Balanced Measurement Sets

Criteria for Improving Project Management Practices

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www.eng.it
**Engineering Group**

The first Italian IT player.

About **7,300** PEOPLE

**7.2%** Italian market share

more than **1,000** large accounts in all markets

System Integration & Application Maintenance

OUTSOURCING

Software Consulting

**Organization**

**40 offices** in Italy and abroad.

**Results** (in millions of Euro)

<table>
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<th>Year</th>
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Welcome to the SEcure Service-oriented Architectures Research (SESAR) Lab homepage within the Computer Science Department of the Università degli Studi di Milano.

The research activities are mainly focused on the following subjects:

- Service Oriented Architectures
- Secure Service Oriented Architectures
- Software Process Engineering
- Knowledge Management
- Business Process Modeling
- Semantic Web
- Innovation
- Enhanced Security Architectures
- Mobile Nets Interaction
- Geolocation
- Open Source Development paradigms
- Distributed Systems
- Net Protocols

The staff is composed by full-time Professors, Researchers, and PhD students.
✓ **G1.** Measurement is not Project Management with its own costs but also revenues → **ROM** (Return on Measurement)!

✓ **G2.** Need for determining **Metrics Patterns** against each phase of the project lifecycle

✓ **G3.** Propose how an **OSS based-solution** could help in managing a multidimensional performance management framework

✓ **G4.** Discuss some possible improvement for achieving higher ROMs
Balanced Measurement Sets

Agenda

- **Introduction**
  - A bit of humor...
  - Measurement: Process, Value, Return, Plans

- **Our Open Source Solution**
  - QEST → QEST nD→ LIME (models)
  - Spago4Q platform

- **Improvement points**
  - Sets of measures
  - Metrics Patterns
  - Proposed Methodology

- **Spago4Q: a Case Study**
  - Description, Results
  - Next implementations

- **Conclusions & Next Steps**

- **Q & A**
**Introduction**

A bit of humour...

URL: [www.dilbert.com](http://www.dilbert.com)
Introduction

Introduction

Some initial questions...

Q: Is Measurement a separate process from Project Management?

Q: How much does it cost to measure? And what about your ROM (Return on Measurement)?
## Measurement

### SwEng – CMMI-DEV v1.2

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- **ML**: 5
- **PA**: 22
- **N.min PA**: ML1 (0)
- **N.max PA**: ML3 (13)

**Measurement is in...**

- ✅ Measurement & Analysis (ME) → ML2

**URL**: [www.sei.cmu.edu/cmmi](http://www.sei.cmu.edu/cmmi)
### Evidences

- **3 main lifecycle process groups**
  - Primary, Organizational, Supporting
- **9 process groups**
  - Primary (ACQ, SPL, ENG, OPE)
  - Organizational (MAN, PIM, RIN, REU)
  - Supporting (SUP)
- **48 processes**
  - Primary (22)
  - Organizational (16)
  - Supporting (10)

### Measurement

- **MAN.6 – Measurement**

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#### PRIMARY Life Cycle Processes

- **Acquisition Process Group (ACQ)**
  - ACQ.1 Acquisition preparation
  - ACQ.2 Supplier selection
  - ACQ.3 Contract agreement
  - ACQ.4 Supplier monitoring
  - ACQ.5 Customer acceptance

- **Supply Process Group (SPL)**
  - SPL.1 Supplier tendering
  - SPL.2 Product release
  - SPL.3 Product acceptance support

- **Engineering Process Group (ENG)**
  - ENG.1 Requirements elicitation
  - ENG.2 System requirements analysis
  - ENG.3 System architectural design
  - ENG.4 Software requirements analysis
  - ENG.5 Software design
  - ENG.6 Software construction
  - ENG.7 Software integration
  - ENG.8 Software testing
  - ENG.9 System integration
  - ENG.10 System testing
  - ENG.11 Software installation
  - ENG.12 Software and system maintenance

- **Operation Process Group (OPE)**
  - OPE.1 Operational use
  - OPE.2 Customer support

#### ORGANIZATIONAL Life Cycle Processes

- **Management Process Group (MAN)**
  - MAN.1 Organizational alignment
  - MAN.2 Organizational management
  - MAN.3 Project management
  - MAN.4 Quality management
  - MAN.5 Risk management
  - MAN.6 Measurement

- **Process Improvement Process Group (PIM)**
  - PIM.1 Process establishment
  - PIM.2 Process assessment
  - PIM.3 Process improvement

- **Resource and Infrastructure Process Group (RIN)**
  - RIN.1 Human resource management
  - RIN.2 Training
  - RIN.3 Knowledge management
  - RIN.4 Infrastructure

- **Reuse Process Group (REU)**
  - REU.1 Asset management
  - REU.2 Reuse program management
  - REU.3 Domain engineering

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#### SUPPORTING Life Cycle Processes

- **Support Process Group (SUP)**
  - SUP.1 Quality assurance
  - SUP.2 Verification
  - SUP.3 Validation
  - SUP.4 Joint review
  - SUP.5 Audit
  - SUP.6 Product evaluation
  - SUP.7 Documentation
  - SUP.8 Configuration management
  - SUP.9 Problem resolution management
  - SUP.10 Change request management

**URL**: [http://www.spiceusergroup.org](http://www.spiceusergroup.org)

**www.eng.it**
• Specific ISO standard on the Measurement process
• ‘Explodes’ the ones in ISO 12207, 15288 or 15504 process models
• Adopt the VIM (Int. Vocabulary of Metrology) terms and glossary
• **Introduction**
  – A bit of humor...
  – Measurement: Process, Value, Return, Plans

• **Our Open Source Solution**
  – QEST → QEST nD→ LIME (models)
  – Spago4Q platform

• **Improvement points**
  – Sets of measures
  – Metrics Patterns
  – Proposed Methodology

• **Spago4Q: a Case Study**
  – Description, Results
  – Next implementations

• **Conclusions & Next Steps**
• **Q & A**
Our work is aimed at showing the integration of:

- **QEST nD** model, a conceptual framework for measuring process performance based on multiple analysis dimensions (e.g. economic, social, and technological dimensions) by its extension to lifecycle phases, called **LIME**
  - [www.semq.eu/leng/modtechqlm.htm](http://www.semq.eu/leng/modtechqlm.htm)

- **Spago4Q**, the open source platform to measure, analyze and monitor quality of products, processes and services
  - [www.spago4q.org](http://www.spago4q.org)

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Our OS Solution

**Method:** Performance is expressed as the combination of the specific ratios selected for each of the 3 dimensions of the *quantitative* assessment (Productivity - **PR**) and the perceived product quality level of the *qualitative* assessment (Quality - **Q**)

\[
\text{Performance} = \text{PR} + \text{Q}
\]

**Model:** QEST (Quality factor + Economic, Social & Technical dimensions) is a “structured shell” to be filled according to management objectives in relation to a specific project.

Such a model has the ability to handle independent sets of dimensions without predefined ratios and weights - referred to as an *open model*.

Our OS Solution | QEST model – Geometrical Indicators

✓ **Target**: measuring project performance ($\rho$) using 3 distinct viewpoints
✓ **Input Data**: list of weighted ratios for each dimension and quality questionnaires
✓ **Output Data**: an integrated normalized value of performance

It is possible to measure performance considering at least 3 distinct geometrical concepts:

- **Distance** between the tetrahedron base center of gravity and the center of the plane section along the tetrahedron height – the greater the distance from 0, the higher the performance level;

- **Area** of the sloped plane section – the smaller the area, the higher the performance level;

- **Volume** of the lowest part of the truncated tetrahedron – the greater the volume, the higher the performance level.
Our OS Solution | QEST model – Key Features

- Integrated quantitative and qualitative evaluation from 3 concurrent organisational viewpoints
- A 3D geometrical representation at a single project phase (usually after the project is completed)
- Use of *de facto* and *de jure* standards (e.g. ISO/IEC 9126 for the Quality Factor)
- Performance Measurement Model to use for consolidating Balanced Scorecard (BSC) measurement outcomes
- Extension of the original 3D model to $n$ possible dimensions-perspectives → QEST $nD$ through the *simplex* as the mechanism to solve the problem from the 4th dimension on

$$P = 1 - \prod_{i=1}^{n} (1 - P_i)$$
Our OSS Solution

Spago4Q (SpagoBI for Quality) is:

- An open source platform for the continuous monitoring of software quality (www.spago4q.org)
- A vertical adaptation of SpagoBI, the Open Source Business Intelligence suite (www.spagobi.org)
- Pure open-source (no commercial version), with commercial support by Engineering Group
- Several adopters in Italy and Abroad (e.g. European Commission – Directorate General for Regional Policy, DG-REGIO)

Main features

- Multi-process multi-project monitoring
- Data Collection run in a fully, transparent way
- Equipped with extractors specific of most-common software process environments (IDE, workflow management, text editing, ...)

www.eng.it
Our OSS Solution

Spago4Q Structure
Spago4Q Case Study

Background, Goals, Improvement actions

• Application Management (AM) services
  ✓ Software Maintenance (Corrective, Adaptive, Perfective, Preventive) for a large mission-critical system in a Finance Institute
  • Services started in 2006 (analysis period: January 2008 – June 2010)
  ✓ Verify QEST nD applicability and results in a context of AM Services
  ✓ Define a QEST nD model aligned to the AM services goals
  ✓ Monitor the effectiveness of improvement action with specific goals and metrics

• Goals
  ✓ EC-G3 Reduce the rework (intended as impact of defects in UAT or production environment)
  ✓ TE-G1 Improve the deploy process
  ✓ TE-G5 Improve effectiveness of peer reviews

• Improvement actions
  ✓ Deploy process automation and automatic analysis of source code
  ✓ Progressively increasing of the number of peer reviews on critical work products
  ✓ Specific tasks were included in Impact analysis phase at the aim to:
    ▪ Classify and identify critical Work Products to be reviewed
    ▪ Assign an owner to solve complex defects impacting on different development streams
    ▪ Root-cause analysis of the recurring defects
The model defined for the case study take into account four analysis dimensions and goals (following the Goal-Question-Metric paradigm):

1. **Economical (E)**
   - E.G1 Reduce the effort of corrective maintenance
   - E.G2 Improve the number of delayed deliverables
   - E.G3 Reduce the rework (intended as impact of defects in UAT or production environment)

2. **Technical (T)**
   - T.G1 Improve the deploy process
   - T.G2 Reduce the resolution time for defects and technical issues
   - T.G3 Improve quality of documents and source code
   - T.G4 Reduce the rework (intended as impact of defects during development phase)
   - T.G5 Effectiveness of peer reviews
   - T.G6 Improve non-regression test

3. **Resource Usage (RS)**
   - RS.G1 Reduce impact of human resource management issues
   - RS.G2 Improve hardware system availability

4. **Customer Satisfaction (CS)**
   - CS.G1 Improve user satisfaction about training courses and application services
<table>
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<tr>
<th>Dimension</th>
<th>Metric Description</th>
<th>Formula</th>
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<tbody>
<tr>
<td>Economical (E)</td>
<td>Incidence of Corrective Maintenance Effort w.r.t. maintained code size</td>
<td>Corrective Maintenance Effort/ KLOC</td>
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<td>Ratio Corrective Maintenance Effort - Adaptive Maintenance Effort</td>
<td>Corrective Maintenance Effort/ Adaptive Maintenance Effort</td>
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<td>Incidence of Delayed Deliverables w.r.t. total number of Deliverables</td>
<td>no. Delayed Deliv. / no. Deliv.</td>
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<td>Incidence of Defects after system test w.r.t. total number of Defects</td>
<td>no. Defects in UAT or production / total no. of Defects</td>
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<td>Resource Usage (RS)</td>
<td>Human Resources management issues w.r.t. total number of issues admitted for working group size</td>
<td>no. HR issues / no. Issues for group size</td>
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<td>Hardware System Availability</td>
<td>Percentage System Availability</td>
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<td>Technical (T)</td>
<td>Technical management issues w.r.t. total number of issues admitted</td>
<td>no. Technical issues / no. issues admitted</td>
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<td>Issues Mean Resolution Time</td>
<td>Total Res. Time / no. Issues</td>
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<td>Document quality: respect of document quality standard</td>
<td>Percentage of positive response to a checklist</td>
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<td>Software Complexity</td>
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<td>Coding rules non-conformity level</td>
<td>Results of automatic static code analysis</td>
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<td>Software Maintenability</td>
<td>Results of automatic static code analysis</td>
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<td>Incidence of Peer Reviews w.r.t. total number of Deliverables</td>
<td>no. Peer reviews / no. Deliverables</td>
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<td>Number of Defects discovered by peer reviews w.r.t. total number of Defects</td>
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<td>Questionnaire results</td>
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<td>User Satisfaction</td>
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### Spago4Q Case Study

#### Results - QEST dashboard

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Spago4Q Case Study

Results – Dimensions trend analysis

Last results for each dimension

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<th>MODEL</th>
<th>KPI</th>
<th>WEIGHT</th>
<th>KPI CHART</th>
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Trend for each dimension

Dimensions comparison

ISSRE 2014 – Naples (Italy), Nov 5, 2014
Spago4Q Case Study

Results – Global and technical % increasing

Global and technical performance indicator

Global and technical performance indicator % increasing for year
Spago4Q Case Study

Detailed Analysis Results (example)

Impact of defects in UAT or production

[AM-EC-M.04] Defects reduction in UAT and production environment
[AM-TE-M.11] Defects mean resolution time reduction
Spago4Q Case Study | Detailed Analysis Results (example)

**Impact of technical issues**

![Graph showing impact of technical issues]

[**AM-TE-M.01**] Technical issues reduction: specifically related to deployment process

[**AM-TE-M.02**] Technical issues mean resolution time
[AM-TE-M.07] Number of peer reviews actually executed vs. number of critical Work Products
[AM-TE-M.08] Defects or potential defects discovered during peer reviews
[AM-TE-M.09] Incidence of defects due to design phase
Balanced Measurement Sets

Agenda

• **Introduction**
  – A bit of humor...
  – Measurement: Process, Value, Return, Plans

• **Our Open Source Solution**
  – QEST → QEST → LIME (models)
  – Spago4Q platform
  – Spago4Q: Case Study

• **Improvement points**
  – Sets of measures
  – Metrics Patterns
  – The proposed methodology

• **Conclusions & Next Steps**

• **Q & A**
Q: Are we applying a suitable and balanced set of measures?

Q: Is such set fitting with a specific SLC phase? Or not?
Improvement Points

Plan of Measures vs Measurement Plan

- Proposed improvements to ISO 15939
- Refinement to the current measurement process
- Introduction of concept of ‘coordinated’ and ‘balanced’ set of measures for the measurement plan
- Refinement of the MIM (Measurement Information Model)
- ...
LIME (LIfe-cycle MEasurement) model represents the extension of QEST features to a dynamic context as the SLC is.

**SLC model selected:** generic 6-steps Waterfall model

**Logic adopted:** the same than in the ETVX (E-ntry-Task-V-alidation-eXit) process notation
Improvement Points

Sets of Measures

- **Set of measures (by SLC phase, Common Issue Areas, ...)**
  - Several sources: e.g. ISO/IEC 9126-x, PSM, ...

<table>
<thead>
<tr>
<th>External metric</th>
<th>Metric name</th>
<th>Method of application</th>
<th>Measurement, formula and data element computations</th>
<th>Interpretation of measured value</th>
<th>Metric scale type</th>
<th>Measure type</th>
<th>Input to measurement</th>
<th>Target audience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated latent fault density</td>
<td>How many problems still exist that may emerge as future faults?</td>
<td>Count the number of faults detected during a defined trial period and predict potential number of future faults using a reliability growth estimation model.</td>
<td>$X = \frac{\text{ABS}(A1 - A2)}{B}$</td>
<td>$0 = \frac{X}{A1}$</td>
<td>Absolute Value</td>
<td>Count</td>
<td>A1: Total number of predicted latent faults in a software product</td>
<td>ISO/IEC 12207 SLC Phase Reference</td>
</tr>
</tbody>
</table>

**Issue - Category - Measure Mapping**

<table>
<thead>
<tr>
<th>Common Issue Area</th>
<th>Measurement Category</th>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule and Progress</td>
<td>Milestone Performance</td>
<td>Milestone Dates</td>
<td>Critical Path Performance</td>
</tr>
<tr>
<td></td>
<td>Work Unit Progress</td>
<td>Requirements Status</td>
<td>Problem Report Status</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Review Status</td>
<td>Change Request Status</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Component Status</td>
<td>Test Status</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Action Item Status</td>
<td>Incremental Capability</td>
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<tr>
<td></td>
<td>Incremental Capability</td>
<td>Incremental Content - Components</td>
<td>Incremental Content - Functions</td>
</tr>
<tr>
<td>Resources and Cost</td>
<td>Personnel</td>
<td>Effort</td>
<td>Staff Experience</td>
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<tr>
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<td>Financial Performance</td>
<td>Staff Turnover</td>
<td>Earned Value</td>
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<tr>
<td></td>
<td>Environment and Support Resources</td>
<td>Cost</td>
<td>Resource Availability</td>
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<tr>
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<td>Product Size and Stability</td>
<td>Resource Utilization</td>
<td>Database Size</td>
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<tr>
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<td>Physical Size and Stability</td>
<td>Components</td>
<td>Interfaces</td>
</tr>
<tr>
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<td>Functional Size and Stability</td>
<td>Lines of Code</td>
<td>Physical Dimensions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Requirements</td>
<td>Functional Change Workload</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Function Points</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**
1. When total number of actually detected faults is less than predicted latent faults, it is recommended to predict the product look better.
2. It is recommended to use several reliability growth models and choose the most suitable one and repeat prediction with monitoring.
### Improvement Points

**Metrics Patterns**

1. Start with a **BMP** (Balancing Measurement Perspective) analysis
2. Refine the measures analyzing any potential counter-effect
3. $1+1 = \ldots 3! \rightarrow$ ROM (Return on Measurement)

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**What to do...**

1. Group projects by similarity (cluster analysis)
2. Determine frequencies for measures by SLC
3. Suggest set of measures by SLC
4. Implement Spago4Q by SLC phase (using the LIME extension)
• **Introduction**
  – A bit of humor...
  – Measurement: Process, Value, Return, Plans

• **Our Open Source Solution**
  – QEST → QEST → LIME (models)
  – Spago4Q platform
  – Spago4Q: Case Study

• **Improvement points**
  – Sets of measures
  – Metrics Patterns
  – The proposed methodology

• **Conclusions & Next Steps**

• **Q & A**
• **Need for Process Improvement tools**
  - Huge attention from Management for low-cost technical solutions for a better monitoring & control both at the project and organizational level → **OSS**
  - The right combination should include both methods and tools

• **QEST nD+ LIME**
  - QEST is multidimensional performance model taking into account several perspectives from interested stakeholders
  - QEST can be exploited also at the SLC level with LIME (see [www.semq.eu](http://www.semq.eu))

• **SPAGO4Q**
  - Spago4Q is a flexible platform for software process/product monitoring applicable to any SPI activity, freely downloadable, not commercial versions: [www.spago4q.org](http://www.spago4q.org)

• **Case study - Provided evidence**
  - Clear Benefits on measurement process with proven effectiveness for peer reviews

• **Difficulties in achieving process improvements**
  - Time pressure
  - Workload and urgent activities disqualify the team to provide sufficient effort to SPI activities
  - SPI is usually considered as a low priority process even if…continuous commitment is needed

• **Next Steps – Spago4Q Implementation for…**
  - ...the Metrics Pattern Calculator (MPC)
  - ...Automatic/Dynamic (re)calculation of KPI thresholds from historical data

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**Analyze facts and talk through data**

(Kaoru Ishiwaka, TQM guru)
Grazie per l’attenzione!
Thanks for your attention!
Balanced Measurement Sets

Our Contact Data

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