KPI/Metrics for the process industry

Charlotta Johnsson
A company is considered a *Business Mover* if it has improved:

a) More than 10% on one or many of the financial metrics

b) More than 1% on over half of the financial metrics

Typical for *Business Movers* is that they:

1) Have well defined KPIs

2) Have informed employees

3) use IT systems to get measurements, calculate Key Performance Indicators (KPIs, Metrics) and display the results.

From: MESA survey "Metrics that Matter", Oct 2006
KPI/Metrics for the process industry

Charlotta Johnsson

CHALLENGES:
1) What key performance indicators are used in process industry today?
2) Do the key performance indicators differ depending on company characteristics?
3) How can key performance indicators be exchanged between different software-applications?

PROJECT:
• PiiA financed project (jan2015-dec2016) called “PiiA-Metrics”
What is a KPI?

**Key performance indicators (KPIs)** are metrics designed to visualize, assess, and manage the performance of specific operations within enterprises.

Performance Management:
1. Awareness of current situation
2. Clear view of the desired situation
3. Improvement potentials
4. Improvement
Functional Model of an Enterprise (ISA95)

Level 5
- Company Management
  - Time Frame: Years, Months
  - 5 - Receive sales orders, assure shipping and customer relations.

Level 4
- Business Planning & Logistics
  - Plant Production Scheduling, Operational Management, etc
  - Time Frame: Months, weeks, days, shifts
  - 4 - Establishing the basic plant schedule - production, material use, delivery, and shipping. Determining inventory levels.

Level 3
- Manufacturing Operations Management
  - Dispatching Production, Detailed Production Scheduling, Reliability Assurance, ...
  - Time Frame: Shifts, hours, minutes, seconds
  - 3 - Work flow / recipe control to produce the desired end products. Maintaining records and optimizing the production process.

Level 2
- Discrete Control
- Continuous Control
- Batch Control
  - 2 - Monitoring, supervisory control and automated control of the production process

Level 1
- 1 - Sensing the production process, manipulating the production process

Level 0
- 0 - The physical production process

9/16/2015
Earlier work

ISO 22400 is an international standard
- Lists 34 commonly used KPIs
- Standard released in 2014
- Used today in e.g. MES-product development
<table>
<thead>
<tr>
<th>KPI definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content:</td>
</tr>
<tr>
<td>Name</td>
</tr>
<tr>
<td>ID</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Scope</td>
</tr>
<tr>
<td>Formula</td>
</tr>
<tr>
<td>Unit of measure</td>
</tr>
<tr>
<td>Range</td>
</tr>
<tr>
<td>Trend</td>
</tr>
<tr>
<td>Context:</td>
</tr>
<tr>
<td>Timing</td>
</tr>
<tr>
<td>Audience</td>
</tr>
<tr>
<td>Production methodology</td>
</tr>
<tr>
<td>Effect model diagram</td>
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<tr>
<td>Notes</td>
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<td></td>
</tr>
<tr>
<td>Description</td>
<td>Availability is a ratio that shows the relation between the actual production time (APT) and the Planned busy time (PBT) for a work unit..</td>
</tr>
<tr>
<td>Scope</td>
<td>Work unit, product, time period, product</td>
</tr>
<tr>
<td>Formula</td>
<td>Availability = APT / PBT</td>
</tr>
<tr>
<td>Unit of measure</td>
<td>%</td>
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</table>
| Range          | Min: 0%  
                | Max: 100% |
| Trend          | The higher, the better |

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**Range**
- Reference time
- Planned operation time
- Planned busy time

**Actual time**
- Actual unit busy time
- Actual unit processing time
- Actual production time

**Planned time**
- POT
- PBT
- No production

**Effect model**
- AUBT
- AUDT
- AUIT
- Actual unit idle time
- Actual unit delay time

**Notes**
- Actual unit set up time
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### Diagram

- **Planned time**
  - Planned operation time (POT)
  - Planned busy time (PBT)
- **Actual time**
  - Actual unit busy time (AUBT)
  - Actual unit processing time (AUPR)
  - Actual production time (APT)
- **Operation sequence**
  - Production order → Area → Work centre → Operation sequence → Work unit → Planned operation time → Planned unit busy time
- **Availability**
  - Operation calendar → Calendar day → Work unit → Planned operation time → Planned unit busy time
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- Find commonly used KPIs in PI
- Interviews with companies (5 signed up)
- Describe KPIs according to table-structure
- Other findings
2: Do the KPIs differ depending on company characteristics

Company characteristics:
- Continuous (CO) vs Discrete Object (DO)
- Speculation (SD), Hybrid (HD) or Customer-order Driven (CD)
- Continuous (CM), Intermittent (IM) or One-time Mode (OM)
3: How can KPIs be exchanged?

UML models are used to define the structure of a KPI.

UML is an implementation independent specification format.
3: How can KPIs be exchanged?

UML models are used to define the structure of a KPI.
3: How can KPIs be exchanged?

UML models define the KPI structure

UML models are translated to XML schemas
XML schemas can be exchanged between various systems
3: How can KPIs be exchanged?

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!-- Sample XML file generated by XMLSpy v2010 rel. 3 sp1 (http://www.altova.com) -->
<KPIDefinition xlink:schemaLocation="http://www.mesa.org/xml/KPI-ML-V01RC03 KPI-ML-V01RC03.xsd" xlink="http://www.mesa.org/xml/KPI-ML-V01RC02" xlinkSchemaLocation="http://www.w3.org/2001/XMLSchema-instance">
  <ID>OLR100</ID>
  <Description>The other loss ratio is the relationship of the quantity of loss not related to production, storage or transportation (QL) to the quantity of consumed material (CM).
  </Description>
  <Name>Other Loss Ration</Name>
  <Scope>Work unit</Scope>
  <Scope>defect type</Scope>
  <Formula>QL / CM</Formula>
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  <Timing>On-demand</Timing>
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  <Timing>real-time</Timing>
  <Audience>Operator</Audience>
  <Audience>supervisor</Audience>
  <Audience>management</Audience>
  <ProductionMethodology>Batch</ProductionMethodology>
  <ProductionMethodology>Continuous</ProductionMethodology>
  <Notes>"The other loss ratio evaluates losses that have not occurred during production, storage, or transportation. See also production loss ratio"
  </Notes>
</KPIDefinition>
```
Exchanging KPIs

XML schemas for KPIs, an implementation proposal for the information to be exchanged
3: How can KPIs be exchanged?

XML schemas are referred to as KPI-ML

KPI-ML was released by MESA, May 2015

Available at MESAs homepage www.mesa.org
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OTHER topics: navigation among KPIs, finding target-values to the KPIs, KPI lifecycle management.
RELATED TO: active participation in ISO22400 and MESA

PROJECT:
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THANK YOU!
KPIs defined

The following 34 KPIs are defined in ISO 22400 – Part 2

6.1 Worker Efficiency
6.2 Allocation Ratio
6.3 Throughput rate
6.4 Allocation efficiency
6.5 Utilization efficiency
6.6 Overall equipment effectiveness index
6.7 Net equipment effectiveness index
6.8 Availability
6.9 Effectiveness
6.10 Quality Ratio
6.11 Setup Rate
6.12 Technical efficiency
6.13 Production process ratio
6.14 Actual to planned scrap ratio
6.15 First pass yield
6.16 Scrap ratio
6.17 Rework ratio
KPIs defined

The following 34 KPIs are defined in ISO 22400 – Part 2

6.18 Fall off ratio
6.19. Machine capability index
6.20 Critical machine capability index
6.21 Process capability index
6.22 Critical process capability index
6.23 Comprehensive energy consumption
6.24 Inventory turns
6.25 Finished goods ratio
6.26 Integrated goods ratio
6.27 Production loss ratio
6.28 Storage and transportation loss ratio
6.29 Other loss ratio
6.30 Equipment load ratio
6.31 Mean operating time between failures
6.32 Mean time to failure
6.33 Mean time to restoration
6.34 Corrective maintenance ratio
Process Industry

• Pulp & paper
• Chemicals and plastics
• Petroleum
• Pharmaceutical
• Mining
• Iron and Steel
• Food

Source: IVA 2006