


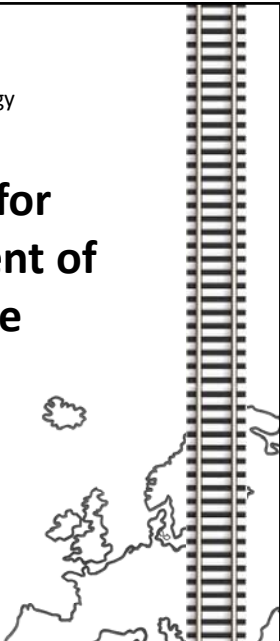
17th Nordic Seminar on Railway Technology



Link and Effect Model for Performance Improvement of Railway Infrastructure




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Luleå University of Technology, Sweden
2012 – 10 – 03





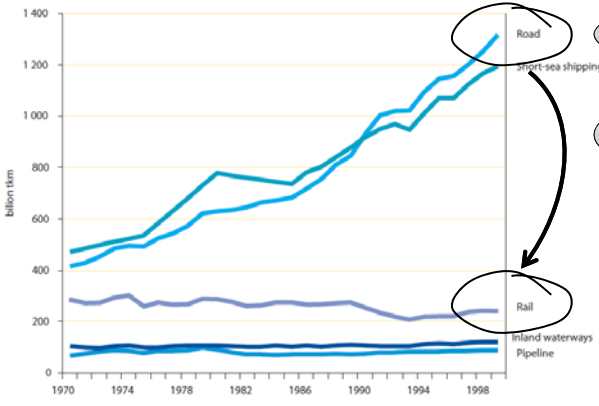
Luleå Railway Research Center

Division of Operation, Maintenance and Acoustics

Introduction

Shift in transportation for the 21st century

Transport of goods in EU-15:

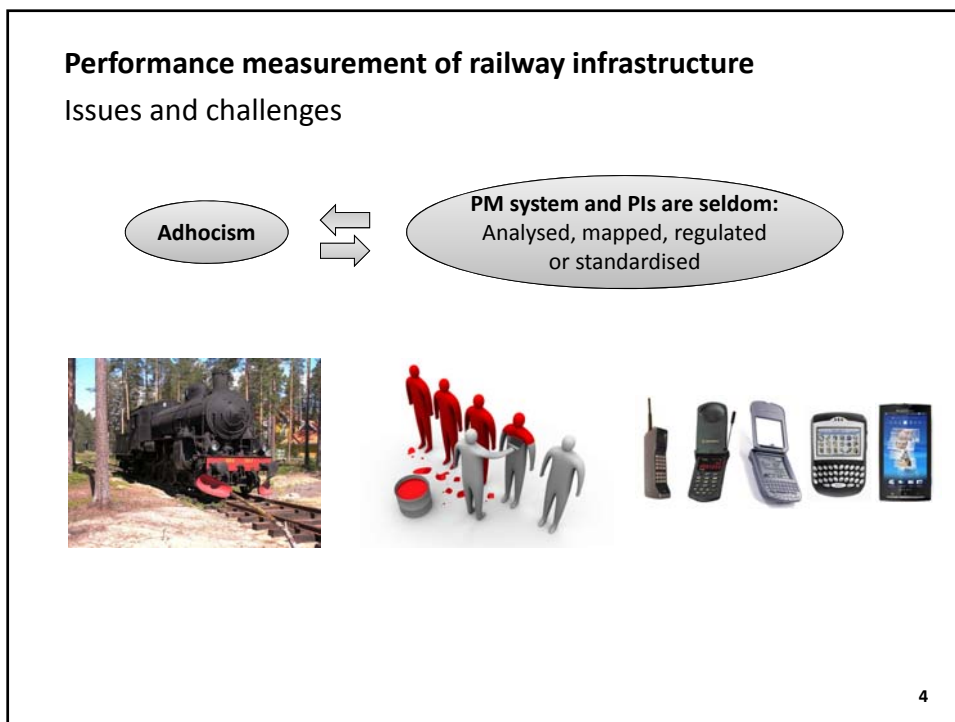
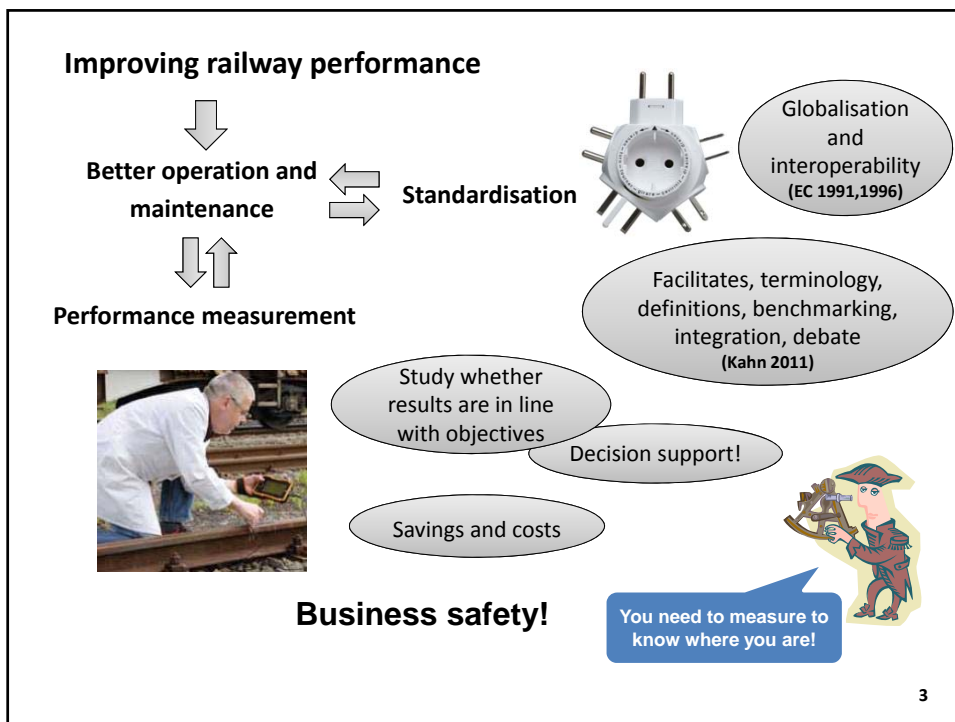


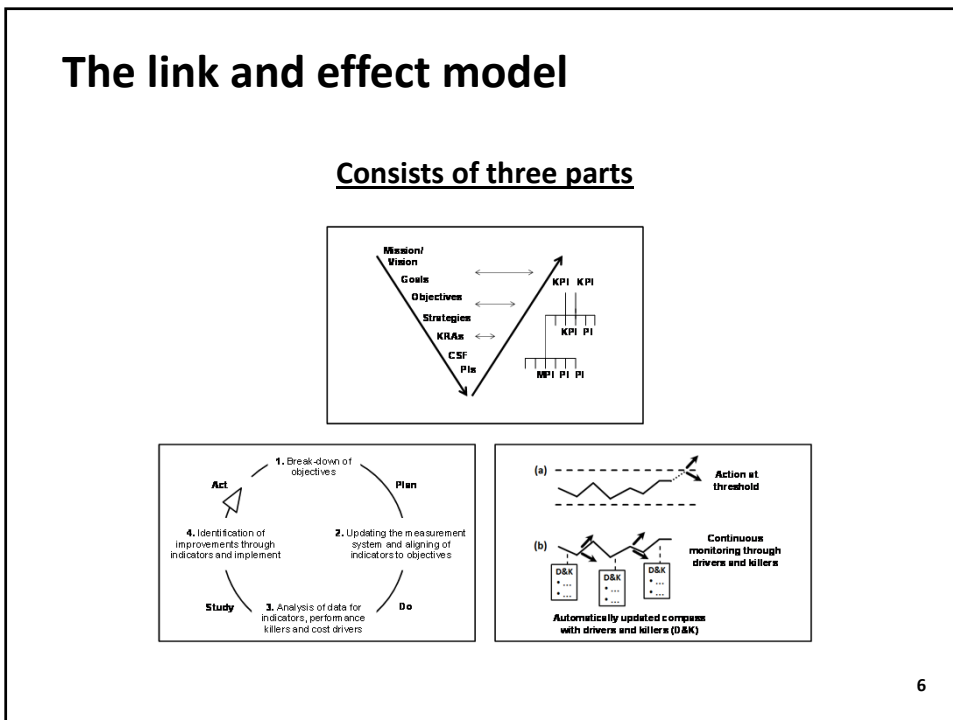
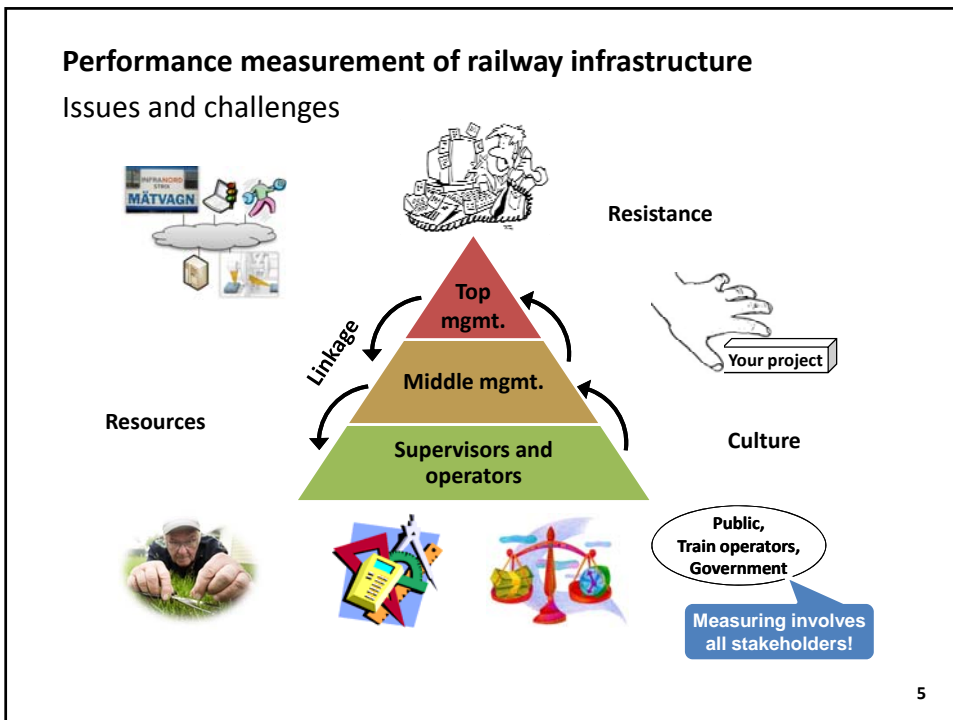
(EC Transport White Paper 2010)

- Congestion of roads and sky
- Safety
- Emissions
- Crude oil peak 2006 (IEA 2010)

Need to improve railway performance!

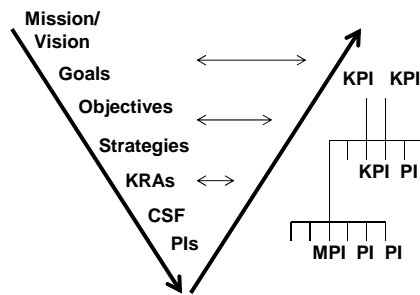
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The link and effect model

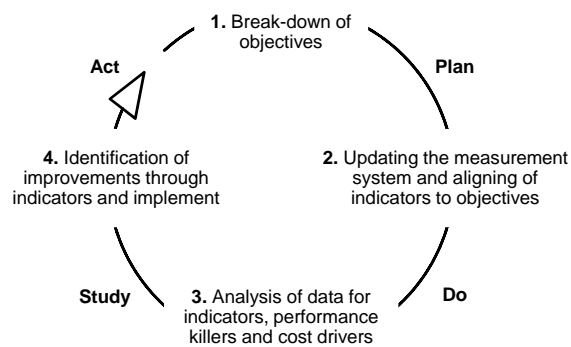
Top-down and bottom-up:



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The link and effect model

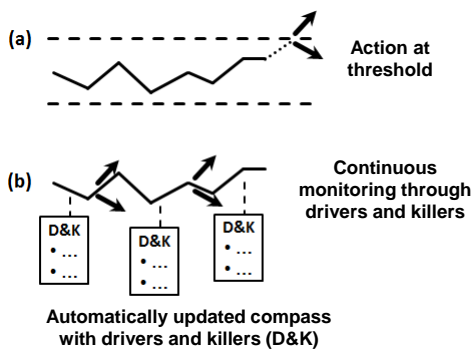
Four step continuous improvement:



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The link and effect model

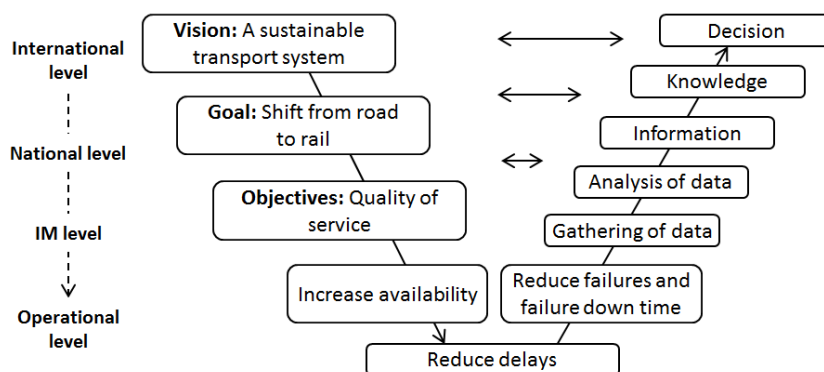
Emphasis on the underlying factors:



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Case study

Step 1: Break-down of objectives



(In agreement to: IEV 60050-191 and EN 50126)

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Case study

Step 2: Updating the measurement system and aligning indicators

Indicators from previous work:

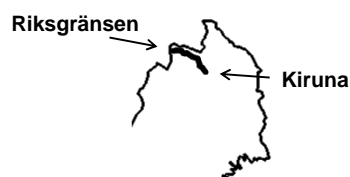
- **Failures or work orders** (in total, per item, track-km or train-km)
- **Train delay** (in total, per item, track-km or train-km)
- **Punctuality** (per line, line class or area)

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Case study

Step 3: Analysis of data for indicators, performance killers and cost drivers

Kiruna – Riksgränsen (Bandel 111):



- 2001.01.01 – 2009.12.01
- Work order (WO) system (Ofelia)
- Train delay system (TFÖR)
- 7476 WOs, 1966 WOs with delays, i.e. 26 %
- 166 693 min train delay

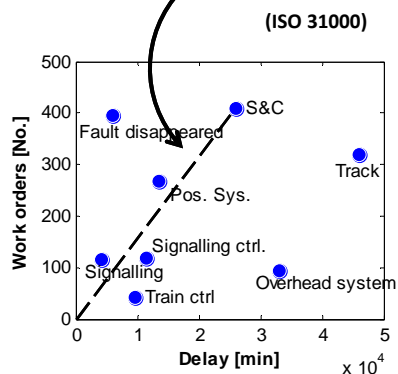
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Case study

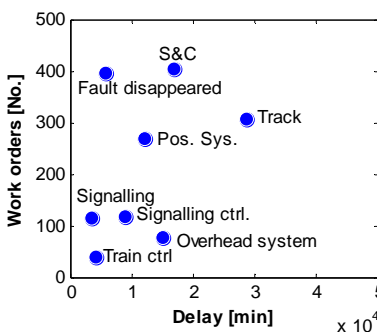
Step 3: Analysis of data for indicators, performance killers and cost drivers

System level: Length = measure of risk

All data:



98th percentile:

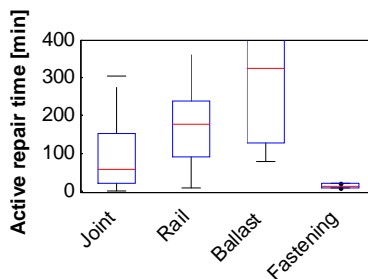
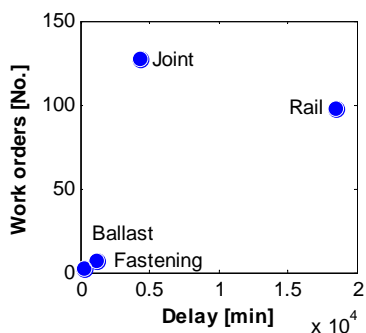


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Case study

Step 3: Analysis of data for indicators, performance killers and cost drivers

Track subsystem/component:



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Case study

Step 3: Analysis of data for indicators, performance killers and cost drivers

Risk ranks:

1926 WOs, 112 616 min delay

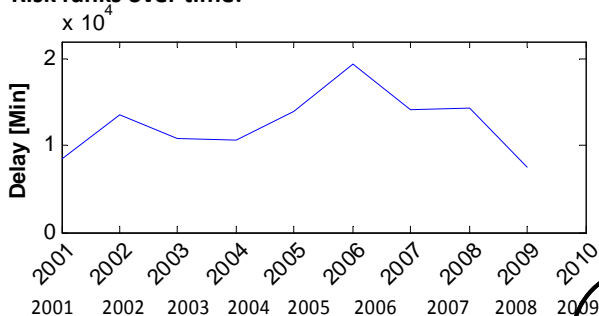
	WOs [No.]	Delay [Min]	Risk rank
System			
S&C	404 (21%)	16880 (15%)	438
Track	308 (16%)	28590 (25%)	420
Subsystem			
S&C: Ctrl sys.	91 (4,7%)	3069 (2,7%)	96
S&C: Motor sys.	78 (4,0%)	2724 (2,4%)	83
Track: Joints	127 (6,6%)	4325 (3,8%)	134
Track: Rail	98 (5,1%)	18470 (16%)	209
Component			
S&C: Connector	37 (1,9%)	989 (0,9%)	38
S&C: Point drive	53 (2,8%)	1898 (1,7%)	56

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Case study

Step 3: Analysis of data for indicators, performance killers and cost drivers

Risk ranks over time:



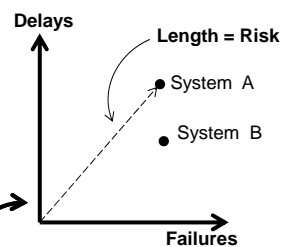
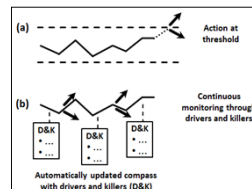
A:	35	B:	96	B:	68	A:	38	D:	59	D:	150	D:	102	D:	64	A:	42
B:	28	A:	32	A:	47	B:	44	A:	57	B:	78	A:	77	A:	51	D:	24
C:	21	C:	30	C:	46	C:	29	C:	43	A:	63	C:	29	C:	40	C:	20

A: Switches and crossings

C: Positioning

B: Track

D: Fault disappeared

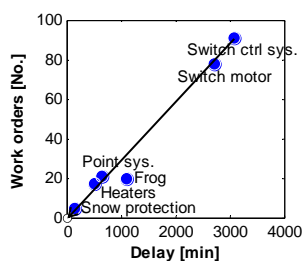


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Case study

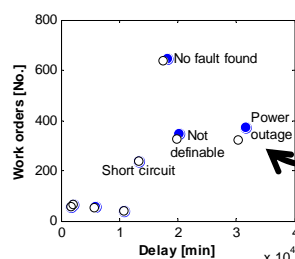
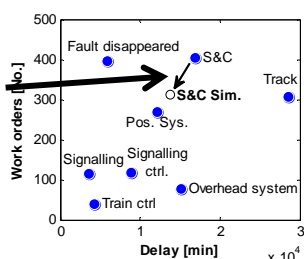
Step 4: Identification of improvements through indicators and implement

Real data simulation:
Zero failures in the
switch control system



Effect on the system level:

S&C risk rank
Old: 438
New: 342



Considerably
less WOs on
"Power outage"

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Conclusions

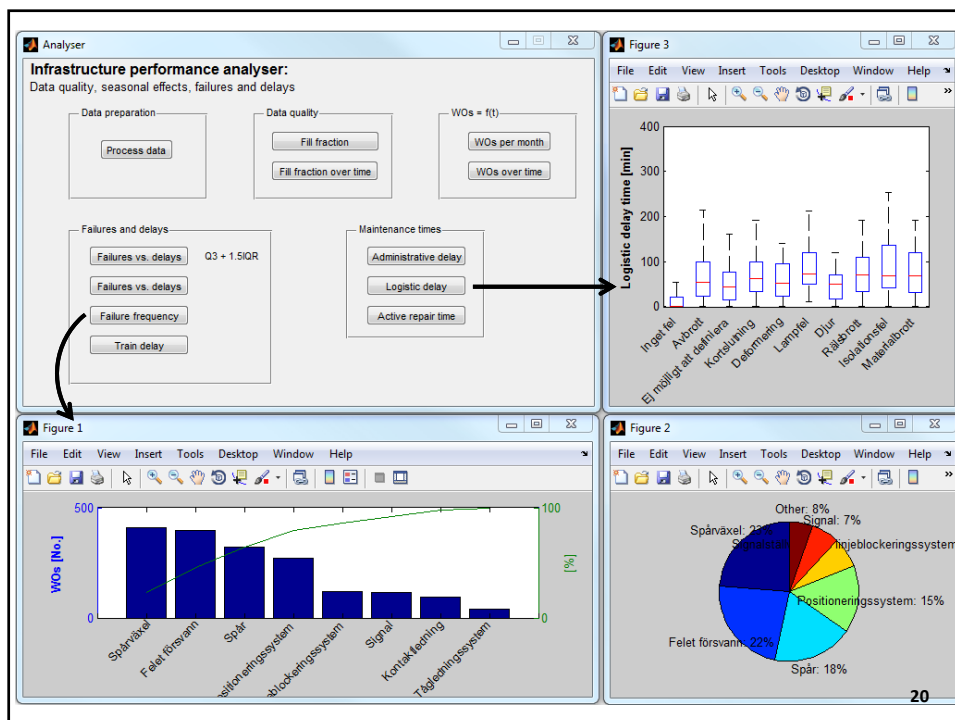
- A link and effect model is developed as a four step continuous improvement process for the railway IM
- Algorithms are developed to analyse railway infrastructure systems and components in terms of risk ranks, which is validated in a case study on a specific railway section
- Simulations are carried out by making changes in the failure data of subsystems and components to study the effect on the railway infrastructure at the system level

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Scope for further research

- Implementation of link and effect model for IMs and their further improvements
- Further develop methodologies and algorithms for linking objectives and indicators, e.g. work orders, train delay, corrective and preventive maintenance

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Thank you!

Questions?

Acknowledgement to:

 **TRAFIKVERKET**




   **Luleå Railway Research Center**

INVITATION TO RAILWAY WORKSHOP on 12 December 2012


During

International Workshop & Congress eMaintenance 2012
12-14 December 2012, Luleå

Theme: eMaintenance Challenges for Railway

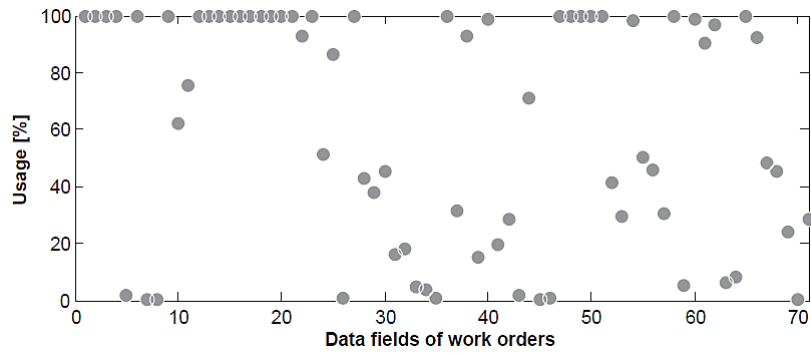
Topics to be discussed:

1. Data Harvesting
2. Data presentation
3. Data to decision example

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Analysis of WOs and train delay data

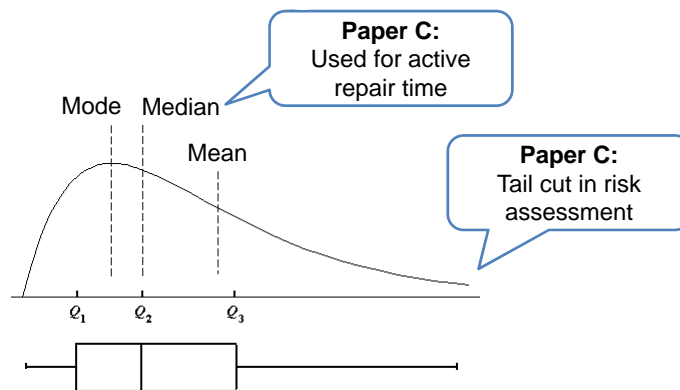
Data quality



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Data quality

Distribution of maintenance times and train delays



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