Attributes

Process Measures

Internal Measures

External Measures

Quality in use Measures

Context of use

Influences

Depends on
Software: ISO 9126 standard explicitly considers three viewpoints (Manager, User, Developer):

<table>
<thead>
<tr>
<th>Actors</th>
<th>Viewpoint</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managers</td>
<td>Economic (E)</td>
<td>Overall quality</td>
</tr>
<tr>
<td>Users</td>
<td>Social (S)</td>
<td>Usability</td>
</tr>
<tr>
<td>Developers</td>
<td>Technical (T)</td>
<td>Conformance to requirements</td>
</tr>
</tbody>
</table>
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Use of Measures in General Business Performance Analysis:

Measures need to be normalised based on the number of functional outputs of a production process (or of a business unit: i.e. How many hours by car, what is the asset cost by unit of production,…).

Why normalise?

• For comparison purposes,
• To develop reference numbers.
How can reference numbers be derived in evaluating software processes?

By figuring out how to measure the number of production units in software;

Proposed Solution:

• Functional Size Measures (FSM) such as:
  • Function Points FPs - IFPUG
  • COSMIC-FFP – ISO 19761

• They measure the appropriate concepts and have the appropriate properties.
Functional Size Measurement

ISO 19761 = COSMIC-FFP

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Functional Size measures provide a mean to measure software from the external user point of view and is particularly effective in supporting contractual aspects.
### FSM-based measures and BSC perspectives

<table>
<thead>
<tr>
<th>Goal/Objective</th>
<th>Driver</th>
<th>Indicator</th>
<th>Comments / Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
<td>Asset Management</td>
<td>Existing asset utilisation</td>
<td>• Total Assets (FSAV) / # employees ($)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• FSAV – FS(_{\text{units}}) Asset Value</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• PS – Portfolio Size</td>
</tr>
<tr>
<td></td>
<td>Revenue &amp; Profitability</td>
<td>Revenue Growth</td>
<td>• Revenues / FSAV (%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Revenues from new customers / Total Revenues (%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• New customers acquired using FSM as a contractual condition for measuring the project – Derived (Improve project governance)</td>
</tr>
<tr>
<td></td>
<td>Profitability</td>
<td></td>
<td>• Profits / FSAV (%)</td>
</tr>
<tr>
<td></td>
<td>Financial Management</td>
<td>Organisation Investments</td>
<td>• Investments in IT</td>
</tr>
<tr>
<td></td>
<td>Project Investments</td>
<td></td>
<td>• PCFS – Project Cost per FS(_{\text{unit}})</td>
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<td></td>
<td></td>
<td></td>
<td>• ECFS – Enterprise Cost per FS(_{\text{unit}})</td>
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<td></td>
<td></td>
<td></td>
<td>• AMCFS – Application Maintenance Cost per FS(_{\text{unit}})</td>
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<tr>
<td><strong>CUSTOMER</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Customer partnership and involvement</td>
<td>Collaboration</td>
<td>• % projects using integrated teams</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• <strong>SR</strong> – Stability Ratio</td>
<td></td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>SLA</td>
<td>• % SLA met</td>
<td>• if the agreement uses FSM as a basis for the contract</td>
</tr>
<tr>
<td>Business Process Support</td>
<td>Innovation usage</td>
<td>• % IT solutions supporting process improvement projects</td>
<td>• project measurement using FSM</td>
</tr>
<tr>
<td>Requirements Management</td>
<td></td>
<td>• Requirement Turnover Index [MELI01]</td>
<td>• Showing the level of turbulence in requisites during the development phase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RTI = [(Σ CRFS)/ Final FS\textsubscript{units}] * 100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• CRFS = Change Request Function Size units</td>
<td></td>
</tr>
<tr>
<td>Problem Management</td>
<td></td>
<td>• <strong>DR</strong> – Defect Ratio</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Market Share</td>
<td>• % Market share</td>
<td>• increasing % using FSM as an initial contract condition</td>
</tr>
<tr>
<td>Business Growth</td>
<td></td>
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<td></td>
</tr>
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<tr>
<td><strong>Process</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Application Development &amp; Maintenance</td>
<td>Size</td>
<td>• FS&lt;sub&gt;unit&lt;/sub&gt; – Functional Size unit,</td>
<td>According to the FSM method used, it can be expressed for instance by:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• FP – Function Points</td>
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<td></td>
<td></td>
<td></td>
<td>• C&lt;sub&gt;fsu&lt;/sub&gt; - COSMIC functional size units –</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• PS – Portfolio Size</td>
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<tr>
<td></td>
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<td></td>
<td>• WE – Work Effort</td>
</tr>
<tr>
<td></td>
<td>Effort</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Productivity</td>
<td>• PDR – Project Delivery Rate</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• EP – Enterprise Productivity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Support</td>
<td>• ASR – Application Support Rate</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• DDR – Duration Delivery Rate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• AMPL – Application Maintenance Load per Person</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Defectability &amp; Test</td>
<td>• RCR – Repair Cost Ratio</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• SR – Stability Ratio</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• DR – Defect Ratio</td>
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<tr>
<td></td>
<td></td>
<td>• TPR – Testing Proficiency Ratio</td>
<td></td>
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<td></td>
<td></td>
<td>• MTTR – Mean Time To Repair ratio</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• AR – Application Reliability</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• DER – Defect Detection Ratio</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• # defects / 100 FS&lt;sub&gt;unit&lt;/sub&gt; according to user acceptance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reuse</td>
<td>• FR – Functional Reuse %</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• TR – Technical Reuse %</td>
<td></td>
</tr>
</tbody>
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<tbody>
<tr>
<td>PEOPLE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core Competencies &amp; Skills</td>
<td>Core Competencies &amp; Skills</td>
<td>Feedback from FSM-based courses (I&amp;I)</td>
<td></td>
</tr>
<tr>
<td>Effects of Training</td>
<td>DER – Defect Detection Ratio</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## FSM-based measures and BSC perspectives

### Innovation & Infrastructure

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</thead>
<tbody>
<tr>
<td>Workforce Improvements</td>
<td>Workforce Competency and development</td>
<td>• IT expended on Training / IT expenses (%)</td>
<td>• Leverage on the increased forecasting ability of Project Managers (Process perspective) and on their increased satisfaction (People perspective)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• % of staff trained in relevant standards or new technologies</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• % employees skilled in advanced application measurement methods</td>
<td></td>
</tr>
<tr>
<td>Tools &amp; Products</td>
<td>Investment in new product support and training ($)</td>
<td>• Investment in new product support and training ($)</td>
<td>• Training in functional measurement for planning and governance</td>
</tr>
<tr>
<td>SPI Improvements</td>
<td>Methodology currency</td>
<td>• % projects measured using recognised methods</td>
<td>• For FSM-based tools or for courses about FSM-based techniques</td>
</tr>
<tr>
<td>Support</td>
<td>PDR – Project Delivery Rate</td>
<td></td>
<td></td>
</tr>
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<td></td>
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FSM-based measures can contribute to the multidimensional nature of a BSc, providing ratios for all the BSc perspectives

- Most impacted perspectives: Process and Financial
- Less impacted perspectives: Customer and People
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Structure of QEST Model

Most current performance models:
A single dimension at once:
with representation into a single dimension, even with Kiviat diagrams

How to take into account many dimensions?

By using geometry to:
- Integrate multiple concepts
- Represent multi-dimensions
Structure of QEST model

Its three dimensional format:

- **Economic dimension (Management)**
- **Social dimension (Users)**
- **Technical dimension (Developers)**

The QEST model provides a multidimensional structured shell, which can then be filled according to management objectives for any specific project

- Referred to as an open model.
The three dimensions (E, S, T) in the space correspond to the corners of the pyramid’s base, and the convergence of the edges to the P vertex, which describes the top performance level.

Thetrahedron = Pyramid (all side equal)

The tetrahedron supplies several performance indices:

- Distance (between the tetrahedron base and the plane)
- Area (of the sloped plane section)
- Volume of the lower part of truncated tetrahedron
QEST Model
E: 0.45
S: 0.55
T: 0.35

distance performance level: 0.46

decomposing area performance level: 0.69

volume performance level: 0.84

slope angle: 16.8

[Options: Repaint, Solid, Only lower part]

[Zoom: In, Out]
Data Collection

Data Preparation

Data Analysis

Measurement Values

Identification of quality related requirements

Comparison of the Values (Interpretation Model)

Generic Thresholds Values OR Targets Values (Indicators)

Identification of the context of interpretation

Derived Measures

Measurement Function

Base Measures

Measurement Method

Attributes

Base Measures

Measurement Method

Attributes
To make judgement on how good the attribute is.
- Normalize the measure (assigned value)
QEST Model
Work in progress

- Development of measurement models adapted to software organizations
- Multi-dimensional representation of business views
- Analysis of impact of innovations
- Building prototypes to integrate contributions of multiple projects
- Automation of all steps for a BSc
distance performance level: 0.51
decreasing area performance level: 0.74
volume performance level: 0.88
slope angle : 13.4

repaint  solid  only lower part
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- Conclusion
Conclusion

Why is BSc not yet wide spread?

– People reluctance?

– Organizational reluctance?
Conclusion

Research Lab. in Software Engineering

Focus:
- Measurement for decision-making
- Measurement as a technology

Approach:
- Which pieces of the measurement technology puzzle are missing?
Conclusion

- We are working at what is missing for implementation
  - Getting it ready for the practitioners
  - Building prototypes (procedures & software tools)
  - Improving it before deployment
Question Time

Thank you for your attention!
Thank You!

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