Planning of production service and maintenance activities – A current state mapping in industry
by

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Objective

- Production service system (PSS)
- Current state mapping of production service and maintenance activities planning in industry
  - To understand how industries work with criticality classification
  - How maintenance activities are prioritized
- Quantitative & qualitative method

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Traditional Maintenance

- Reactive
- Preventive
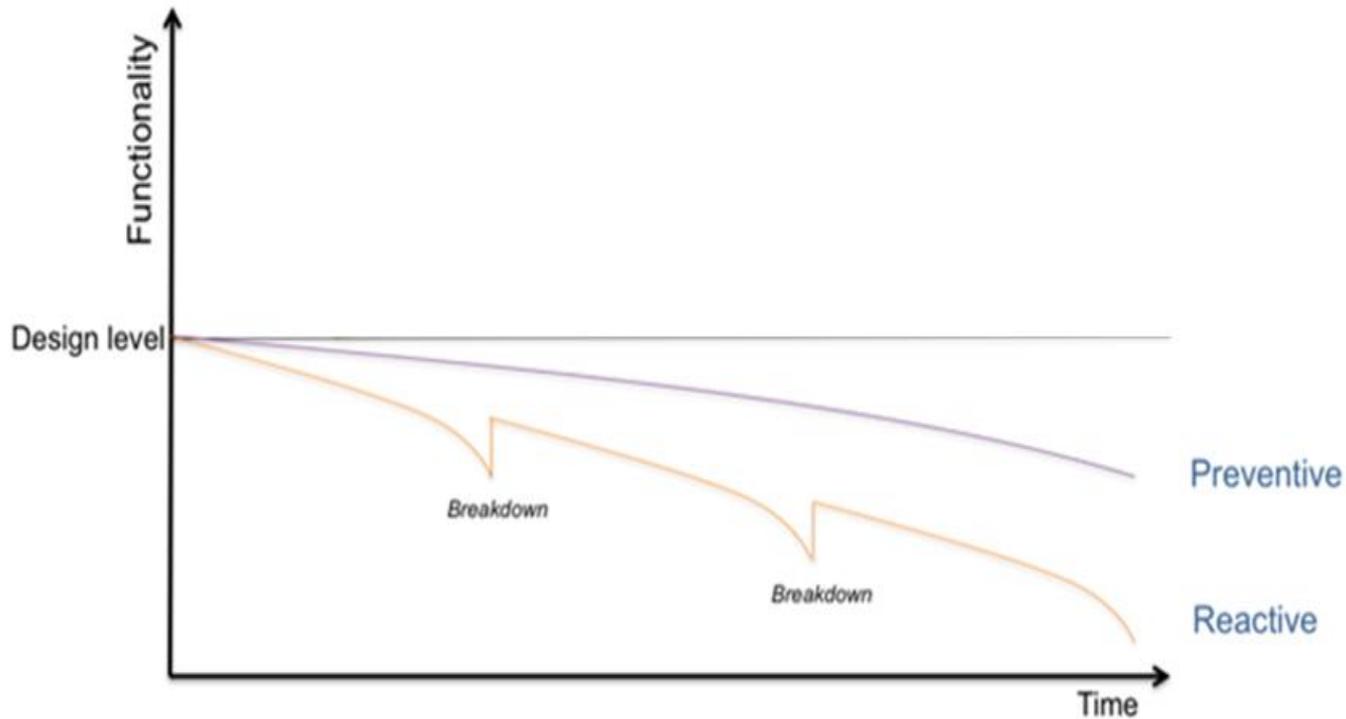
Production Service System (PSS)
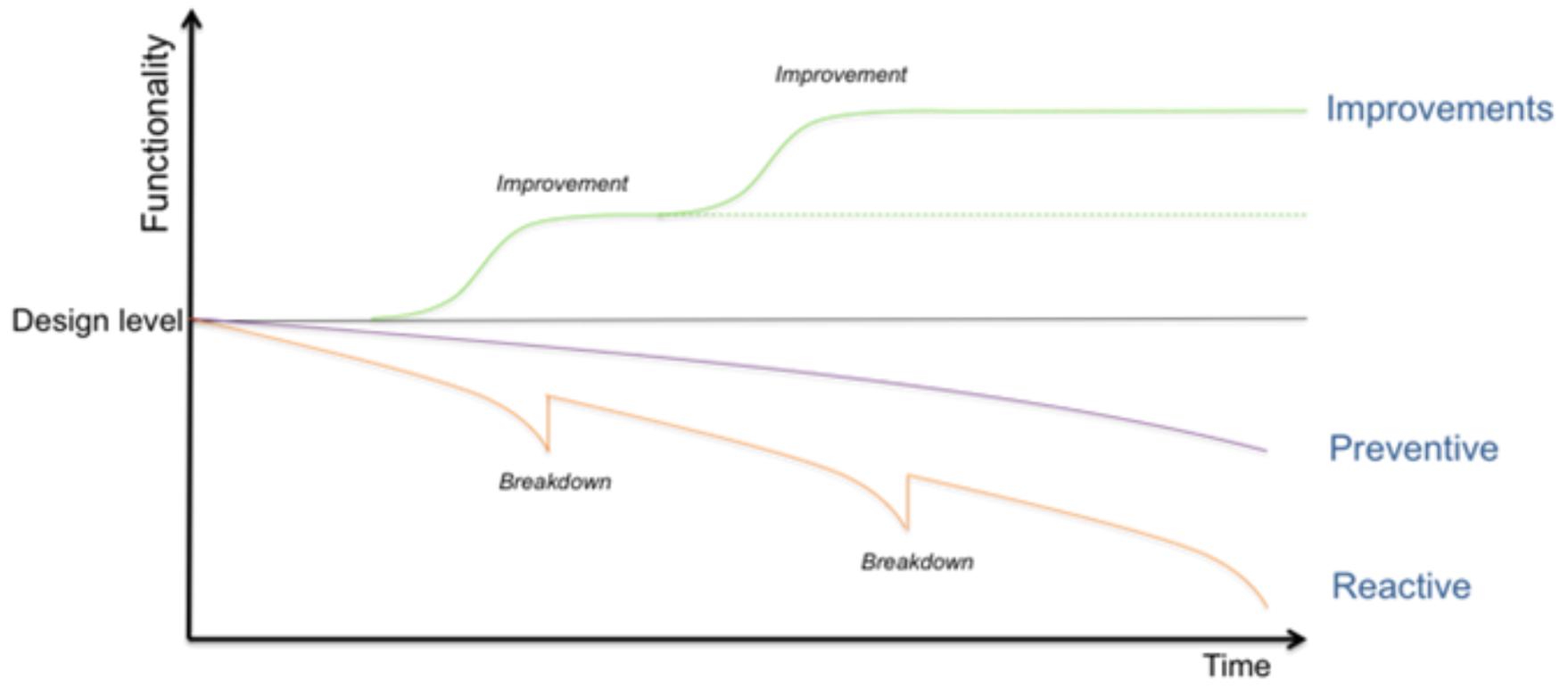
Background

A Product-Service System can be defined as the result of an innovation strategy, shifting the business focus from designing and selling physical products only, to selling a system of products and services which are jointly capable of fulfilling specific client demands.

"user need is addressed more precisely" – Tim McAloone

Production service system as IPSS

- Production system is the product that manufacturing companies use

- Production system is a complex product with different discrete resources

- Production services are high in demand to run the production system effectively

- Production services could include preventive and reactive maintenance, design changes, reuse, replacement, and upgrades

Background

- Throughput increase in industries is of high importance
- Previous study shows 5% increase in throughput by prioritizing throughput bottleneck machines on maintenance work orders

In literature,

- Different criticality assessment such as FMECA, CBC, AHP, etc.
- Prioritizing maintenance using priority codes based on criticality – bottleneck, specific component, productivity, etc

Research Question

RQ1: To what extent are companies working with criticality classification?

RQ2: What is criticality from a maintenance perspective, and how are critical resources identified?

RQ3: To what extent are maintenance activities prioritized, and how are the criticality classification used for this purpose?

Quantitative & Qualitative method

Survey:

- Quantitative web-based survey targeting maintenance and production experts

- 82 respondents from 71 different companies in Sweden

Maintenance Fair:

- Seven structured interviews during maintenance fair

- Randomly selected respondents – maintenance experts from industry and consultancy firms
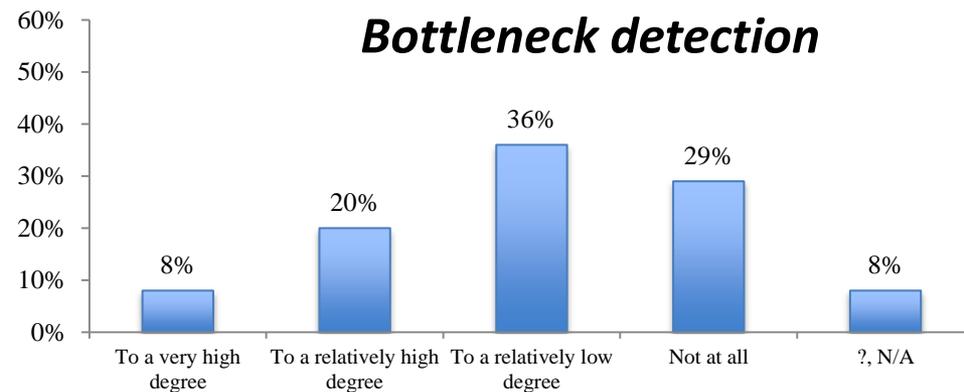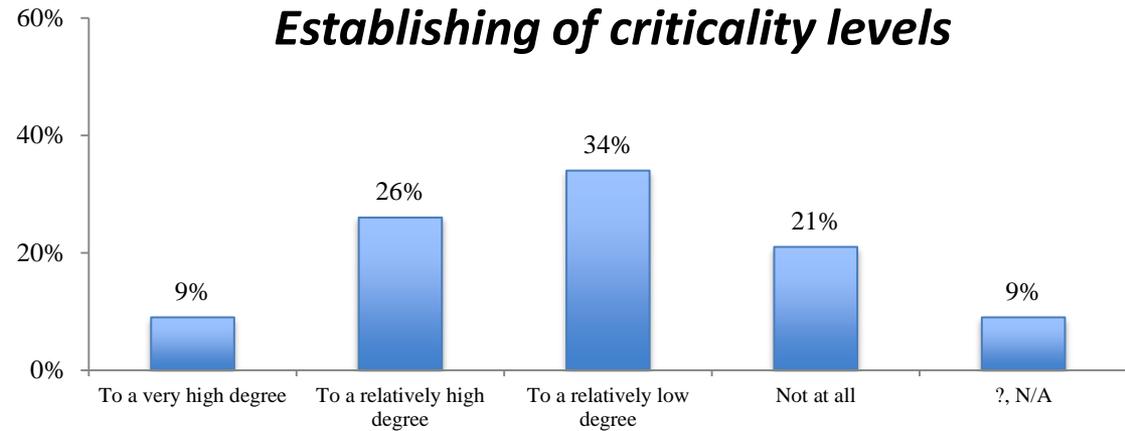
Interviews:

- Semi-structured face-to-face interviews as part of StreaMod research project

- 3 – maintenance manager & 1 – maintenance strategist respondents from large multi-national corporations

Data analysis

- Descriptive research approach

- Quantitative data – SPSS

- Qualitative data – Content analysis

RQ1: To what extent are companies working with criticality classification?

- Survey

  ✓ Majority companies working with criticality classification also continuously updates criticality levels

Establishing of criticality levels

Bottleneck detection

RQ1

Maintenance fair:

- 4 out of 7 indicated working with bottleneck detection

Interviews:

- All work with establishing criticality levels
  - 1st interviewee: Equipment priority numbers created when new machines are installed
  - All others: Criticality classification as part of technical classification during early project phase
- All said bottleneck detection being performed
  - 1st interviewee: both short term and long term bottlenecks based on data and meetings
  - 2nd interviewee: detection is based on facts and data
  - 3rd interviewee: production engineers are responsible for bottleneck detection
  - 4th interviewee: VSM to detect bottleneck conducted by production and maintenance personnel

Survey:

Table 1. Basis for establishing criticality levels.

Primary basis for criticality levels	n	%
ABC-classification	23	30%
Operator influence	8	11%
Bottleneck analysis	7	9%
Cost-based priority	5	7%
Time of purchase	4	5%
Other basis	9	12%
Do not know/ "N/A" /Missing answer	20	26%

Maintenance Fair:

- All respondents pointed to ABC-classification

RQ2: What is criticality from a maintenance perspective, and how are critical resources identified?

Interviews:

- All 4 pointed to ABC-type classification
  - 1st interviewee: 1-5 numbered equipment priority; other exact ABC classification
- All answered differently on how classifications are set
  - 1st & 4th interviewee: priority codes are dependent on the production set-up and ABC codes for single line, parallel machine
  - 2nd Interviewee: component level based on risk analysis
  - 3rd interviewee: based on safety, productivity, environment, etc

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RQ2: What is criticality from a maintenance perspective, and how are critical resources identified?

- Critical machine question prompted random answers
 - All mentioned bottleneck after deep enquiry

"It's really difficult for me to point out one that is critical [...] Critical for me is focus. I mean it's not always the machines. It's the people around it"

"if you look at the assembly line from an overall perspective, then that is very critical. If we get a stop here, it always affects the end customer directly"

"The layout is very unfortunate and the parts move back and forth making it hard to understand the flow and analyse the losses"

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RQ2: What is criticality from a maintenance perspective, and how are critical resources identified?
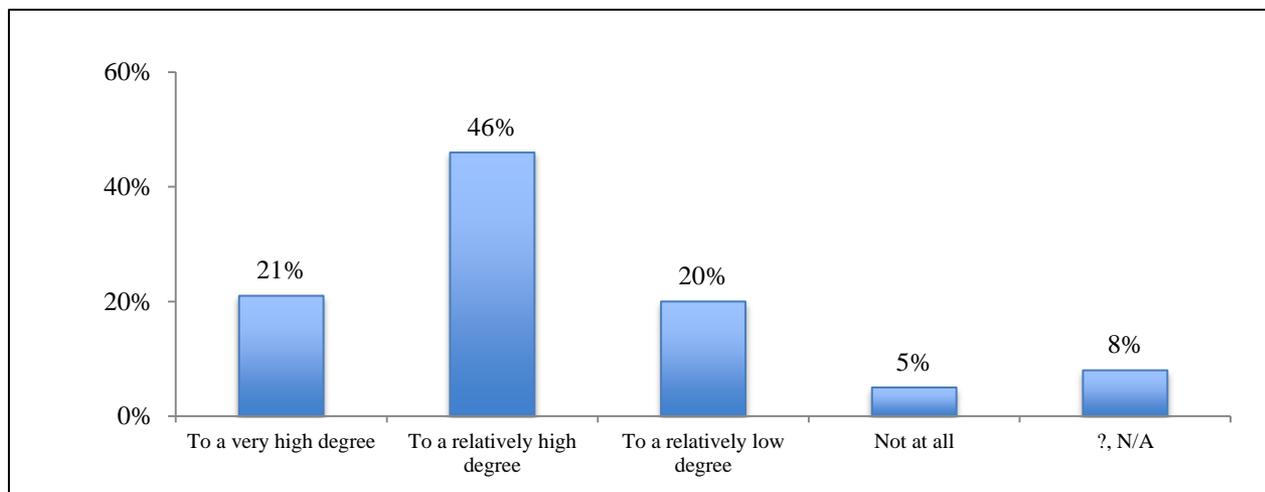
- Confidence on the bottleneck and critical resource
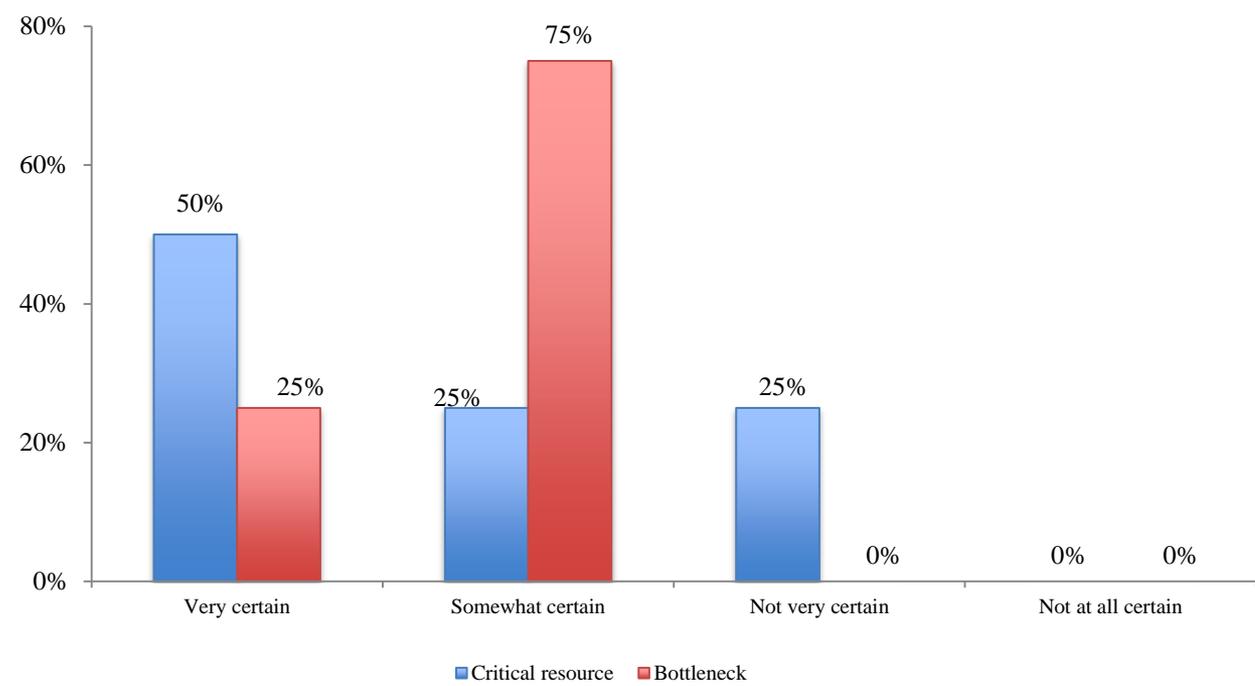
RQ3: To what extent are maintenance activities prioritized, and how are the criticality classification used for this purpose?

- Survey

Prioritizing work orders

- Maintenance fair:
  - 4 out of 7 use fixed priorities
  - 2 out of 7 use continuously updating priorities

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RQ3: To what extent are maintenance activities prioritized, and how are the criticality classification used for this purpose?

Interviews:

- All agreed on prioritizing maintenance work orders
  - 1st interviewee: equipment priority routine
  - 2nd interviewee: "*what is crucial for us right now*"
  - 4th interviewee: logistics department sets a plant or line priority
- Reactive maintenance prioritization largely situation dependent
  - 1st interviewee: Maintenance technician combines how situation looks along with priority number. Uses alarms, where severity of the alarm decides calling an operator
  - 3rd interviewee: Similar alarms used, person creating work-orders decides alarms

"For reactive maintenance work orders, it is up to each maintenance technician to prioritize"

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RQ3: To what extent are maintenance activities prioritized, and how are the criticality classification used for this purpose?

- Regarding preventive maintenance
    - 1st interviewee: combine the equipment priority with maintenance priority
    - All others: "*We have special windows within production where we stop the production*"

- 3 interviewees pointed criticality classification not used in prioritizing maintenance

"If we use the criticality classification for prioritizing? Hmm, I don't know… The people who are running around have pretty good awareness of the equipment, and they know what's critical and not. So that's pretty much how we control and plan"

"we find a way to attack our already critical equipment, make them less critical and the most important"

RQ3: To what extent are maintenance activities prioritized, and how are the criticality classification used for this purpose?

- Regarding bottleneck usage in maintenance planning
  - 1st interviewee: clear connection on how bottleneck being used for planning purpose. Identified long-term bottlenecks and spend more maintenance hours in them. ABC alarms are based on short-term bottlenecks
  - 4th interviewee: VSM based bottleneck is used to ensure they spend time on the right machine
  - 2nd interviewee: do not work with bottlenecks
  - 3rd interviewee: bottlenecks are for production related and not performed by maintenance

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Discussion

- RQ1:To what extent are companies working with criticality classification?
  - Few companies works with criticality classification
  - Companies working with criticality classification also update their classification
  - Majority companies worked with bottleneck detection
  - However, interviews from major corporation showed all worked with both criticality classification and bottleneck detection

Discussion

- RQ2*:* What is criticality from a maintenance perspective, and how are critical resources identified?
  - All criticality analyses in literature are created based on overall system perspective
  - Similarly, results from this study shows system perspective on their criticality analysis
  - All 3 sources pointed towards ABC classification
  - Despite this, it was ambiguous to point what a critical resource is. No connection with criticality classification
  - Further explanation resulted in 2 interviewees saying bottlenecks can be perceived critical
  - Evidently, interviews were not 100% certain about their critical and bottleneck machines

Discussion

- RQ3: To what extent are maintenance activities prioritized, and how are the criticality classification used for this purpose?

  - Majority prioritize maintenance work-orders
  - However, priorities did not come from criticality classification or the critical resource
  - Instead, priorities are set by the one who creates work orders
  - Good example: Interviewee 1, clear connection between criticality classification and setting priorities for maintenance. Also clear connection between bottleneck being used for creating priorities

Conclusion

- Current state maintenance planning of industries
- It covered, includes finding critical resource, how are they classified, and the gap between criticality classification and maintenance planning

Summary,

- Overall, criticality classification is not extensively used
- Industries use ABC-type approach
- Term critical resource is vague in industry and is not connected to criticality classification
- Most industries prioritize maintenance, however criticality classification and bottlenecks are seldom used
- These are the inputs in developing production service system