Analysis of railway accidents using the „Why-Because Analysis“

Deutsche Bahn AG

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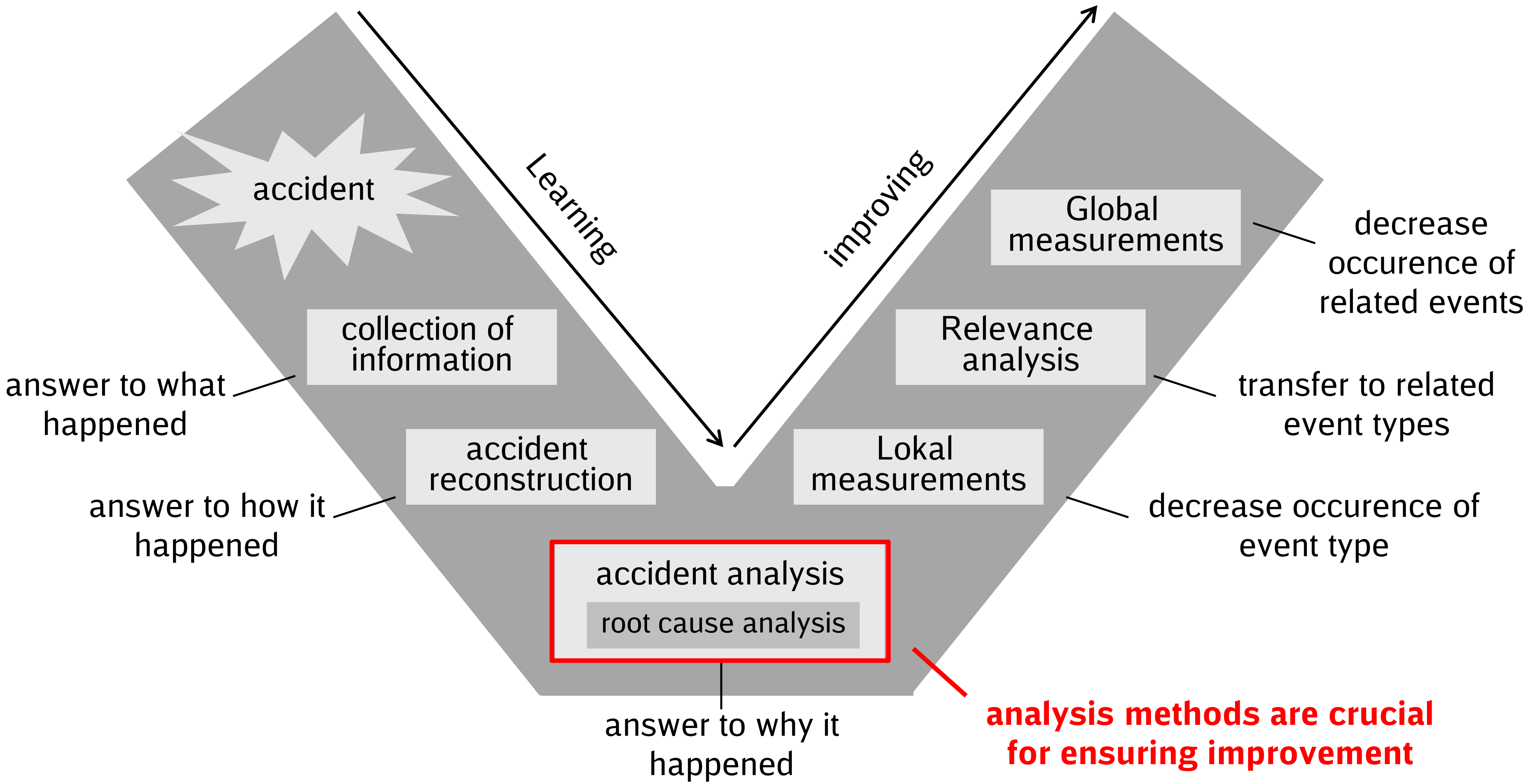
Accidents can only lead to improvements when we understand why something happened

V-model of accident investigation



An analysis method should provide a standard procedure, completeness and objectivity

Main threats in accident analysis

- quality of analysis depending on quality of analyst
- monocausal thinking
- direction of analysis and presentation of result influenced by (political) interests

main requirements for analysis method

- standard analyzing procedure
- completeness - identificaiton of all the root causes
- objectivity – unaffected to questions of „who is to blame“ or political interests

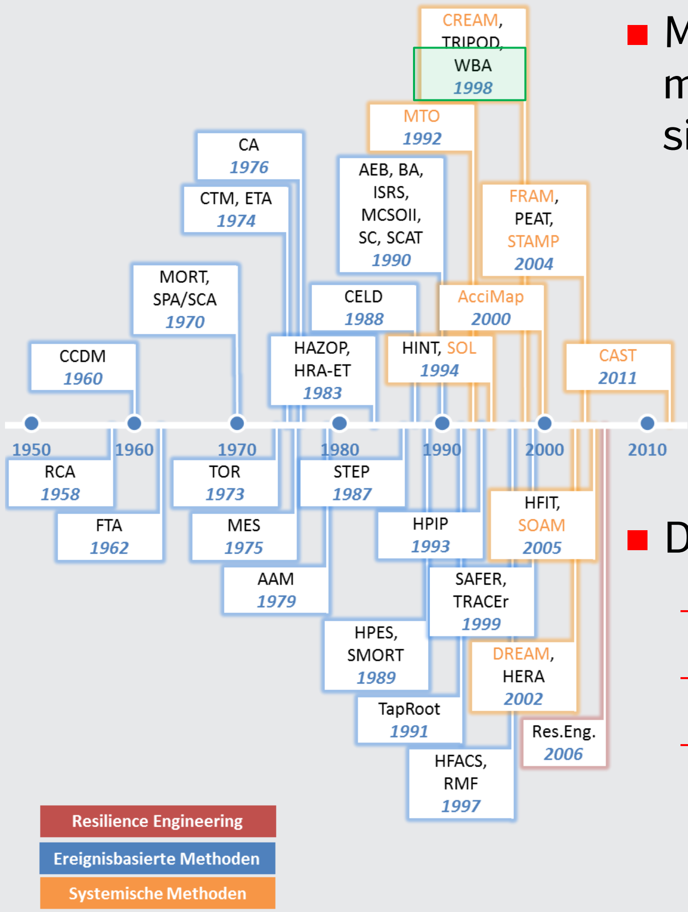
agenda of presentation

1. methods in accident analysis
2. introduction of Why-Because Analysis
3. analysis example using Why-Because Analysis
4. evaluations and conclusions

Why-Because Analysis was chosen out of many methods by benchmark analysis

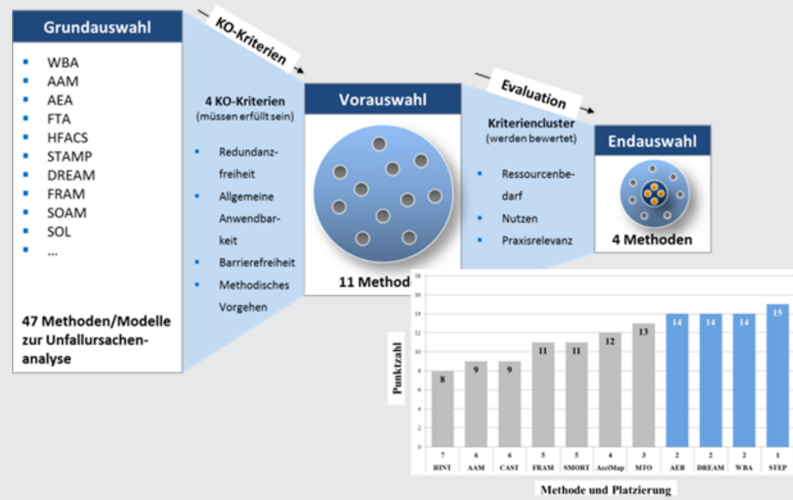
1 methods in accidents analysis

Multitude of Methods



- More than 40 methods developed since 1950
- Different approaches
  - event based
  - systemical
  - resilience engineering

Benchmark



- benchmark of analysis methods (focus on railway accidents)
- preselection of 11 out of 47 methods
- detailed evaluation shows best fit for 4 methods
- best fitting to requirements: **Why-Because Analysis (WBA)**

Why-Because Analysis focuses on cause and effect relations providing logical test questions to ensure completeness

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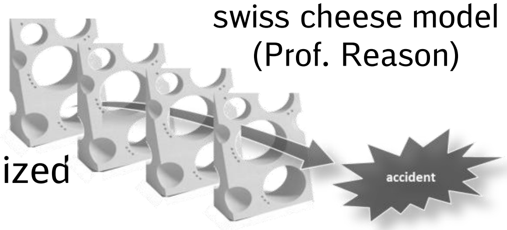
② introduction of WBA

Why-Because Analysis – short overview

Approach

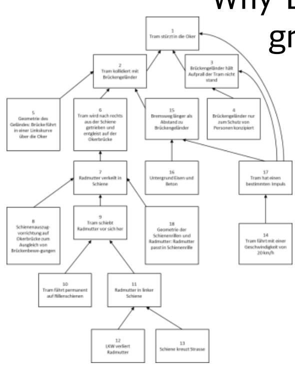
- accidents are caused by a combination of factors or conditions (similar to swiss cheese model)
- causal connections between the factors are analysed and visualized



swiss cheese model (Prof. Reason)

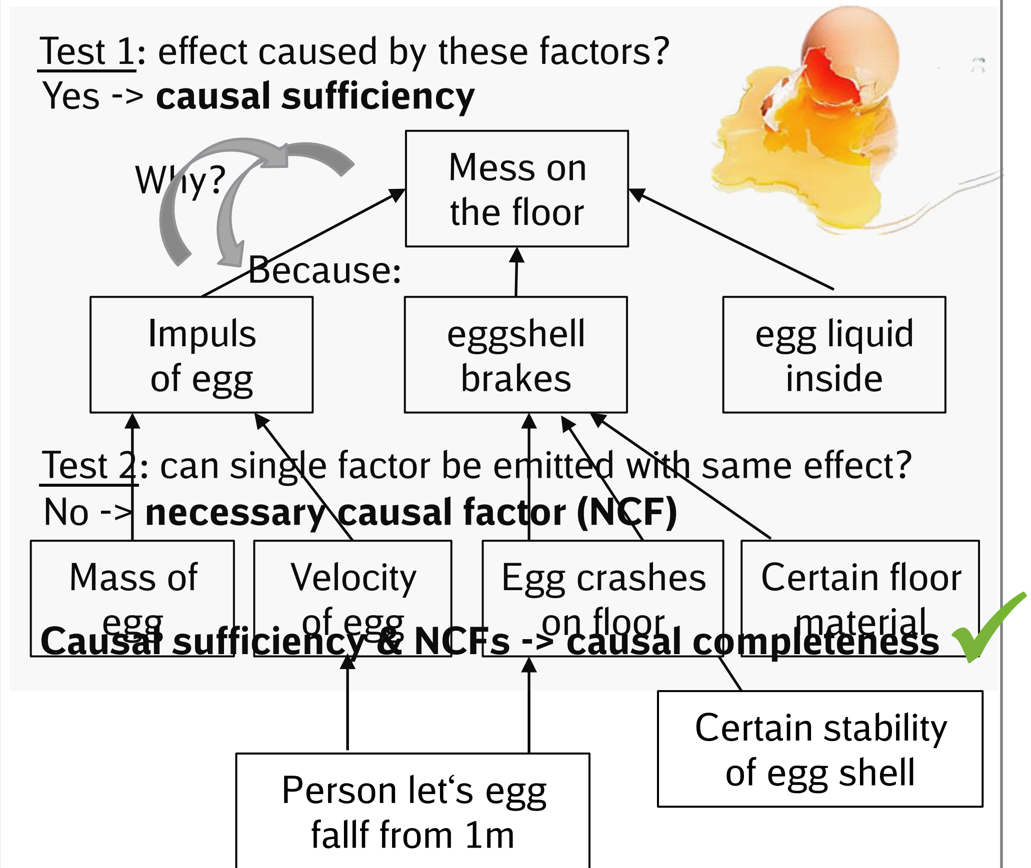
Analysis

- up to required analysis-depth (-> root causes)
- formal test (test questions) make sure of correctness of analysis
- Result: Why-Because graph („cause and effect graph")



Why-Because graph

Example



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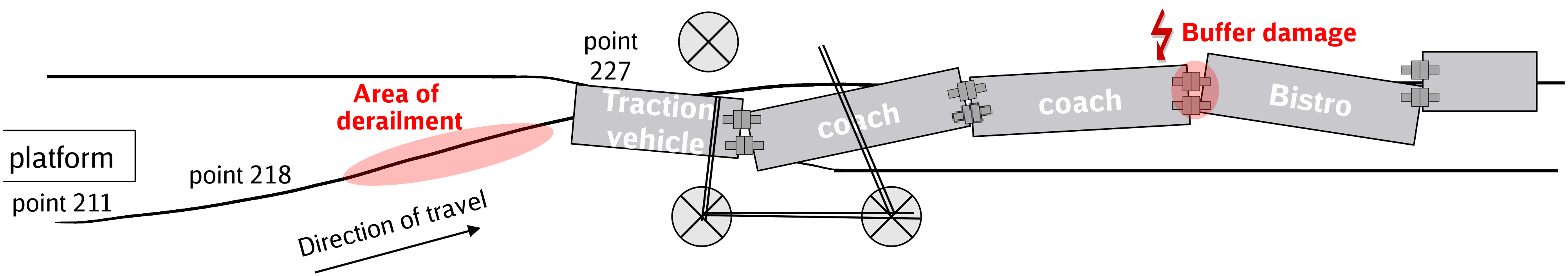
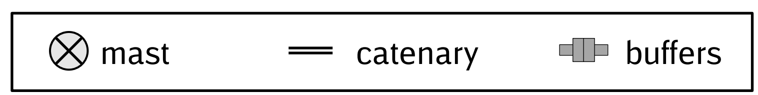
Why-Because Analysis analysis example:
Derailment of InterCity train exiting Stuttgart main station

3 WBA – analysis example

process of InterCity-derailment
- InterCity leaves platform in push-operation
- speeds up to ca. 38 km/h
- passes three points of various radius (S-curve 300m-190m-190m)
- traction vehicle and three last coaches derail within S-curve
- 5 people slightly injured & major damage

additional facts
- buffer damage
- Two more derailments with very similar circumstances (IC push-operation in S-curve Stuttgart main station)





All parameters were within regulations – no simple single cause explanation possible

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3 WBA – analysis example

topic	parameter (excerpt)	within regulations?
infrastructure	condition of points and tracks	✓
	track geometry (radius combination in S-curve)	✓
vehicle	buffer geometry, material, maintenance etc.	✓
	vehicle condition (maintenance history, etc.)	✓
operation	force in push-operation	✓
	Velocity	✓
	local operation regulations	✓

Arising question:
„what was different from usual operation that could have caused the derailment?“

Analysis of journey data shows anomalies in acceleration of derailed trains

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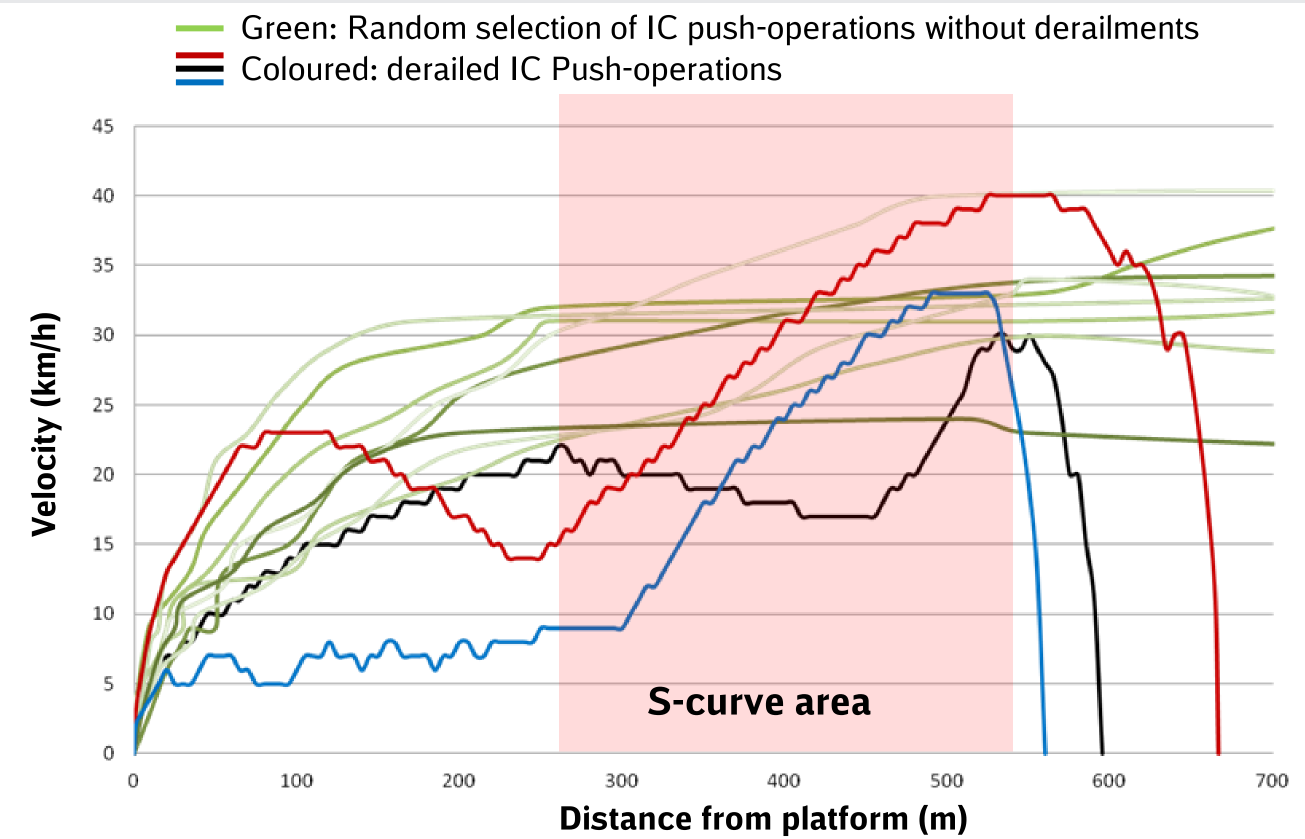
③ WBA – analysis example

Comparison of InterCity journey data in push-operation (same track in Stuttgart main station)



Observations

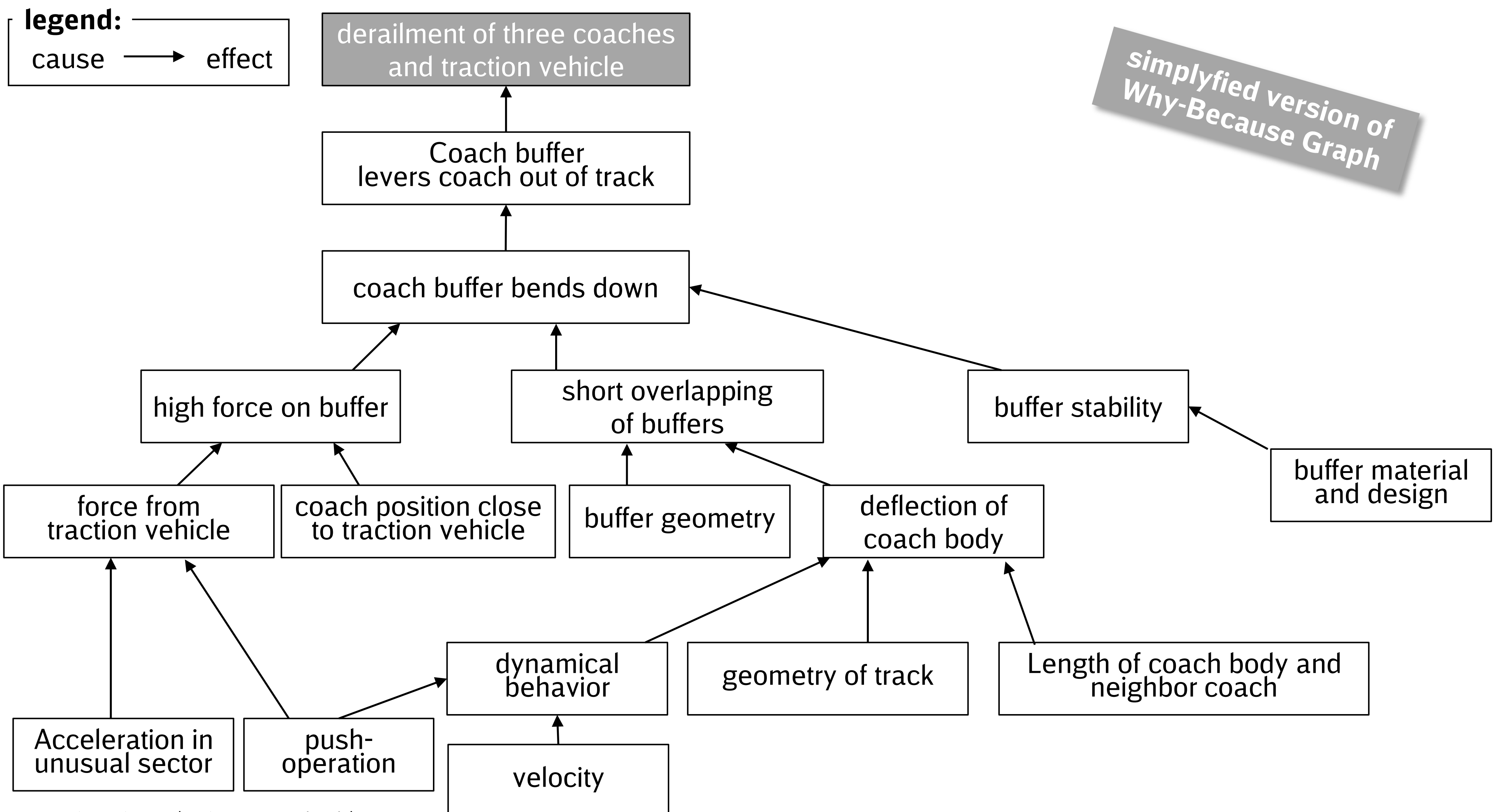
- IC push-operations with no derailment accelerate **before entering S-curve**
- IC push-operation with derailments show similar **accelaration behavior in S-curve**

effects in S-curve

→ increased force on buffers in acceleration phase (see graphic)
→ shorter buffer overlapping
→ coach bodies function as oscillation arm
→ Dynamical behavior of coaches due to velocity and acceleration

Why-Because graph identifies all distributing causal factors

③ WBA – analysis example



The combination of 7 factors caused the derailment; for improvement these factors are possible fields of action

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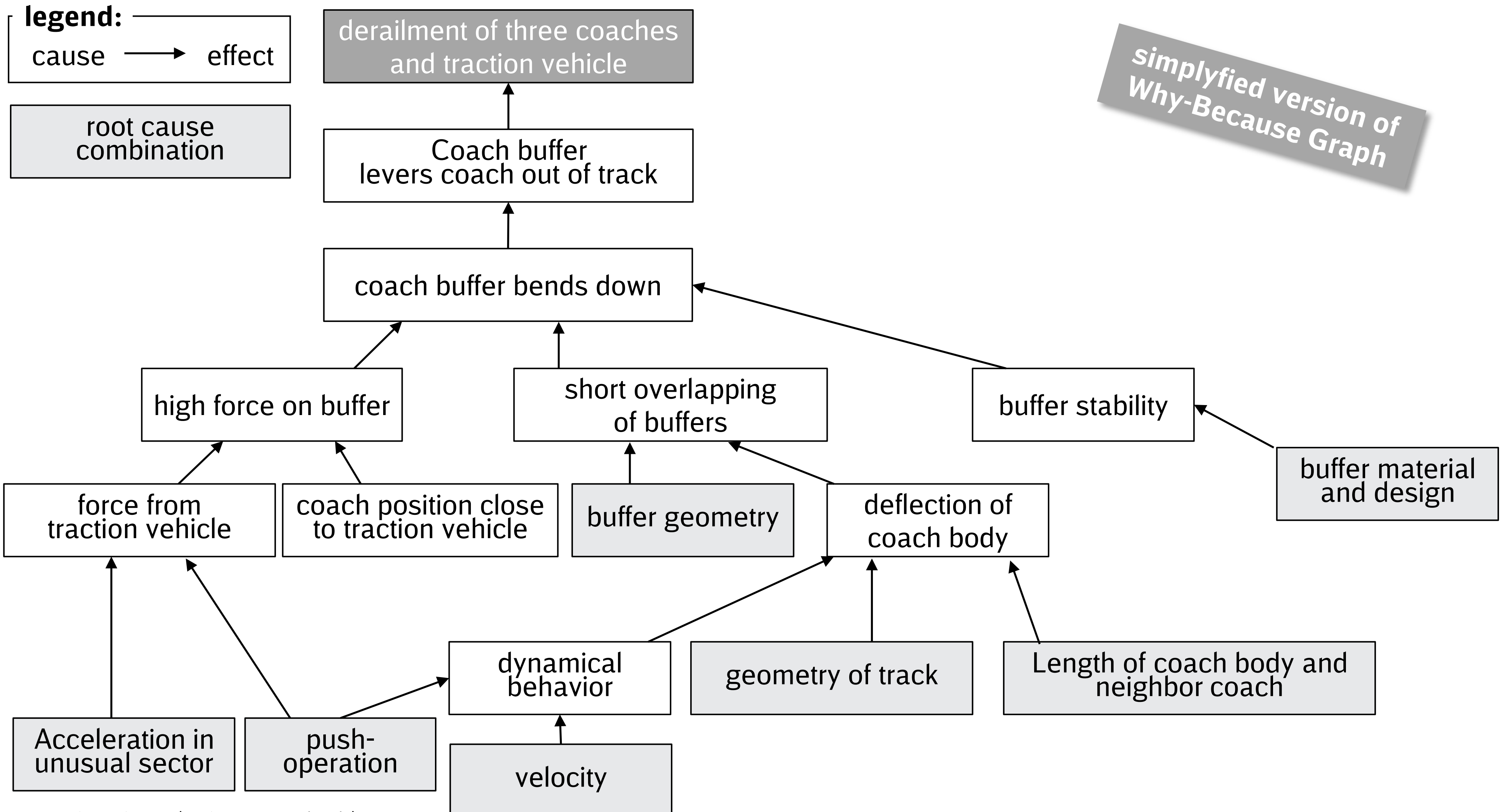
3 WBA – analysis example



Why-Because Analysis has great potential in railway accident analysis

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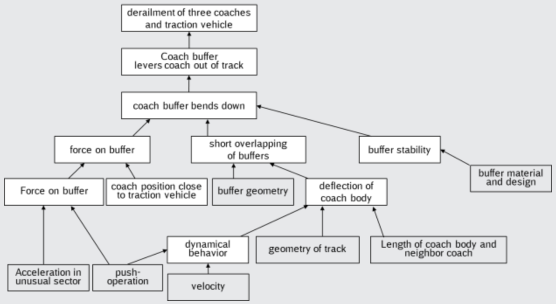
4 evaluations and conclusions

experience from example

- eliminated discussions about „who is to blame“
- efficient for internal communication
- helped to focus on relevant fields of action
- doesn‘t replace experience and expertise



evaluation and conclusions (approx. 15 real life cases)

requirements as stated above

- standard analyzing procedure
- completeness - identificaiton of all the root causes
- objectivity – unaffected to questions of „who is to blame“ or political interests

WBA requirement-evaluation

- provides standardized method ✓
- ensured by causal completeness tests ✓
- objective result: Why-Because graph ✓

conclusions

- further usage in upcoming cases
- potential to become standard part in accident analysis

Selection of railway accidents where a Why-Because Analysis was applied (mostly by scientific institutions)

Brühl (DE)
Derailment - 2000

- 9 dead
- 149 injured
- 50 Mio. DM damage

Eschede (DE)
Derailment - 1998

- 101 dead
- 88 injured
- 300 Mio. DM damage

Ladbroke Grove (UK)
Slanting collision - 1999

- 31 dead
- 523 injured
- High damage

Asta (NOR)
Frontal collision - 2000

- 19 dead
- High damage

Thank you very much for your attention!