

Measuring loss



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Setting up measurements

**What isn't measured
can't be controlled**



Setting up measurements

Co-ordination; Monitoring; Diagnostics

- Forward-looking prediction and insight

- Provide feedback and build understanding

- Focus on: systematic thinking, fundamental structural change and organisational learning

- A framework for understanding and alignment with top-level objectives of the organisation



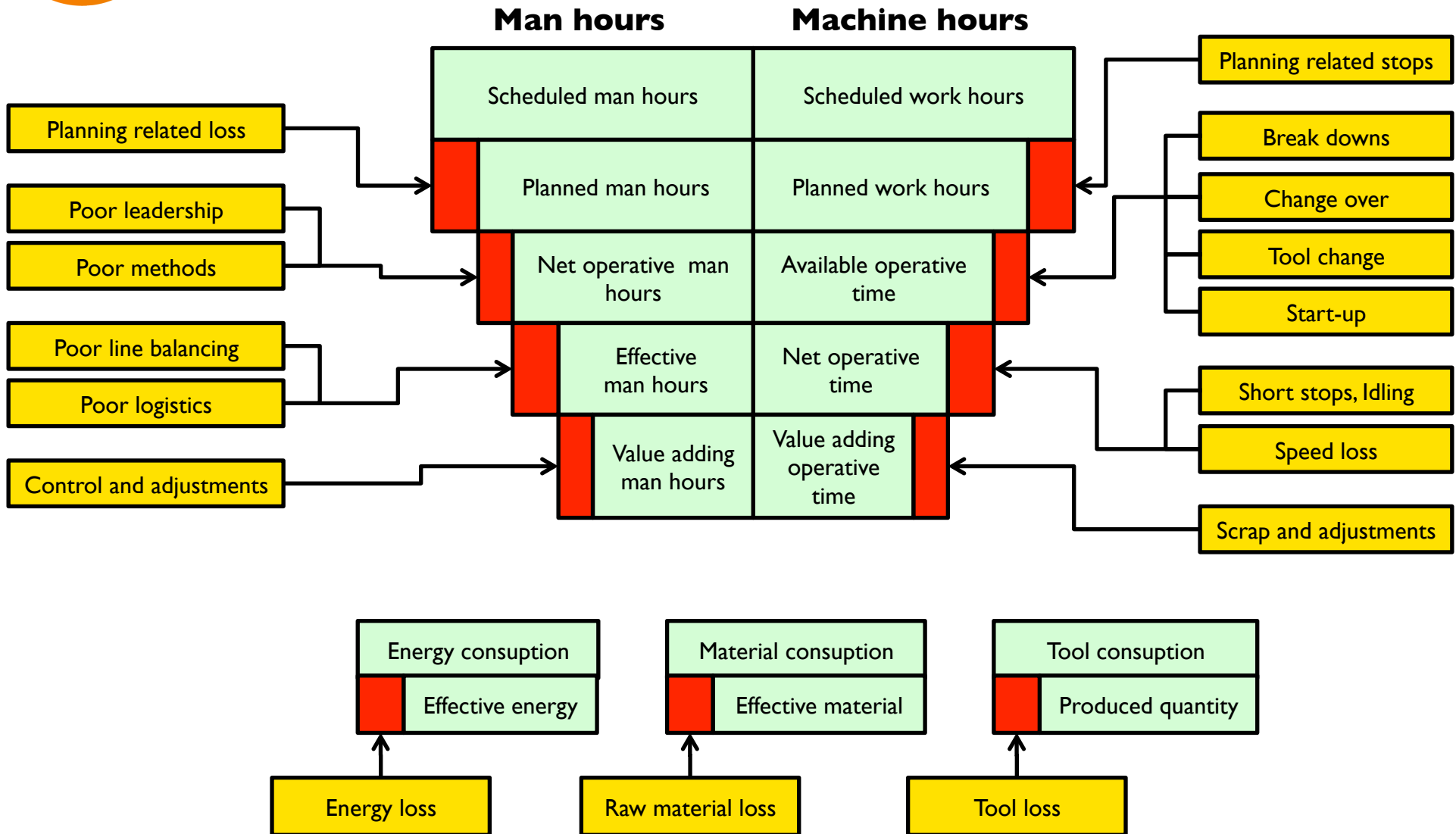
Setting up measurements

Basic questions:

- Why is measurement required? (Purpose.)
- What should be measured? (Finding factors that are important.)
- How should it be measured? (Methods.)
- When should it be measured? (Timing and time frame.)
- Who should measure it? (Owner of the process versus independent party.)

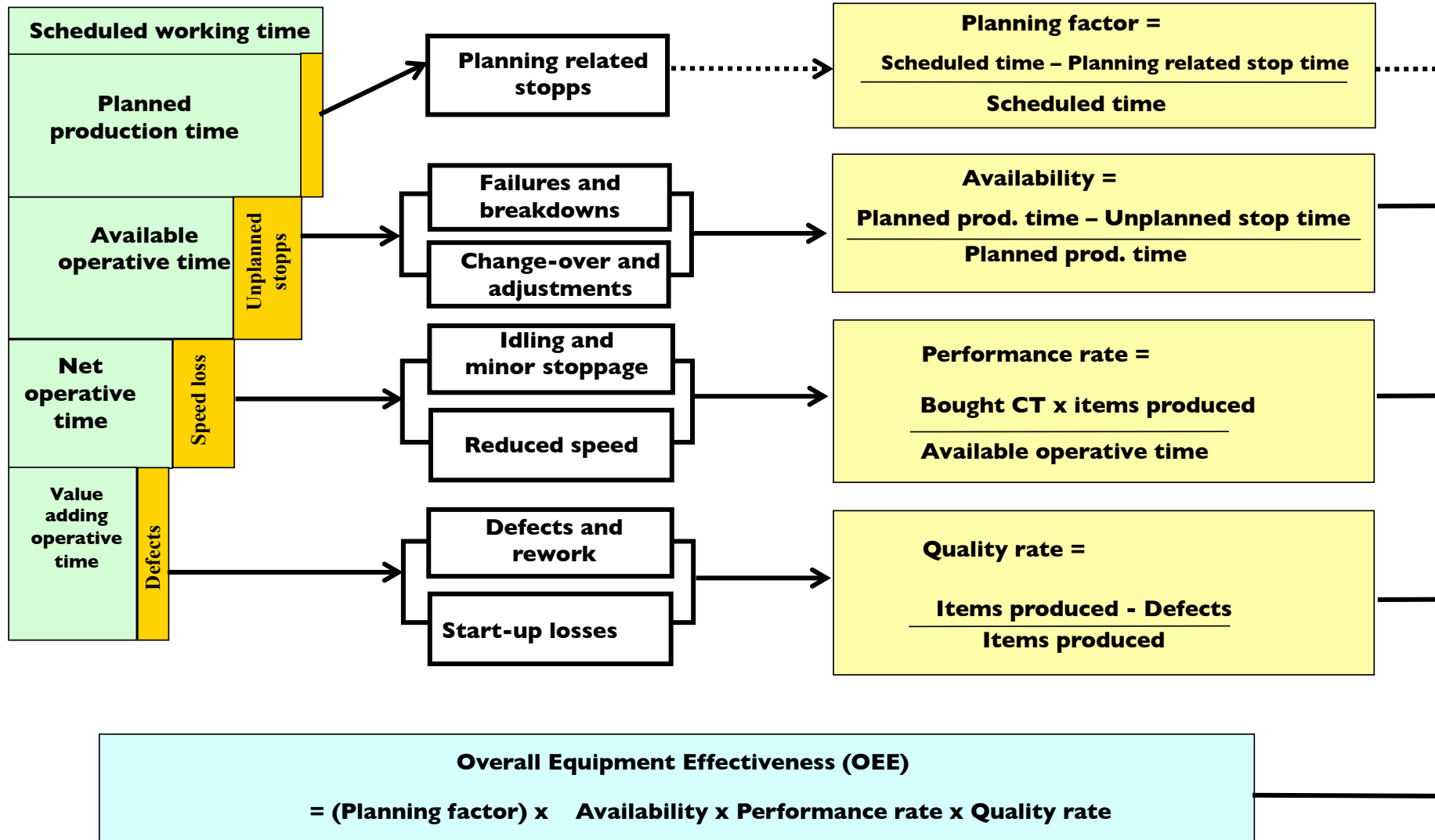


Sources of loss





Machine hours, OEE





Machine hours, OEE

System loss

- Conveyor systems between equipment
- Over-all computer systems like MPS
- Mal functioning buffer systems
- Power outs
- Failures in central systems e.g. central lubrication



Machine hours, OEE

System availability

Equipment

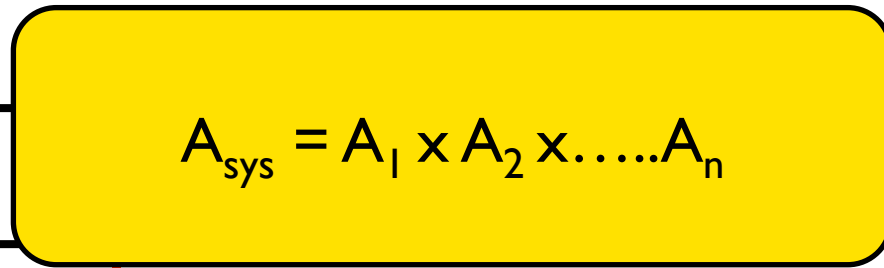
1

2

3

4

5



Availability

93%

96%

93%

95%

91%

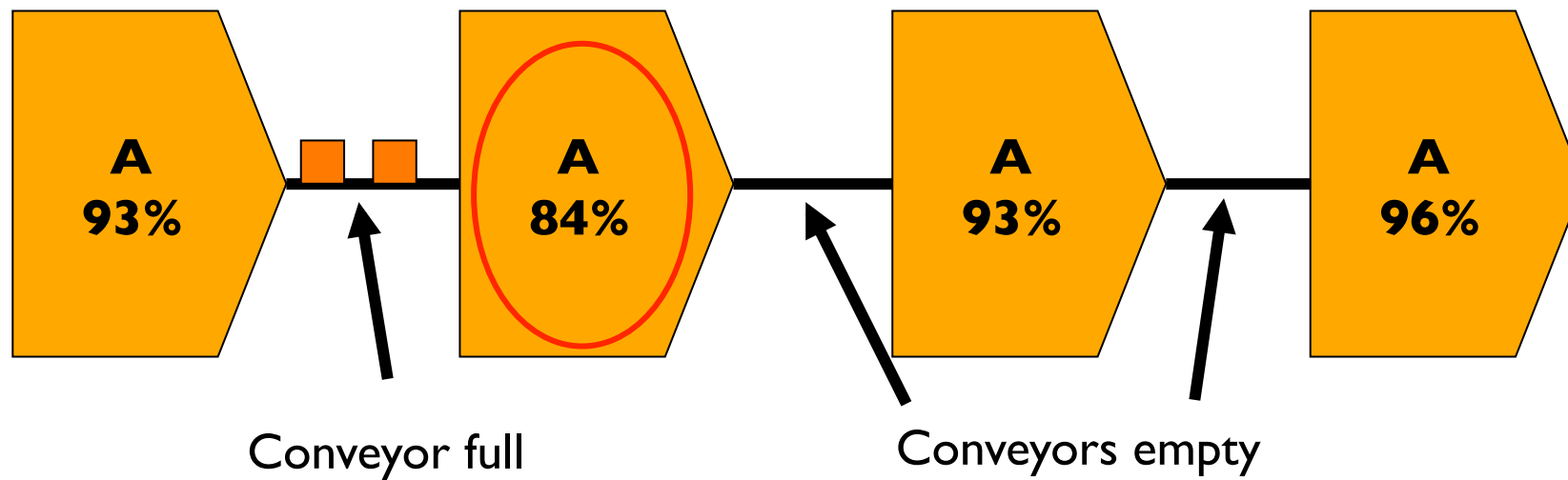
**System
availability**

71.8%



Machine hours, OEE

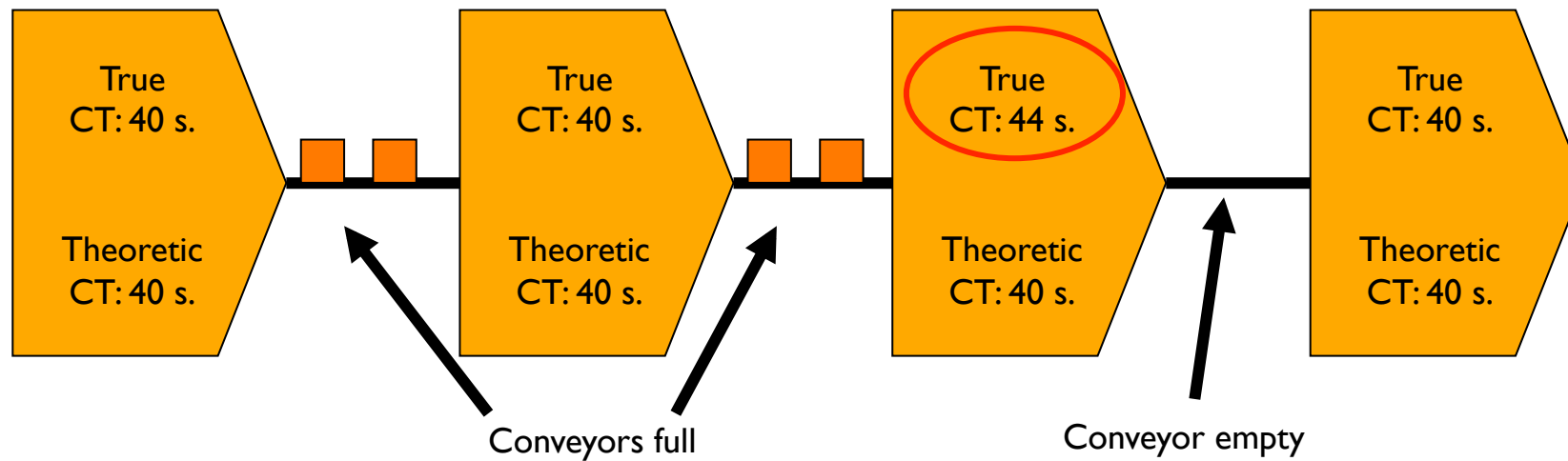
System availability loss





Machine hours, OEE

System cycle-time loss



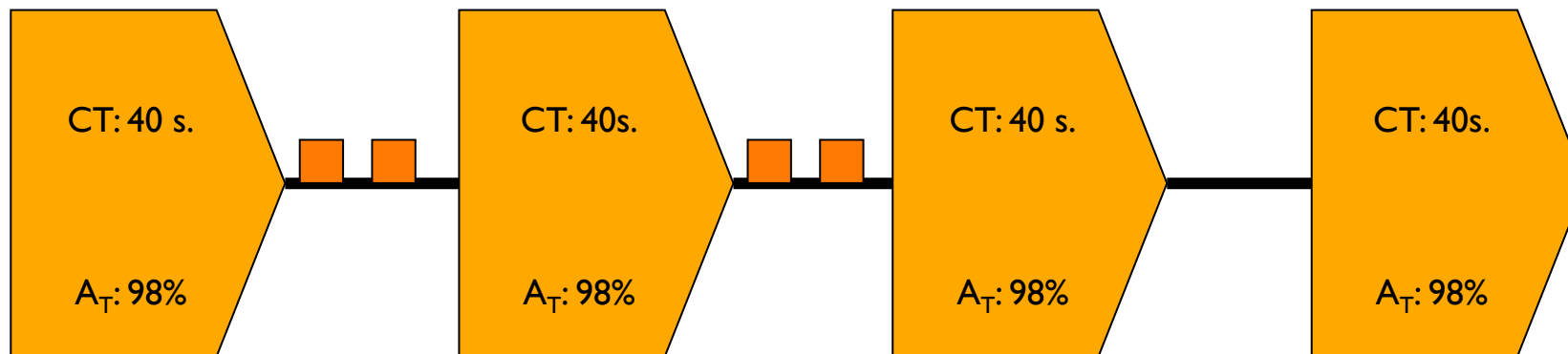
True cycle time of system: 44 s.



Machine hours, OEE

Bought capacity (with an assumed A_T of 98% and $CT = 40s$):

$$C_{sys} = (3600/40) \times 0.98 \times 0.98 \times 0.98 \times 0.98 = 83 \text{ u/h}$$

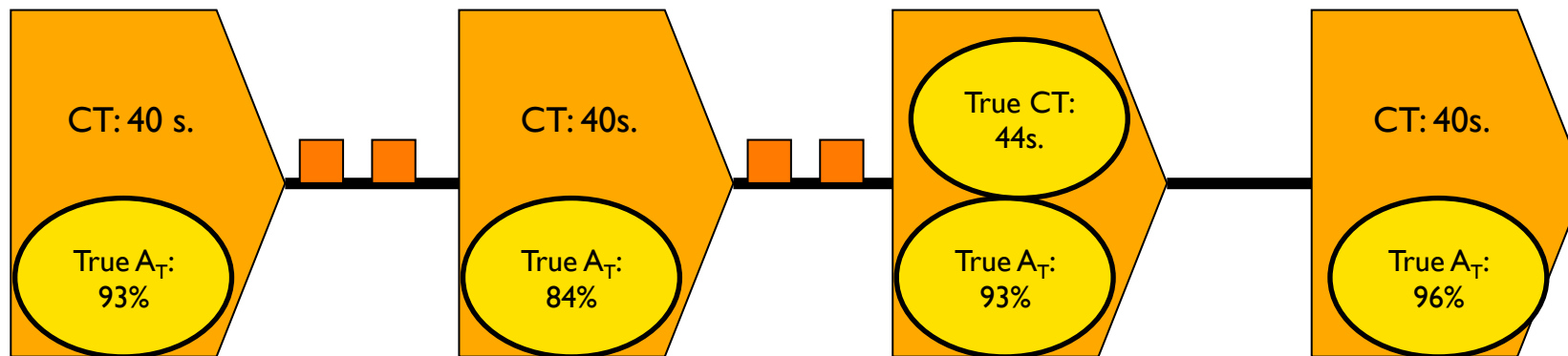




Machine hours, OEE

Bought capacity (with an assumed A_T of 98% and $CT = 40s$):

$$C_{sys} = (3600/40) \times 0.98 \times 0.98 \times 0.98 \times 0.98 = 83 \text{ u/h}$$



True capacity, based on the actual data, presented above:

$$C_{sys} = (3600/44) \times 0.93 \times 0.84 \times 0.93 \times 0.96 = 57 \text{ u/h}$$



Machine hours, OEE

How to measure?

Start by asking if OEE figures are available!

If so, check:

- Definitions
- Measurement method
- Reliability



Machine hours, OEE

Data sources?

Combine multiple data sources!



Machine hours, OEE

Data sources?

Inform the operators!



Machine hours, OEE

What's essential?

$$\frac{\text{Achieved output}}{\text{Planned output}} = \text{OEE}$$



Machine hours, OEE

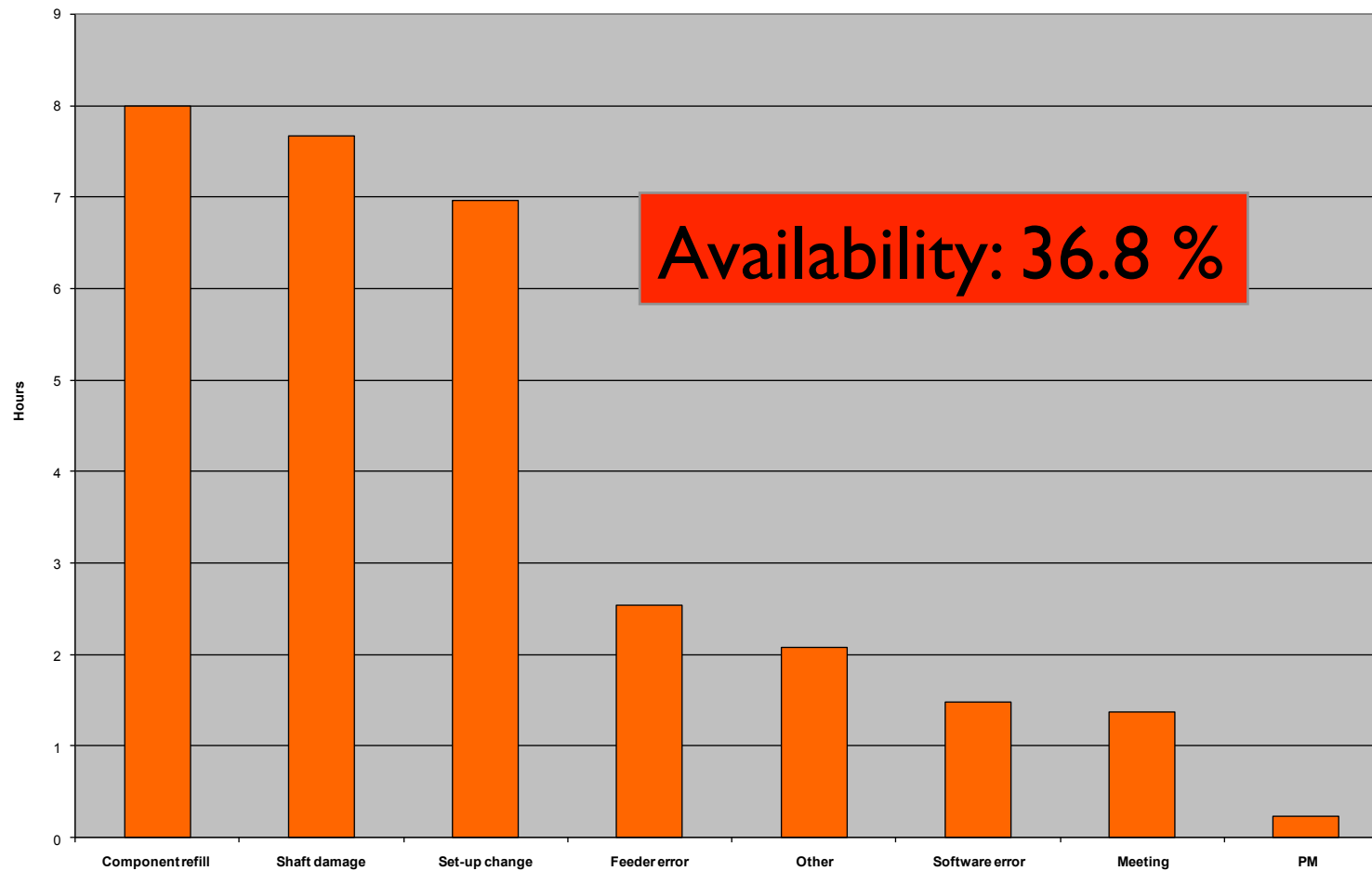
Data sources?

Error sources?



Machine hours, OEE

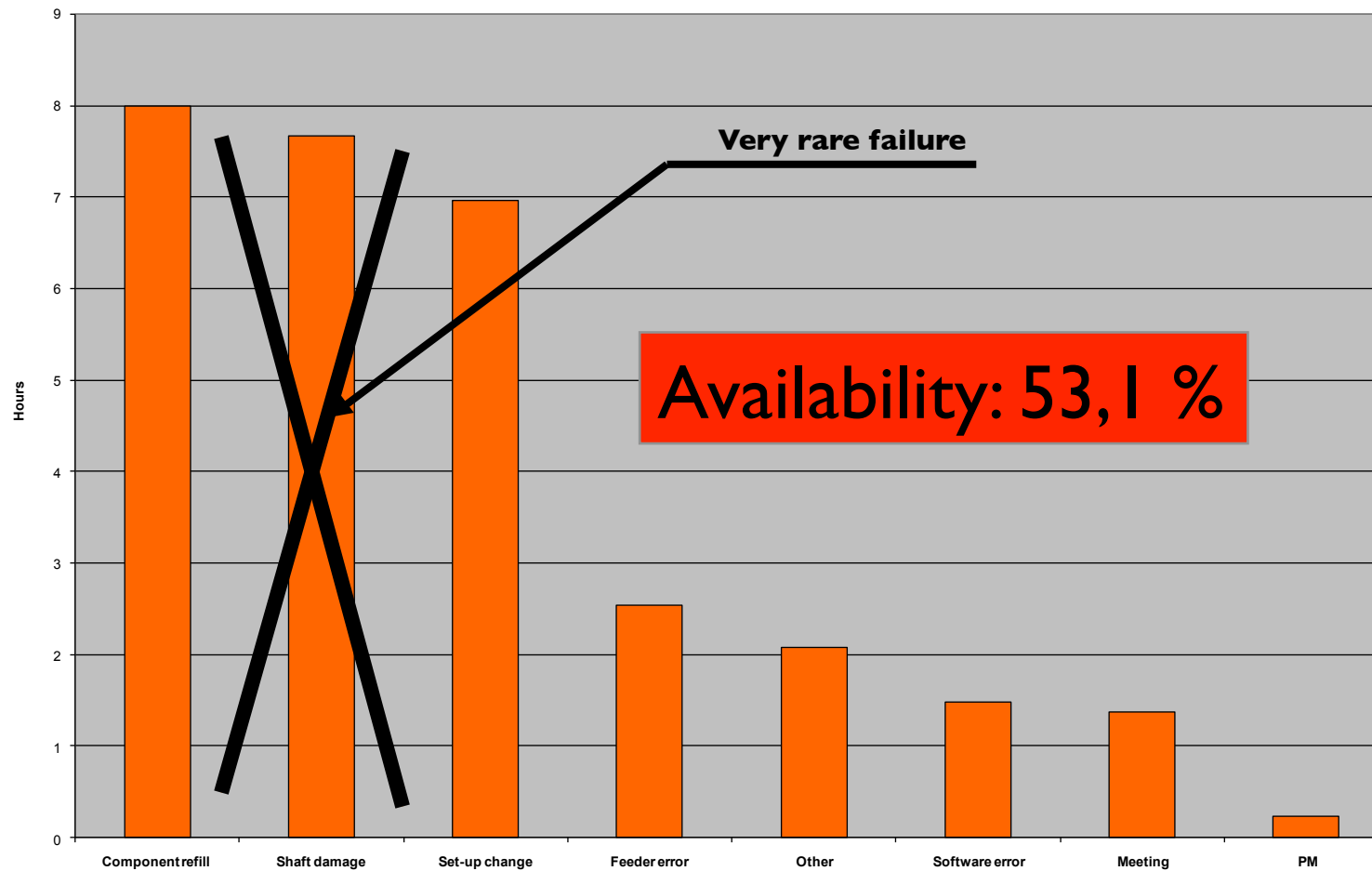
Random events? Stop causes





Machine hours, OEE

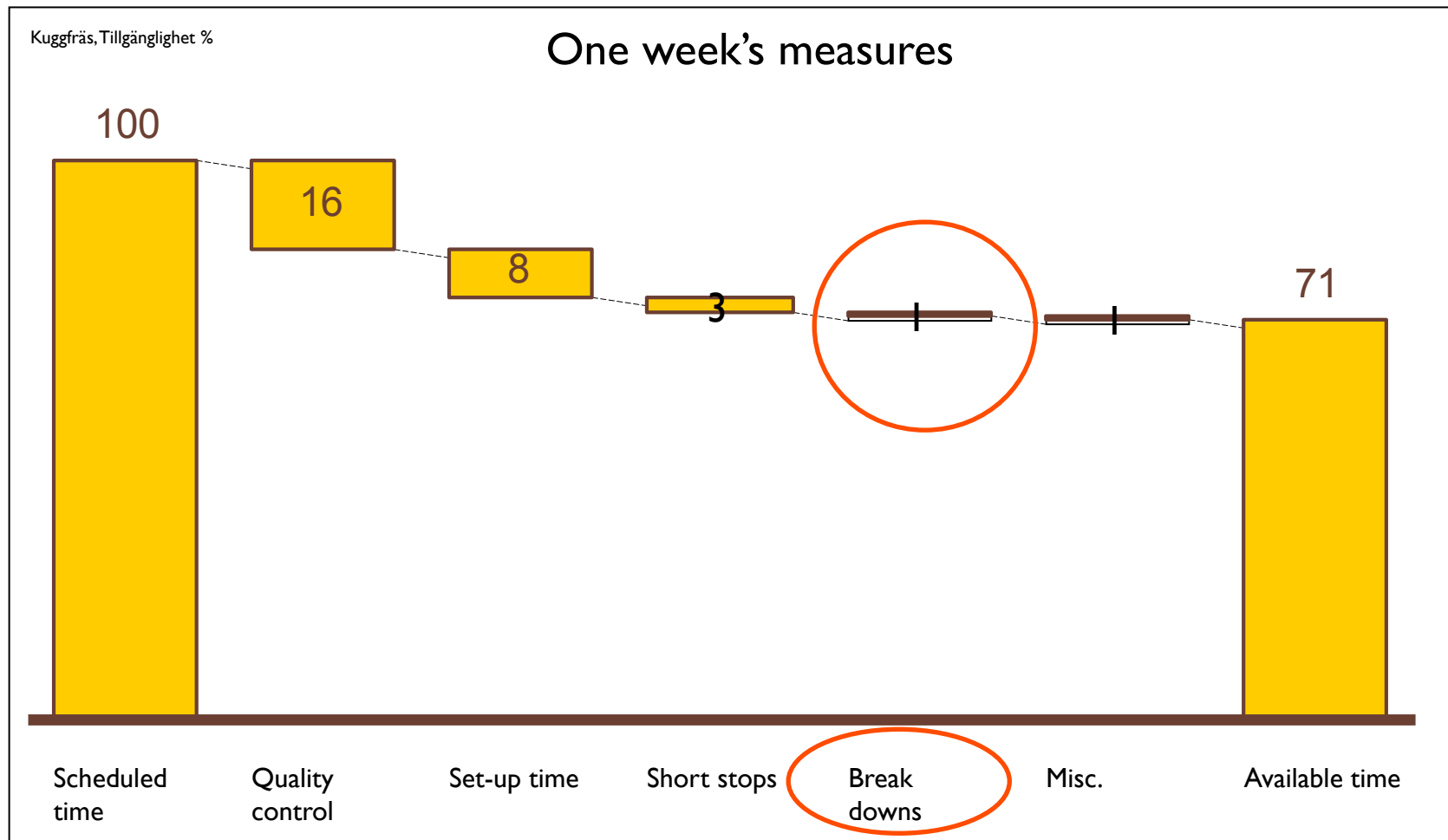
Random events? Stop causes





Machine hours, OEE

Too short time span?





Machine hours, OEE

Alternative data sources?

Milling:

-MTBF: 113,25h

-MTTR: 6,01h

Grading:

-MTBF: 117,4h

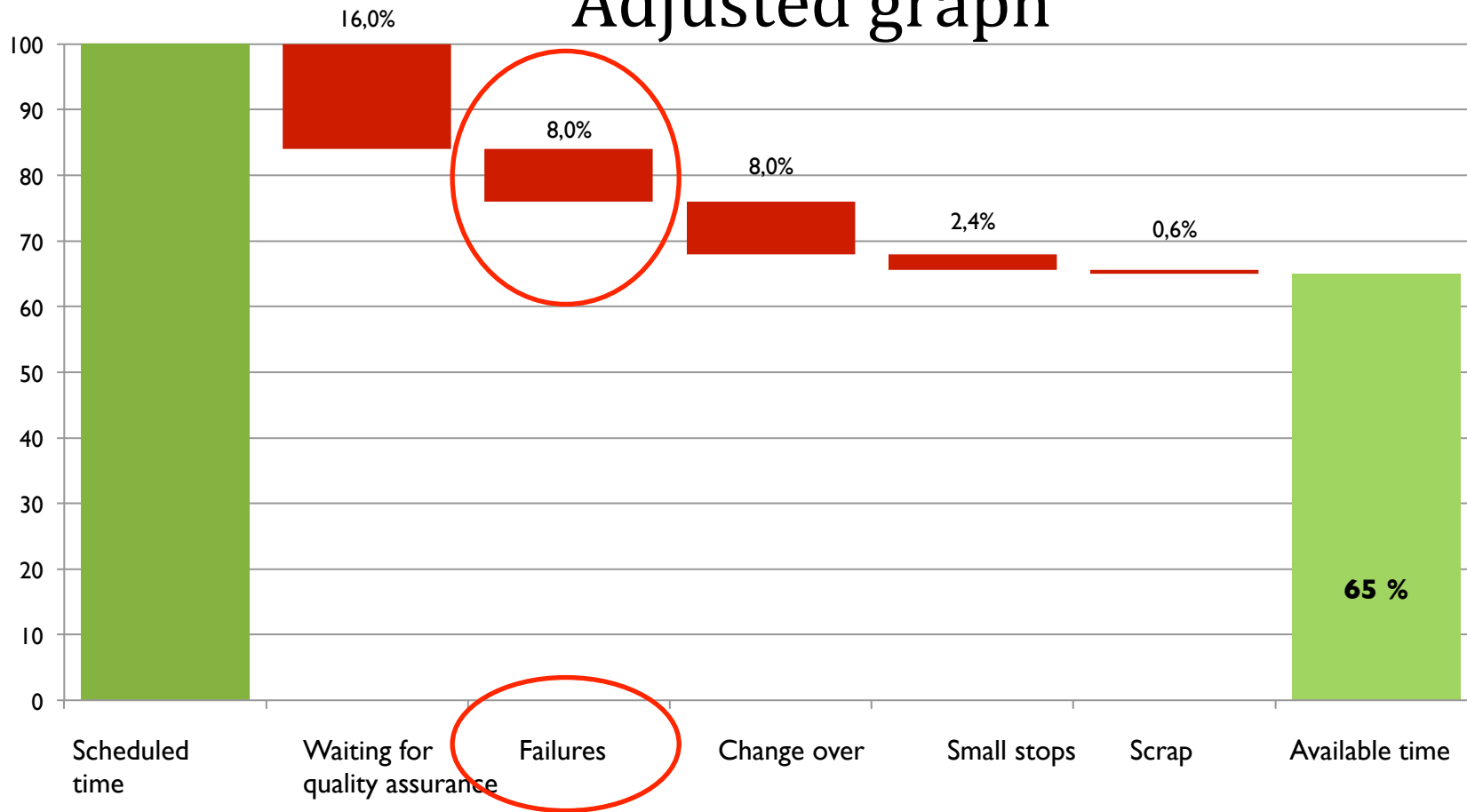
-MTTR: 3,0h

A_{sys} : 92,6%



Machine hours, OEE

Adjusted graph





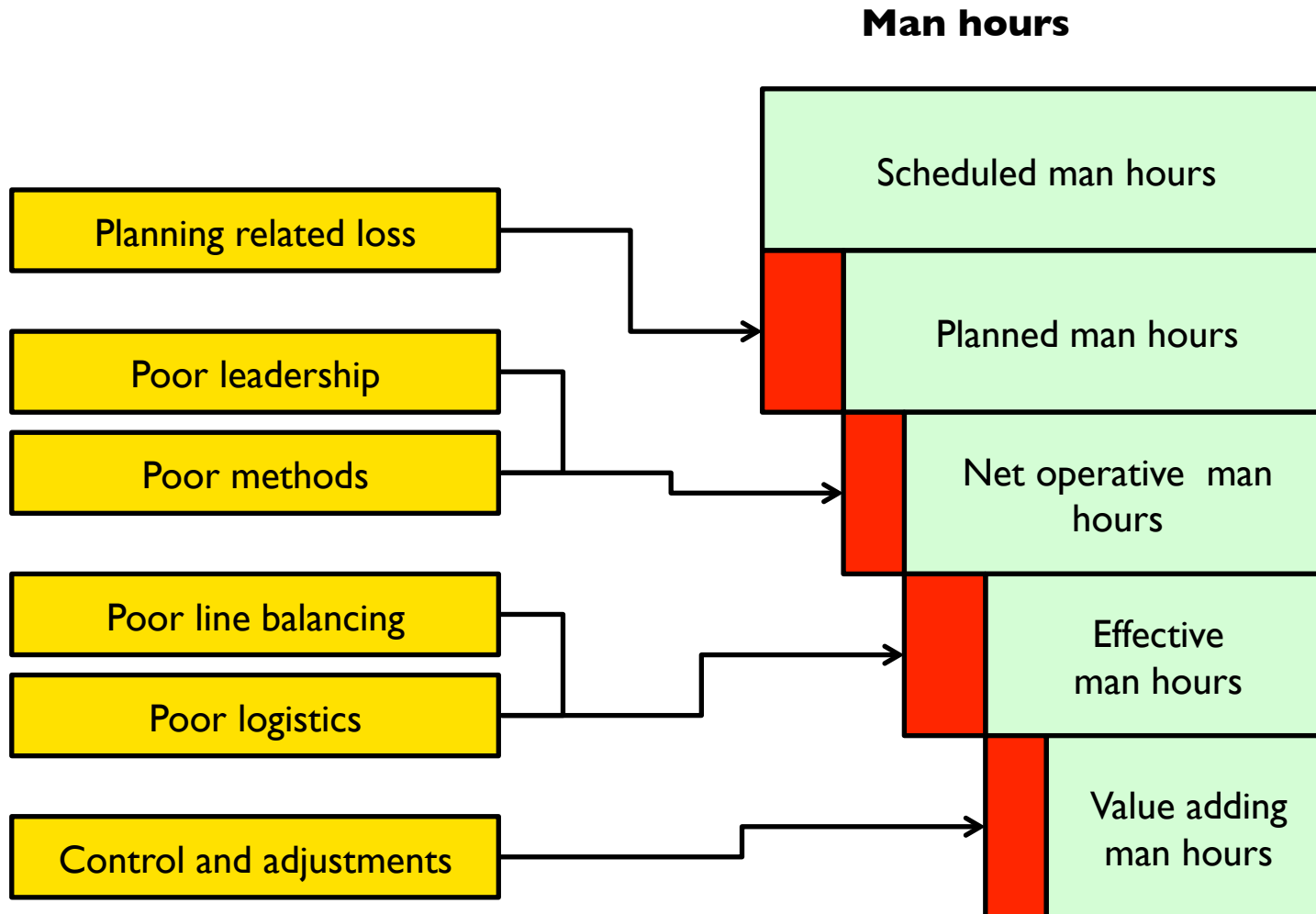
Machine hours, OEE

Validity/Reliability

Let the staff verify your findings!



Loss in manual labor





Loss in manual labor

Methods:

- Time studies
- Frequency studies
- Pre-determined Motion Time System
- Time formulas



Man hours, Frequency studies

First!

**Check that measuring is approved
by the union and the operators.**

**Then inform the operators of the
purpose of the study.**



Man hours, Frequency studies

Necessary sample size:

$$n = \left(\frac{c}{z}\right)^2 * p(1 - p)$$

n = number of samples

c = degree of confidence*

z = percentage error

p = probability of activity

* C = 1.96 is commonly used for 95% confidence

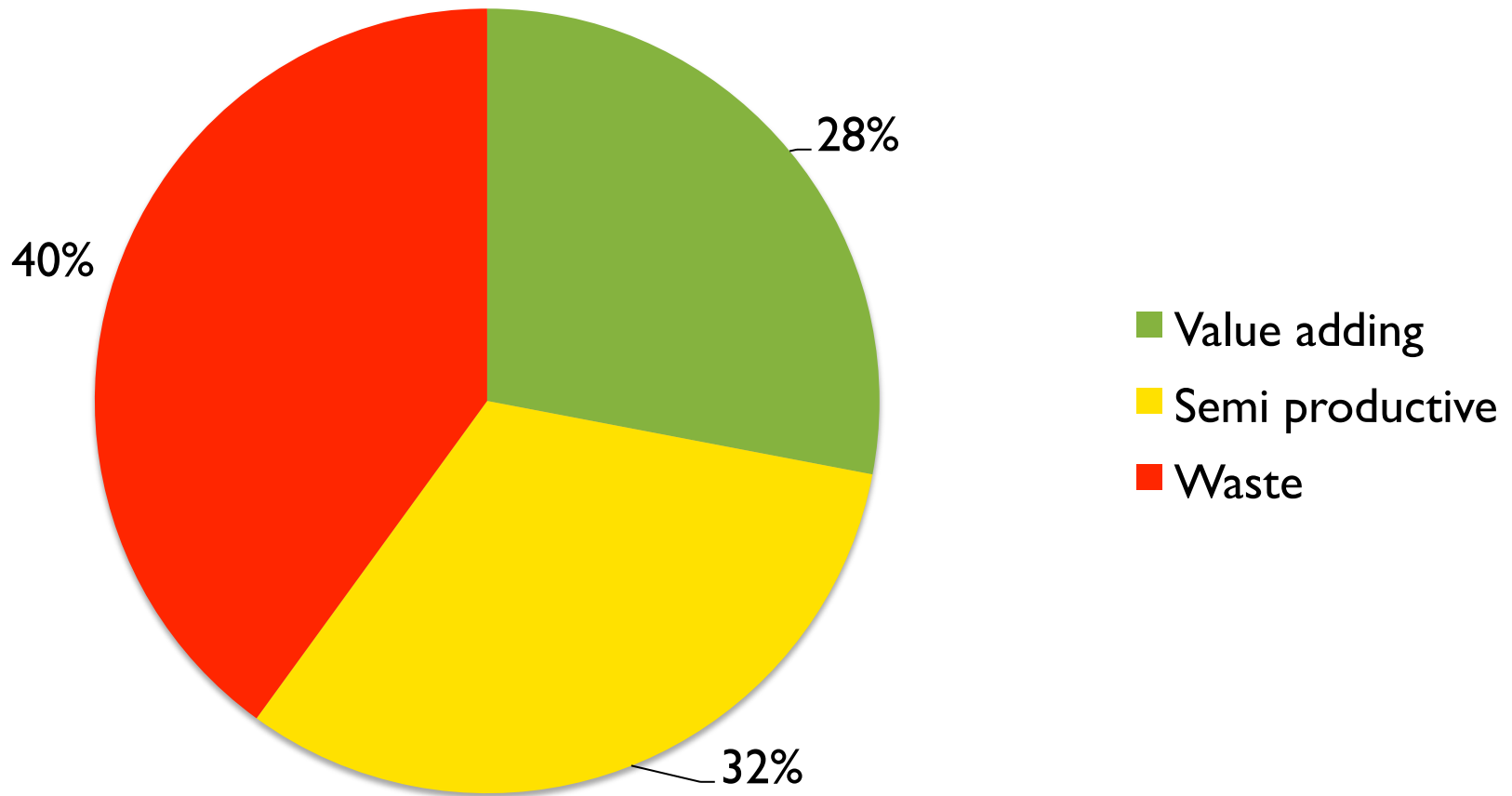


Man hours, Frequency studies

Activity	Observations	%	Deviation Z	Cost (SEK)
Value adding:				
Assembly	56	28	6.22	1514
Value adding total:	56	28	6.22	1514
Semi productive				
Fetch material	22	11	4.34	595
Prepare assembly	18	9	3.97	487
Fetching tools	15	7.5	3.65	406
Inspection	3	1.5	1.68	81
Administration	0	0	0	0
Getting information	1	0.5	0.98	27
Cleaning	4	2	1.94	108
Semi productive total:	63	31.5	6.44	1704
Waste				
Adjustments	43	21.5	5.7	1163
Searching for material	2	1	1.94	135
Waiting for material	2	1	1.38	54
Searching for tools	0	1.5	0	0
Waiting for tools	0	1	0	0
Searching for information	1	0	0.98	27
Personal time	14	0	3.54	379
Fetching material outside station	8	0.5	2.72	216
Helping colleague	8	7	2.72	216
Waste total:	81	40.5	6.8	2190



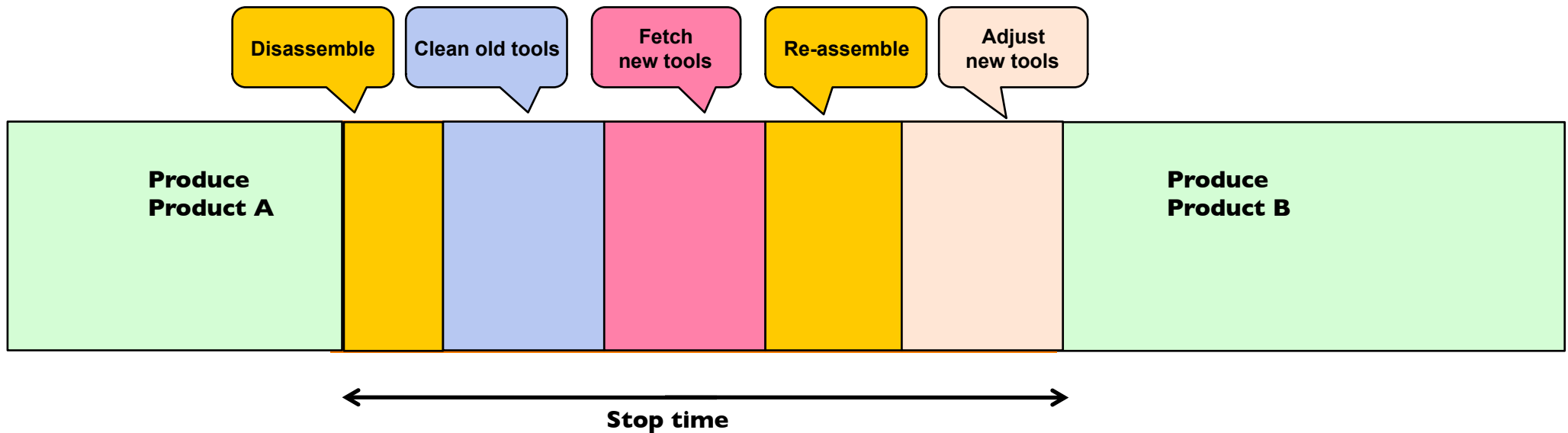
Result: Distribution





Loss in Change-over

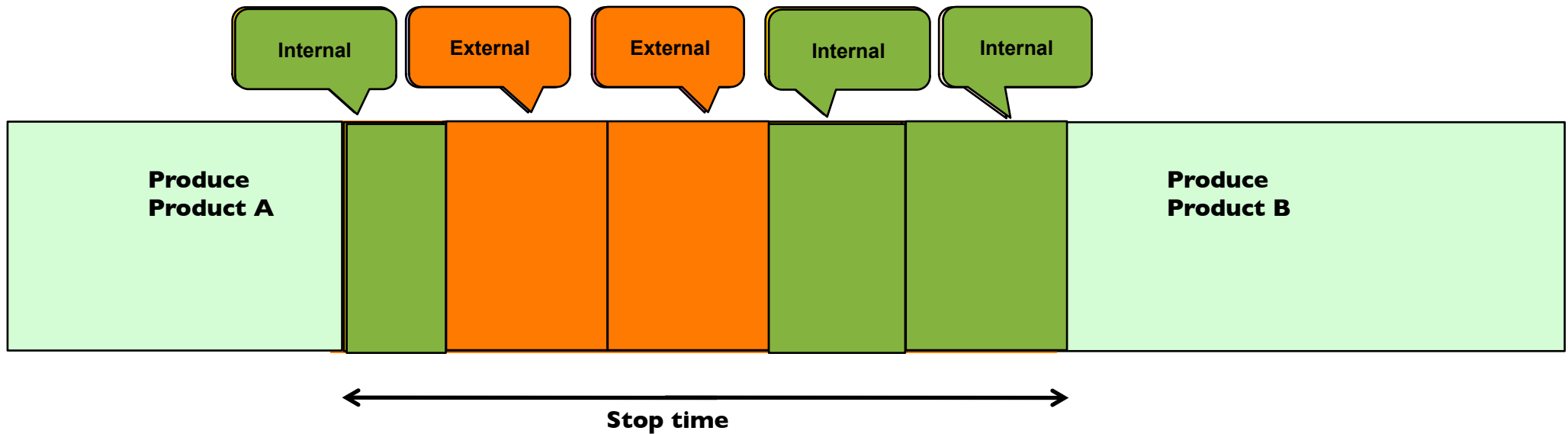
Intermittent procedural work





Loss in Change-over

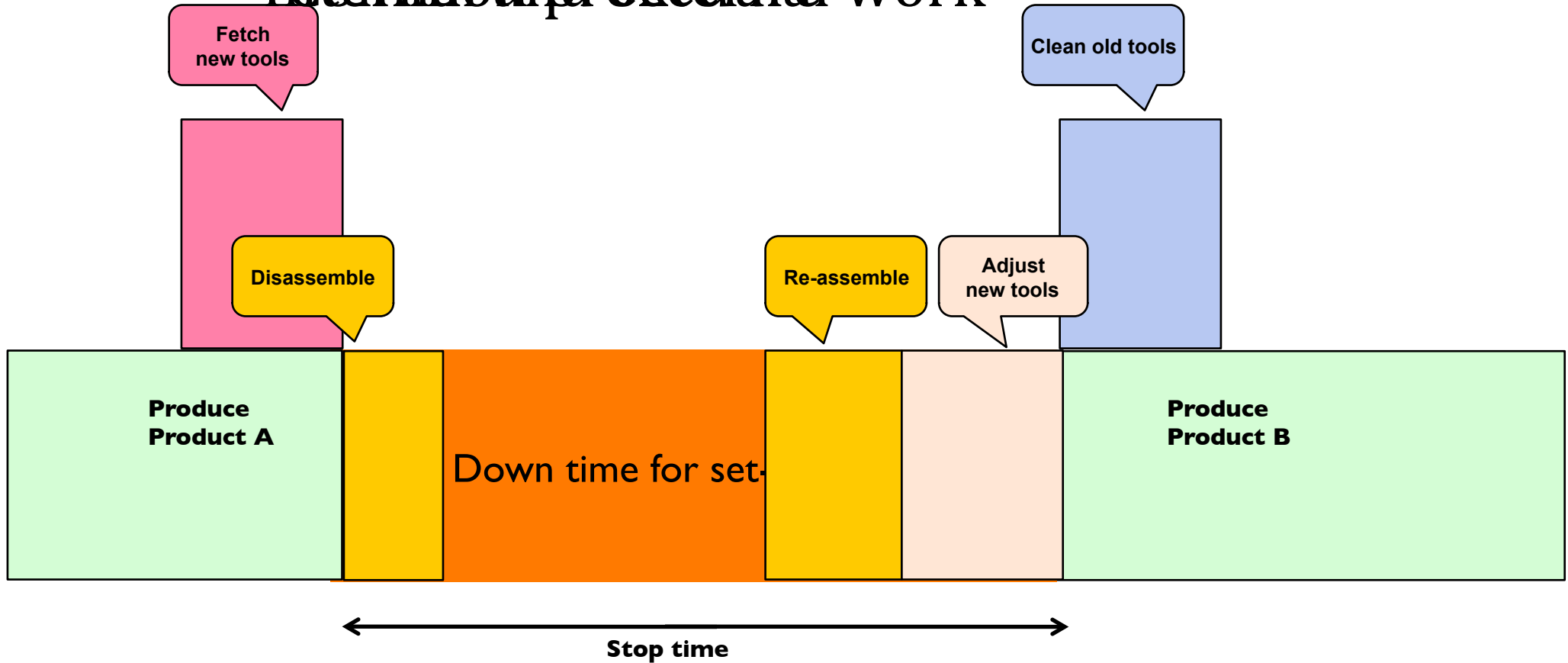
Internal and external work





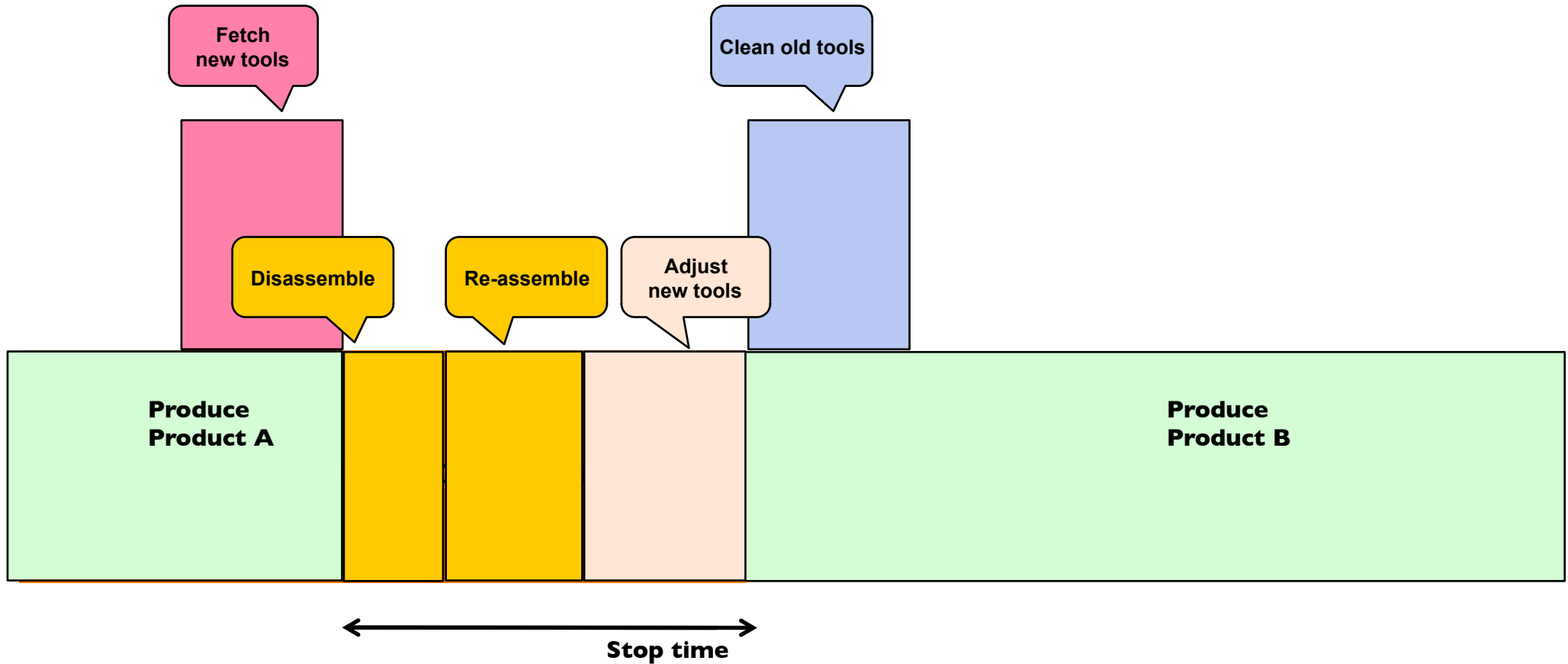
Loss in Change-over

Internal procedural work





Loss in Change-over





Loss in Change-over

Further reading:

- Muchiri, P., Pintelon, L., (2008), "Performance measurement using overall equipment effectiveness (OEE): literature review and practical application discussion", International Journal of Production Research, Vol. 46, No. 13, pp. 3517-3535.
- Mali, Y.R., Inamdar, K.H., (2012), "Changeover Time Reduction using SMED Technique of Lean Manufacturing", International Journal of Engineering Research and Applications, Vol. 2, Issue 3, pp. 2441-2445.