Factors affecting the Sustainability of the Continuous Improvement (CI) Process

Johanna Madrigal, ULACIT*
Henry Quesada, Virginia Tech
November 5, 2012

*Former doctoral student
CI definition

• Approach to quality assurance that involves creating a culture concerned with quality as an integral part of the product/service delivery

• A company-wide process of focused and continuous incremental innovation where small changes with high frequency result in a cumulative positive impact on performance.

• Consistent improvements that increase success and reduce failures

• CI as a culture of sustained improvement which continuously focuses on eliminating waste in all the processes of the organization
CI methodologies

• Lean thinking
  – The elimination of waste

• Six sigma
  – Within Six Sigma, the focus is to produce no more than 3.4 defects for every million of produced units
  – Define, measure, analyze, improve, and control (DMAIC)

• Lean Six Sigma
CI methodologies

• Total Quality Management
  – A concept also is defined mostly as a management philosophy that supports reduction of costs by creating high quality products and services fulfilling customer requirements

• Kaizen
  – Kaizen is the Japanese word for improvement, and it is used to describe a focused and structured improvement project targeting a specific goal, in a specific area, in a short period of time
CI inhibitors

Process issues
Lack of structure to stop backsliding
No formal problem-solving process
Unsuccessful implementation of changes suggested
Failure to complete projects

Strategy and objectives
Absence of target and common understanding of direction
Lack of deployment plan
Lack of CI strategy
No long term objectives linked to CI
No measurable objectives related to CI

Leadership and motivation
Lack of clear motivation as to why improvement is important
Inadequate leadership (e.g., no experience, no charismatic leaders)
Absence of top management support

Cultural issues
Resistance to change
Lack of awareness of CI by employees and managers

Measurement and information
Lack of measurement
Inadequate information and analysis
No feedback systems

Training learning and skills
Lack of learning as a value in the organization
Lack of training
Lack of problem solving skills

Others
Emphasis in disruptive innovation undertaken incremental innovation
Break of CI teams
Short resources assigned to CI
Gap in involving employees at every level
Innovation

• **Product Innovation:** A good or service that is new or has been significantly improved. Significant improvements include technical specifications, components and materials, software, user friendliness, or other functional characteristics.

• **Process Innovation:** A new or significantly improved production or delivery method including relevant changes in techniques, equipment, and/or software.

• **Marketing Innovation:** New marketing methods involving significant changes in product design or packaging, product placement, promotion or pricing.

• **Organizational Innovation:** The introduction of a new organizational method in the business practices of the firm, workplace organization, or external relations.
## CI and Innovation

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Innovation</th>
<th>Continuous Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timeframe</td>
<td>Continuous and incremental</td>
<td>Intermittent and non-incremental</td>
</tr>
<tr>
<td>Change</td>
<td>Abrupt and volatile</td>
<td>Slow and gradual</td>
</tr>
<tr>
<td>Scope of the effort</td>
<td>Technological breakthroughs, new inventions, new theories</td>
<td>Conventional know-how</td>
</tr>
<tr>
<td>Advantage</td>
<td>Works well in fast-growth economies</td>
<td>Works well in slow-growth economies</td>
</tr>
<tr>
<td>Requirements</td>
<td>Large investments</td>
<td>Low investments</td>
</tr>
<tr>
<td>Modality of work</td>
<td>Scrap, rebuild or replace</td>
<td>Maintenance and improve</td>
</tr>
</tbody>
</table>
CI and Innovation

• Both approaches search to solve customer needs
• CI improvement can lead to incremental innovation
• Organizational culture oriented to CI contains vital elements to developing an innovative firm.
• The use of problem-solving tools in CI helps to foster creativity and invention, which are elements that develop innovation.
• Firms that perform tasks under CI initiatives also have shown positive performance in innovation.
• A culture of CI within a company acts as a solid foundation on which an innovative culture and organization can be built.
• Training associated with CI resulted in increased employee knowledge of customers, competition, and markets which, in turn, lead to employee-generated innovative product-related ideas.
CI and Innovation

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Products</td>
<td>1%</td>
</tr>
<tr>
<td>Software Publishers (5112)</td>
<td>11%</td>
</tr>
<tr>
<td>Communication equipments (3342)</td>
<td>11%</td>
</tr>
<tr>
<td>Pharmaceutical/medicines (3254)</td>
<td>13%</td>
</tr>
<tr>
<td>Semiconductor/Other electronic components (3344)</td>
<td>15%</td>
</tr>
</tbody>
</table>

*NFS (2010)
CI and Innovation

• Findings from the literature reveal that:

  – Innovation is strongly related to economic growth

  – *Wood products* industry has the *lowest* R&D expenditure /sale rate among *US business sectors*

  – To the knowledge of the authors there are a limited amount of analysis of successful innovation management practices aiming to help the wood products industry to become innovative
Best innovation practices*

2012 Case study of a medical, energy, and wood industry*
# Measuring of CI factors

## Case Study Methodology

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Judgmental selection based on defined criteria</td>
<td>Literature Review</td>
<td>Cronbach’s $\alpha$</td>
<td>ANOVA Correlation Analysis</td>
<td>Causal Relationship Analysis</td>
</tr>
<tr>
<td></td>
<td>Experts’ review IRB approval</td>
<td>CFA EFA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Measuring of CI factors

- Case selection using defined criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Company A</th>
<th>Company B</th>
<th>Company C</th>
<th>Company D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Medical Devices Manufacturing</td>
<td>Chemical Manufacturing</td>
<td>Wood Products Manufacturing</td>
<td>Health Care Provider</td>
</tr>
<tr>
<td>CI process</td>
<td>Over 2 years</td>
<td>Over 8 years</td>
<td>Over 15 years</td>
<td>Over 2 years</td>
</tr>
<tr>
<td>Size (selected site)</td>
<td>Over 300 employees</td>
<td>~ 300 employees</td>
<td>380 employees</td>
<td>~ 400 employees</td>
</tr>
</tbody>
</table>
Demographics of responses

• Total of 353 questionnaires, four replicas
Demographics of responses

Percentage of responses per functional area

- Director: 42%
- Manufacturing: 19%
- Finance: 15%
- Engineering: 5%
- HR: 7%
- Facilities: 3%
- Project Management: 1%
- Logistics: 2%
- IT: 2%
- Customer Service: 0%
- Other: 4%
Data validation

• Questionnaire Validation
  – Internal Reliability of Items
    • Cronbach’s $\alpha$: used to test the extent to which items measure the same construct
    • Cut off value for good internal reliability is $\geq 0.70$

<table>
<thead>
<tr>
<th>Construct</th>
<th>Item</th>
<th>Cronbach’s $\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic Management</td>
<td>V1 to V12</td>
<td>0.95</td>
</tr>
<tr>
<td>Leadership</td>
<td>V13 to V21</td>
<td>0.95</td>
</tr>
<tr>
<td>Measurement and Information Deployment</td>
<td>V22 to V31</td>
<td>0.95</td>
</tr>
<tr>
<td>Operational Management</td>
<td>V32 to V39</td>
<td>0.95</td>
</tr>
<tr>
<td>Training</td>
<td>V40 to V47</td>
<td>0.95</td>
</tr>
<tr>
<td>Change Adoption</td>
<td>V48 to V56</td>
<td>0.95</td>
</tr>
<tr>
<td>Continuous Improvement Sustainability</td>
<td>V57 to V60</td>
<td>0.96</td>
</tr>
</tbody>
</table>
Data validation

• Confirmatory Factor Analysis (COF) results

<table>
<thead>
<tr>
<th>Construct</th>
<th>Item</th>
<th>$\chi^2$</th>
<th>RMSEA</th>
<th>CFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic Management</td>
<td>V1 to V12</td>
<td>&lt;0.0001</td>
<td>0.10</td>
<td>0.91</td>
</tr>
<tr>
<td>Leadership</td>
<td>V13 to V21</td>
<td>&lt;0.0001</td>
<td>0.07</td>
<td>0.95</td>
</tr>
<tr>
<td>Measurement and Information Deployment</td>
<td>V22 to V31</td>
<td>&lt;0.0001</td>
<td>0.17</td>
<td>0.84</td>
</tr>
<tr>
<td>Operational Management</td>
<td>V32 to V39</td>
<td>&lt;0.0001</td>
<td>0.10</td>
<td>0.95</td>
</tr>
<tr>
<td>Training</td>
<td>V40 to V47</td>
<td>&lt;0.0001</td>
<td>0.18</td>
<td>0.85</td>
</tr>
<tr>
<td>Change Adoption</td>
<td>V48 to V56</td>
<td>&lt;0.0001</td>
<td>0.12</td>
<td>0.94</td>
</tr>
<tr>
<td>Continuous Improvement Sustainability</td>
<td>V57 to V60</td>
<td>&lt;0.0001</td>
<td>0.22</td>
<td>0.95</td>
</tr>
</tbody>
</table>

• The proposed model is not a good fit for the data
Data validation

– Exploratory Factor Analysis (EFA): to uncover the structure that best fit the data

• Fitting procedure used is Maximum Likelihood (ML)
  – Select the number of factors
    » Kaiser criterion using Eigenvalues of the correlation matrix ≥ 1
    » Scree plot determines the number of constructs based on the observed elbow of the curve
    » Accumulated variance (86%)

• Extract the initial set of factors using maximum likelihood as the extraction method
Data validation

• 5 constructs and 50 items were identified
Change Management

- Perceptions

Medical firm: Training CI plan for all associates

**Chemical firm**: No differences found

Kitchen cabinet firm: No Kaizen events in third period

Health care provider: No differences found
Strategic Planning

- Perceptions

![Graph showing perceptions over time for Medical, Chemical, Kitchen cabinet, and Health care provider firms.]

- **Medical firm**: CI as working policy, including the hiring of a CI leader.
- **Chemical firm**: No differences found.
- **Kitchen cabinet firm**: No Kaizen events in third period.
- **Health care provider**: No statistical significance.
Knowledge Management

• Perceptions

Medical firm: Use of communication tools such as boards
Chemical firm: No differences found. Ability to sustain the CI process
Kitchen cabinet firm: No Kaizen events in third period
Health care provider: No statistical significance
Performance Management

• Perceptions

Medical firm: No significant changes

Chemical firm: No differences found.

Kitchen cabinet firm: No Kaizen events in third period

Health care provider: No statistical significance
Sustainability

• Perceptions

Medical firm: No significant over time

Chemical firm: No differences found.

Kitchen cabinet firm: No Kaizen events in third period

Health care provider: No statistical significance
Kitchen Cabinet

- Third quarter, no Kaizen events because a new manufacturing performance system was being implemented.
CI factors correlations

- Strategic planning supports Change Management
- Performance management supports Knowledge Management

<table>
<thead>
<tr>
<th>Construct</th>
<th>SP</th>
<th>CM</th>
<th>KM</th>
<th>PM</th>
<th>SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP (F1)</td>
<td>1.00</td>
<td>0.79 &lt;0.0001</td>
<td>0.79 &lt;0.0001</td>
<td>0.64 &lt;0.0001</td>
<td>0.64 &lt;0.0001</td>
</tr>
<tr>
<td>CM (F2)</td>
<td></td>
<td>0.75 &lt;0.0001</td>
<td>0.73 &lt;0.0001</td>
<td>0.65 &lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>KM (F3)</td>
<td></td>
<td></td>
<td>0.68 &lt;0.0001</td>
<td>0.59 &lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>PM (F4)</td>
<td></td>
<td></td>
<td></td>
<td>0.63 &lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>SI (F5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>
To become Innovative...

Become Innovative

- Define innovation as a strategic goal
- Select a methodology to develop innovative projects
- Establish partnerships with research centers
- Use continuous improvement to support incremental innovation
A path to sustain CI efforts...

<table>
<thead>
<tr>
<th>CI sustainability framework and management practices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic Planning</strong></td>
</tr>
<tr>
<td>• Define CI as a strategic goal</td>
</tr>
<tr>
<td>• Cascade this goal into departmental and individual goals</td>
</tr>
<tr>
<td>• Define a CI leader</td>
</tr>
<tr>
<td>• Set up CI role modeling expectations to managers and supervisors</td>
</tr>
<tr>
<td><strong>Knowledge management</strong></td>
</tr>
<tr>
<td>• Use IT to spread knowledge</td>
</tr>
<tr>
<td>• Develop a training plan using success histories</td>
</tr>
<tr>
<td>• Capitalize knowledge</td>
</tr>
<tr>
<td>• Develop a certification plan for strategic employees.</td>
</tr>
</tbody>
</table>
• Thanks!
• quesada@vt.edu