



Foundation

Global
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Centre

Who funds engineering safety research?



Safety
Science



Research
Report



Briefing

1. The quick read

Engineering safety research is a term used for this project to describe the *generation and sharing of scientific knowledge related to assessing and controlling risks within engineered systems and processes, with the overall aim of preventing accidents and reducing harm to people and property*. The goal of this project was to explore how engineering safety research has evolved globally over the past decade; where the funding has gone, what areas have grown, and what trends are shaping the landscape.

The findings showed that engineering safety research is a rapidly growing field, having developed considerably in recent years. Broadly, the bibliometric review of 15,705 publications from 130 countries found:

- Large differences in engineering safety research outputs and funding across the globe. China, the USA and South Korea generally led the way, having published and funded the most engineering safety research.
- Significant national variation in funding sources, collaborations and funder acknowledgements, with collaborative working seen more in Europe than elsewhere.
- Differences between countries in the types of leading funding organisations may contribute to variation, with researchers in high publication countries being heavily supported by their governments.
- The popularity of different engineering safety topics has changed over time, with publications on machine learning and data-driven methods growing the most in the past decade.
- Funding patterns in sectors related to Lloyd's Register Foundation's strategy are similar to those overall, except in maritime and electrical power where Europe has a larger role.

We recommend that:

- Funders use this work to drive portfolio development and the initiation of collaborative calls.
- Researchers use this work to identify research gaps and consider the availability of engineering safety research funding.
- Policymakers and professionals use this work to develop areas of research interest (ARIs), as well as infrastructure and skills investment plans.

We also provide recommendations for future research on the engineering safety research landscape.

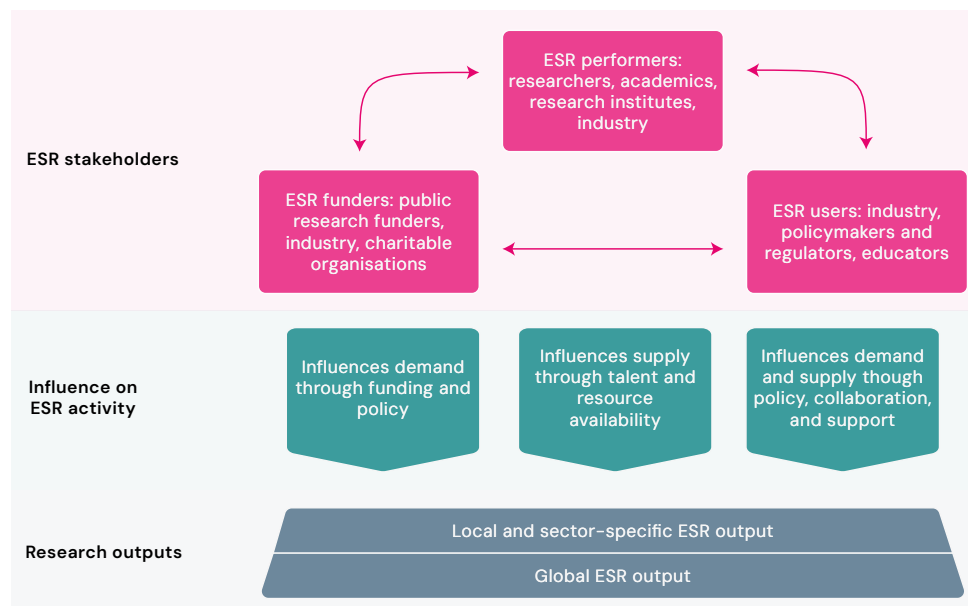
2. Why this is important

By developing understanding of the global engineering safety research publication and funding landscape, this work is intended to support research and funding in the field, leading to the development of safer engineered systems. The report has three primary intended uses:

1. For funders and commissioners, to understand reach and scope of engineering safety research funding and their place within the ecosystem.
2. For researchers, to understand current research gaps, popular topics and the availability of engineering safety research funding globally.
3. For practitioners and policymakers, to understand the availability of geographically relevant safety knowledge, which also serves as a proxy indicator of safety and risk awareness in new and emerging sectors and systems.

These stakeholders are connected as shown in figure 1. Ultimately, we hope this work supports end users to make informed strategic decisions about their future engagement with engineering safety research and collaborations within the engineering safety research ecosystem.

Figure 1. Engineering safety research funding and performance ecosystem

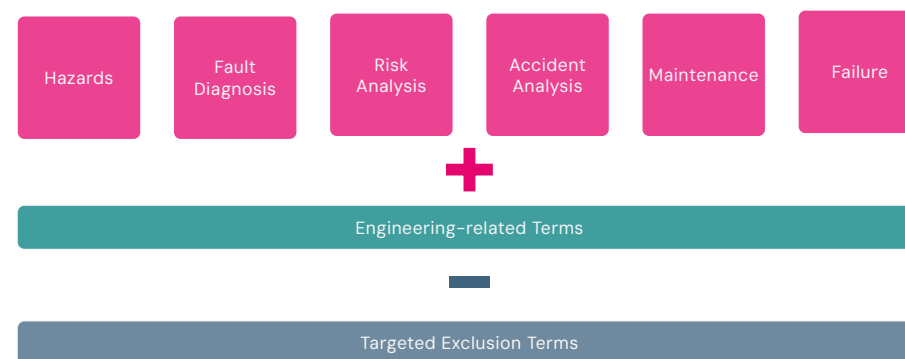


3. The research

Engineering safety research shares features with several established research and safety science fields such as healthcare, security and digital. However, in this project the focus was on core engineering topics, which consequently minimised the huge number of engineering safety research 'hits' that would have been returned had all fields been included.

Journals publishing engineering safety research were identified through scoping searches and input from Lloyd's Register Foundation. Key word and topic analysis was applied which resulted in the conceptual framework shown in figure 2. Inclusion and exclusion criteria along with the search string were refined through a workshop involving RAND Europe analysts and Lloyd's Register Foundation colleagues.

Figure 2. Conceptual framework for engineering safety research publications



A bibliometric analysis of engineering safety research studies published in the Web of Science database returned 15,705 documents in total. These included research articles, reviews and conference proceedings (excl. editorial content). Web of Science was chosen because of its minimum requirements for peer review, coverage, editorial board composition, author affiliation data and funder acknowledgements, which are not guaranteed with open access platforms. Where possible, information on funders was supplemented using the Research Organisation Registry.

Using statistical methods, 50 data-driven topics, falling into 11 clusters, were generated from the document titles and abstracts (see table 1).

Table 1. The 50 data-driven topics generated from the titles and abstracts in engineering safety research, colour coded by cluster

#	Topic	#	Topic
1	Dam Safety and Structural Integrity	26	Defect and Anomaly Detection
2	Seismic Hazard and Earthquake Engineering	27	Fault Diagnosis and Industrial Monitoring
3	Slope Stability and Landslide Risk	28	Machine Learning and Data-Driven Methods
4	Fire Safety and Building Evacuation	29	Predictive Modelling and Neural Networks
5	Flame Retardant Materials and Combustion	30	Dust, Coal Dust, and Explosion Risk
6	Lithium-Ion Battery Safety and Thermal Runaway	31	Explosion Hazards and Pressure Events
7	Thermal Hazards and Stability	32	Hydrogen Energy Safety and Storage
8	Concrete Structures and Reinforcement	33	Spontaneous Combustion in Coal Mining
9	Corrosion and Material Degradation	34	Gas and Oil Industry Leakage Hazards
10	Crack Detection and Fracture Propagation	35	Nuclear Power Plant Safety
11	Fatigue Analysis and Structural Life	36	Pipeline Safety and Failure Risk
12	Steel Structures and Mechanical Performance	37	Industrial Systems Design and Technology
13	Bridge Engineering and Structure Safety	38	Process and Chemical Industry Safety
14	Railway and Rail Infrastructure Safety	39	Accident Analysis, Investigation, and Prevention
15	Structural Damage Detection	40	Construction Safety and Project Risk
16	Structural Health Monitoring and Sensors	41	Cybersecurity and Industrial Safety
17	Wind Turbine and Offshore Wind Engineering	42	Human and Causal Risk Factors
18	Coal Mine Safety and Underground Mining	43	Human Error and Human Reliability
19	Mine Water Inrush and Hydrogeological Hazards	44	Maritime Safety and Collision Risk
20	Rock Mechanics and Support in Mining	45	Occupational Health, Noise, and Safety Exposure
21	Tunnel Construction and Deformation	46	Risk and Safety Assessment Methods
22	Failure Modes and Probability Analysis	47	Risk Management and Risk Analysis
23	Maintenance Strategies and Predictive Maintenance	48	Safety and Risk Management Systems
24	Structural Design, Reliability, and Optimization	49	Safety Resilience and Organizational Culture
25	System Reliability and Safety	50	Worker Behaviour, Risk Perception, and Safety Training

Desk research was also carried out to generate 'funder spotlights' and 'sector deep-dives' on key funders and areas of interest in relation to Lloyd's Register Foundation's strategic priorities of safer maritime systems and safer sustainable infrastructure.

Due to the vast amount of data generated by this approach, the report highlights top publishers and funders of engineering safety research. However, it is acknowledged that those not funding or publishing engineering safety research would also be interesting to explore in future.

3. The findings

Engineering safety research trends and topics: what has changed?

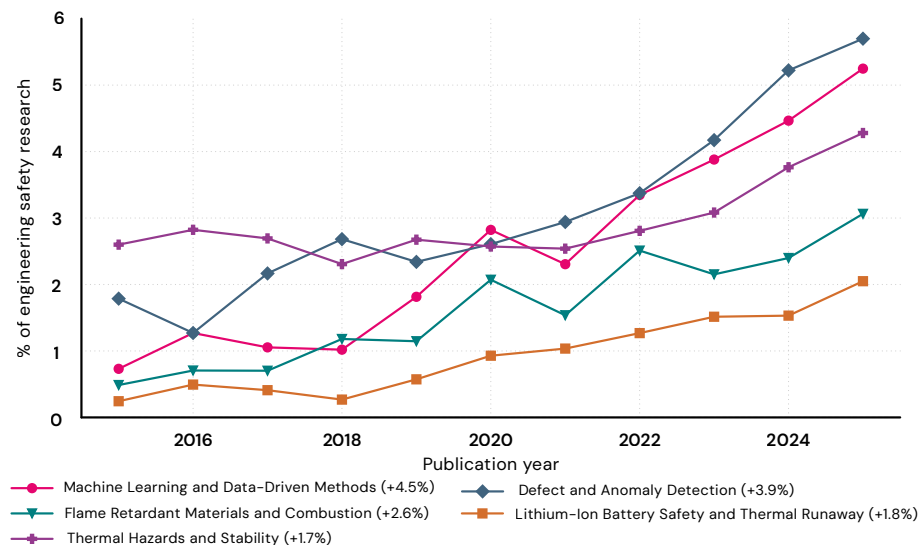
Between 2015 and 2025, the amount of engineering safety research increased at a much higher average rate (18% annually) than engineering publications overall (4% annually), particularly in 2024 where engineering safety research grew by 42%.

Under the Web of Science categorisation system most engineering safety publications fell under traditional engineering (civil, construction) and materials science disciplines. The topics for which publication numbers grew the most were:

1. Machine learning and data-driven methods
2. Defect and anomaly detection
3. Flame retardant material and combustion
4. Lithium-ion battery safety and thermal runaway
5. Thermal hazards and stability

Machine learning and data-driven methods were, perhaps unsurprisingly due to the global interest and advancement of artificial intelligence in recent years, number one (see figure 3).

Figure 3. Relative proportion of publications for the top five engineering safety topics, measured by the difference in publications from 2015 to 2025



Engineering safety research has been a field of global interest, with authors coming from 130 countries in our study. China leads by far on the publication front, with 6,480 first authored publications. The USA, which authored 1,332 publications, was a distant second. The top five countries thereafter were:

- South Korea (686)
- Italy (566)
- United Kingdom (497)
- India (471)
- Germany (417)

The relative amount of engineering safety research produced by China and Europe in particular, has changed over the last ten years (see figure 4).

Figure 4. Percentage of engineering safety publications with an author from China, the US or Europe (excluding the UK)

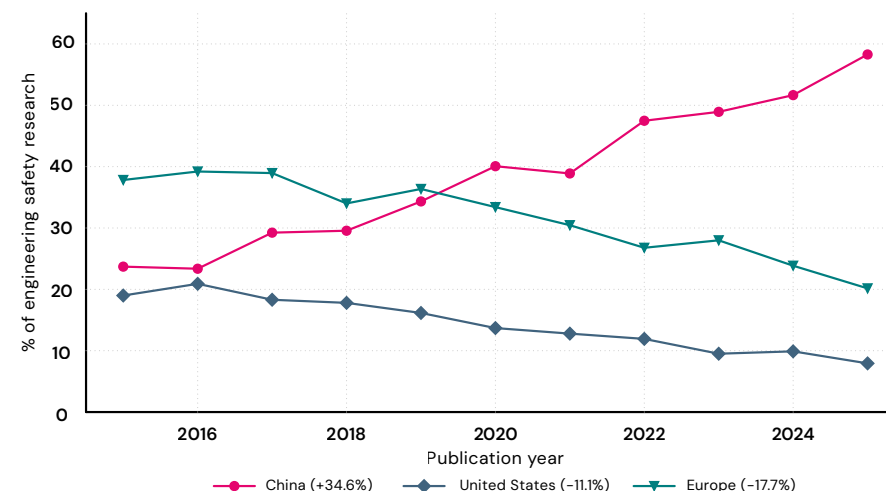
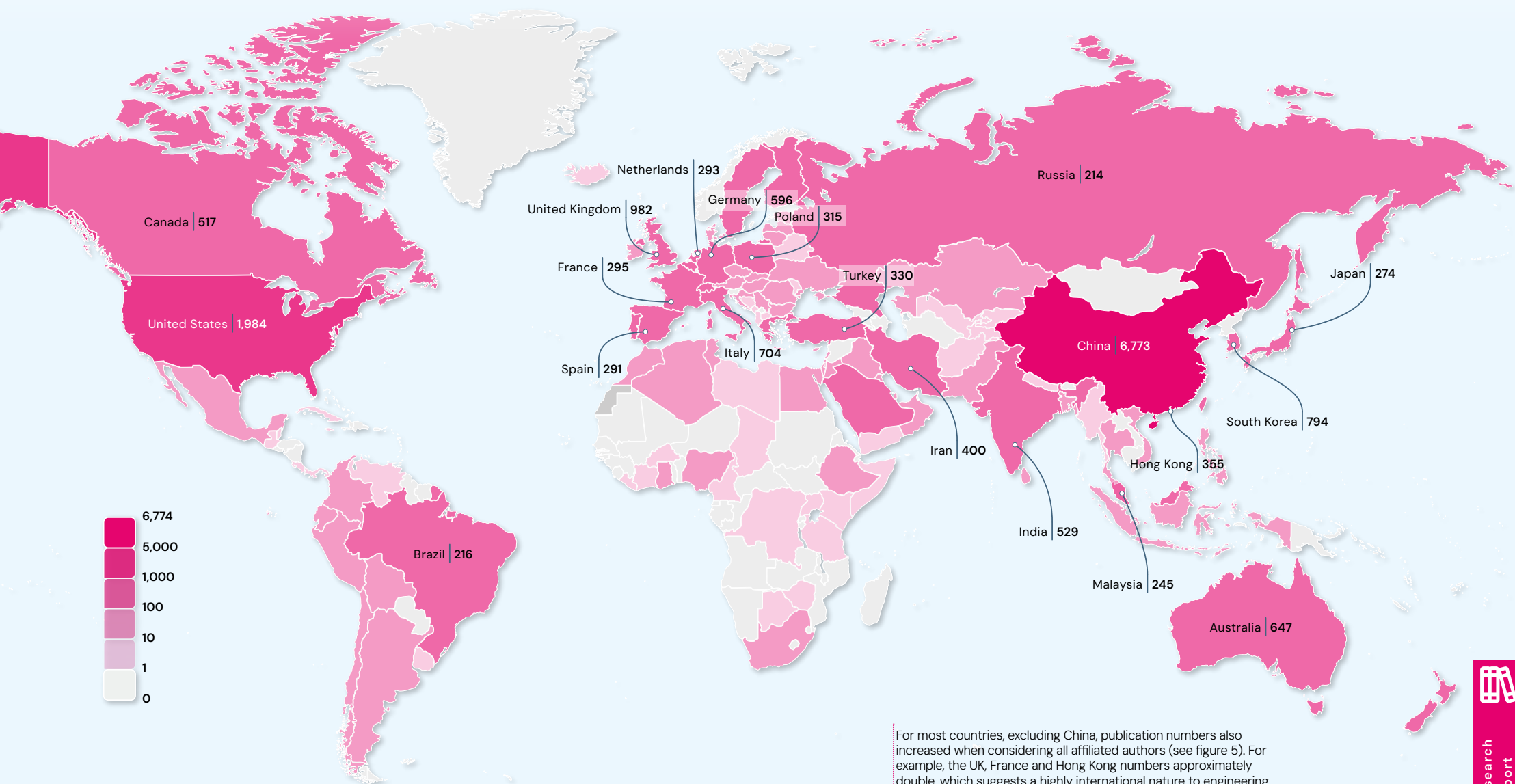


Figure 5. World map showing the number of publications according to all author affiliations



For most countries, excluding China, publication numbers also increased when considering all affiliated authors (see figure 5). For example, the UK, France and Hong Kong numbers approximately double, which suggests a highly international nature to engineering safety research collaborations in these countries.

Six shades are used to band the volume of outputs (see legend right). The top 20 countries/regions (by volume) are labelled.

Funders: who acknowledges them?

Funder information came from acknowledgements in engineering safety research publications (66% of publications included their funders). Acknowledgements differed substantially across the globe (see table 2). For example, China and South Korea showed the highest level of funder acknowledgement (included in over 80% of publications). At the other end of the scale, authors from Russia, Romania and Turkey acknowledged their funder less than 25% of the time.

Table 2. Percentage of publications that contain a funder acknowledgement, for each of the top 30 countries based on first author affiliation

Country/region	#	% funding acknowledged	Country/region	#	% funding acknowledged
China	6,480	86	Australia	320	54
South Korea	686	83	Japan	188	51
Hong Kong	160	79	Taiwan POC*	135	50
Portugal	138	75	United States	1,332	50
Finland	91	75	Netherlands	131	48
Singapore	75	75	Poland	242	45
Brazil	174	63	France	160	44
Canada	304	62	Italy	566	43
Sweden	119	61	Greece	80	43
Malaysia	181	61	Indonesia	77	42
Norway	164	60	Iran	343	30
United Kingdom	497	57	India	471	28
Germany	417	57	Russia	169	24
Spain	194	56	Romania	61	23
Switzerland	73	55	Turkey	289	22

*Taiwan POC is included in line with UN guidance. This does not constitute a position on the legal status of any country or territory on part of Lloyd's Register Foundation.

Who are the top funders?

Eight of the ten top funders in the study were from China, with the top funder, the National Natural Science Foundation of China, acknowledged in over 3,700 publications. The Ministry of Science and Technology of the People's Republic of China was in second place, funding over 1,100 publications. Provincial funders also supported a considerable number of publications, including the Government of Jiangsu Province, acknowledged by 347 publications.

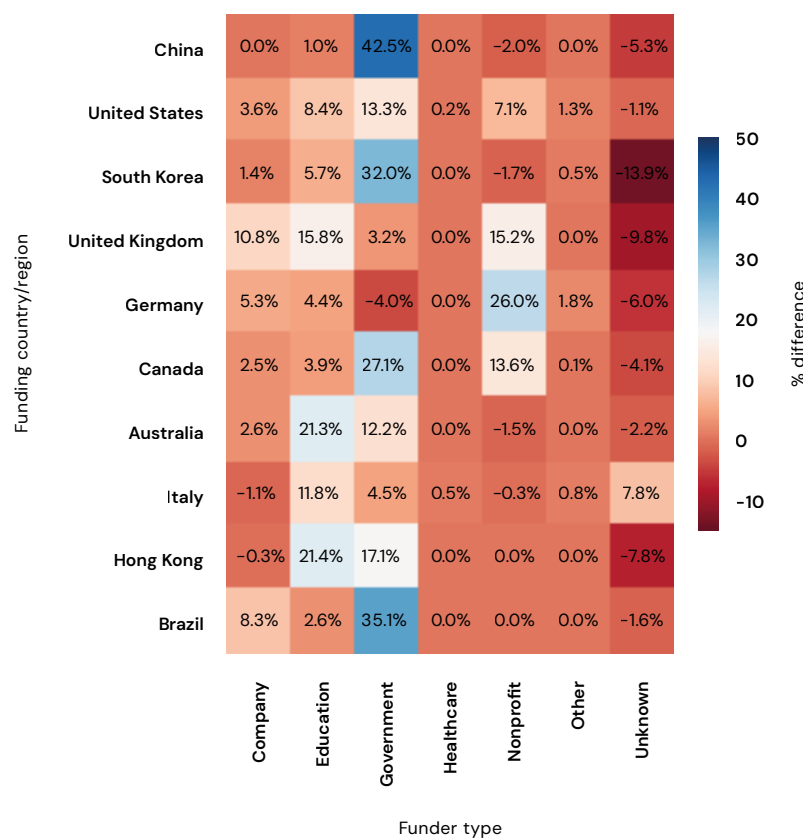
Beyond China, the European Commission was acknowledged the most, having funded 505 publications. Funding outputs then halved with:

- 236 from the National Research Foundation of Korea
- 152 from the U.S. National Science Foundation
- 146 from the Natural Sciences and Engineering Research Council (Canada)
- 99 from the Engineering and Physical Sciences Research Council (UK)
- 91 from the Fundação para a Ciência e Tecnologia (Portugal)
- 87 from the Australian Research Council

What types of funders are there?

More than half of the engineering safety research publications were funded by government bodies. However, this is likely to be driven by China, South Korea, and the USA, who proportionally have very high numbers of government funded publications (see figure 6). Interestingly, in the UK and Australia most engineering safety research is funded by the education sector. In Germany, research was largely funded by non-profit organisations, which might reflect systemic differences in funding culture in these countries.

Figure 6. Heatmap showing the difference (compared to all safety engineering publications) in the percentage of outputs according to acknowledged funder type for the top 10 countries



Who funds within country, and who funds across borders?

Funders generally support research in their own country; particularly countries such as China, South Korea, India and Iran, where over 92% of funded engineering safety research had a domestic first author. This contrasts with receiving funding, where Chinese researchers, for example, received considerable funding from international sources.

Countries in Europe appear to fund more internationally. For example, almost a third (32%) of UK funding went to first authors outside the UK, and only half (50%) of first authors who acknowledged the European Research Council were from Europe (excl. the UK). However, because countries that might fund across borders more were not represented among the top funders overall, cross-border funding is not a key focus of this report.

Funders: who funded what?

Popular engineering safety research topics in particular funder regions included mining and oil and gas safety in China, maritime safety and risk assessment in the EU (excl. the UK), occupational health and safety topics in the USA, and industrial systems design and reliability in the UK, likely reflecting respective industrial priorities.

Funders for the top five emerging topics (machine learning and data-driven methods, spontaneous combustion in coal mining, flame-retardant materials and combustion, lithium-ion battery safety and thermal runaway, and thermal hazards and stability) were almost the same as for engineering safety research generally. The top topic for each top funder region is shown in table 4.

Table 4. Top engineering safety research topics funded by the 10 most active engineering safety research funder regions

Country	Total Engineering safety research funded	Top topic	Top topic count	% top topic
China	5609	Steel Structures and Mechanical Performance	947	16.9
United States	734	Occupational Health, Noise, and Exposure Levels	113	15.4
South Korea	570	Steel Structures and Mechanical Performance	75	13.2
EU	561	Maritime Safety and Collision Risk	149	26.6
United Kingdom	272	Industrial Systems Design and Technology	59	21.7
Germany	235	Steel Structures and Mechanical Performance	58	24.7
Canada	224	Safety and Risk Management Systems	37	16.5
Australia	185	Structural Design, Reliability, and Optimization	30	16.2
Italy	175	Maintenance Strategies and Predictive Maintenance	29	16.6
Hong Kong	158	Fire Safety and Building Evacuation	35	22.2

Funders: spotlights and deep dives

Three top funders are spotlighted in the full report for details on their portfolios. The largest funder, the National Natural Science Foundation, covered all topic clusters, with considerable investment in fundamental research in engineering and material science. Of the non-Chinese top funders, the European Commission emphasised safety and risk management work through smaller collaborative projects, and the National Research Foundation of Korea also focused on fundamental science and sustainability as well as reliability and industrial safety.

Four priority sectors are also further explored in the report's deep dive section. Maritime, chemical processing, electrical power and industrial manufacturing sectors are highly relevant to Lloyd's Register Foundation's strategy, and all have seen significant growth in engineering safety research in the past decade. As might be expected, funding patterns already discussed applied, albeit less so in relation to the maritime and electrical power sectors, where funders from the EU such as the Research Council of Norway and European Commission were shown to have significant roles.

4. Implications and limitations

China currently dominates the engineering safety research landscape, raising an important question: is China driving global discovery or responding to industrial needs? The likelihood is that both factors are at play. However, China as a driver of engineering safety research has larger implications for the rest of the world. For example, if most of the engineering safety research literature base is orientated to Chinese engineering safety priorities, we could see a lagging effects in sectors prioritised in other parts of the world and, ultimately, on safety therein.

Why do such large national differences in publications, funding and funder acknowledgement exist? Countries like China and South Korea, which lead on output, rely heavily on government funding and rarely fund across borders, generally maintaining funds 'in-house'. Knowledge sharing and intellectual property priorities are not uniform across organisations and countries, likely contributing to such variable collaboration patterns.

However, the key difficulty with using publications as the primary data source on funding is the variability between countries in tendency to acknowledge funders. Although clearly this does not relate to the number of engineering safety research publications, it does mean that funders from China, for example, were overrepresented in the data, and funders from countries such as Turkey, who were acknowledged much less, were underrepresented. That some countries tend to acknowledge their funders more than others could be due to cultural or systemic factors, or more simply due to differences in stipulation by funders and research organisations.

A limitation of the bibliometric approach is that data not available in the public domain, i.e. through journal sources, is not included. Funded work in the commercial sector, for example, is usually withheld for privacy and protection reasons, which adds to the difficulty in assessing organisational contributions to engineering safety research.

Interestingly, some countries with highly developed infrastructure, such as Japan, do not feature in the top engineering safety research funding or publication lists. This could mean engineering safety research is not a priority there, but it might simply be because Web of Science includes limited publications from East Asia¹ and a multi-database approach would be useful in future.

The aim of this project was to provide an overview of leading engineering safety research and funding activities globally, not impact per se. Although China seems to be highly influential in the engineering safety research world, the extent to which research is applied domestically and in other countries is unclear and generally challenging to assess; however, this could be a focus in future work.

5. Insights and recommendations

This report offers a global snapshot of the engineering safety research funding landscape to inform funders, researchers and policymakers.

We first make recommendations for future research on the engineering safety funding landscape:

- To improve the global representativeness of the sample, future bibliometric research could use a combined database approach. Using both Web of Science and OpenAlex, for example, would have the benefit of including more content from beyond a limited selection of generally high-income economies. Similarly, probing the funding landscape beyond the top 30 funders, to where funding and research is absent, would also broaden the geographical scope of this type of work.
- Considering the significant number of publication retractions in the engineering science disciplines in recent decades^{2,3} we recommend that future research attention is given not only to the number of funded outputs and publications, but also to the quality of those outputs.
- It is also important that future research considers impact. While common quality and impact metrics, such as citations and journal impact score, are also dependent on the availability of information in journal databases, they could complement bibliometric research for this purpose.
- Digital research terms were not part of the search string in this project, but machine learning and data-driven methods still emerged as the top engineering safety research topic. Artificial intelligence is undeniably a global focus and future engineering safety research will benefit from its inclusion.

We also provide some initial suggestions for engineering safety research stakeholders:

- Funders (including Lloyd's Register Foundation) can use this work to infer their place in the engineering safety research funding ecosystem, which we hope will in turn drive portfolio development and the initiation of collaborative calls.
- Researchers can use this work to identify key engineering safety research funders and the availability of funding through relevant and/or local organisations, as well as research gaps, topics of interest, and potential opportunities for domestic and international collaboration.
- Policymakers and professionals can use this work to grow ARIs, infrastructure development plans and skills investment strategies in line with current engineering safety trends and organisational demands.

Last but not least, to improve any research where funding information is collected from publications, we recommend that consistent funder acknowledgement is encouraged across funding and research organisations globally.

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About Lloyd's Register Foundation

Lloyd's Register Foundation is an independent global safety charity that supports research, innovation, and education to make the world a safer place. Its mission is to use the best evidence and insight to help the global community focus on tackling the world's most pressing safety and risk challenges.

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