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Research and innovation capacity in cooperative, connected and automated transport

An assessment based on the Transport Research and Innovation Monitoring and Information System (TRIMIS)

van Balen, M., Grosso, M., Tsakalidis, A., Gkoumas, K., Haq, G. and Pekar, F.

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Research and innovation capacity in cooperative, connected and automated transport - An assessment based on the Transport Research and Innovation Monitoring and Information System (TRIMIS)

The European Commission's Strategic Transport Research and Innovation Agenda (STRIA) defines cooperative, connected and automated transport (CAT) as a key research area. TRIMIS supports STRIA by monitoring the status of transport research across Europe, including CAT. This report maps CAT research and innovation capacity and focuses on framework programmes, the geographical and organisational distribution of funds, as well as investments per Member State and per mode of transport. The results inform policy makers where potential interventions are beneficial.

Contents

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Executive summary

The Transport Research and Innovation Monitoring and Information System (TRIMIS) is the analytical support tool for the establishment and implementation of the Strategic Transport Research and Innovation Agenda (STRIA), and is the European Commission's (EC) instrument for mapping transport technology trends and research and innovation capacities.

A total of seven STRIA roadmaps have been developed covering various thematic areas, namely:

— Cooperative, connected and automated transport;

— Transport electrification;

— Vehicle design and manufacturing;

— Low-emission alternative energy for transport;

— Network and traffic management systems;

— Smart mobility and services; and

— Infrastructure.

Policy context

In May 2017, the European Commission (EC) adopted the Strategic Transport Research and Innovation Agenda (STRIA) as part of the 'Europe on the Move' package (European Commission, 2017a), which highlights main transport research and innovation (R&I) areas and priorities for clean, connected and competitive mobility to complement the 2015 Strategic Energy Technology Plan (European Commission, 2015).

The latest 'Europe on the Move' package adopted by the EC in May 2018 includes a Communication on Automated Mobility. It proposes a strategy that aims to make Europe a world leader for fully automated and connected mobility systems and advances that cooperative, connected and automated transport (CAT) should remain a priority in the next framework programme for research and innovation (European Commission, 2018).

Considering these points, the European Commission has started the development of an updated STRIA roadmap on Cooperative, connected and automated transport, in close cooperation with the Member States (MS) and industry stakeholders. The roadmap will include an action plan for short, medium and long-term R&I initiatives. The present report supports this process with a specific assessment of R&I capacity in connected and automated transport, based on TRIMIS.

Key conclusions

The report provides insights into the status of CAT R&I across Europe from several perspectives. A notable observation is that the spending on CAT research through framework programmes (FP) has increased over time. It was moreover observed that distinct drops in funding exist between the ending and start of each FP.

Funding drops at the end of a FP should be critically assessed, as they may disrupt the continuity of research efforts — a point that is explicitly addressed in the recent Communication on Automated Mobility (European Commission, 2018). The project timelines that were presented in this report could also be used as an instrument to detect drops in funding per transport mode. For instance, while road transport enjoys a continuous number of projects of different sizes, projects on multimodal transport seem to be largely finished by 2018.

Main findings

Various observations were made on research and innovation capacities in CAT. Road transport receives the greatest interest in terms of total funding and the number of

organisations involved. Using spatial analysis it was observed that most CAT research organisations are located near car manufacturers, as well as in large urban centres in western Europe and university cities. A large number of the top 30 beneficiaries perform CAT research on multiple modes of transport. Insights gained from research on one mode can therefore be beneficial to another mode. Still, CAT funding in waterborne transport remained limited. It is of interest to analyse why this is the case and whether additional funding is needed.

Currently most organisations are funded through Research and Innovation Action (RIA) grants. Considering the fast development of CAT technologies, one could consider if RIA should remain the primary instrument for CAT funding or whether the focus should shift towards Innovation Action (IA) and Coordination and Support Action (CSA) funding. The observation that mostly private firms benefit from CAT funding, which is indicative of the market maturity of some CAT technologies, can inform this discussion.

Germany is the largest beneficiary of CAT research funds. Relatively speaking, it appears that organisations from Germany, Finland and Sweden are the most successful in Horizon 2020 (H2020) CAT proposals. The correlation matrix identified strong links as well as gaps in cooperation between organisations from MS. Networking events and targeted linking could help organisations connect across Europe to deliver stronger H2020 proposals in the field of CAT.

Related and future JRC work

The TRIMIS team is expanding the data repository to better assess R&I efforts of projects that are not funded by the EU or national governments. As part of this effort, information will be added on technologies, patents and publications, and various other topics of interest.

Moreover, to better understand the ability of research organisations to develop new partnerships and integrate innovative ideas, the strength of the collaborations between organisations will be assessed in future reports.

Quick guide

The report is structured as follows: Chapter 1 gives a brief introduction. Chapter 2 outlines the methodological background. Chapter 3 presents results on the following CAT R&I indicators: framework programmes, geographical and organisational distribution of funds, investments per MS and mode of transport. Chapter 4, finally, presents the conclusions of the report.

1 Introduction

In May 2017, the European Commission (EC) adopted the Strategic Transport Research and Innovation Agenda (STRIA) as part of the 'Europe on the Move' package (European Commission, 2017a), which highlights main transport research and innovation (R&I) areas and priorities for clean, connected and competitive mobility to complement the 2015 Strategic Energy Technology Plan (European Commission, 2015).

The STRIA roadmaps set out common priorities to support and speed up the research, innovation and deployment process leading to radical technology changes in transport. One of the STRIA roadmaps defines future research needs for developing and deploying cooperative, connected and automated transport (CAT) technologies and systems for all modes of transport. The importance of the CAT roadmap was restated in the latest 'Europe on the Move' package of May 2018 through a dedicated Communication on Automated Mobility.

The STRIA roadmap on CAT focuses on a list of actions to develop technologies and support their swift deployment while ensuring competitiveness. The actions cover the following themes:

- Active management of CAT technologies
- User and societal acceptance
- Socioeconomic impacts
- Environmental and climate impacts
- Human–machine interface
- Innovative hybrid vehicles
- Cybersecurity and data protection
- ICT infrastructure
- Optimised use of internet of things, data and governance.

CAT is a high priority on the European research agenda, as it is expected to impact the transport sector as well as other areas, including regional development, energy, climate change, economic growth, jobs and skills (European Commission, 2017b; 2017c; Alonso et al., 2017; 2018).

To better understand the status and capacity of CAT R&I in Europe, this report leverages socioeconomic and financial data from the Transport Research and Innovation Monitoring and Information System, also known as TRIMIS ([1]) (European Commission, 2017d). The analysis focuses on European Union (EU) co-funded projects that cover all modes of transport.

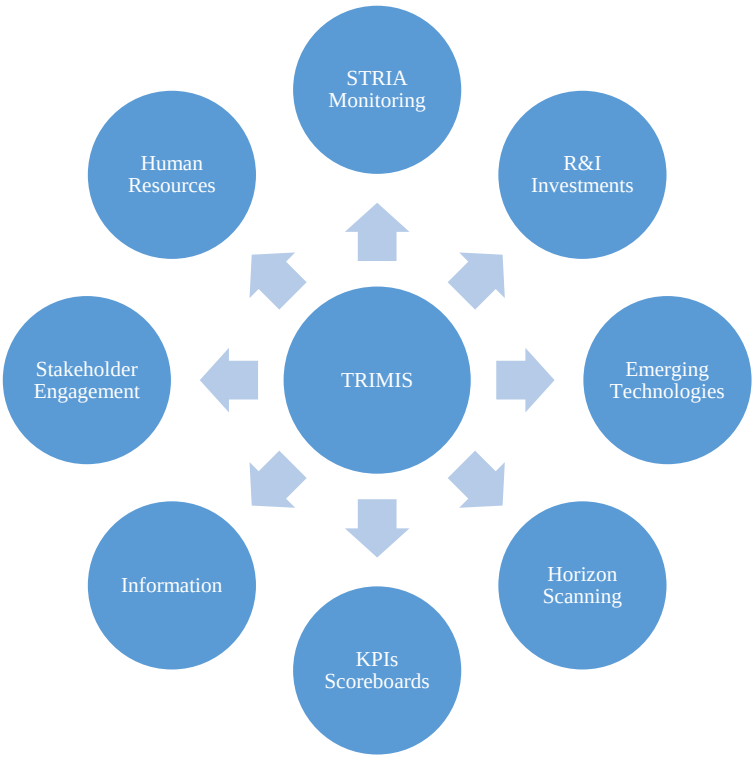
The report is structured as follows: Chapter 2 outlines the methodological background. Chapter 3 presents results on economic indicators concerning CAT R&I along several dimensions: framework programmes, geographical and organisational distribution of funds, investments per Member State (MS) and mode of transport. Chapter 4, finally, presents the conclusions of the report.

([1]) https://trimis.ec.europa.eu

2 Methodology

The EC Joint Research Centre (JRC) has developed TRIMIS to support the implementation of STRIA. TRIMIS provides an effective monitoring and information mechanism that assists the development and updating of STRIA and supports analyses on transport R&I (European Commission, 2017a; 2017d). It hosts a continuously updated extensive database of EU and MS programmes and projects (currently over 6 500) on transport R&I (Tsakalidis et al., 2018a). The projects are classified according to the seven roadmaps identified in STRIA (European Commission, 2017a). The figure below illustrates the topics that TRIMIS covers.

Figure 1. TRIMIS main features and functionalities



Source: Tsakalidis et al., 2018b.

Information in the TRIMIS database is enriched by data from several other sources, including the Community Research and Development Information Service (CORDIS) and other EC and external databases.

Based on the information within the database a list of indicators was established that improve our understanding of the capacity of CAT R&I in Europe (See Annex). The indicators cover several dimensions, including: financial, technological, organisational, legal, and socioeconomic elements. For each indicator a description is provided together with the measurement unit, source and data availability.

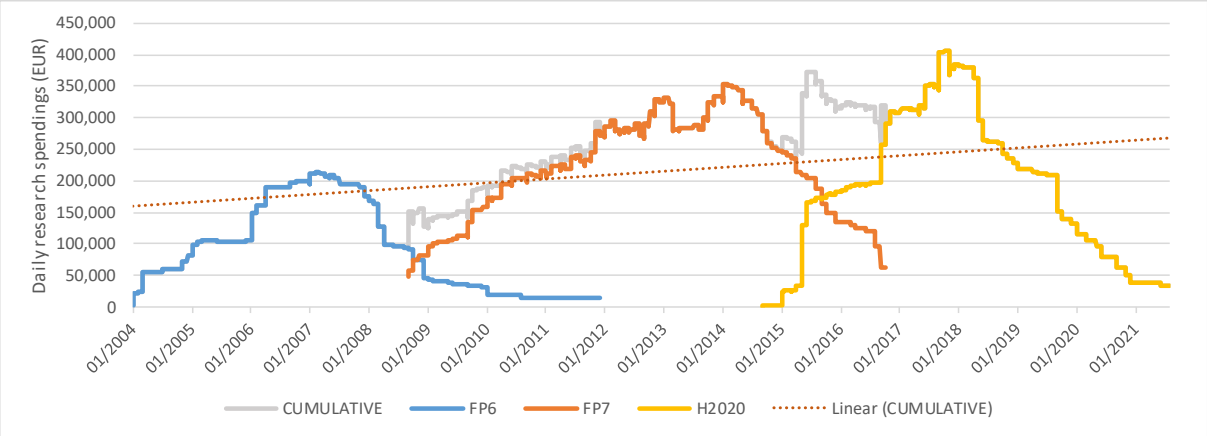
The current report builds on these indicators and focuses primarily on projects that fall under the Horizon 2020 Framework Programme (H2020), given that the data quality of H2020 projects is the highest and these projects represent the state of the art. The data was extracted from the TRIMIS database in March 2018.

3 Assessment of CAT research

3.1 Framework programmes analysis

Figure **2** provides an overview of framework programme (FP) investments in CAT research. Overall, an increase in spending on CAT research is observed. At the same time, the graph identifies drops in research spending at the end and beginning of each FP.

Figure 2. Daily CAT R&I spending under framework programmes

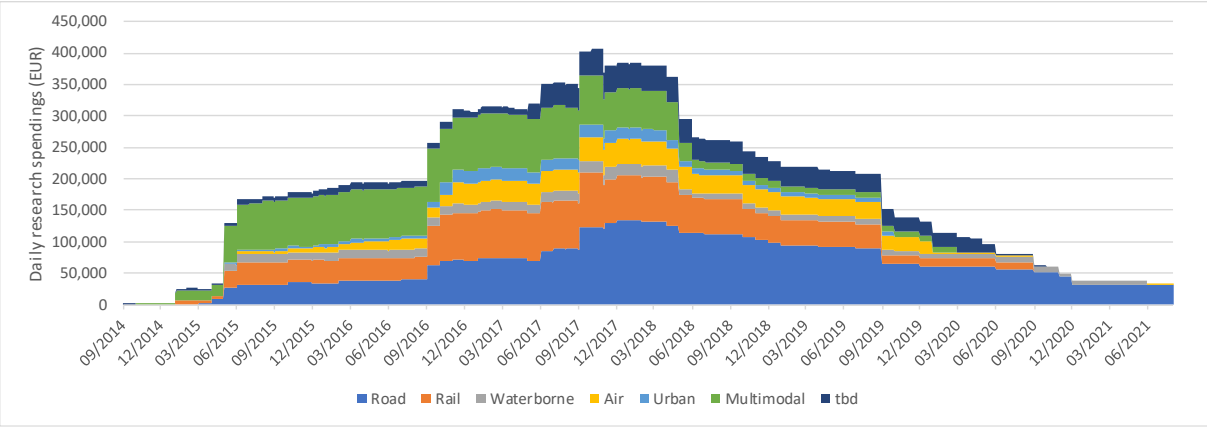


Source: TRIMIS

Under H2020 a total of EUR 473 million has been invested in CAT research. This includes EUR 406 million of EU funds and EUR 67 million of own contributions by beneficiary organisations. Figure **3** shows the average daily H2020 related spending for each transport mode. The investments peaked at approximately EUR 400 000 of daily research spending by late 2017.

It is noticeable that the multimodal category is relatively large compared to the other categories. The reason is in part methodological, as projects that relate to road and urban transport were categorised as multimodal projects. An additional finding is the limited CAT research that is uniquely dedicated to waterborne transport. Although not all projects have yet been assigned to a transport mode, it seems likely that there is a comparatively smaller interest in connected and automated waterborne transport.

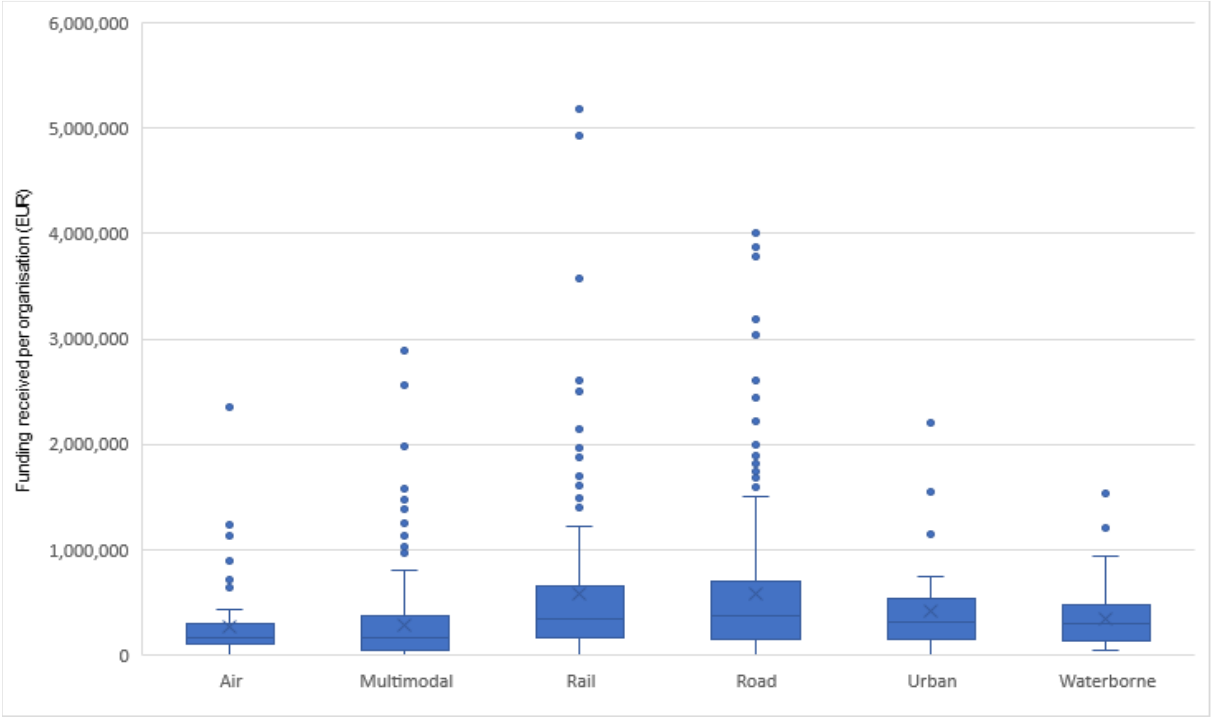
Figure 3. Daily H2020 CAT R&I spending per transport mode



Source: TRIMIS.

Figure **4** provides an additional perspective on research spending per mode of transport. It highlights the variation in CAT research funding amongst the beneficiary organisations. The median funding is highest for organisations that conduct research in road transport, closely followed by rail. The aviation sector receives a smaller portion of the H2020 funds in the field of CAT. The outliers represent organisations that received large amounts of funding.

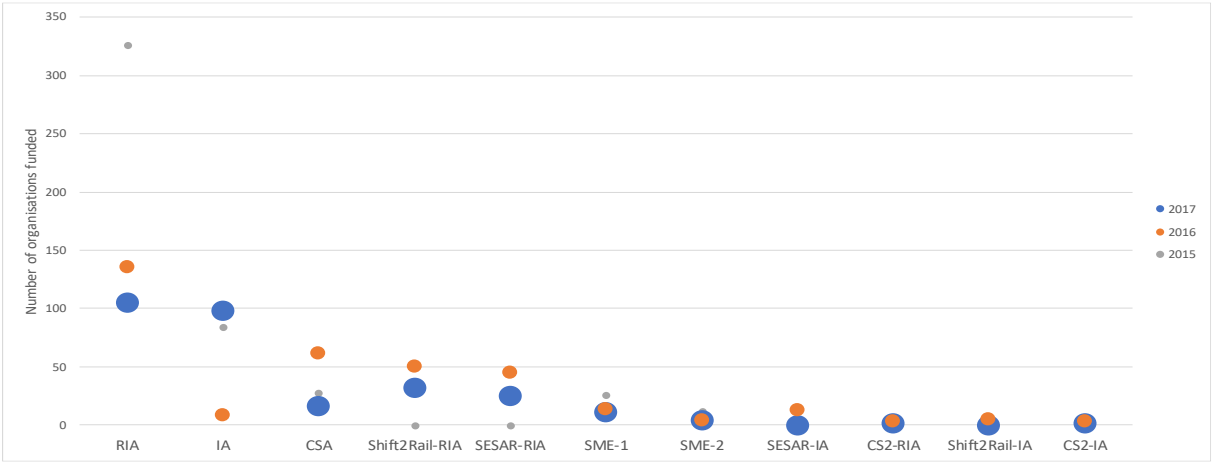
Figure 4. Variation in H2020 CAT R&I spending per transport mode



Source: TRIMIS.

Figure **5** shows an analysis on the various funding schemes under H2020. The Research and Innovation Actions (RIA) scheme funds the largest number of organisations, albeit the numbers have decreased. In 2015, a total of 326 organisations were awarded funds, falling to 105 beneficiaries in 2017. It is also visible that the joint undertakings (JU) invested in CAT projects as of 2016 (see the projects under Shift2Rail and SESAR).

Figure 5. H2020 CAT funding beneficiaries per scheme (*)



(*) Research and Innovation Action (RIA); Innovation Action (IA); Coordination and Support Action (CSA); SME instrument (SME)

Source: TRIMIS.

3.2 Geographical and organisation analysis

In total 868 organisations received funding for CAT research, with an average of EUR 468 000. Table **1** shows the top 30 beneficiaries, the total amount of funds received and their research focus in terms of transport mode. Some organisations focus exclusively on CAT in one mode of transport, whereas others are active in CAT across several modes. The blue bars in the table indicate the percentage of funds that are dedicated to research in that mode for each organisation.

Of the top 30 beneficiaries, 18 are active in road transport, 14 in rail, and five in aviation. Organisations that are active in the field of road transport typically are also involved in research on other transport modes.

Table 1. Top 30 H2020 CAT funding beneficiaries, including division between transport modes

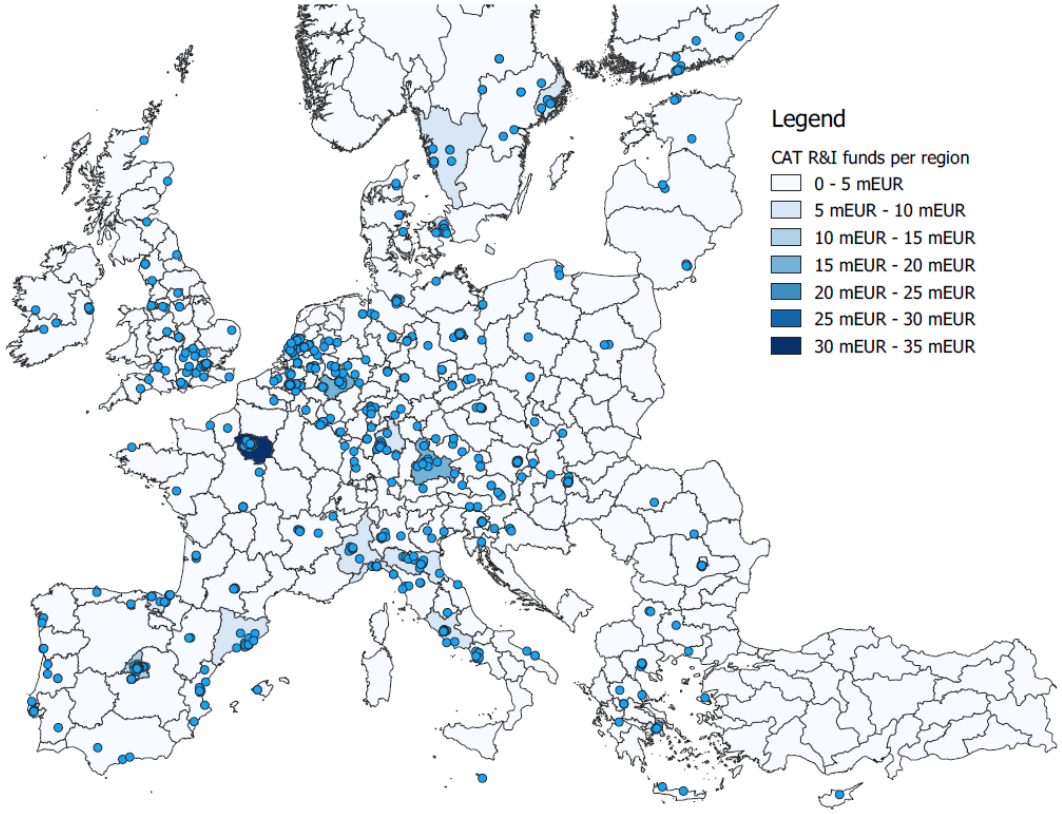
		mEUR	% Road	% Rail	% Water	% Air	% Urban	% Multi	% tbd
DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV	€	8.7	46	12	0	27	0	5	10
SIEMENS AKTIENGESELLSCHAFT	€	5.2	0	100	0	0	0	0	0
ALSTOM TRANSPORT SA	€	4.9	0	100	0	0	0	0	0
INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS	€	4.3	32	0	0	15	17	11	25
CENTRO RICERCHE FIAT SCPA	€	4.3	74	0	0	0	14	0	12
CEA	€	4.1	29	0	0	0	0	71	0
FRAUNHOFER	€	4.0	20	11	0	10	0	40	20
RENAULT SAS	€	3.9	78	0	0	0	16	0	6
VOLKSWAGEN AG	€	3.9	100	0	0	0	0	0	0
BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT	€	3.8	68	0	0	0	0	0	32
VOLVO PERSONVAGNAR AB	€	3.8	100	0	0	0	0	0	0
THALES COMMUNICATIONS & SECURITY SAS	€	3.7	0	47	0	0	0	53	0
ANSALDO	€	3.6	0	100	0	0	0	0	0
UNIVERSITY OF LEEDS	€	3.1	62	15	0	0	0	0	22
INDRA SISTEMAS SA	€	3.1	0	52	0	12	0	35	0
TECHNISCHE UNIVERSITEIT DELFT	€	2.9	2	20	27	44	0	0	7
CHALMERS TEKNISKA HOEGSKOLA AB	€	2.7	81	0	19	0	0	0	0
Teknologian tutkimuskeskus VTT Oy	€	2.7	82	13	0	0	0	0	5
KIR	€	2.6	0	100	0	0	0	0	0
STICHTING OPEN TICKETING	€	2.6	0	0	0	0	0	100	0
ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS	€	2.5	49	0	0	0	0	39	13
BOMBARDIER TRANSPORTATION GMBH	€	2.5	0	100	0	0	0	0	0
TOYOTA MOTOR EUROPE	€	2.4	100	0	0	0	0	0	0
ERTICO	€	2.4	73	0	0	0	14	0	13
FORD-WERKE GMBH	€	2.2	79	0	0	0	0	21	0
INDOORATLAS OY	€	2.2	0	0	0	0	100	0	0
ANSALDO STS S.p.A.	€	2.2	0	100	0	0	0	0	0
PERPETUUM LIMITED	€	2.1	0	100	0	0	0	0	0
IDIADA AUTOMOTIVE TECHNOLOGY SA	€	2.1	72	0	0	0	13	15	0
LEADEC ENGINEERING GMBH	€	2.0	0	0	0	0	0	100	0

Source: TRIMIS.

The top 30 beneficiaries received approximately EUR 100 million of funding, which is 25 % of the total budget. The funding is thus spread amongst a relatively large number of organisations. The number of projects in which the top 30 beneficiaries participate ranges from 4 to 16.

Organisations in all MS receive funding, but research clusters are clearly observable in Figure 6. Areas where car manufacturers are active or have their headquarters legally registered (e.g. southern Germany, northern Italy, Île-de-France) are notably present. western European urban areas and university cities are equally well represented.

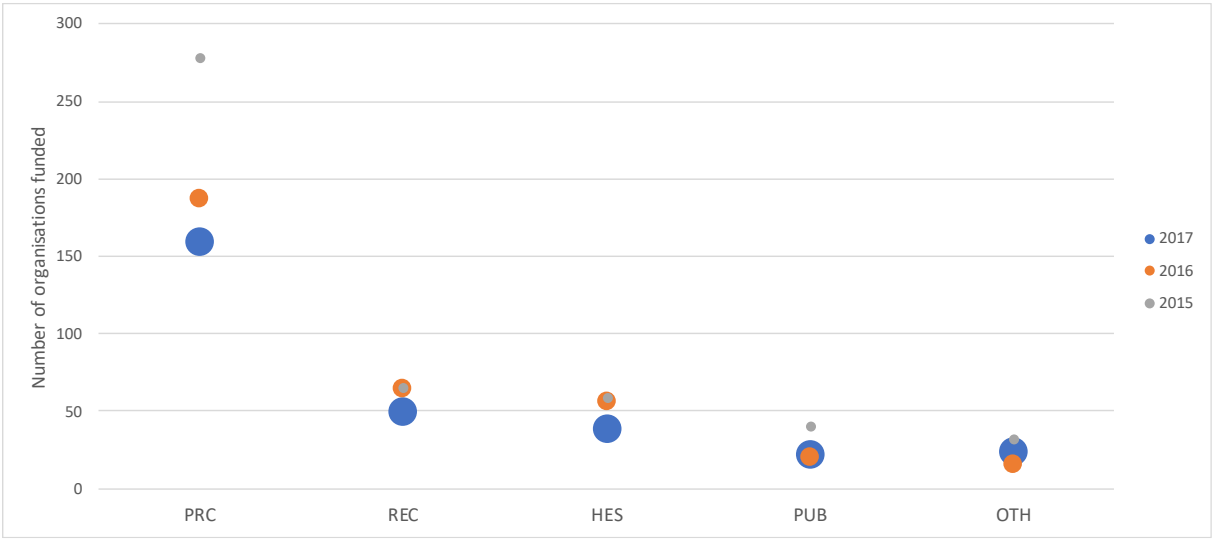
Figure 6. Location of H2020 CAT funding beneficiaries



Source: TRIMIS

When considering the type of organisations that receive CAT research funding it is observed that private companies benefit most (see Figure 7). Whilst the number of private companies that was awarded funding decreased over time, this group remains the largest. This can be indicative of the market readiness of several technologies that are developed in the H2020 projects.

Figure 7. H2020 CAT funding beneficiaries per type of organisation (*)



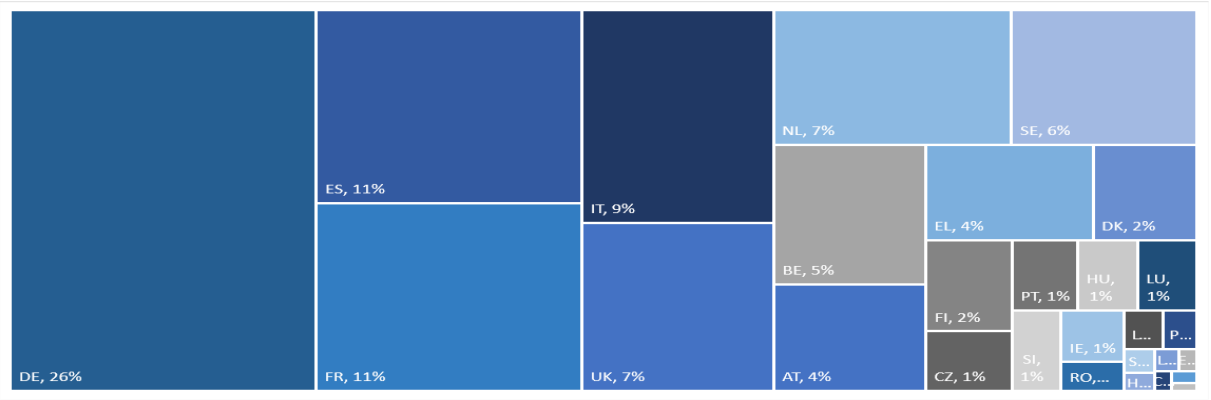
(*) Private companies (PRC); research organisations (REC); higher education establishments (HES); public sector (PUB); other (OTH).

Source: TRIMIS.

3.3 Member State analysis

An assessment of H2020 CAT research in terms of acquired funds received by MS, shows that Germany is the largest beneficiary (see Figure **8**). This reflects the high number of German manufacturers and research organisations in the field of transport compared to other countries. A strong imbalance is moreover noticeable as beneficiaries of EU-13 countries receive ~ 5 % of all CAT research funding.

Figure 8. Member State shares of H2020 CAT funding



Source: TRIMIS.

Table **2** provides a more detailed overview on the funds received per MS, showing the total amount of funding received for CAT and the division per transport mode.

Table 2. H2020 CAT funding MS performance, including division between transport modes

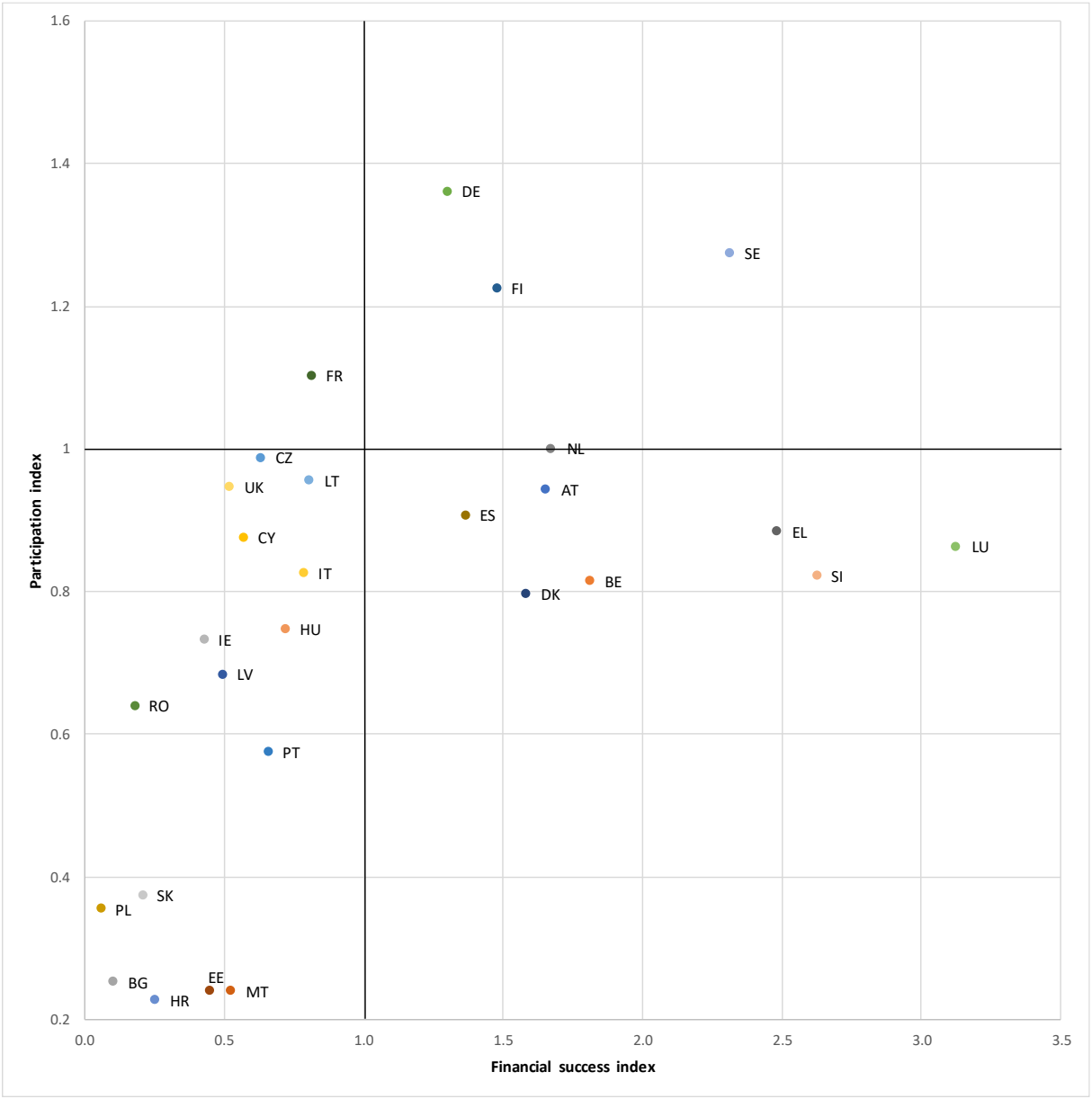
Member State		mEUR	% Road	% Rail	% Water	% Air	% Urban	% Multi	% tbd
DE	€	101.0	46	20	2	5	2	13	11
ES	€	44.4	26	34	0	6	7	20	7
FR	€	43.2	32	28	3	6	4	24	3
IT	€	35.3	26	33	0	5	7	21	8
UK	€	27.9	32	23	1	10	0	25	10
NL	€	27.8	36	6	14	9	0	24	11
SE	€	21.7	36	35	10	0	0	14	5
BE	€	18.4	42	3	8	5	2	20	19
AT	€	14.1	19	32	4	2	3	16	25
EL	€	13.8	38	0	0	6	8	23	26
DK	€	8.6	15	4	58	9	0	3	13
FI	€	6.8	38	9	9	0	33	4	8
CZ	€	4.5	24	61	0	1	0	13	0
PT	€	4.0	1	5	0	10	0	50	34
HU	€	3.6	23	0	5	41	0	17	14
LU	€	3.6	5	0	0	0	26	51	18
SI	€	3.4	42	27	0	0	0	28	4
IE	€	2.8	45	29	0	16	0	6	5
RO	€	1.6	0	74	0	0	0	18	9
LT	€	1.3	4	0	0	2	0	0	94
PL	€	1.1	4	7	49	13	0	26	0
SK	€	0.7	47	3	0	0	40	0	11
HR	€	0.5	0	61	0	5	0	24	11
LV	€	0.5	0	0	21	0	0	79	0
EE	€	0.3	0	0	30	0	0	70	0
CY	€	0.3	0	0	0	0	0	100	0
BG	€	0.3	0	34	0	21	0	0	45
MT	€	0.2	0	0	60	40	0	0	0
EU28	*€*	*391.5*	*34*	*22*	*5*	*6*	*4*	*19*	*11*

Source: TRIMIS.

To understand the relative performance of MS, the participation and financial success rates are normalised based on gross domestic product (GDP) in 2016. The participation rate assesses the involvement of organisations from one MS compared to the total participation. Similarly, the financial success rate assesses the total amount of granted funds of a MS as compared to the total CAT R&I funding. A score of one indicates an average performance, with scores above or below one being better or worse respectively.

Figure **9** shows three strong performers in terms of participation and financial success, namely Germany, Finland and Sweden. A large number of countries in the lower right quadrant succeed in attracting larger funds with relatively fewer organisations. This may be indicative of a few expert organisations in these MS. The lower left corner shows a large number of countries that are involved less in H2020-funded CAT research relative to what could be expected based on the MS size.

Figure 9. Participation and financial success rate of Member States



Source: TRIMIS.

Collaborations between MS were assessed using a correlation matrix (see Figure **10**). The analysis looked into the organisations that participate within the same projects. The higher the value, the more common it is that organisations from those MS collaborate.

It should be noted that the values are influenced by the (sometimes) limited number of participating organisations. Such is especially the case for EU-13 MS. Despite this limitation there are several linkages that become apparent, such as the collaboration between Germany, France and Sweden.

Figure 10. Correlation matrix on Member State collaborations in H2020 CAT funding

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
AT	-																											
BE	0.15	-																										
BG	-0.06	0.05	-																									
CY	0.09	0.17	-0.01	-																								
CZ	0.20	0.32	-0.04	-0.02	-																							
DE	0.18	0.39	0.00	-0.01	0.33	-																						
DK	0.09	0.02	-0.02	-0.01	-0.01	-0.01	-																					
EE	0.05	0.18	-0.02	-0.01	0.09	0.01	0.53	-																				
EL	0.14	0.33	-0.05	0.07	-0.04	0.30	0.09	-0.05	-																			
ES	0.07	0.40	-0.08	0.06	0.23	0.31	0.01	0.09	0.28	-																		
FI	0.19	0.14	-0.04	-0.02	-0.02	0.19	0.36	0.17	0.03	0.16	-																	
FR	0.12	0.44	-0.07	0.02	0.24	0.59	0.09	0.17	0.13	0.51	0.20	-																
HR	0.10	0.02	-0.02	-0.01	0.05	-0.07	0.02	-0.03	-0.02	0.01	-0.05	-0.01	-															
HU	0.16	0.09	-0.04	-0.02	-0.08	-0.01	-0.01	-0.05	0.10	-0.05	-0.08	-0.06	0.04	-														
IE	0.05	0.03	-0.03	-0.02	0.00	0.12	0.00	-0.03	0.04	0.01	0.04	0.17	0.58	-0.05	-													
IT	0.08	0.48	0.05	0.06	0.22	0.32	-0.03	0.10	0.25	0.55	0.17	0.58	0.12	-0.03	0.03	-												
LT	-0.01	-0.03	-0.02	-0.01	0.07	-0.08	0.01	-0.02	-0.04	-0.04	-0.04	-0.02	0.12	-0.04	0.06	-0.03	-											
LU	0.02	0.10	0.11	-0.02	-0.07	-0.04	-0.04	-0.04	0.03	0.00	-0.06	0.07	0.13	0.12	-0.04	0.24	-0.03	-										
LV	0.04	-0.06	-0.02	-0.01	-0.03	-0.02	0.66	0.34	0.03	-0.07	0.27	0.02	-0.02	-0.03	-0.02	-0.06	-0.02	-0.03	-									
MT	0.04	-0.06	0.40	-0.01	-0.03	0.01	0.66	0.34	-0.04	-0.07	0.27	0.02	-0.02	-0.03	-0.02	0.05	-0.02	-0.03	0.49	-								
NL	0.10	0.49	0.02	0.03	0.10	0.40	0.01	-0.04	0.28	0.20	0.07	0.28	0.02	0.13	0.19	0.08	-0.06	0.12	-0.05	-0.05	-							
PL	0.06	0.04	-0.03	-0.02	0.02	-0.08	0.57	0.28	-0.05	0.03	0.33	0.03	0.18	0.02	0.02	0.16	0.10	0.10	0.41	0.41	0.01	-						
PT	0.16	0.21	0.22	-0.02	-0.07	-0.04	-0.04	-0.04	0.15	-0.03	0.03	0.01	-0.04	0.20	0.02	0.02	-0.03	0.37	-0.03	-0.03	0.02	-0.05	-					
RO	0.00	0.03	-0.02	-0.01	-0.04	-0.02	0.05	0.24	-0.05	-0.09	-0.04	0.07	-0.03	-0.04	-0.03	-0.06	-0.02	0.09	-0.02	-0.02	-0.01	-0.03	0.04	-				
SE	0.16	0.16	-0.05	-0.03	0.12	0.54	0.31	0.12	0.09	0.30	0.31	0.55	0.00	0.10	0.08	0.29	-0.01	-0.06	0.21	0.21	0.11	0.19	0.02	0.02	-			
SI	0.18	0.04	-0.03	-0.02	-0.05	-0.05	-0.03	-0.03	0.12	0.00	-0.05	-0.05	0.33	0.31	0.22	0.02	-0.03	0.20	-0.02	-0.02	0.03	0.02	0.39	0.13	-0.01	-		
SK	0.14	0.19	-0.03	-0.01	0.19	0.19	0.00	-0.03	0.07	0.20	0.14	0.27	0.13	-0.05	0.16	0.32	0.16	-0.04	-0.02	-0.02	-0.05	0.10	0.02	-0.03	0.06	-0.04	-	
UK	0.14	0.34	-0.03	0.42	0.06	0.27	0.17	0.23	0.29	0.21	0.10	0.43	0.16	0.17	0.08	0.39	-0.07	0.25	0.05	0.05	0.20	0.10	0.08	0.20	0.16	0.21	0.01	-

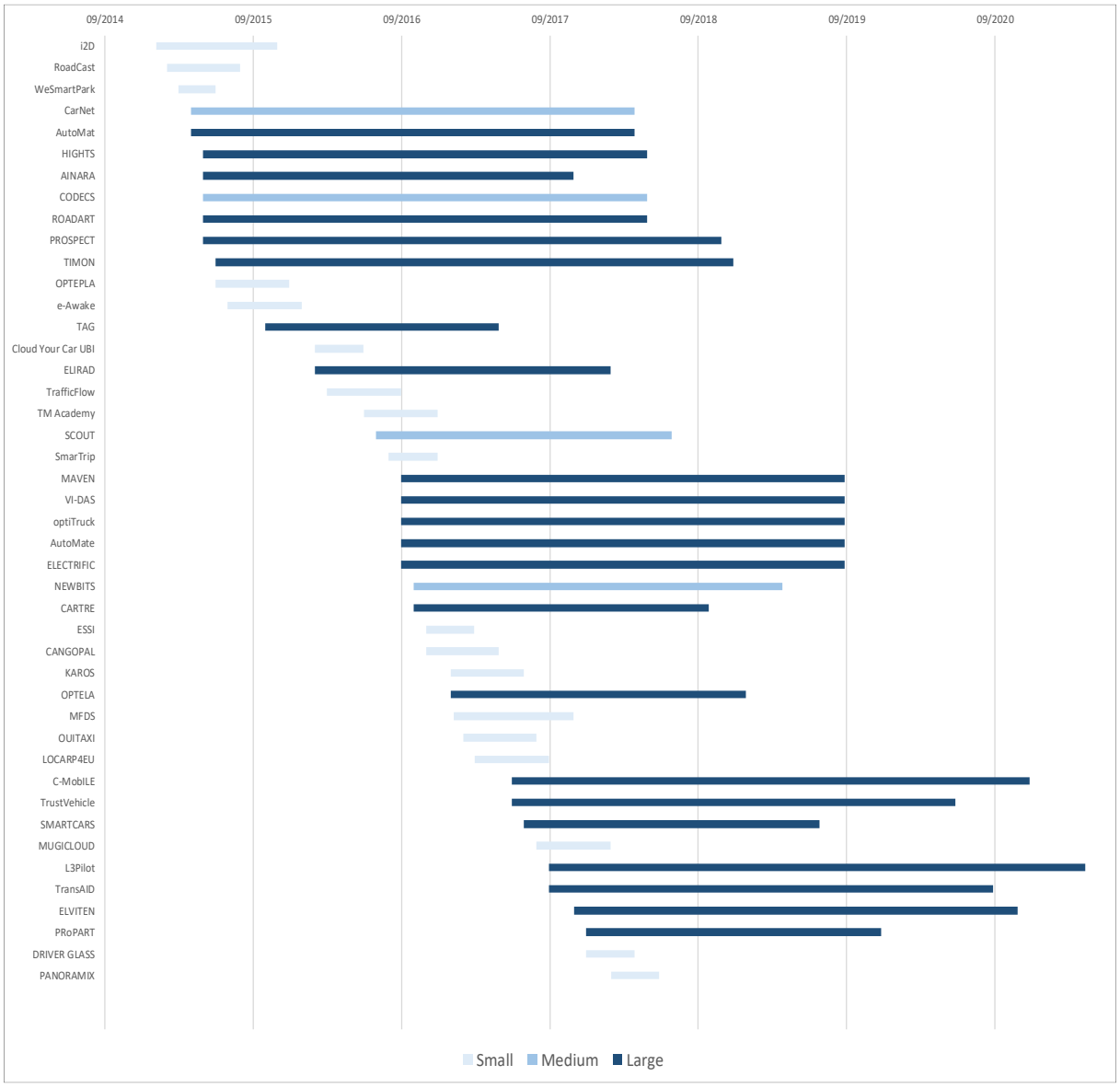
Source: TRIMIS.

3.4 Transport mode analysis

This final section of the results chapter provides on overview of the CAT projects that have been conducted, showing their timelines and associated funding. The timelines are split per transport mode, so that the research efforts per field can be more clearly identified. The funding categories are split into small (< EUR 500 k), medium (EUR 500 k-2 000 k) and large (> EUR 2 000 k) projects.

Figure **11** shows that in the field of road transport most projects received a large amount of funding. A total number of 44 road transport research projects were funded, which typically cover a 3-year period.

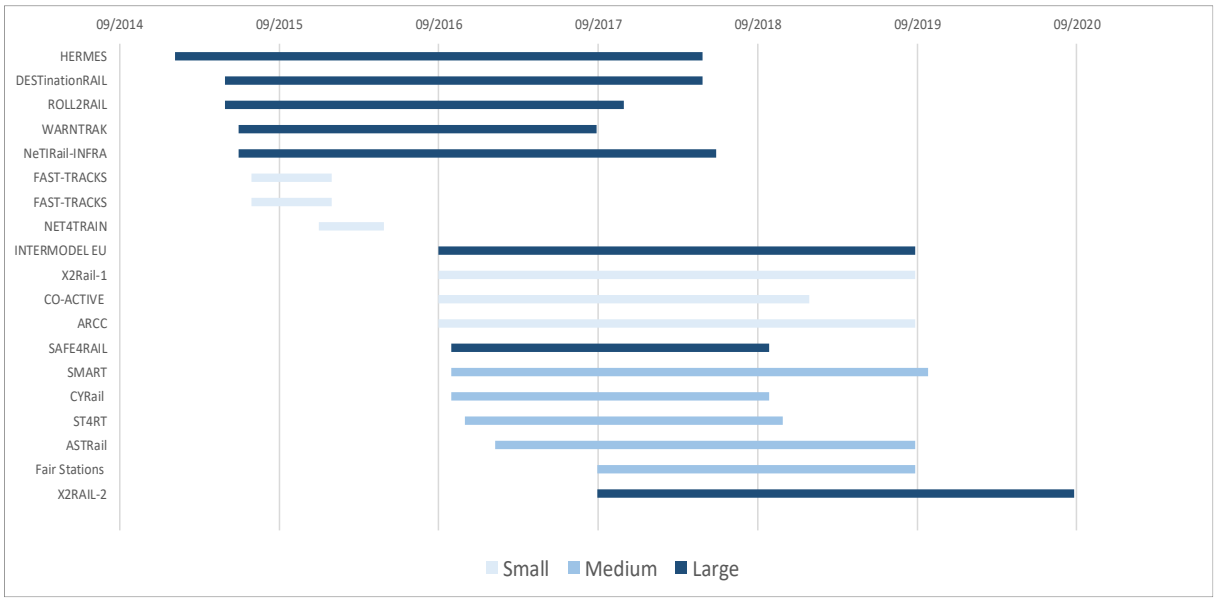
Figure 11. H2020 CAT projects in road transport



Source: TRIMIS.

Figure **12** shows the rail transport-related CAT projects under H2020. It is observed that there are fewer rail transport projects compared to road transport. The projects show a balanced spread between small, medium and large projects. Five of the larger projects ended at the beginning of 2018, while 11 projects are still ongoing.

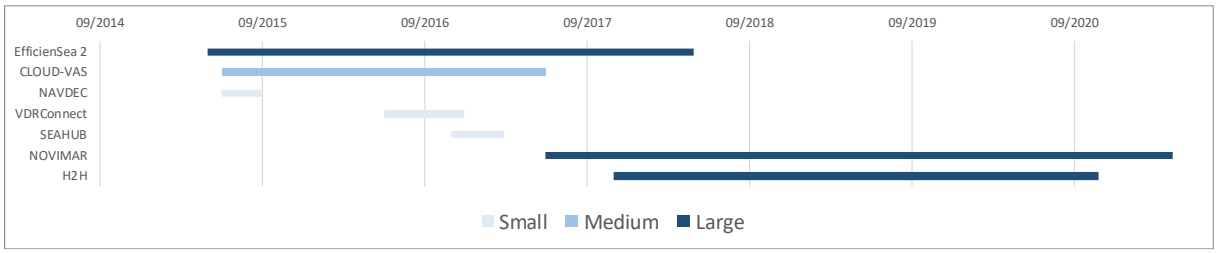
Figure 12. H2020 CAT projects in rail transport



Source: TRIMIS.

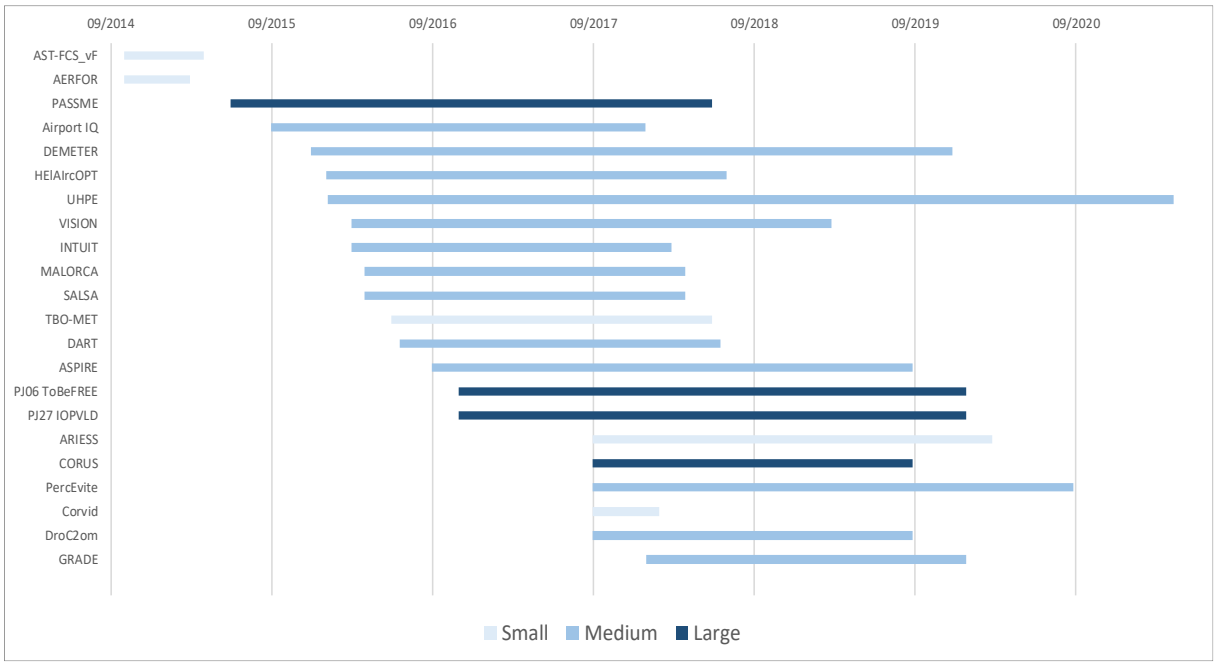
As indicated before there is a relatively smaller focus on CAT research in waterborne transport. The projects and their timelines are shown in Figure 13. The projects that are conducted are however quite large in terms of funding received. This includes EfficienSea 2 (~ EUR 9.7 million) and Novimar (~ EUR 7.9 million). The number of projects and involved organisations remains nevertheless quite small compared to CAT research on the other modes of transport.

Figure 13. H2020 CAT projects in waterborne transport



CAT research in air transport mostly occurs through medium-sized projects. The projects are spread throughout time and are larger in number than the rail projects (see Figure **14**). Most projects fall under the H2020 schemes that are managed by the SESAR JU. A few smaller SME projects are identified as well, including those that focus on small electric passenger aircraft (i.e. Corvid).

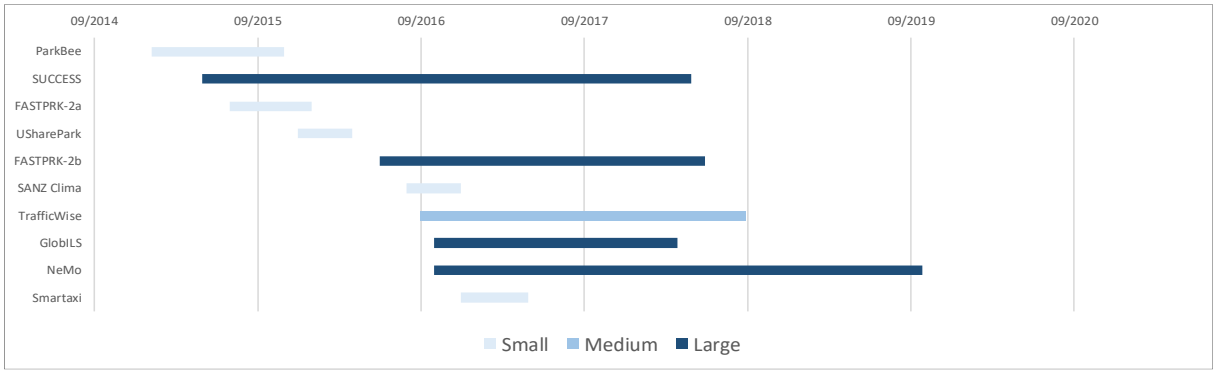
Figure 14. H2020 CAT projects in air transport



Source: TRIMIS.

In the field of urban transport there were 10 projects identified that focus exclusively on urban transport (see Figure **15**). However, as stated, several urban transport projects were labelled as multimodal projects because they also explicitly involved road and/or rail transport. To gain a better understanding of research efforts in the field of urban transport one should therefore also consider several of the multimodal transport research projects.

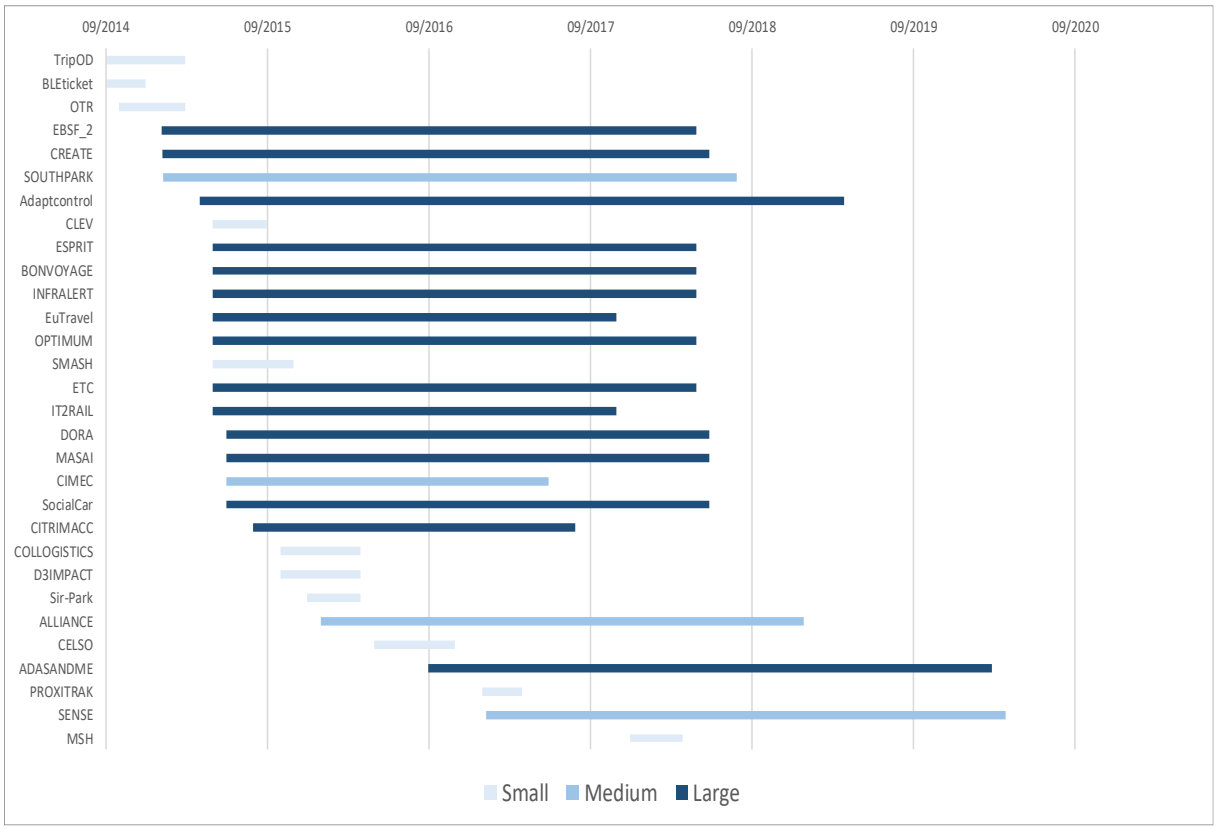
Figure 15. H2020 CAT projects in urban transport



Source: TRIMIS.

The multimodal transport field concerns mostly large projects with a duration of 3 years. However, it should be noted that research projects in this field have largely ended and few projects are ongoing (Figure **16**). Such research gaps should be carefully considered when determining future funding actions to ensure the durability of research efforts in this field.

Figure 16. H2020 CAT projects in multimodal transport



Source: TRIMIS.

In conclusion, CAT research is ongoing in each of the modes of transport, with strongest interest in road and rail transport. The types, size and timeline of projects that are funded varies however substantially between the various transport modes.

4 Conclusions

The report provides insights into the status of CAT R&I across Europe from several perspectives. It was found that the spending on CAT research through framework programmes has increased over time. It was moreover observed that distinct drops in funding exist between the ending and start of each FP.

Drops in funding at the end of an FP should be critically assessed, as they may disrupt the continuity of research efforts — a point that is explicitly addressed in the recent communication on automated mobility (European Commission, 2018). The project timelines that were presented in this report could be used as an instrument to detect drops in funding per transport mode. For instance, while road transport enjoys a continuous number of projects of different sizes, projects on multimodal transport seem to be largely finished by 2018.

Overall it was observed that road transport is the mode that receives greatest interest in terms of total funding and the number of organisations that are researching CAT. Using spatial analysis it was shown that most CAT research organisations are located near car manufacturers, as well as in large urban centres in western Europe and university cities.

A large number of the top 30 beneficiaries perform CAT research on multiple modes of transport. Insights gained from research on one mode can therefore be beneficial to another mode. Having said that, CAT funding in waterborne transport remained limited. It is relevant to analyse why this is the case and whether additional funding is called for.

Currently most organisations are funded through RIA grants. Considering the fast development of CAT technologies, one could consider if RIA should remain the primary instrument for CAT funding or whether the focus should shift towards IA and CSA funding. This discussion can be informed by the observation that mostly private firms benefit from CAT funding, which is indicative of the market maturity of some CAT technologies.

Germany is the largest beneficiary of CAT research funds. Relatively speaking, it appears that organisations from Germany, Finland and Sweden are the most successful in H2020 CAT proposals. The correlation matrix identified strong links as well as gaps in cooperation between organisations from MS. Networking events and targeted linking in CAT research could help organisations to better connect across Europe to deliver stronger H2020 proposals.

To better understand the ability of research organisations to develop new partnerships and integrate innovative ideas, the strength of the collaborations between organisations could also be further assessed.

The analysis is subject to several limitations as well, namely:

- The most recent H2020 projects were not yet categorised in the TRIMIS database, and are therefore not included.
- Information on some variables was missing and therefore classified as 'tbd' or 'unknown', as shown in some of the figures above. These data gaps are in the process of being resolved.
- For some indicators that were mentioned in the Annex, no information could be provided due to data availability issues. It is expected that future reports will provide information on these indicators as well.

Whilst acknowledging these limitations, this report does offer a comprehensive and up-to-date overview on the capacity of CAT research across Europe. The report therefore provides relevant insights to update the STRIA Roadmap on CAT.

Annex

List of indicators

	Indicator category	Focus	Indicator	Description	Unit	Source	Currently available
1	Financial	Input	Total amount of money spent in Europe in Transport R&D	Sum of money spent on Transport R&D projects	Euro	CORDIS/TRIMIS	YES
2	Financial	Input	Cash flow in Transport R&D Projects	Average daily investment in Transport R&D projects	Euro	CORDIS/TRIMIS	YES
3	Financial	Input	Total amount of money spent in Transport R&D according to funding scheme	Sum of money spent on Transport R&D projects according to the funding scheme	Euro	CORDIS/TRIMIS	YES
4	Financial	Input	Total amount of money spent in Transport R&D for each mode of transport	Sum of money spent on Transport R&D projects per mode of transport	Euro	CORDIS/TRIMIS	YES
5	Financial	Input	Total EU contribution in Transport R&D	Sum of EU money granted to Transport R&D projects	Euro	CORDIS/TRIMIS	YES
6	Financial	Input	Total amount of money spent in Transport R&D for freight/passengers/combined	Sum of money spent on Transport R&D projects according to the following transport sectors: freight, passenger and the two combined	Euro	CORDIS/TRIMIS	YES
7	Financial	Input	Total amount of money spent in Transport R&D based on NUTS classification	Sum of money spent on Transport R&D projects according to territorial statistics units, NUTS Nomenclature	Euro	CORDIS/TRIMIS/ Eurostat	YES
8	Financial	Input	Total amount of money spent in Transport R&D according to organisation type	Sum of money spent on Transport R&D projects according to the following types of organisations: Higher or Secondary Education Establishments, Research Organisations, Private for-profit entities (excluding Higher or Secondary Education Establishments), Public bodies (excluding Research Organisations and Secondary or Higher Education Establishments), Other	Euro	CORDIS/TRIMIS	YES
9	Financial	Input	Total amount of money spent in Transport R&D according to projects partners' names	Sum of money spent on Transport R&D projects per beneficiary	Euro	CORDIS/TRIMIS	YES

	Indicator category	Focus	Indicator	Description	Unit	Source	Currently available
10	Financial	Input	Total amount of money spent in each MS in Transport R&D	Sum of money spent on Transport R&D projects in each MS	Euro	CORDIS/TRIMIS	YES
11	Financial	Input	Total EU contribution in Transport R&D in each MS	Sum of EU money granted to Transport R&D projects in each MS	Euro	CORDIS/TRIMIS	YES
12	Financial-Organisational-Socio-economic	Input	Participation Index	Normalised rate (based on GDP) of Transport R&D project participation per MS	Rate	CORDIS/TRIMIS	YES
13	Financial	Input	Financial success index	Normalised rate (based on GDP) of Transport R&D project funding per MS	Rate	CORDIS/TRIMIS	YES
14	Organisational	Input	Level of cooperation among MSs and projects participants	List and description of cooperation initiatives (Agreements/collaborations/partnerships) among MSs and among projects participants	Number/ Description	CORDIS/TRIMIS/ COMPASS/CORDA/ EXPERTS	PARTIALLY
15	Transport	Input	Projects timeline according to transport modes	Start and end data of projects per mode of transport	Number of projects	CORDIS/TRIMIS	YES
16	Legal	Input	List or relevant legal initiatives at European level	List and description of the relevant legal initiatives linked to the RM implementation	Number/ Description	EUR-Lex/EXPERTS	YES
17	Financial	Input	Total amount of money spent in Transport R&D according to beneficiary names and mode of transport	Sum of money spent on Transport R&D projects according to the beneficiary names and transport modes	Euro	CORDIS/TRIMIS	YES
18	Technological-Organisational	Input	Projects timeline according to technologies	Projects evolution during years according to technology types	Number of projects	CORDIS/TRIMIS	YES
19	Financial-Organisational	Input	Projects timeline according to Funding Scheme	Projects evolution during years according to Funding Scheme	Number of projects	CORDIS/TRIMIS	YES
20	Socio-economic	Input	Total number of staff working on Transport R&D projects	Total number of staff mentioned in Transport R&D projects	Number	CORDIS/TRIMIS/ COMPASS/CORDA	PARTIALLY
21	Socio-economic	Input	Total number of man-months involved on Transport R&D projects	Total number of man-months that worked on the Transport R&D projects	Number	CORDIS/TRIMIS/ COMPASS/CORDA	PARTIALLY

	Indicator category	Focus	Indicator	Description	Unit	Source	Currently available
22	Socio-economic	Input	Total number of full-time equivalent (FTE) units working on Transport R&D projects	Total number of FTE that worked on the Transport R&D projects	Number	CORDIS/TRIMIS/ COMPASS/CORDA	PARTIALLY
23	Socio-economic	Input	Total number of people involved in Transport R&D projects according to expertise fields	Total number people involved in Transport R&D projects classified according to the following backgrounds/field of expertise: Exact sciences, Economics, Legal, Administrative	Number	CORDIS/TRIMIS/ COMPASS/CORDA	PARTIALLY
24	Socio-economic	Input	Total number of people involved in Transport R&D projects according to gender	Total number of people involved in Transport R&D projects classified according to their gender	Number	CORDIS/TRIMIS/ COMPASS/CORDA	PARTIALLY
25	Socio-economic	Input	Average age of the people involved in Transport R&D projects	Average age of the people involved in the Transport R&D projects	Average age	CORDIS/TRIMIS/ COMPASS/CORDA	PARTIALLY
26	Organisational	Input	Level of international cooperation in Transport R&D	Correlation matrix based on collaborations between organisations in the MS	Number/ Description	CORDIS/TRIMIS/ COMPASS/CORDA/ Experts	PARTIALLY
27	Socio-economic	Input	Small Medium Enterprise (SME) participation	Number of SME companies participating in Transport R&D projects	Number	CORDIS/TRIMIS/ CORDA	PARTIALLY
28	Socio-economic	Output	Patent's application	Number of patents applications for each company participating in Transport R&D projects	Number	CORDIS/TRIMIS/ CORDA	PARTIALLY
29	Socio-economic	Output	Bibliometrics - Number of scientific publications	Number of scientific publications for each company participating in Transport R&D projects	Number	CORDIS/TRIMIS/ CORDA	PARTIALLY

References

Alonso Raposo, M., Ciuffo, B., Makridis, M. and Thiel, C., 2017 (2017), *The r-evolution of driving: from Connected Vehicles to Coordinated Automated Road Transport (C-ART), Part I: Framework for a safe & efficient Coordinated Automated Road Transport (C-ART) system*, EUR 28575 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-79-68606-1, doi:10.2760/052089, JRC106565

Alonso Raposo M., Grosso, M., Després, J., Fernández Macías, E., Galassi, C., Krasenbrink, A., Krause, J., Levati, L., Mourtzouchou, A., Saveyn, B., Thiel, C. and Ciuffo, B., *An analysis of possible socio-economic effects of a Cooperative, Connected and Automated Mobility (CCAM) in Europe — Effects of automated driving on the economy, employment and skills*, EUR 29226 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-85857-4, doi:10.2760/777, JRC111477

European Commission (2015), *Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation* C/2015/6317 final, Brussels.

European Commission (2017a), *Towards clean, competitive and connected mobility: the contribution of Transport Research and Innovation to the Mobility package* SWD/2017/0223 final, Brussels.

European Commission (2017b), GEAR 2030, *High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union: final report*, 2017a, available at: https://ec.europa.eu/docsroom/documents/26081/attachments/1/translations/en/renditions/native (last accessed 3 May 2018).

European Commission (2017c), 'Europe on the Move: An agenda for a socially fair transition towards clean, competitive and connected mobility for all', Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2017) 283, available at: https://ec.europa.eu/transport/sites/transport/files/com20170283-europe-on-the-move.pdf (last accessed 3 May 2018).

European Commission (2017d), *Transport Research and Innovation Monitoring and Information System (TRIMIS) programmes and projects database*, JRC109363, http://publications.jrc.ec.europa.eu/repository/handle/JRC109363, Ispra (last accessed 8 June 2018).

European Commission (2018), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 'On the road to automated mobility: An EU strategy for mobility of the future', COM/2018/283 final.

Tsakalidis, A., Gkoumas, K., Pekar, F., Grosso, M., Haq, G. and Marelli, L. (2018a), *EU Transport Research & Innovation Status Assessment Report 2017: An overview based on the Transport Research and Innovation Monitoring and Information System (TRIMIS) database*, EUR 29032 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-79-77358-7, doi:10.2760/39908, JRC109784.

Tsakalidis, A., Gkoumas, K., Pekar, F., Grosso, M., Haq, G. and Marelli, L. (2018b), 'Towards an integrated European platform for monitoring and analysing transport research and innovation (TRIMIS)', Proceedings of 7th Transport Research Arena, 16-19 April 2018, Vienna, Austria.

List of abbreviations and definitions

AT	Austria
BE	Belgium
BG	Bulgaria
CAT	connected and automated transport
CORDA	Common Research Data Warehouse
CORDIS	Community Research and Development Information Service
CSA	Coordination and Support Action
CY	Cyprus
CZ	Czech Republic
DE	Germany
DG MOVE	Directorate-General for Mobility and Transport
DG RTD	Directorate-General for Research and Innovation
DK	Denmark
EC	European Commission
EE	Estonia
EL	Greece
ES	Spain
EU	European Union
EU-13	Group of 13 EU countries: Bulgaria (BG), Czech Republic (CZ), Croatia (HR), Cyprus (CY), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Malta (MT), Poland (PL), Romania (RO), Slovakia (SK) and Slovenia (SI)
EUR	euro
FI	Finland
FP	framework programme
FR	France
GDP	gross domestic product
H2020	Horizon 2020 framework programme
HR	Croatia
HU	Hungary
IA	innovation action
IE	Ireland
IT	Italy
JRC	Joint Research Centre
JU	joint undertaking
LT	Lithuania
LU	Luxembourg
LV	Latvia

MS	Member States
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
R&D	Research and Development
R&I	Research and Innovation
RIA	Research and Innovation Action
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia
SME	small and medium-sized enterprises
STRIA	Strategic Transport Research and Innovation Agenda
TRIMIS	Transport Research and Innovation Monitoring and Information System
UK	United Kingdom

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