Quantitative CMMI Assessment for Offshoring Through the Analysis of Project Management Repositories

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Motivation

• SPI is often achieved through the transfer of best practices from a company headquarters to its offshoring units.

• This requires
  – strong project management skills
  – well-built onshore-offshore coordination
  – onsite visits

• In distributed and multi-site setting, CMMI implementation can be costly, time-consuming and complex.

• The *qualitative* characteristics of CMMI makes things even harder.
Our Solution

• Change from “qualitative” to “quantitative”.
• Allow remote monitoring of local CMMI implementation by
  – Automatically and collectively store objective evidence about a project’s activity while the project is in progress.
  – Calculate assessment results by measuring the existence or the numbers of object evidences collected.
Quantitative CMMI Assessment Model for Offshoring
Our Use Case Model

Assessment Pre-Process

- Add items to project CI repository
- Set up quantitative CMMI assessment rules
- Conduct CMMI assessment
- View CMMI assessment results

CMMI Appraiser

Software Developer

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Quantitative CMMI Assessment Process

Project Configuration Items Repository Manager

- Add items to project repository
- Project configuration items
- Project CI repository

Project Configuration Items Repository Manager

- Project configuration items data
- Project CI Schema

Quantitative CMMI Assessment Engine

- Set up quantitative CMMI assessment rules
- Conduct CMMI assessment
- Generate CMMI reports
- SQL statements for assessment rules
- Updated assessment results
- Assessment results

CMMI Appraiser

- Types of rules and objective evidence for assessment
- Project to be assessed
- Type of assessment report required

Software Developer

- Add items to project repository
- Project configuration items
- Project CI repository
Example of PMRConfig.xml

```
<MainTable tblname = "PMR_WBS">
  <Column pk = "Y" fk = "N" dbType = "integer" size = "" nullable = "N" defaultValue = "" readOnly = "Y">WBS_ID</Column>
  <Column pk = "N" fk = "Y" dbType = "integer" size = "" nullable = "N" defaultValue = "" readOnly = "Y">Task_No</Column>
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  <Column pk = "N" fk = "Y" dbType = "varchar" size = "" nullable = "N" defaultValue = "" readOnly = "Y">Task_Desc</Column>
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  <Column pk = "N" fk = "Y" dbType = "varchar" size = "" nullable = "N" defaultValue = "" readOnly = "Y">Task_Relate</Column>
  <Column pk = "N" fk = "Y" dbType = "varchar" size = "" nullable = "N" defaultValue = "" readOnly = "Y">Task_Categroy</Column>
  <Column pk = "N" fk = "Y" dbType = "varchar" size = "" nullable = "N" defaultValue = "" readOnly = "Y">Task_Constraint</Column>
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  <Column pk = "N" fk = "N" dbType = "varchar" size = "" nullable = "N" defaultValue = "" readOnly = "Y">Initiation_By</Column>
  <Column pk = "N" fk = "N" dbType = "datetime" size = "" nullable = "N" defaultValue = "" readOnly = "Y">Completed_By</Column>
  <Column pk = "N" fk = "N" dbType = "datetime" size = "" nullable = "N" defaultValue = "" readOnly = "Y">Deadline</Column>
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<LinkTables>
  <Table tblname = "PMR_WBS_Emp_Role" key = "WBS_ID"/>
  <Table tblname = "PMR_Expense" Key = "WBS_ID"/>
  <Table tblname = "PMR_Policy_Used" key = "WBS_ID"/>
  <Table tblname = "PMR_Skill_Need" key = "WBS_ID"/>
  <Table tblname = "PMR_Skill_Evaluation" key = "WBS_ID"/>
  <Table tblname = "PMR_Training" key = "WBS_ID"/>
  <Table tblname = "PMR_SH_WBS_Responsibility" key = "WBS_ID"/>
  <Table tblname = "PMR_Product_Need" key = "WBS_ID"/>
  <Table tblname = "PMR_Froj_Corrective_Action" key = "WBS_ID"/>
  <Table tblname = "PMR_Supplier_Agreement" key = "WBS_ID"/>
  <Table tblname = "PMR_Froj_Doc" key = "WBS_ID"/>
  <Table tblname = "PMR_Froj_Revise" key = "Review_ID"/>
  <Table tblname = "PMR_Froj_Measurement" key = "WBS_ID"/>
  <Table tblname = "PMR_Sgd_Proccess_Used" key = "WBS_ID"/>
  <Table tblname = "PMR_Froj_Risk" key = "WBS_ID"/>
</LinkTables>
```
Design of Quantitative Assessment Rules

CMMI Components Relation

- Process Area Category
  - Process Area
    - Specific Goal
    - Generic Goal
      - Specific Practice
    - Specific Goal
      - Specific Practice
      - SubPractice
    - SubPractice

Our CMMI Assessment Rule Relation

- SubPractice
  - Rule
    - Rule for Check by Score
      - Statement
        - Statement Component
      - Statement Component
    - Rule for Check by Compliant
      - Statement
        - Statement Component
Design of Quantitative Assessment Rules

CMMI Components Relation

- Process Area Category
- Process Area
- Specific Goal
  - Specific Practice
  - SubPractice
- Generic Goal
  - Specific Goal
  - SubPractice

Our CMMI Assessment Rule Relation

- Rule
- SubPractice
- Rule for Check by Score
  - Statement
  - Statement Component
- Rule for Check by Compliant
  - Statement
  - Statement Component

Check whether an activity is carried out or not
Assessment Rule Construction

PA Category: Project Management.
PA: Project Monitoring and control.
SG1: Monitor project against the plan.
SP1.1: Monitor project planning parameters.
Sub-Practice: Monitor progress against schedule.
Rule 1: Periodically measuring the actual completion of activities and milestones

SELECT COUNT(*) FROM WBS WHERE Percent_Complete IS NOT NULL; SELECT COUNT(*) FROM WBS
Example of CMMI Rule Construction

**Descriptive:** Periodically measuring the actual completion of activities and milestones.

**Rule Type:** By Score

**Assessment Rule:** Count all availability of “Percent_Completed” in “WBS” data template compare with all “WBS’ in a project.

**SQL Statement:**
```
SELECT COUNT (*) FROM WBS WHERE Percent_Completed IS NOT NULL divided by SELECT COUNT (*) FROM WBS;
```
Sample Screen of CMMI Assessment
Rules Constructor

Rules and Conditions Setting

Practice Selection

SP 1.1: Monitor Project Planning Parameters

[Sub Practice] 1: Monitor progress against schedule

<table>
<thead>
<tr>
<th>Rule ID</th>
<th>Rule Description</th>
<th>Rule Type</th>
<th>Delete</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Count ratio of &quot;Percent_Completed&quot; in table &quot;WBS&quot; compare with all WBS in a</td>
<td>Check Score</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Count ratio of field &quot;Start_Time_Planned&quot;</td>
<td>Check Score</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Count ratio of field &quot;End_Time_Planned&quot; and &quot;Action_End_Time&quot; in table &quot;WBS&quot;</td>
<td>Check Score</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Count ratio of field &quot;Deviation_From_Plan&quot; in</td>
<td>Check Score</td>
<td></td>
</tr>
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</table>

Save Rules

Rule ID: 1

Add Condition

<table>
<thead>
<tr>
<th>Divisor</th>
<th>Assessment Item</th>
<th>Attribute</th>
<th>Operator</th>
<th>Value</th>
<th>Delete</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PMR_WBS</td>
<td>Percent_Completed</td>
<td>IS NOT NULL</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PMR_WBS</td>
<td>WBS_ID</td>
<td>IS NOT NULL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Save Conditions

Query Statement Generated

```
(SELECT COUNT(*) FROM PMR_WBS WHERE PMR_WBS.Percent_Completed IS NOT NULL;
SELECT COUNT(*) FROM PMR_WBS WHERE PMR_WBS.WBS_ID IS NOT NULL)
```
Calculation process from Sub-Practice up to Process Area Category

1. Calculate Score of each SubPractice
2. Calculate Score of each Practice
3. Calculate Score of each Goal
4. Calculate Score of each Process Area
5. Calculate Score of each Process Area Category

Calculation score of each Sub Practice

\[
\text{Total score of rule(s)} \times 100 \over \text{Number of Rules}
\]

Calculation score of each Goal

\[
\text{Total score of Practice(s)} \times 100 \over \text{Number of Practices}
\]

Calculation score of each Process Area

\[
\text{Total score of Goal(s)} \times 100 \over \text{Number of Goals}
\]

Calculation score of each Process Area Category

\[
\text{Total score of Process Area(s)} \times 100 \over \text{Number of Process Areas}
\]
Sample Screen of Summarized Report by Process Area Category

**Summarized Report By Process Area Category**

- **Assessment Version:** 5
- **Assessment Name:** PM PAC
- **Project Assessed:** AIR IP Radio
- **Process Area Category:** Project Management
- **Process Area:**
- **Total Score:** 28.88 %

<table>
<thead>
<tr>
<th>Project Management</th>
<th>Practice</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>INTEGRATED PROJECT MANAGEMENT + IPPD</td>
<td>NaN</td>
</tr>
<tr>
<td></td>
<td>PROJECT MONITORING AND CONTROL</td>
<td>33.64 %</td>
</tr>
<tr>
<td></td>
<td>PROJECT PLANNING</td>
<td>98.73 %</td>
</tr>
<tr>
<td></td>
<td>QUANTITATIVE PROJECT MANAGEMENT</td>
<td>NaN</td>
</tr>
<tr>
<td></td>
<td>RISK MANAGEMENT</td>
<td>NaN</td>
</tr>
<tr>
<td></td>
<td>SUPPLIER AGREEMENT MANAGEMENT</td>
<td>40.90 %</td>
</tr>
</tbody>
</table>
Sample Screen of Summarized Report by Process Area (Project Planning)

<table>
<thead>
<tr>
<th>Summarized Report By Process Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment Version:</td>
</tr>
<tr>
<td>Assessment Name:</td>
</tr>
<tr>
<td>Project Assessed:</td>
</tr>
<tr>
<td>Process Area Category:</td>
</tr>
<tr>
<td>Process Area:</td>
</tr>
<tr>
<td>Total Score:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SG 1 Establish Estimates</th>
<th>Score: 96.53 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice</td>
<td>Score</td>
</tr>
<tr>
<td>SP 1.1 Estimate the Scope of the Project</td>
<td>100.00 %</td>
</tr>
<tr>
<td>SP 1.2 Establish Estimates of Work Product and Task Attributes</td>
<td>91.67 %</td>
</tr>
<tr>
<td>SP 1.3 Define Project Lifecycle</td>
<td>100.00 %</td>
</tr>
<tr>
<td>SP 1.4 Determine Estimates of Effort and Cost</td>
<td>94.44 %</td>
</tr>
</tbody>
</table>
Sample Screen of Summarized Report by Specific Practices & Sub Practices

Sub Practice Scores

<table>
<thead>
<tr>
<th>Process Area</th>
<th>PROJECT PLANNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal</td>
<td>SG1 Establish Estimates</td>
</tr>
<tr>
<td>CHMI Practices</td>
<td>SP 1.1 Estimate the Scope of the Project</td>
</tr>
<tr>
<td>Practice Detail</td>
<td>Establish a top-level work breakdown structure (WBS) to estimate the scope of the project.</td>
</tr>
</tbody>
</table>

### SP 1.1 Estimate the Scope of the Project

<table>
<thead>
<tr>
<th>Sub-Practice</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>Develop a WBS based on the product architecture</td>
<td>1</td>
</tr>
<tr>
<td>Identify the work packages in sufficient detail to specify estimates of project tasks, responsibilities, and schedule</td>
<td>1</td>
</tr>
<tr>
<td>Identify products or component that will be externally acquired</td>
<td>1</td>
</tr>
<tr>
<td>Identify work products that will be reused</td>
<td>1</td>
</tr>
</tbody>
</table>

Rule Scores

<table>
<thead>
<tr>
<th>Process Area</th>
<th>PROJECT PLANNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal</td>
<td>SG1 Establish Estimates</td>
</tr>
<tr>
<td>CHMI Practices</td>
<td>SP 1.1 Estimate the Scope of the Project</td>
</tr>
</tbody>
</table>

### Sub Practice Develop a WBS based on the product architecture

<table>
<thead>
<tr>
<th>Rules</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check availability of WBS relationship with project table</td>
<td>1</td>
</tr>
<tr>
<td>Check availability of WBS relationship with skill need table and training table</td>
<td>1</td>
</tr>
<tr>
<td>Check availability of WBS/Task Category is supported plan, configuration management</td>
<td>1</td>
</tr>
</tbody>
</table>
Sample Screen of Assessment Results in Area Chart Diagram

**Assessment Result (Area Chart)**

<table>
<thead>
<tr>
<th>Specific Goal</th>
<th>SG 3</th>
<th>SG 2</th>
<th>SG 1</th>
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</thead>
<tbody>
<tr>
<td>IPM</td>
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<td></td>
<td></td>
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<tr>
<td>PMC</td>
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<tr>
<td>PP</td>
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<tr>
<td>QPM</td>
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<tr>
<td>RSKM</td>
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<tr>
<td>SAM</td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Generic Goal</th>
<th>GG 5</th>
<th>GG 4</th>
<th>GG 3</th>
<th>GG 2</th>
<th>GG 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPM</td>
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<td>SAM</td>
<td></td>
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</tr>
</tbody>
</table>

**Assessment Version:** 1
**Assessment Name:** FM PAC
**Project Assessed:** ABC Company Inventory System
**Process Area Category:** Project Management

Not Rated—0—
Not Implemented—20—
Partially Implemented—50—
Implemented—70—
Fine Implementer—80—
Good Implementer—90—
Excellent Implementer—100—
Some Remarks

• Our model follows activities as defined by SCAMPI but moves part of the data collection activity prior to conducting the appraisal.

• This would not eliminate the need for site visits in real CMMI appraisal but aims to help reduce the tasks and time required when the appraisal is conducted.
On-going Work

• Evaluate its practicality and appeal to the wider software industry.

• Extend the design of the project’s CI repository and its data entry to cover the entire software development phases.
Conclusion

1. Which aspects of software engineering has the paper addressed?
   – Software Process Improvement

2. What approach is being proposed?
   – Quantitative CMMI assessment

3. How will this approach improve software engineering in an offshore and outsourced context?
   – Reduce the cost and effort of SPI implementation, especially in emerging offshoring countries where the costs of such implementation are prohibitive and guidelines are not so well-established.

4. What are the main problems with the approach?
   – Require further proof on its practicality from commercial points of view.

5. Can the proposed approach scale as global software engineering development matures?
   – Yes. It could enable continual assessment for an entire application management lifecycle in a distributed manner.