EXAMINING THE ROLE OF SAFETY IN COMMUNICATION CONCERNING EMERGING HYDROGEN TECHNOLOGIES BY SELECTED GROUPS OF STAKEHOLDERS

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OUTLINE

Motivation

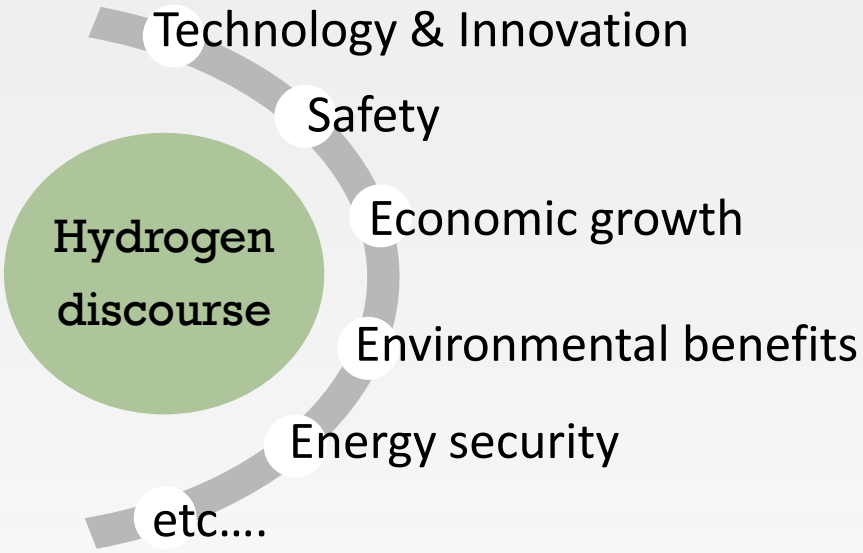
THE HYDROGEN DISCOURSE

This study

AIMS
MATERIALS
METHODOLOGY
RESULTS & DISCUSSION
CONCLUSIONS

Further work

THE HYDROGEN ECONOMY

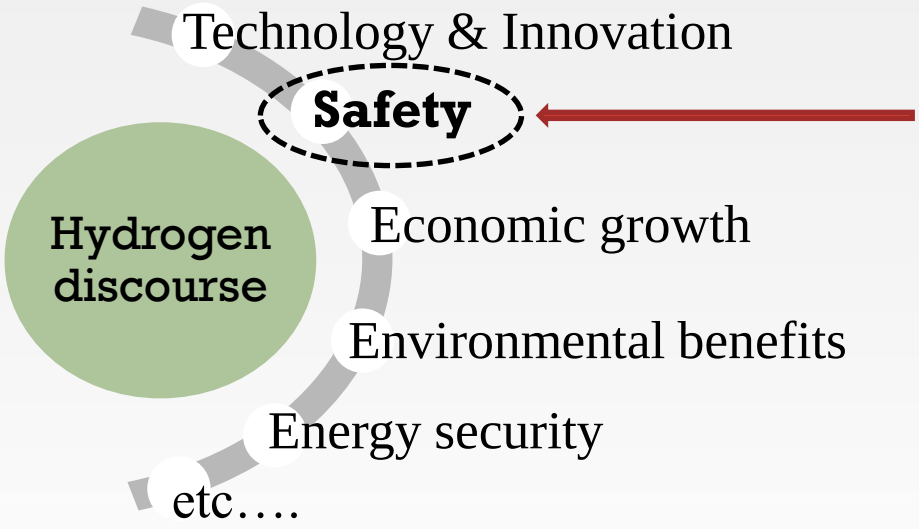


In a symbolic, the Tokyo 2020 Olympic flame burns with hydrogen. Image: https://apnews.com/article/2020-tokyo-olympics-sports-science-tokyo

EXAMINING THE ROLE OF SAFETY IN COMMUNICATION CONCERNING EMERGING HYDROGEN TECHNOLOGIES BY SELECTED GROUPS OF STAKEHOLDERS

AIMS & OBJECTIVES

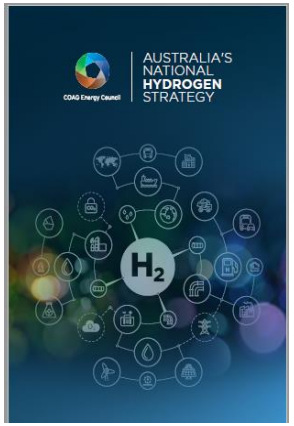
- The framing of hydrogen safety in the hydrogen discourse

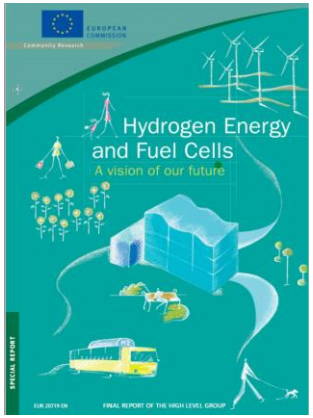


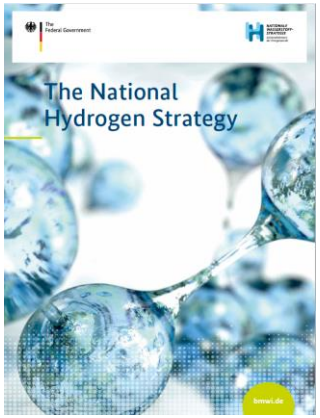
- Critical aspects addressed?
- Framing consistent with the recent state of the art for hydrogen safety management?

MATERIALS

- **17 Strategic documents outlining visions or roadmaps for hydrogen**
  - Selected national states
  - The European Union (EU)







METHODOLOGY

MAIN CONCEPTS

- **Discourse Analysis**
  - Study of language, recurrent ideas & frames.
  - Tool for exploring the perspectives in the framing of a concept.

- **Framing**
  - The process of selecting information from the complexity of knowledge to give it specific meaning and make it manageable.
  - Make a theme understood in a specific way.

"To frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such ways as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described"

Entmant, R., Framing: toward clarification of a fractured paradigm. *Journal of Communication*, 43, 1993, pp. 51–58.

METHODOLOGY – Discourse analysis

- 3 Distinct levels

✓ **Level1**: Semi-quantitative content analysis: Automated word counting

- *MaxDictio* module in *MAXQDA Analytics Pro 2020* (v20.4.0)
  - Word frequency function
  - Dictionary based search

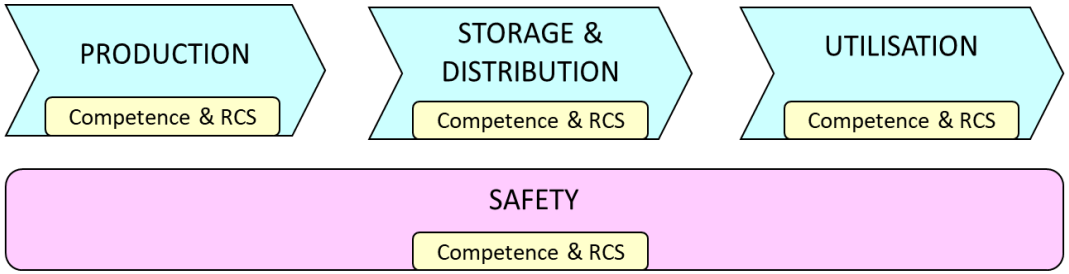


Figure 1: Simplified value chain for hydrogen as an energy carrier

✓ **Level2**: Semi-quantitative text analysis: Close reading supported by qualifying questions.

- Framework for risk management and governance
  (see *Aven, T. and Renn, O., Risk management and Governance, 2010, Springer, London*)

✓ **Level3:** Close reading to identify statements concerning the overall safety in hydrogen:

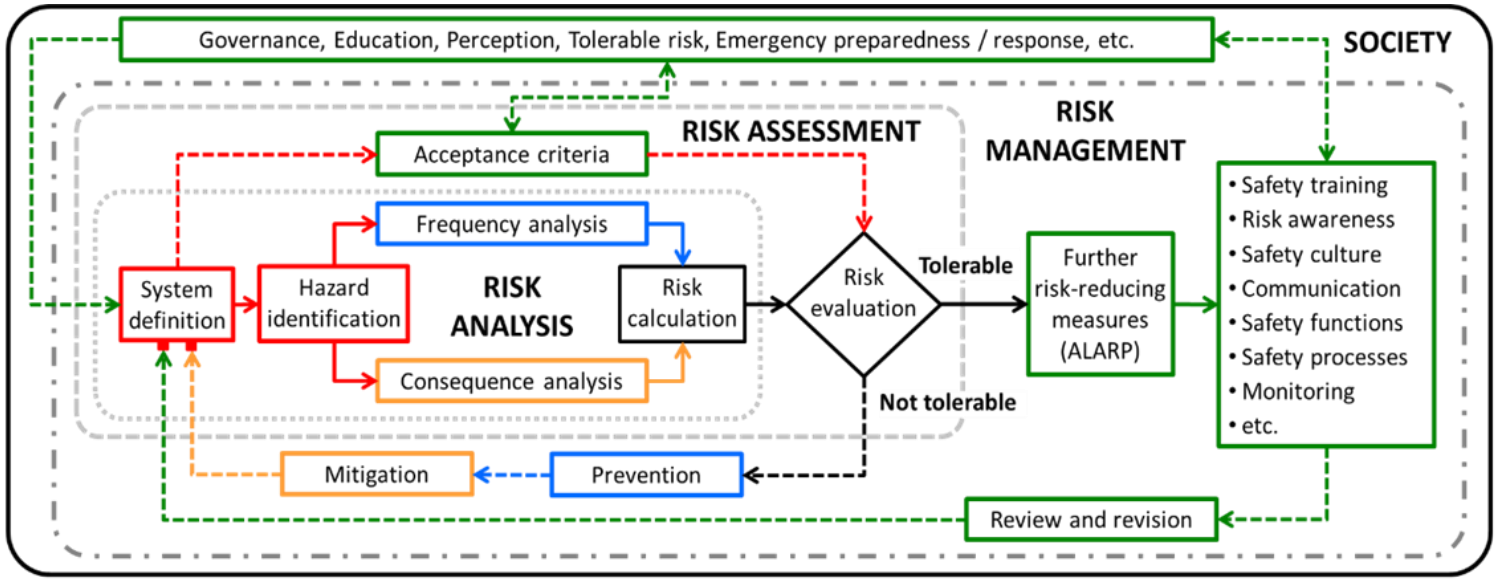
"How safe is hydrogen"?

"Is hydrogen technologies more or less safe compared to other energy technologies"?

Level 2

Semi quantitative text analysis supported by qualifying questions

✓ 4 categories x 5 subcategories



1. System & hazards	2. Frequency & prevention	3. Consequence & mitigation	4. Risk management & society
1A: Classification	2A: Density/buoyancy	3A: Fire and flame	4A: Governance
1B: Process conditions	2B: Flammable range	3B: Deflagration	4B: Competence
1C: Compatibility	2C: Ignition sensitivity	3C: Detonation	4C: Safety culture
1D: RCS limitations	2D: Prevention	3D: Mitigation	4D: Perception
1E: Inherent safety	2E: Experience	3E: Modelling	4E: Tolerable risk

Figure 2: Schematic of risk-related processes and the four categories of qualifying questions

Level 2

Qualifying questions- an example

"Does the document mention.." ?

1. System & hazards

1D RCS Limitations:*"Does the document mention any need for developing or updating specific RCS to facilitate or support safe deployment and operation of hydrogen energy systems?"*

- 1 point for a positive answer
- 0 point for a negative answer

Potential issues! The binary scale involves interpretation/personal judgement.

Fix: qualified only if the statement met the specific context of each question.

Level 2

Qualifying questions- more examples

2 . Frequency analysis & prevention

2A Density/ buoyancy: *"Does the document mention any implications for safety of the low density of hydrogen relative to air at the same temperature and pressure ?"*

RESULTS & DISCUSSION

RESULTS (Level 1):
Semi-quantitative content analysis based on counted words

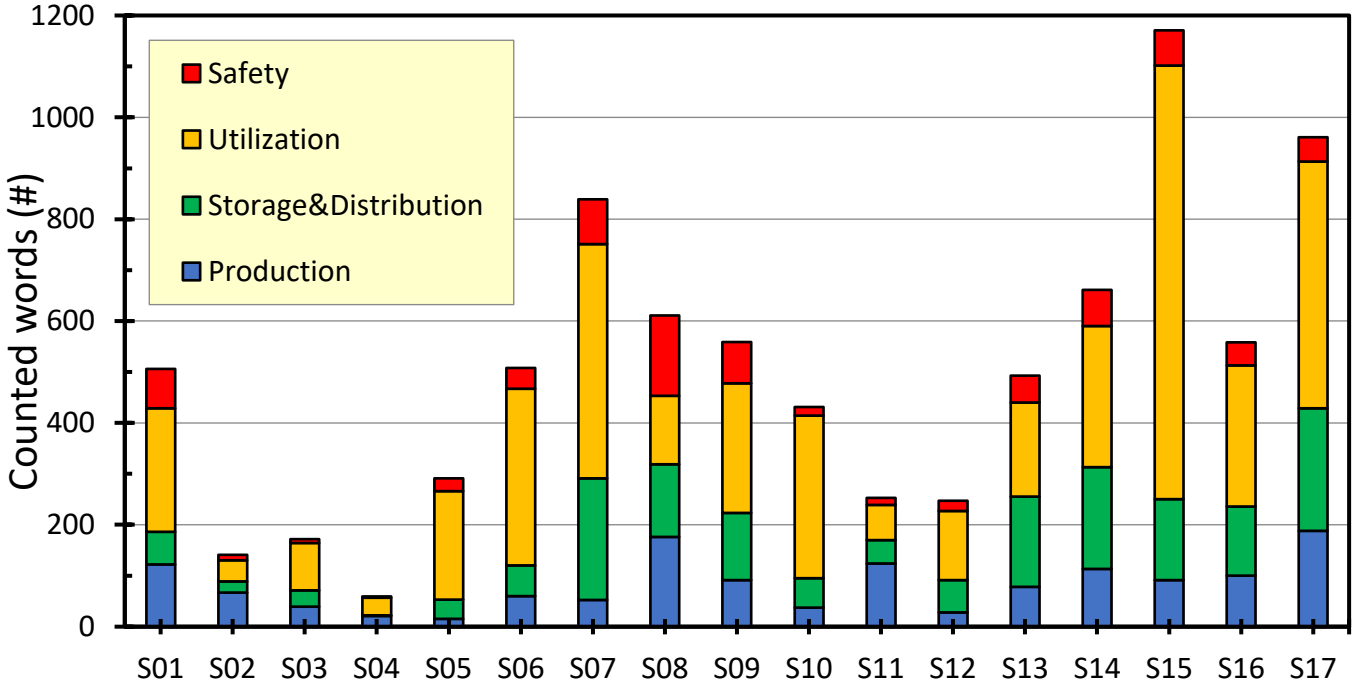


Figure 4: Total number of words counted, sorted by category (S01-S17)

ID	Country	Year
S01	Norway	2020
S02	The Netherlands	2020
S03	Germany	2020
S04	France	2020
S05	Japan	2017
S06	Japan	2019
S07	South Korea	2019
S08	Australia	2019
S09	New Zealand	2019
S10	EU	2003
S11	EU	2020
S12	USA	2002
S13	USA	2002
S14	USA	2006
S15	USA	2011
S16	USA	2020
S17	Canada	2020

RESULTS (Level 1):
Semi-quantitative content analysis based on counted words

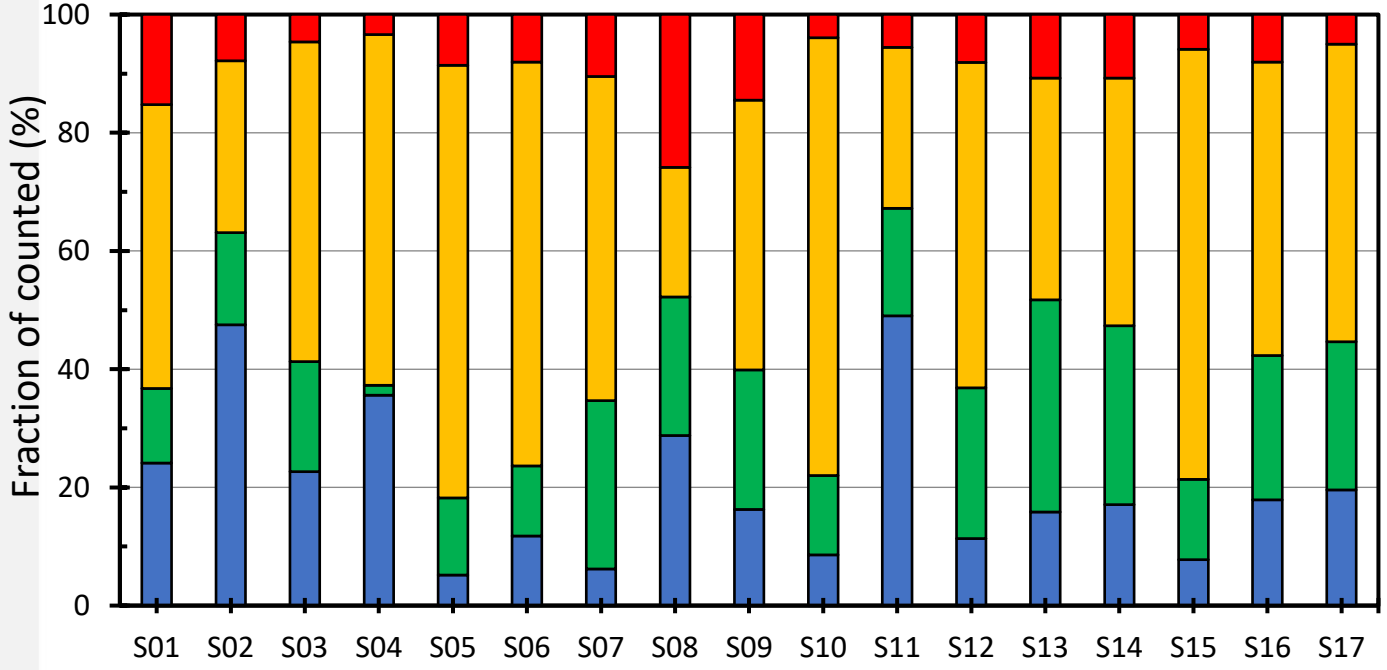


Figure 4: Fraction of counted words per category for each document (S01-S17) normalised by the total number of words counted

ID	Country	Year
S01	Norway	2020
S02	The Netherlands	2020
S03	Germany	2020
S04	France	2020
S05	Japan	2017
S06	Japan	2019
S07	South Korea	2019
S08	Australia	2019
S09	New Zealand	2019
S10	EU	2003
S11	EU	2020
S12	USA	2002
S13	USA	2002
S14	USA	2006
S15	USA	2011
S16	USA	2020
S17	Canada	2020

RESULTS (Level 2):
Semi-quantitative text analysis using qualifying questions

ID	Country	Year
S01	Norway	2020
S02	The Netherlands	2020
S03	Germany	2020
S04	France	2020
S05	Japan	2017
S06	Japan	2019
S07	South Korea	2019
S08	Australia	2019
S09	New Zealand	2019
S10	EU	2003
S11	EU	2020
S12	USA	2002
S13	USA	2002
S14	USA	2006
S15	USA	2011
S16	USA	2020
S17	Canada	2020

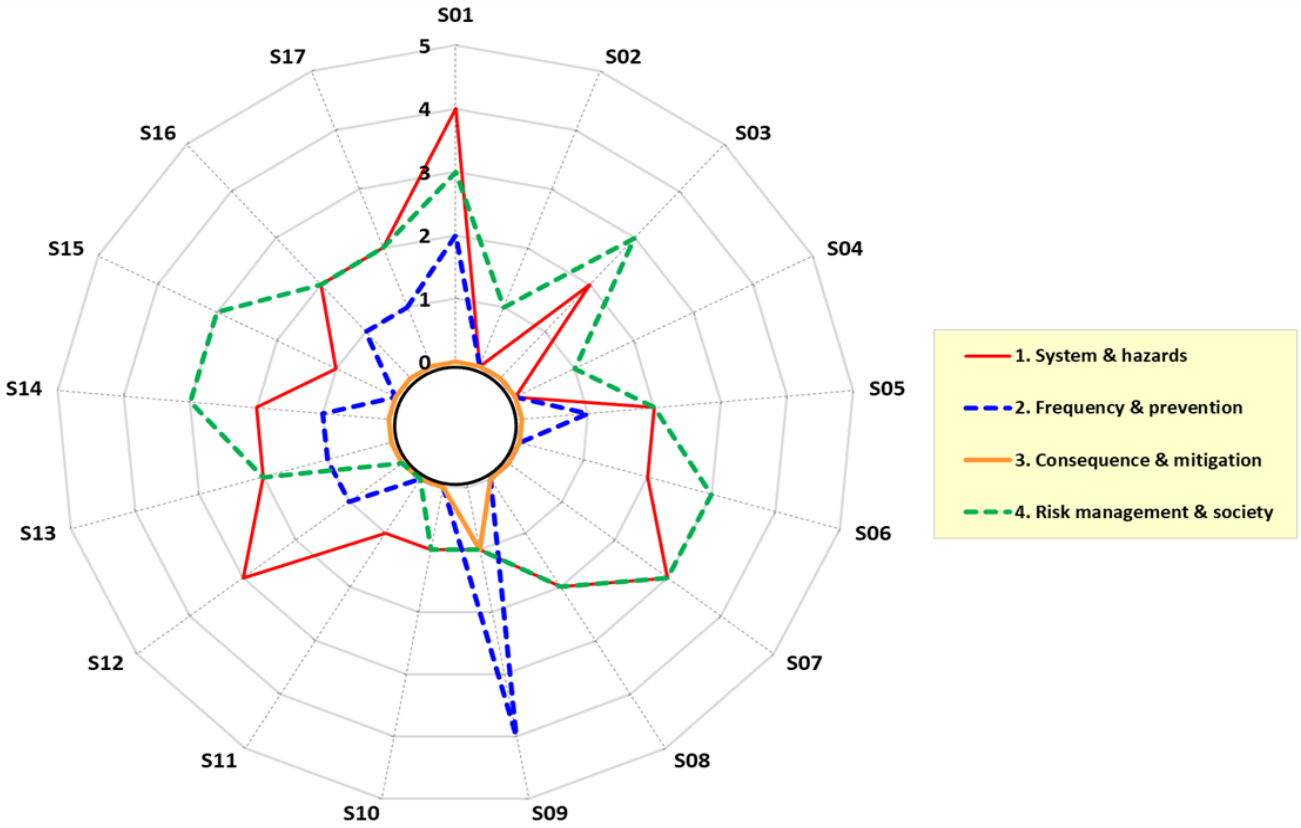


*Figure 5: Score **per category** in the semi-quantitative text analysis using qualifying questions:*

- ✓ *Spread in the results*
- ✓ ***Aspects related to Consequences & Mitigations are under communicated***

RESULTS (Level 2):
Semi-quantitative text analysis using qualifying questions

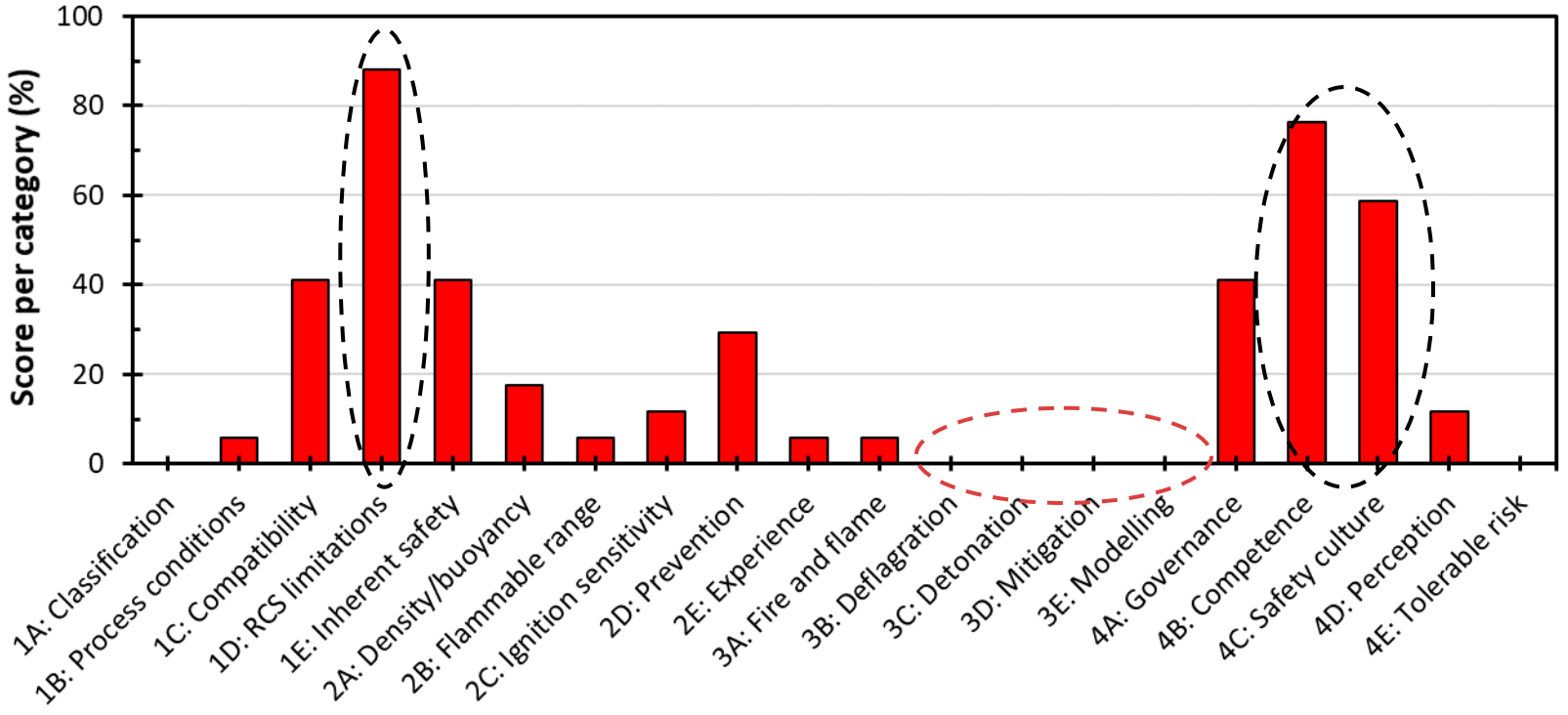


*Figure 6: Score **per sub-category** in the semi-quantitative text analysis using qualifying questions*

✓ **RCS (88%), Competence (76%), Safety Culture (59%):** Procedural & societal aspects have dominant role in the framing of safety!

RESULTS (Level 2):
Total score on safety based on pre-defined questions

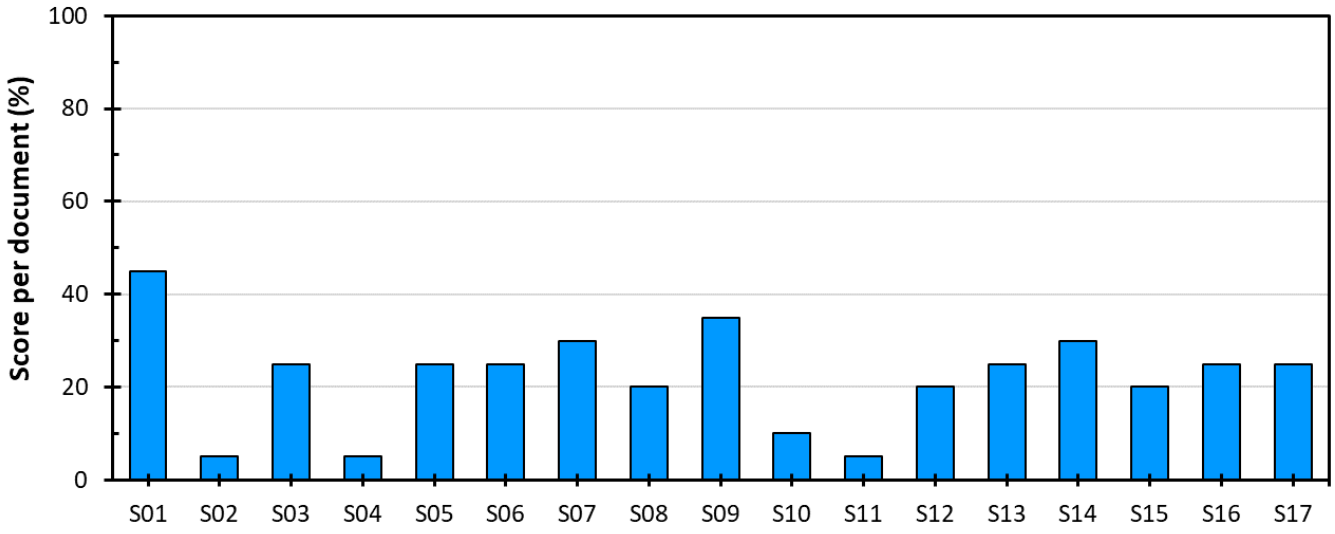


*Figure 7: Score **per document** in the semi-quantitative text analysis using qualifying questions*

ID	Country	Year
S01	Norway	2020
S02	The Netherlands	2020
S03	Germany	2020
S04	France	2020
S05	Japan	2017
S06	Japan	2019
S07	South Korea	2019
S08	Australia	2020
S09	New Zealand	2019
S10	EU	2003
S11	EU	2020
S12	USA: the Vision	2002
S13	USA: The Roadmap	2002
S14	USA	2006
S15	USA	2011
S16	USA	2020
S17	Canada	2020

✓ Norway (S01), New Zealand (S09), South Korea (S07) and the *"The 2006 Posture plan"* – USA (S14), exhibited the highest overall score in safety.

Correlation between level 1 & level 2 of the analysis

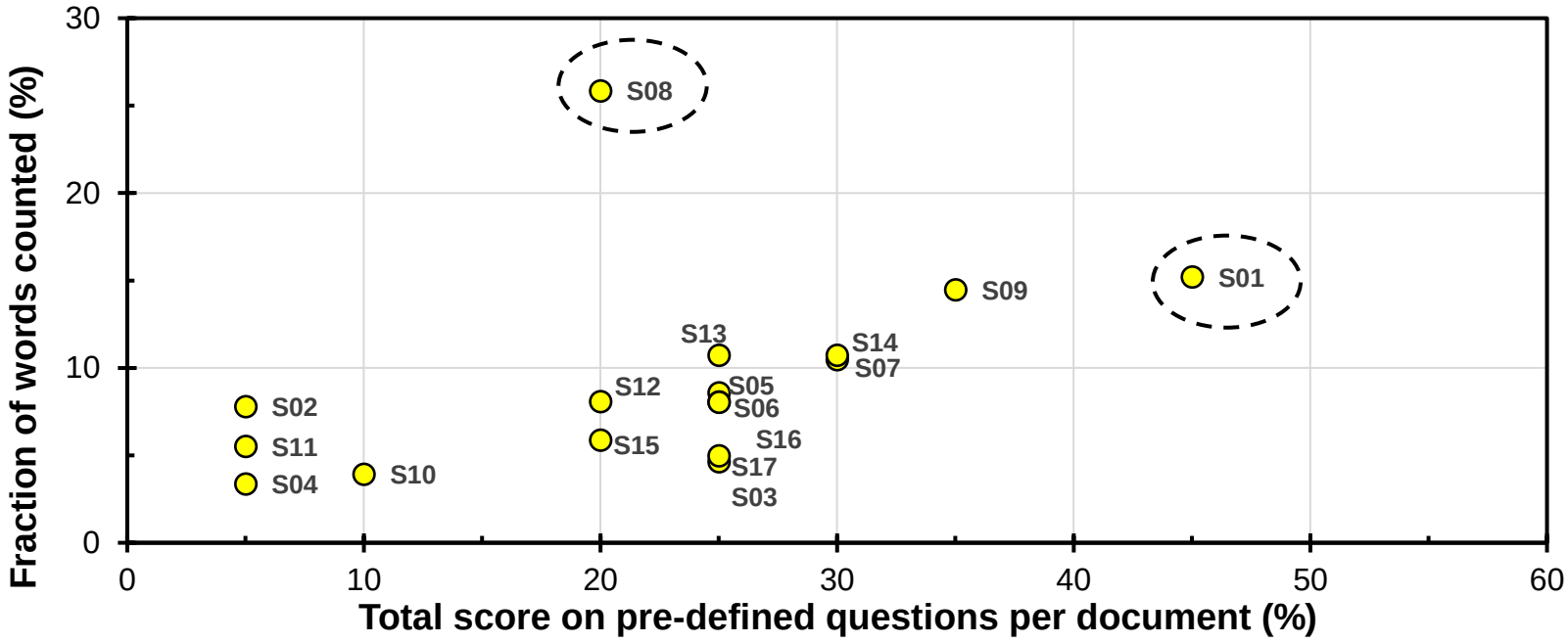


Figure 8: Correlation between fraction of words counted and total score on guiding questions

Explaining the deviations

CONTENTS

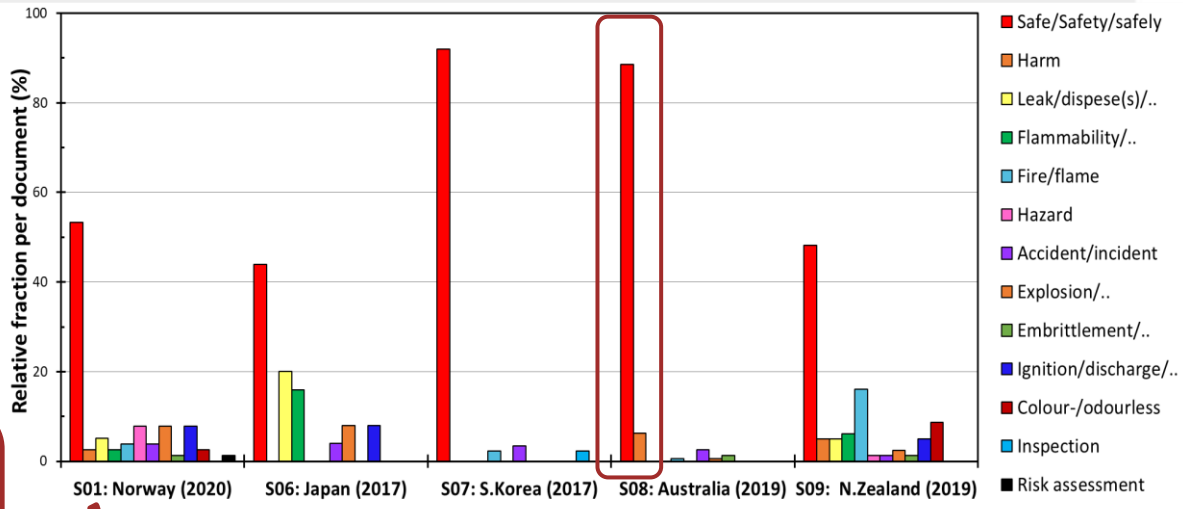


*Figure 9: Relative fraction of counted words pointing to safety for **all non-zero search terms** for 5 selected documents: highest normalised score on safety (level 1)*

CONCLUSIONS

- Framing of safety in hydrogen strategies
- Fairly consistent results in the 2 levels of the analysis: deviations can be explained.
- Safety prioritisation: messages conveyed across the addressed sources are not consistent. Yet, strong focus in consumption (level1).
- The framing of critical aspects in hydrogen safety: Varies significantly across the reviewed strategies (level2).

Common denominator! Emphasis on **procedural, organisational and societal measures of risk reduction**, at the expense of well-known challenges and knowledge gaps.

FURTHER WORK

- Extend the analysis to address other groups and qualify selected sources of documents e.g.:
  - ✓ outlook reports & energy forecasts
  - ✓ Peer-reviewed scientific publications

- Follow the developments in national-states and EU level.
  - ✓ updated strategies & roadmaps *(e.g. Japan)*
  - ✓ additional national states issuing implementation plans (see *UK National Strategy, Hungary*)

Thank you!