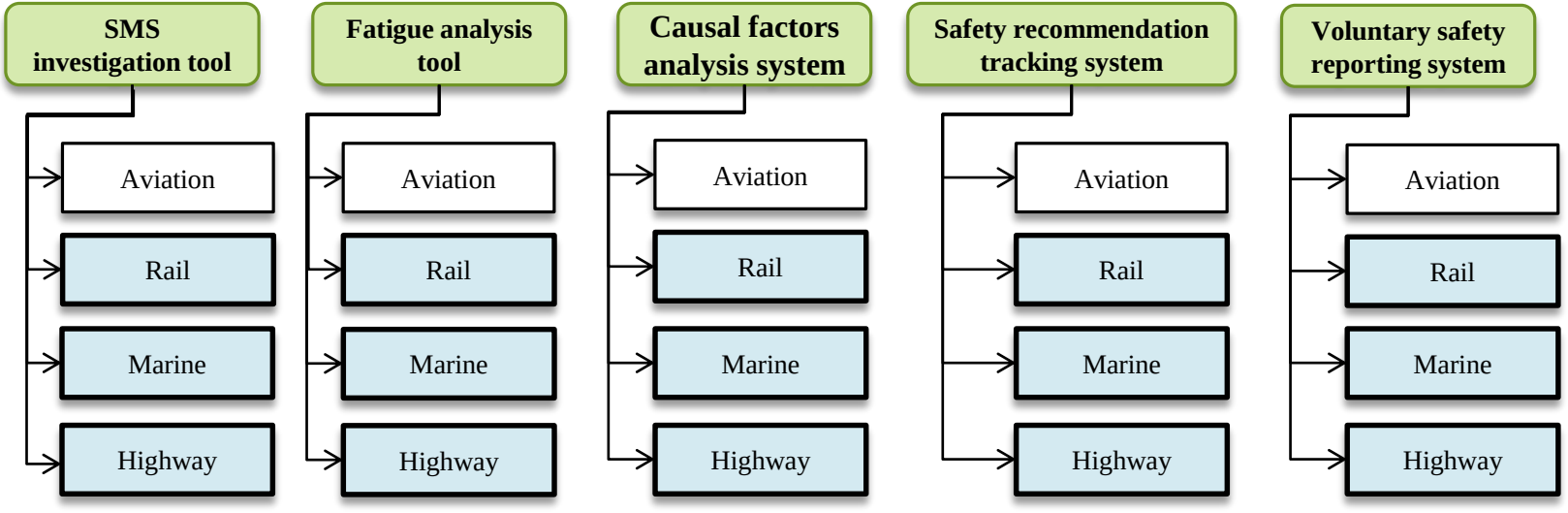
Tools for TTSB Transportation Occurrence Investigation

Board member/ TTSB
Yannian Lee
October 23, 2025

OUTLINE

- **TTSB investigation tools and systems**
- **Causal Factors Analysis System (CFAS)**
- **Safety Factors Map (SFM)**
- **Case example**

TTSB investigation tools and systems

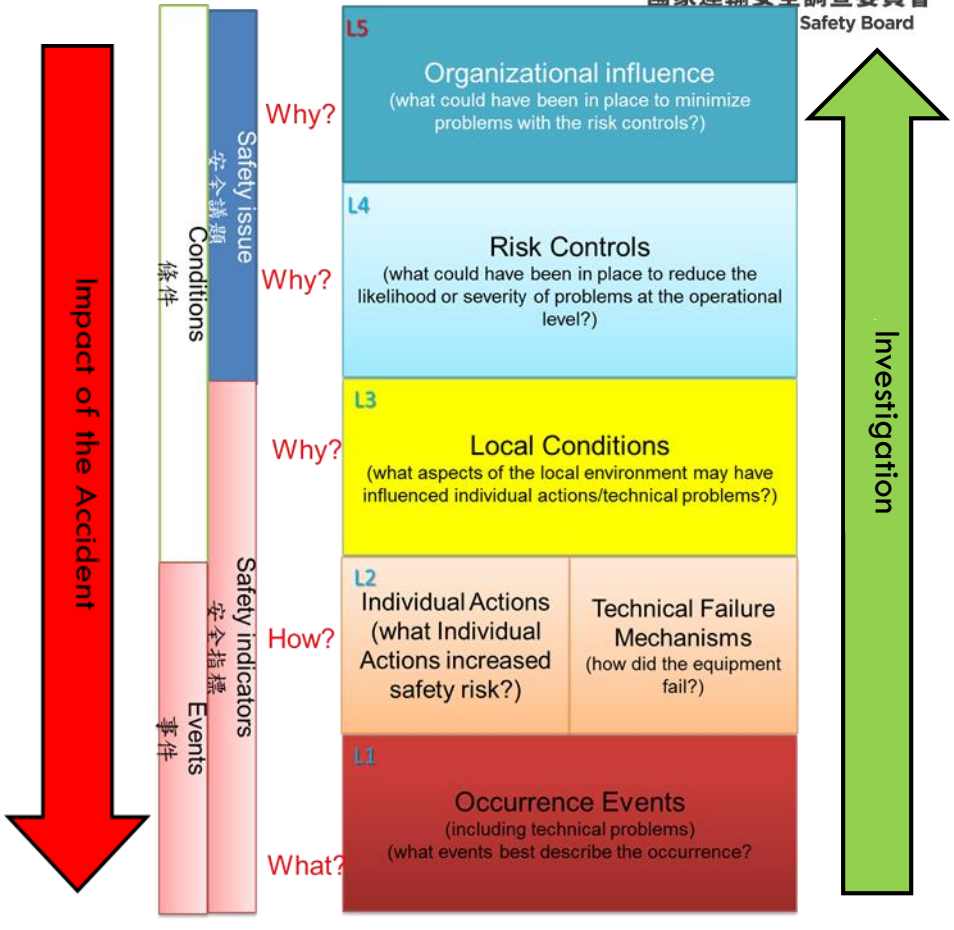


ASC established

TTSB established

Development of TTSB CFAS

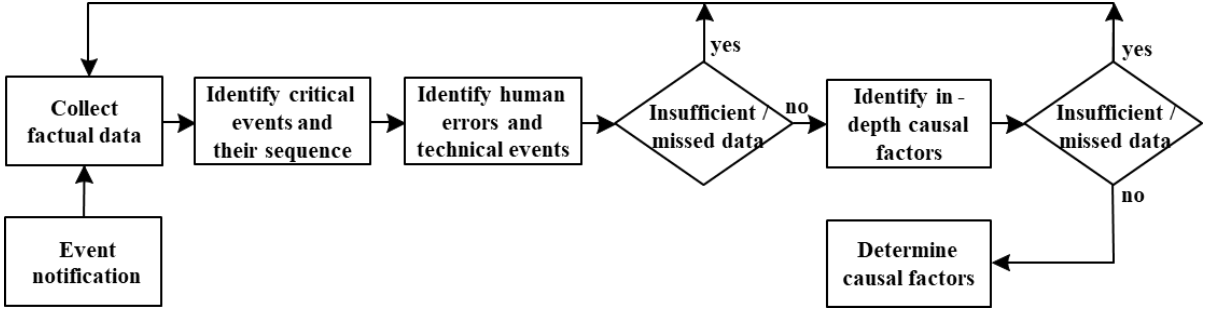
- CFAS was established by borrowing the ideas of ATSB's (AU) Safety Investigation Information Management System (SIIMS) and adding localized material in 2015 for ASC's aviation occurrence investigation. (Ref. 1, 2)
- CFAS framework is an extension of HFACS by adding a Technical Events category to classify causes resulted from human errors and mechanical failures. (Ref. 3, 4)
- CFAS was extended to marine, highway, railway modules for occurrence investigation after 2020.



CFAS framework

Functions of CFAS

- Workflow of CFAS

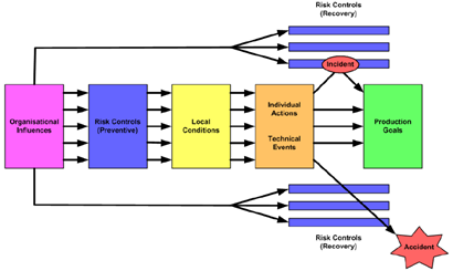


- Investigation progress control
- Documents storage and retrieval
- Investigation analysis (using SFM)
  1. safety factors at operational and organizational levels are clearly present
  2. analysis topics can be identified earlier, important safety issues will not missing
- Investigators have consistent standards to conduct investigation

SFM -- unique feature of CFAS

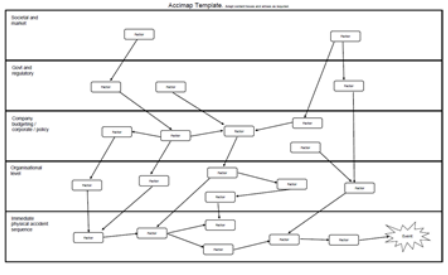
Taiwan TTSB 國家運輸安全調查委員會 Transportation Safety Board

- The bespoke TTSB SFM is a causal factors analysis tool adapted from ATSB's causal and influence diagrams of SIIMS, HFACS, and borrowed the ideas of Rasmussen's hierarchical 'Accimap', and Reason's accident causation model.

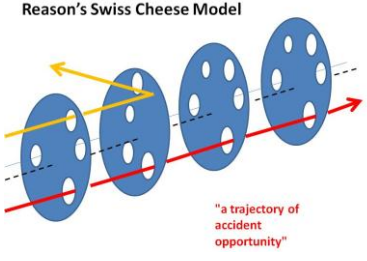


+

+

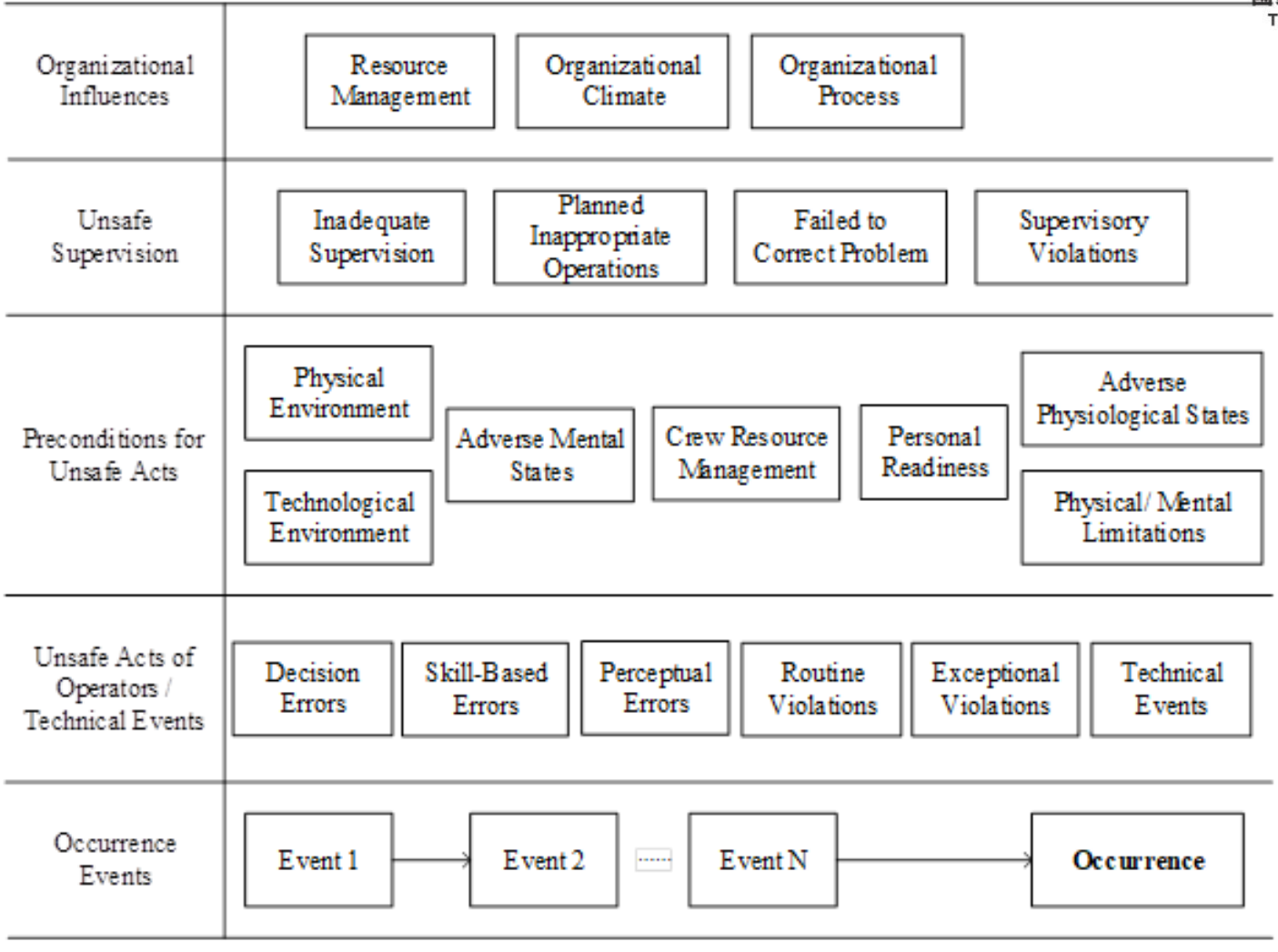


+



- The display of SFM shows logical relationships of consecutive sequential events and top down influences of causal factors at different levels.
- The connections of classified affecting factors present in the SFM can assist investigators to capture the analysis topics of occurrence investigation.

SFM coding form (Ref. 5, 6)



Case example

TRA's Train No. 408 accident at Qingshui Tunnel on Apr. 2, 2021, investigation report published by TTSB (Ref. 7)

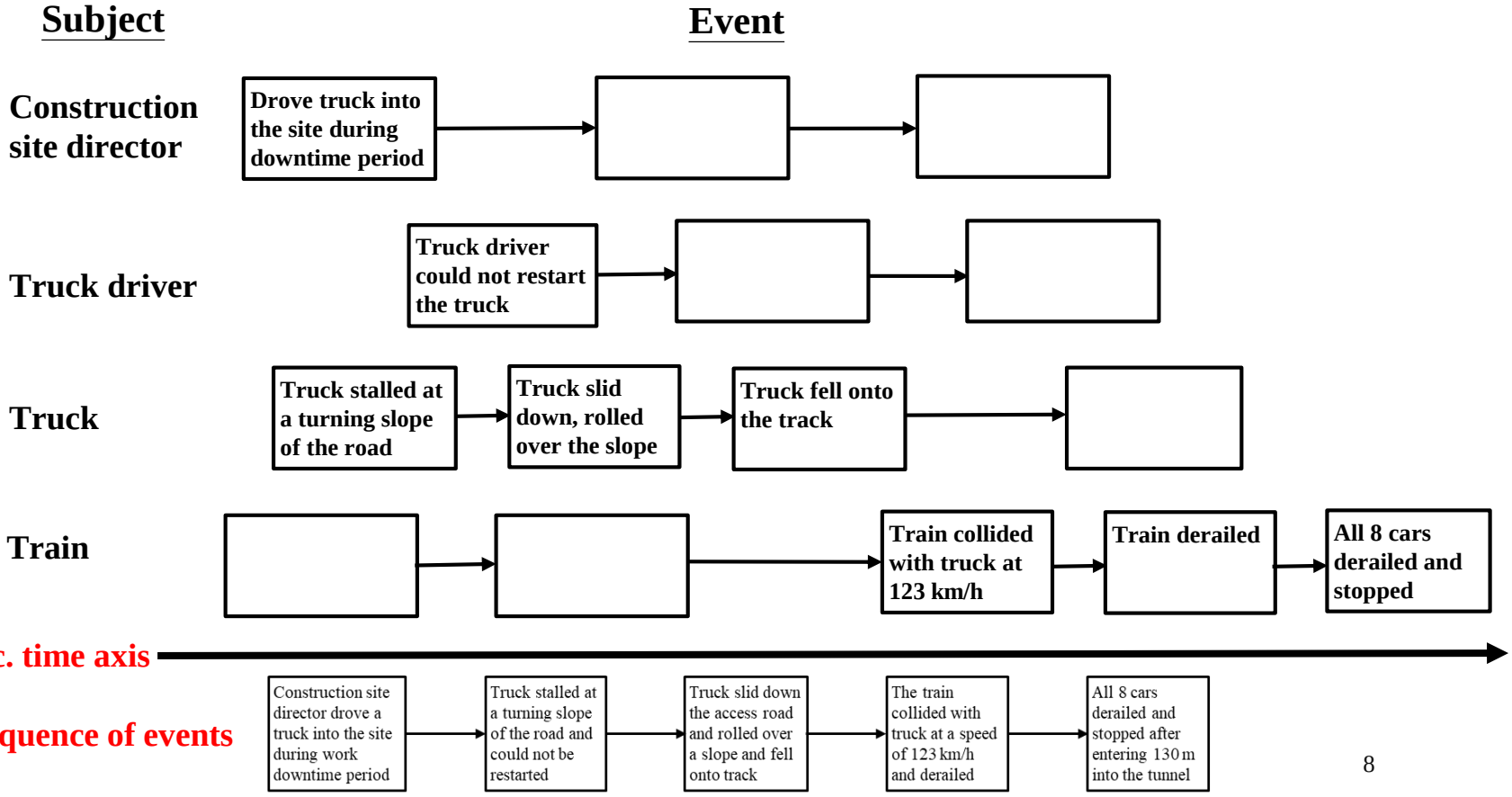
Findings related to probable causes

The construction site director drove a truck into the construction site during work downtime period. Due to improper operations and poor battery power efficiency, the truck stalled at a turning slope and could not be restarted. Non-compliant pavement and surface conditions caused the truck to slide down the access road after the construction site director failed to recover the truck. Lack of guardrails caused the truck to roll over a side slope and fell onto the track. The construction site director did not carry TR communication radio to notify the drivers to stop the train. After the train exiting Heren tunnel, driver's vision was affected by light adaptation, track alignment and track-side retaining walls. When the driver saw a foreign object on the track ahead, emergency brake was activated immediately. The train collided with the foreign object one second later at a speed of 123 km/h and derailed.

Procedures to conduct SFM analysis

Step 1.

Collect factual info. and identify events and subjects; synchronize time axis to consolidate events and connect critical events IAW time sequence to determine sequence of events



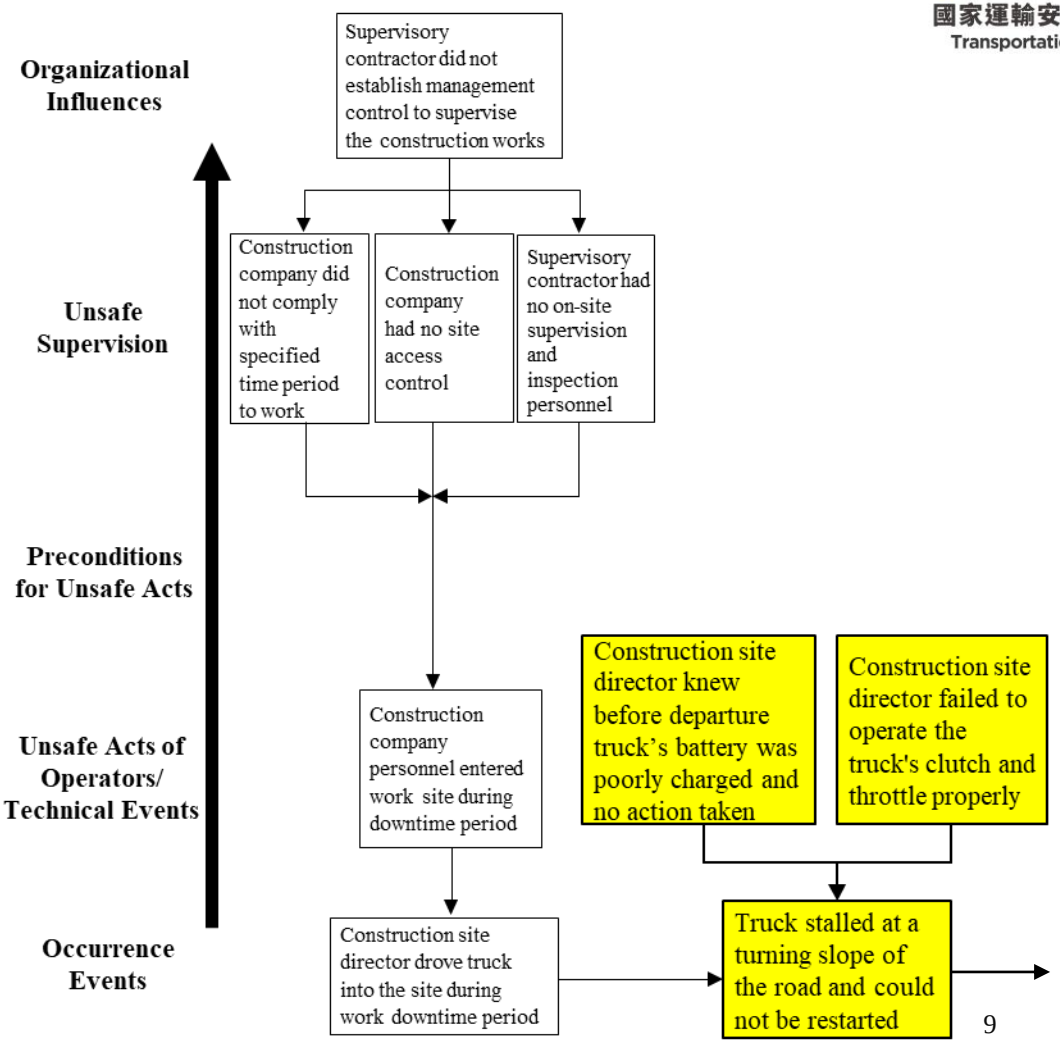
Procedures to conduct SFM analysis

Step 2.

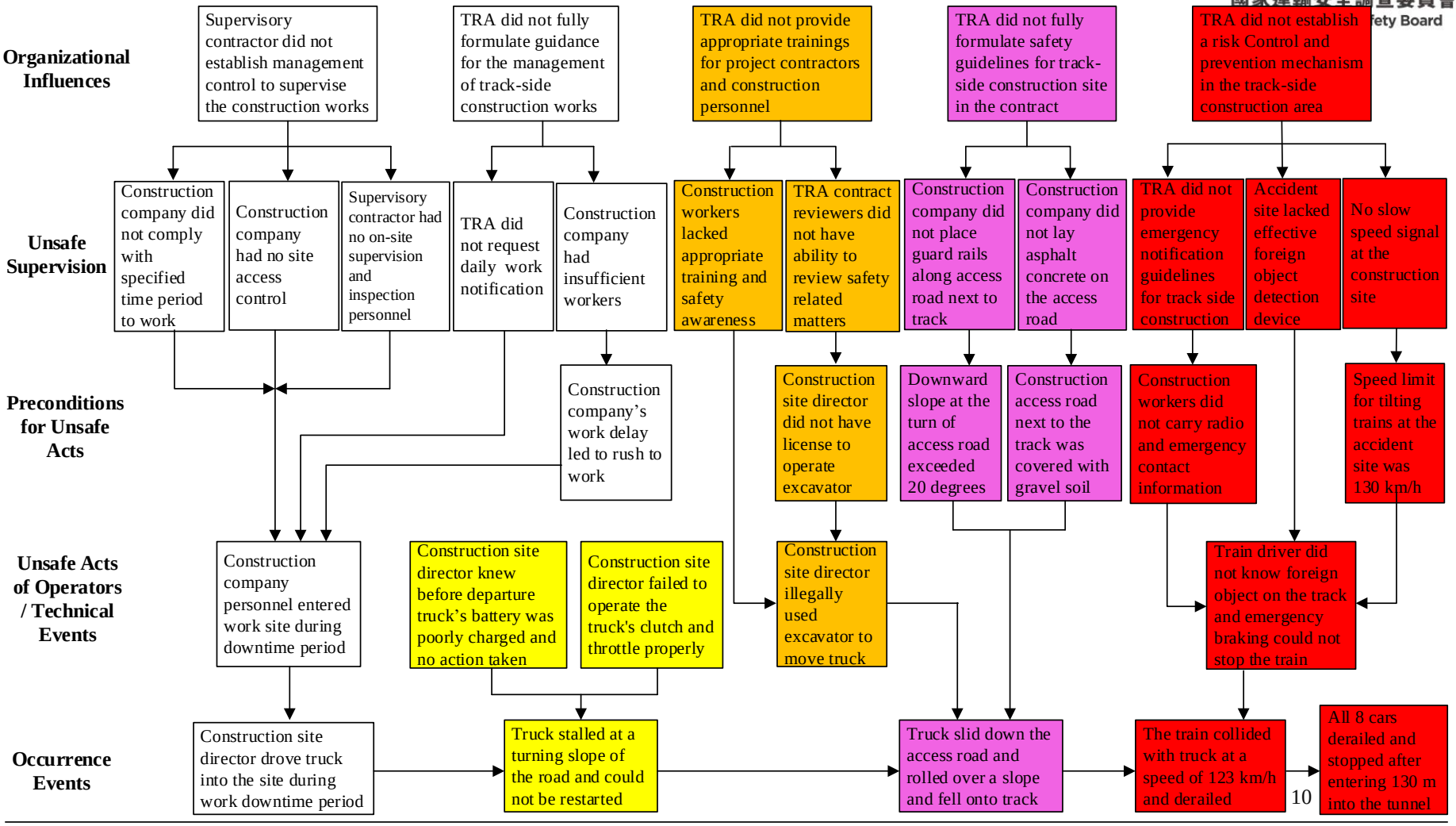
Bottom up approach to identify unsafe acts of operators/ technical events, preconditions for unsafe acts, unsafe supervision and organizational influences which caused those critical occurrence events.

Step 3.

Combine the sequence of events and the identified factors at each level to form a safety factors map.

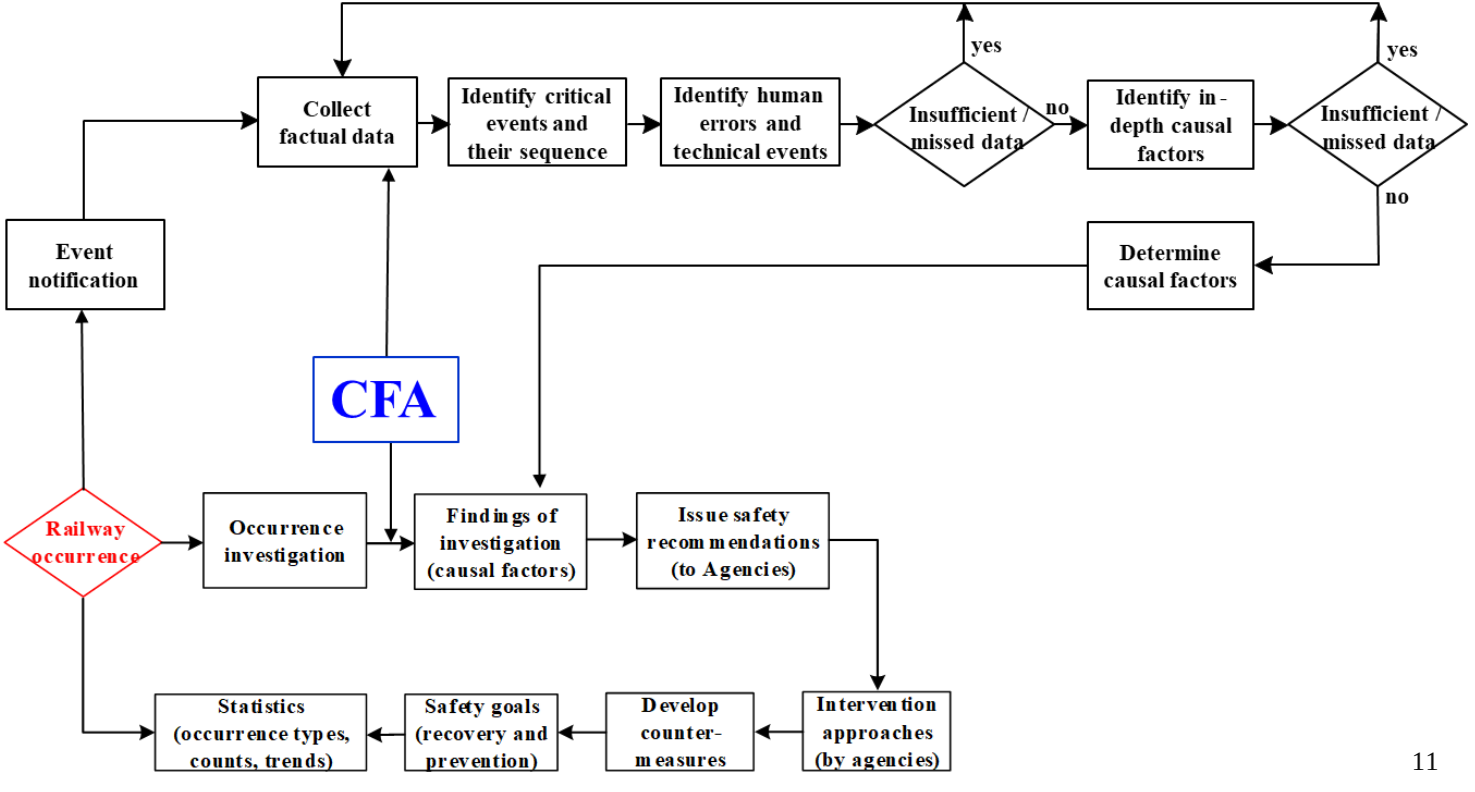


SFM of TRA's Train No. 408 accident



When to apply the CFAS?

- SFM (CFAS) can assist investigators to classify factors and summarize topics for investigation analysis. Findings and conclusions are drawn based on the results of analysis. **CFAS is applied from the beginning of occurrence investigation.**



References:

1. Safety Investigation Guidelines Manual -- Analysis, Version 1.06, 2011. Australian Transportation Safety Bureau.
2. Tools -Analysis Supplement, Version 1.05, 2011. Australian Transportation Safety Bureau.
3. Evaluation of the Human Factors Analysis and Classification System as a predictive model, AR-2008-036. Australian Transport Safety Bureau, 2008.
4. Shappell, S. A., Wiegmann, D. A., 2001. Applying reason: The human factors analysis and classification system (HFACS). Human Factors and Aerospace Safety, 1(1), 59-86.
5. Lee, Y. N., Causal Factors Analysis of runway excursion occurrences through Fuzzy Logic Modeling method, Transportation Engineering, Volume 14, December 2023, 100204. https://doi.org/10.1016/j.treng.2023.100204
6. Lee, Y. N., A new approach to identify critical causal factors and evaluate intervention strategies for mitigating major railway occurrences in Taiwan, Journal of Rail Transport Planning & Management, Volume 33, 2025, 100507, ISSN 2210-9706, https://doi.org/10.1016/j.jrtpm.2025.100507
7. Occurrence investigation report, TRA's Train No. 408 derailment on mainline at Qingshui Tunnel, Apr. 2, 2021.

Taiwan
TTSB
國家運輸安全調查委員會
Transportation Safety Board

Thank You for Your Attention