European Commission

JRC SCIENCE FOR POLICY REPORT

Innovation capacity in the transport sector: a European outlook

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

Grosso, M., Ortega Hortelano, A., Marques dos Santos, F., Tsakalidis, A., Gkoumas, K. and Pekár, F.

2020

Joint Research Centre

EUR 30326 EN

Contact information
Name: Ferenc Pekár
Address: European Commission, Joint Research Centre (JRC), Vie E. Fermi 2749, I-21027, Ispra (VA) - Italy
Email: ferenc.pekar@ec.europa.eu
Tel.: +39 0332 783925

EU Science Hub
https://ec.europa.eu/jrc

JRC121463

EUR 30326 EN

PDF	ISBN 978-92-76-21045-0	ISSN 1831-9424	doi:10.2760/592161
Print	ISBN 978-92-76-21044-3	ISSN 1018-5593	doi:10.2760/839590

Luxembourg: Publications Office of the European Union, 2020

How to cite this report: Grosso, M., Ortega Hortelano, A., Marques dos Santos, F., Tsakalidis, A., Gkoumas, K. and Pekár, F. *Innovation capacity in the transport sector: a European outlook. An assessment based on the Transport Research and Innovation Monitoring and Information System (TRIMIS),* EUR 30326 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-21045-0, doi:10.2760/592161, JRC121463.

Unless otherwise indicated, all figures and tables derive from JRC analysis.

Contents

Abstract

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. Seven STRIA Roadmaps have been developed which cover various thematic areas.

TRIMIS provides periodical assessments of transport research and innovation (R&I) for the various thematic areas. This report provides a macro-level assessment of the overall innovation capacity in the European transport sector and complements the analysis with the results of an Innovation Capacity survey distributed to private and public transport stakeholders aiming at gathering insights on transport research trends, drivers and enablers, challenges, role of policy measures, etc. This report updates the previous TRIMIS report on the topic and complements the analysis with the results of a TRIMIS stakeholder survey.

The finding of the analysis show that research and development (R&D) activities are key in transport, where the private sector is mostly engaged. Business investments in R&D in the transport sector amounted to more than €47 billion in 2017 and total European public investment in transport R&D in 2018 was equal to €2.9 billion. Transport researchers and R&D personnel amounted to 309.000 people working in the European transport sector in 2017, the majority of them working in the automotive industry.

The outcomes of the TRIMIS survey reflect the views and opinions of transport stakeholders. The results show an almost unanimous opinion in relation to the key role that R&I plays in relation to the quality of the services or goods provided, moreover the competitiveness of the transport sector will be enhanced when R&I activities are intensified. Although almost all the stakeholders recognised the importance of R&I, they also pointed out obstacles and barriers, such as financial constraints and management, market dynamics, lack of qualified personnel that slow down or prevent them to fully engage in such activities.

Acknowledgements

The European Commission's Joint Research Centre (JRC) is responsible of the development of the Transport Research and Innovation Monitoring and Information System (TRIMIS). The work has been carried out under the supervision of the European Commission's Directorate-General for Mobility and Transport (DG MOVE) and Directorate-General for Research and Innovation (DG RTD) which are co-leading the Strategic Transport Research and Innovation Agenda (STRIA). The authors would like to acknowledge the support of Hannah Figg of Ricardo-AEA Ltd. The views expressed here are those of the authors and may not, under any circumstances, be regarded as an official position of the European Commission.

Authors

Monica Grosso, European Commission, Joint Research Centre

Alejandro Ortega Hortelano, European Commission, Joint Research Centre

Fabio Marques dos Santos, European Commission, Joint Research Centre

Anastasios Tsakalidis, European Commission, Joint Research Centre

Konstantinos Gkoumas, European Commission, Joint Research Centre

Ferenc Pekár, European Commission, Joint Research Centre

Executive summary

This report provides an assessment of the innovation capacity of the European transport, looking at research and development (R&D) indicators, complemented by the results of a TRIMIS survey on the topic.

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[1] [2], which highlights key transport research and innovation (R&I) areas and priorities for clean, connected and competitive mobility, under seven roadmaps. The STRIA roadmaps set out common priorities to support and speed up the research, innovation and deployment process leading to technology changes in transport that can act as enablers for future transport trends.

In May 2018, the EC published the third Mobility Package with the objective to allow citizens to benefit from safer traffic, less polluting vehicles and more advanced technological solutions, while supporting the competitiveness of the EU industry.[3]

The European Green Deal[4] aims at decreasing emissions by 90% by 2050, where transport R&I actions are key to support their implementation. In this direction, the upcoming Strategy on Sustainable and Smart Mobility[5] will pursue the objective of reducing CO_2 and pollutant emissions and will exploit technological pathways towards digitalisation and automation, aiming at ensuring safer and more accessible transport. The role played by R&I is central in achieving a more sustainable transport system.

Main findings and conclusions

R&D activities are key in transport, where the private sector is mostly engaged. Business investments in R&D in the transport sector amounted to more than €47 billion in 2017; business R&D expenditures have increased by almost 12% since 2015, with the automotive industry leading the trend. European Member States with strong design and manufacturing automotive industries are the ones with higher business investments.

Total European public investment in transport R&D in 2018 was equal to €2.9 billion, showing a decrease compared to the year 2017, when the total amount was around €3.3 billion.

Transport researchers and R&D personnel amounted to 309.000 people working in the European transport sector in 2017, the majority of them working in the automotive industry. The researchers were roughly 40% of the total people counted.

The second part of the research, through the TRIMIS survey, extended the analysis beyond the R&D indicators and included transport stakeholders' views on the topic, through an online survey followed by phone-interviews. The outcomes of the TRIMIS survey refer to the views and opinions of transport stakeholders based on their experience that could differ according to their transport sector, to the geographical coverage and also in relation to national or transport mode specificities. Although differences in experiences and views exist, some common understandings were retrieved from the web and phone survey.

The results show an almost unanimous opinion in relation to the key role that R&I plays in relation to the quality of the services or goods provided, moreover the competitiveness of the transport sector will be enhanced when R&I activities are intensified. Although almost all the stakeholders recognised the importance of R&I, they also pointed out obstacles and barriers, such as financial constraints and management, market dynamics, lack of qualified personnel that slow down or prevent them to fully engage in such activities. In this view, effort is needed to help them in decreasing or overcoming such obstacles.

Financial means are at the core of transport R&I activities, showing the high commitment of the private sector that seems to claim insufficient business resources and to recognise the vital role played by public funding. It is noteworthy that the main issue does not seem to be the funding availability, rather the difficulty to access public funding, especially in relation to certain R&I areas, and to manage the funding framework through the

[1] Commission staff working document — Towards clean, competitive and connected mobility: the contribution of transport research and innovation to the mobility package, SWD(2017) 223, Brussels. (European Commission, 2017b)

[2] Europe on the move - An agenda for a socially fair transition towards clean, competitive and connected mobility for all, COM(2017) 0283 final, Brussels. (European Commission, 2017a)

[3] Europe on the move - Sustainable Mobility for Europe: safe, connected, and clean COM/2018/293 final, (European Commission, 2018)

[4] The European Green Deal, COM(2019)640 final, Brussels. European Commission (2019a).

[5] Commission Work Programme 2020, A Union that strives for more Brussels, COM(2020) 37 final, Brussels.

entire project life. Some stakeholders pointed at the scarce visibility of certain funding options, hampering interested actors to equally compete for such funding. It would be therefore advisable to invest on focused communication and dissemination activities to ensure a broader and differentiated audience.

Some stakeholders mentioned that a crucial and very often problematic phase in research activities is the one from design and planning to market uptake. The common concern is that the time lag is very often too long, leading to slowing down piloting activities and hence market distribution, which could create a cascade effect, decreasing market competitiveness and affecting company revenues. Market dynamics, as uncertainty market demand or different levels of competitiveness, influence very much R&I activities and cannot be entirely steered; nonetheless the stakeholders interviewed did not fail to mention that specific regulatory measures could streamline the overall research process and increase its effectiveness and efficiency.

Market competition has been identified as a stimulus to R&I activities. Nonetheless, collaboration among transport stakeholders does not always come as an easy task, mainly when private operators are involved, that acknowledge though the benefits deriving from R&I collaboration. These contradictory elements lead transport stakeholders to face challenging situations when it comes to working together and cooperating in R&I activities, namely in project consortiums, where the access to the partnerships, the role played and the project management could become laborious. Some stakeholders witnessed situations where "big" partners would benefit from the project, putting in the shade others with smaller roles, sizes, etc. This point was mainly referring to SMEs, which although having access to dedicated financial means, still can find challenging to participate in really innovative projects.

A key aspect is the role played by transport researchers. It is a shared opinion that qualified and skilled personnel are crucial to achieve high quality R&I outcomes, though it is also commonly observed that it is not always possible to count on qualified researchers, especially in the public sector. Considering the importance of transport researchers to perform R&I activities, as clearly shown also from the results of the TRIMIS survey, it would be suitable to have more knowledge and data on the profile and characteristics of transport researchers.

The research trends identified by the transport stakeholders, at present, are mainly the ones of automation, decarbonisation and digitalisation. Moreover, other relevant trends are the ones of social impacts, user's acceptance and participatory approach through all transport R&I phases, from planning to implementation and market uptake.

Overall, the identified trends can mirror a general view on how the transport sector has changed or is approaching towards future scenarios, showing a more structural change the transport sector is facing. In this frame, the transport sector is seen as a key part of an overall complex system comprising economic, environmental and social aspects. In this perspective, policy plays a main role in the development of transport R&I, both as a driver and as an enabler to boost it. Stakeholders agreed to state the key role played by policy measures, especially those linked to the introduction of greener technologies, environmental protection and safety conditions, which are at the core of EU policies. Policy measures can also act as drivers for R&I activities, which could be both linked to specific topics, as the ones mentioned earlier, but could also serve as a framework to facilitate stakeholders' engagement and participation in R&I activities. The analysis showed that there is a need for a clearer research framework, which could encompass several aspects, such as access to data and information, clearer dissemination and promotion means related to R&I initiatives and funding opportunities aiming at broadening the target audience, streamlining the administrative and bureaucratic procedures and increasing visibility of projects' results, best practices and challenges faced.

Related and future JRC work

The JRC has launched TRIMIS in 2017 on behalf of DG MOVE and DG RTD and has published a number of Science for Policy and Technical reports[6] that directly support the STRIA process and the related roadmaps. This report cuts through the STRIA Roadmaps and provides a macro-level assessment of the overall innovation capacity in the European transport sector. It does so by identifying and assessing R&D indicators, updating the first TRIMIS Report on Innovation Capacity in Europe[7] (Grosso et al., 2019). The current report, moreover,

[6] https://trimis.ec.europa.eu/archive/trimis/documents

[7] Grosso, M., van Balen, M., Ortega Hortelano, A., Haq, G., Gkoumas, K., Tsakalidis, A. and Pekár, F. (2019) Innovation Capacity of the European Transport Sector, A macro-level analysis, EUR 29749 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-03655-5

complements the R&D indicators assessment through the analysing the results of a TRIMIS survey on the topic. TRIMIS will continue with a periodic assessment of the European transport R&I capacity.

Quick guide

The report is structured as follows:

Chapter 1 gives a brief introduction and background on the topic. Chapter 2 presents the rationale and the methodological approach used. Chapter 3 shows the results of the innovation capacity assessment in Europe and Chapter 4 provides the results of the dedicated TRIMIS survey of stakeholders. Chapter 5 presents the conclusions of the analysis.

1 Introduction

The present TRIMIS report updates the analysis on innovation capacity of the European transport sector (Grosso et al., 2019) and improves it by including the results of a survey on the viewpoint of private and public transport stakeholders.

Nowadays the transport sector is faced with many challenges that the modern society is imposing, congestion, accidents, increasing pollution, and complex logistic management to mention a few (European Union, 2019). Research and Innovation (R&I) in transport is addressing these and other aspects aiming to increase transport efficiency. A more efficient and competitive transport sector will enhance European economy and will benefit the mobility of our society, helping to achieve the sustainable development goals defined by the United Nations. (United Nations, 2015)

Transport R&I is at the core of European policies, as indicated in the European Green Deal (European Commission, 2019a). With the aim of decreasing emissions up to 90% by 2050, the European commission (EC) proposes a list of key actions that transport R&I will support in their implementation.

In 2017, the EC released the "Europe on the Move" mobility package (European Commission, 2017a) including the Strategic Transport Research and Innovation Agenda (STRIA) (European Commission, 2017b), which identifies seven priority areas (roadmaps):

- Connected and automated transport (CAT);
- Transport electrification (ELT);
- Vehicle design and manufacturing (VDM);
- Low-emission alternative energy for transport (ALT);
- Network and traffic management systems (NTM);
- Smart mobility and services (SMO); and
- Transport infrastructure (INF).

This TRIMIS report provides a macro-level assessment of the overall innovation capacity in the European transport sector and complements the analysis with the results of an Innovation Capacity survey that focused on private and public transport stakeholders aiming at gathering insights on transport research trends, drivers and enablers, challenges, role of policy measures, etc.

This report provides an updated overview of the status of transport R&I in Europe that acts as a reference when assessing the individual STRIA roadmaps (Tsakalidis et al., 2020a). Overall, the outcome of this report can contribute to the discussion on transport R&I priorities and the related policy measures.

The report is divided into five chapters. Chapter 1 briefly introduces the topic. Chapter 2 presents the rationale and the methodological approach. Chapter 3 shows the results of the innovation capacity assessment in Europe and Chapter 4 provides the results of the TRIMIS survey. Chapter 5 presents the conclusions of the analysis.

2 Rationale and methodological approach

This research maps transport innovation capacity in Europe: defines Europe's performance, reflects on the drivers and bottlenecks, and provides recommendations to improve the European position.

Research in this field is scarce and the existing analyses have different approaches or methodologies (Wiesenthal et al., 2011 and 2015; Tsamis et al., 2016), except for the TRIMIS report on "Innovation Capacity in European Transport Sector" which follows the same methodology used in this report (Grosso et al, 2018, 2019). Nonetheless, the scope of this analysis is wider. It is developed in two phases, which are linked to each other: the first phase looks at R&D indicators and analyses the relevant European performance, while the second part of the work includes the development and management of the TRIMIS survey with transport stakeholders.

In exploring this issue, the present analysis intends to shed light on the current European R&I transport capacity, looking at financial and human resources; moreover, the role of R&I within the transport sector has been assessed, taking into consideration the main enablers as well as the obstacles that support or prevent its development respectively. To this aim, major R&I trends have been taken into consideration, together with the impacts of policies measures.

2.1 Methodology of assessing innovation capacity

The assessment of innovation capacity focuses on indicators linked to R&D funding, human resources engaged in R&D and patenting activities. An important group of indicators is linked to innovation engagement of the business sector, nonetheless these indicators are collected every two years within the European Community Innovation Survey and the last available data have been analysed and included in Grosso et. al. (2019).

The indicators presented in this analysis are shown in Table 1.

Table 1 R&D Indicators

Area of Indicator	Indicator	Description
Funding	Business expenditure on R&D (BERD)	BERD represents the component of Gross domestic expenditure on R&D (GERD) incurred by units belonging to the business enterprise sector. It is the measure of intramural R&D expenditures within the business enterprise sector during a specific reference period
Funding	Business R&D Intensity	Total business R&D spending as percentage of Gross Domestic Product (GDP)
Funding	Total Government Budget Appropriations or Outlays for Research and Development (GBAORD)	The GBAORD measures the government support for research and development activities. GBAORD include all appropriations given to R&D in central government budgets
Funding	Total GBAORD as a % of total general government expenditure	Percentage over government expenditure
Human resources	Total R&D personnel in business enterprise	Total number of persons employed in research in a specific sector
Human resources	Total R&D researchers in business enterprise	Total number of researchers employed in a specific sector
Innovation engagement	Patent applications to the European Patent Office(EPO)	Patent applications filed directly under the European Patent Convention or to applications filed under the Patent Co-operation Treaty and designated to the EPO

Source: Grosso et al. (2018).

In this report, the Oslo Manual definition of innovation has been used, defining innovation as: "…the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations".

Within the Oslo Manual definition, different types of innovations are identified: product, process, organisational and marketing innovations[8]. (OECD/Eurostat, 2005).

The data included in this report are the most up-to-date one[9] and refer to the transport sector in Europe and in each Member State (MS). When data are missing a note has been added. To overcome problems in comparing data in time series, an estimation has been made, using the average method (i.e. using years before and after the gap year).

The Eurostat data used in this report, follow the Statistical Classification of Economic Activities (NACE) Rev.2 and the Statistical Classification of Socio-economic Objectives (NABS) 2007 classifications.

Transport activities mainly belong to the following NACE Rev.2 categories:

- C29 (Manufacture of motor vehicles, trailers and semi-trailers);
- C30 (Manufacture of other transport equipment) and
- H (Transportation and storage)[10].

Annex 1 provides a detailed description of each category of transport-related economic activities. For the majority of the indicators considered a distinction among C29, C30 and H is provided. The two manufacturing economic activities, C29 and C30, are presented separately as they substantially differ in characteristics and market structure.

In the NABS 2007 classification the transport sector is captured in Chapter 4 - Transport, telecommunication and other infrastructures (see Annex 2).

The main source of information is Eurostat (European Commission, 2019b), namely the following datasets:

- Structural Business Statistics (SBS);
- Research and Development;
- Patents.

Moreover, additional information was collected from:

- EC – Industrial R&D Investment Scoreboard (European Commission, 2019c);
- EC – European Innovation Scoreboard (European Commission, 2019d);
- Organisation for Economic Co-operation and Development (OECD) – Science, Technology and Industry Outlook (OECD, 2020);

For some indicators, the high number of missing data imposes caution in interpreting the outcomes and could entail underestimation of the figures presented.

2.2 Survey methodology

With the second part of the research, the analysis is extended beyond the R&D indicators and includes transport stakeholders' views on the topic, through an online survey followed by phone-interviews.

A questionnaire was developed and distributed to European private and public transport stakeholders from November 2019 until March 2020. Through a purposive sample approach, (Bryman, 2012) the target group for

[8] Product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics). Process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. Organisational innovation is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations. Marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

[9] Data were retrieved in December 2019.

[10] The NACE REV.2 classification provides a 4-digit specification of indicators, which is the most detailed level available for the different economic activities. Within the Eurostat datasets the level of data disaggregation varies. It is therefore not always possible to compare indicators on the same level of data disaggregation. In this study, where possible, the 3-digit codes have been considered, while in many cases the 2-digit level was the only available disaggregation. G45 (Wholesale and retail trade and repair of motor vehicles and motorcycles) also belong to the transport sectors within NACE Rev. 2, nonetheless no representative data are available for many of the indicators considered, therefore it is not included in this analysis.

this survey was composed of transport experts with R&I experience and knowledge. The sample was selected from the list of stakeholders within the TRIMIS network. To ensure a broader coverage, representatives from all transport modes operating in European countries were selected; this allowed to capture a variety of perspectives from across the spectrum of the European transport sector.

The TRIMIS survey "Innovation Capacity of the European Transport Sector" was included two steps. In the first step, respondents were asked to fill in a web survey, at the end of which they could express their availability to have a phone-interview, as a second step, in order to further examine some topics. The web survey was chosen as it represents a cost-effective and swift solution (Bryman, 2012).

Experts have been first contacted by emails that contained the background information and a link to the web survey: 38 responses were gathered during the survey period, among these respondents 11 declared their availability to be contacted for a phone-interview, of which 9 took place eventually. Once respondents expressed their intention to take part in the second phase of the survey, they were contacted by email to agree on the phone interview schedule.

For the web survey, a questionnaire has been designed (see Annex 3) which aimed at gathering information on innovation capacity of the transport sector, focusing on: innovation activities, barriers and enablers. After an introduction describing the aim of the survey, respondents were asked for some general information on their fields of expertise, their seniority and their experience with regards to transport funding means. The main body of the questionnaire was composed by closed questions where respondents could express their level of agreement or disagreement on a five-point Likert scale (ranging from 1= strongly disagree to 5= strongly agree). According to the type of organisation where the respondent worked, either private or public, the questionnaire would be adapted and slightly modified in terms of the number and type of questions to match the type of the respondents. To this aim, EU-Survey, the EC tool for online surveys was used[11]. The full list of the web survey respondents is presented in Annex 4.

Moreover, at the end of the survey, the respondents were given the possibility to add any additional input or comments on R&I. The ones that would be willing to further contribute to the TRIMIS survey, with a phone call interview, could express their availability in the concluding part of the survey. The average time to fill in the questionnaire was estimated to be between 10 and 15 minutes.

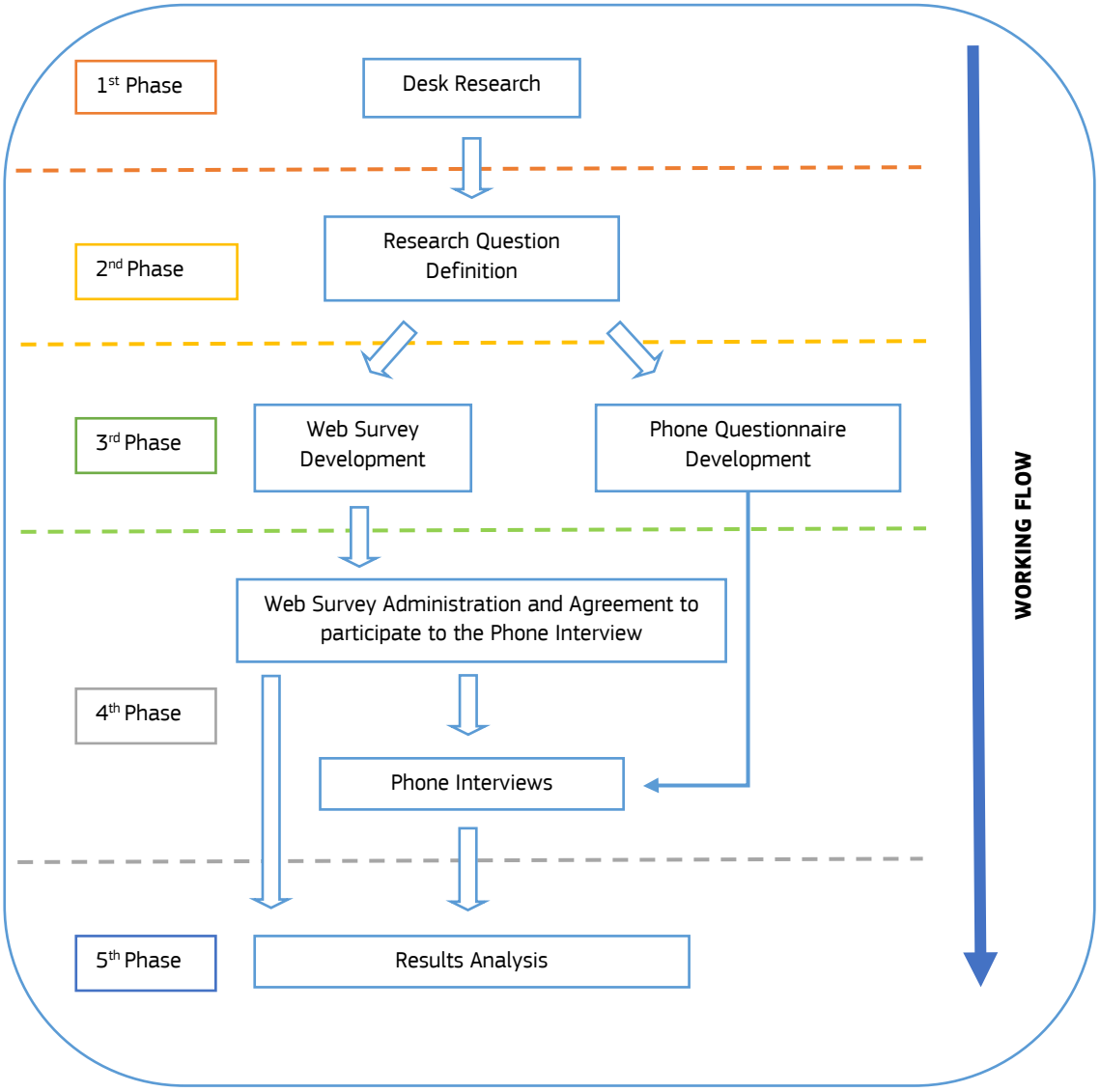
In the second phase, after having scheduled the phone calls, a semi-structured interview was carried out, where the respondents were asked to reply to a list of six questions (see Annex 5). After an introductive phase and personally introducing the topic of the survey, the interviewer posed the questions following the questionnaire structure, leaving though leeway to the respondents in order to ease the conversation and gather more insightful information. The phone interview framework was structured around two different blocks of questions: the first on transport R&I insight and trends, the second on bottlenecks and policy implications. The interviewer guided the conservation, allowing the transport stakeholders to express themselves freely and to add any relevant information, not previously captured, in the last open question. The phone interviews were conducted mainly by a web service call tool and only in few cases by phone. The duration of the interview session was from 30 minutes to 1 hour, in case of more extensive answers. For analysing the collected data a qualitative content analysis was used, following the four steps suggested in literature: de-contextualisation, re-contextualisation, categorisation and compilation (Bengtsson, 2016). The 9 phone interviews have been transcript using a summarising technique, the input received was revised again and the answers received coded, deleting duplications and clustering replies belonging to the same topics; several rounds of codes' interpretation have been performed. All the input related to different topics, regardless their frequency, have been considered in the analysis.

A pilot test with a group of transport researchers was conducted to fine-tune the web survey and the phone interviews.

Figure 1 illustrates the methodological framework that has been developed and followed for the TRIMIS survey.

[11] https://ec.europa.eu/eusurvey/home/welcome

Figure 1 TRIMIS survey on Innovation Capacity of the European Transport Sector: Methodological framework



Source: TRIMIS

At the moment of writing this report the United Kingdom (UK) is not a European Union Member State anymore thus it will be referred to as a European country. Nonetheless, Chapter 3 of this analysis looks at R&D indicators that refer to dates prior to February 2020 and therefore in this part of the report the UK is included in the group of EU-28 countries and is referred to as an EU Member State.

3 Assessment of the innovation capacity in the European transport sector

This section presents the analysis of the selected R&D indicators, as described in Chapter 2, looking at funding indicators, human resources engagements and patents.

3.1 Funding

The investments, either private or public, are the core of this analysis since they represent the means through research activities can be developed.

A major distinction is made, between private and public investments, which is reflected in the following four indicators: Business Expenditure on R&D (BERD), Business R&D Intensity, Government Budget Appropriations for Outlays for Research and Development (GBAORD) and GBAORD as a share of total general government expenditure.

3.1.1 Business R&D expenditure

Business R&D expenditures are defined as the component of Gross Domestic Expenditures on R&D, incurred in the business enterprise sector (OECD/Eurostat, 2005).

The total transport business R&D expenditure in 2017 increased to more than €47 billion[12] from €42 billion in 2015, and €43,8 billion in 2016 (see Figure 2). At the moment of writing this report, few data are available for the year 2018, higher quality data are ensured for 2017[13] which have been then selected as most updated reference period.

At international level, Europe is leading the automotive R&D activities. In Europe, in 2018, 31% of total R&D spending was in the automobiles and other transport sector, while the same share was registered in Japan. Other major economies, such as the United States (US) or China, invested mainly in R&D areas such as health industry or Information and Communication Technology (ICT), and automobiles and other transport sector spending was 7.6% in the US and 11.5% in China. (European Commission, 2019c)

It is possible to narrow down the business spending at European level in 2017 in the different transport economic activities. The production of motor vehicles (C29) accounted for 76.3%, almost €36 billion of the total expenditures, the construction of other transport equipment (C30) was around 22% or €10,5 billion, while 1.4% or €0,65 billion of the total transport R&D business expenditure came from transportation and storage (H). The manufacturing of motor vehicles (C29), from 2015 until 2017, increased business expenditures, from €31 to almost €36 billion. During the same period, the industry producing other transport equipment (C30) decreased its share over the total spending, while transportation and storage (H) remained unchanged.

In 2017, Germany was the largest investor in the all transport sector, accounting for 86% in the manufacturing of motor vehicles (C29), 39% in the industry producing other transport equipment (C30) and almost 22% in transportation and storage (H) respectively. Italy and Spain follow when looking at the private spending in R&D related to the production of other transport equipment (C30), respectably 33% and 13% over the total European spending.

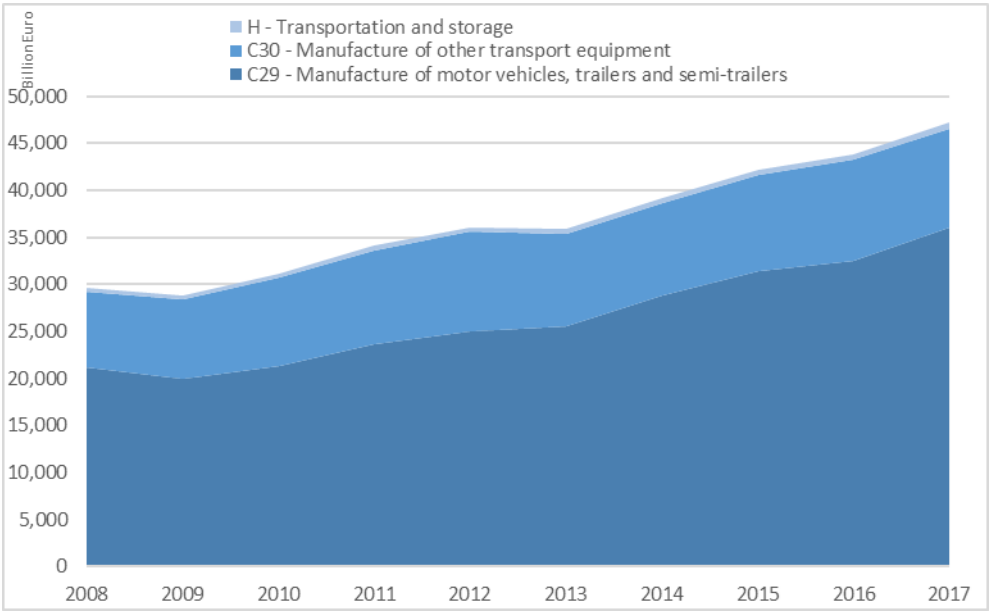
In transportation and storage (H), the Netherlands invested 17% over the total European business R&D funding, being the second main investor after Germany. Greece and Spain were also among the countries with highest share of private R&D investments in this area.[14]

[12] Based on JRC-TRIMIS elaborations for this report, in Current Euros.

[13] Data missing, in 2017, for: C29 (EL, FR, LU, LV, SE, UK), C30 (EE, EL, FR, LU, LV, SE, UK), H (FR, LU, UK). For CY all the values were zero, hence it is not represented in Figure 3.

[14] It is important to highlight that for 2017, data for France and the UK was not available in none of the three transport sectors considered.

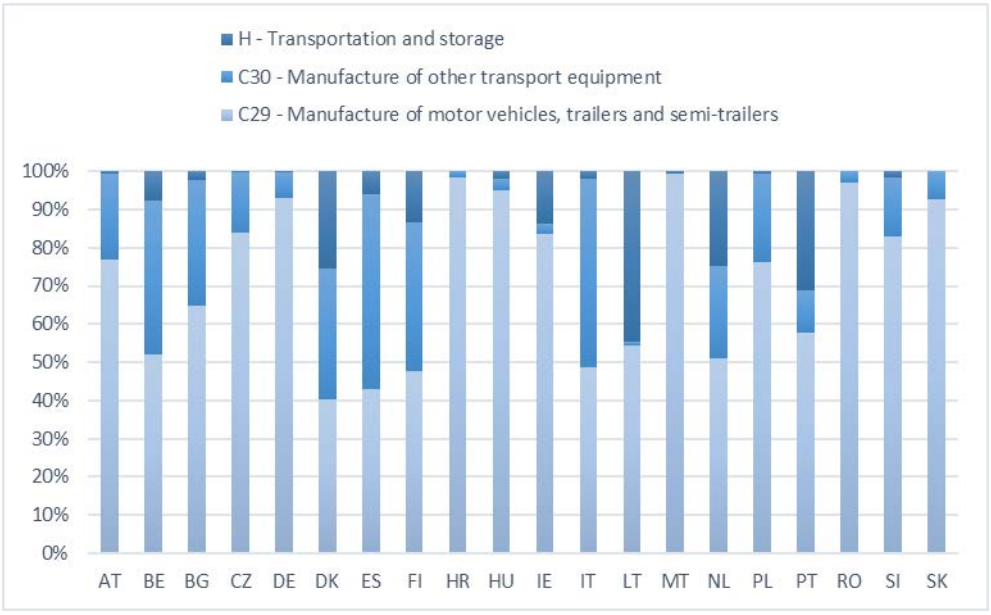
Figure 2 Business R&D expenditure in transport related economic activities (billion Euro, 2008-2017)



Data source: Eurostat (2017) and TRIMIS elaboration.

The different levels of private investment, in MSs in 2017, for each of the transport related economic activities, are presented in Figure 3. The vast majority of the observed MSs invest in manufacturing of motor vehicles (C29), while for few of them the funding distribution is almost equally distributed between manufacturing of motor vehicles (C29) and other transport equipment (C30), namely Belgium, Denmark, Spain, Finland and Italy. The countries were a relatively high share of business funding is allocated to transportation and storage (H) are: Denmark, Lithuania, the Netherlands and Portugal.

Figure 3 Business R&D expenditure in transport related economic activities in MSs (%, 2017)



Data source: Eurostat (2017).

In 2017, among the transport manufacturing sub-sectors, the aviation equipment and components industry was the one with the highest amount of expenditures on R&D, almost €6 billion, as shown in Figure 4. France (€2.6 billion), Germany (€1.4 billion) and Italy (€1.2 billion) were the largest investors in this sector. Data are missing for the UK that in 2015 and 2016, together with France, were the major investors in Europe. Compared

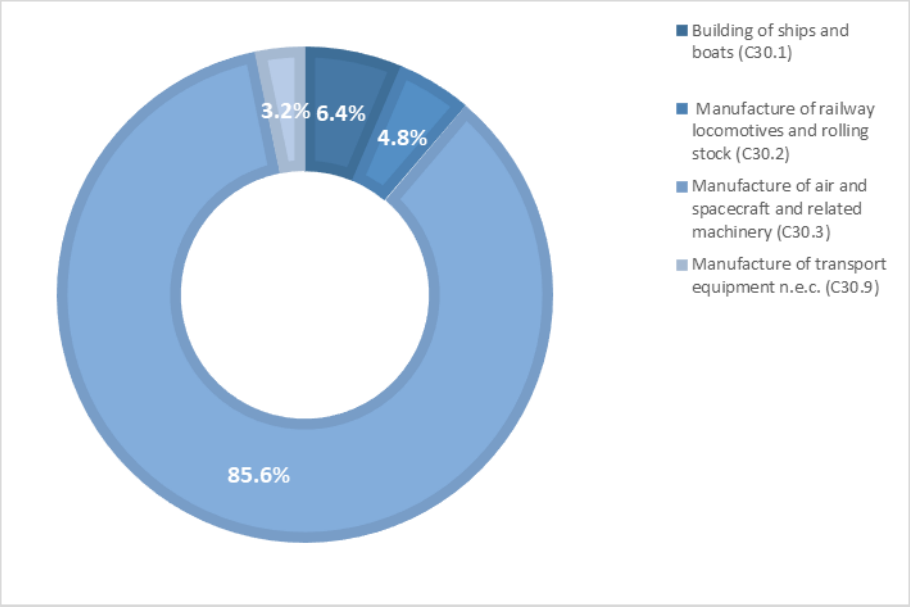
to the previously available data, 2015, it is interesting to observe an increase of the Italian industry in this sector, together with a slightly funding decrease in Germany.

The business expenditure for the construction of ships and boats was the highest in France, Germany and Italy[15]. Denmark plays also a key role in this segment; €4 million were spent in R&D in this sector in 2017, as important European shipyards are also located in this country.

Germany was also the leader in private R&D expenditure in the manufacture of railway locomotives and rolling stock, with more than €127 million spent in 2017. Other major investors in the rail sector were Spain, Italy and Czechia.

The available data about business R&D financing other transport equipment (C30.9) shows that Austria and Italy have been the countries that invested the most.

Figure 4 Business R&D expenditure in the other transport equipment economic activities (C30) (%, 2017)



Data source: Eurostat (2017).

These results are in line with the data of the EU R&D Industrial Scoreboard, (European Commission, 2019c) that identifies the automobile and other transports sector, as the main investor, with €64.6 billion, in 2018, showing an increase equal to 6.4% in one year time. In 2018 automobiles and other transport activities accounted for 31% of European industry R&D investments, making the transport sector the largest private investor in R&D in Europe.

Some transport associations produce interesting statistics based on their own data sources, as in the case of the AeroSpace and Defence Industries Association of Europe (ASD, 2019). According to their analysis, the civil aeronautics R&D spending amounted to €9 billion in 2018. Their analysis takes into consideration private and public spending and in their last report, emphasis was put on the increasing financial commitment of the business sector, counterbalanced by increasingly marginal contribution of governmental support.

3.1.2 Business R&D intensity

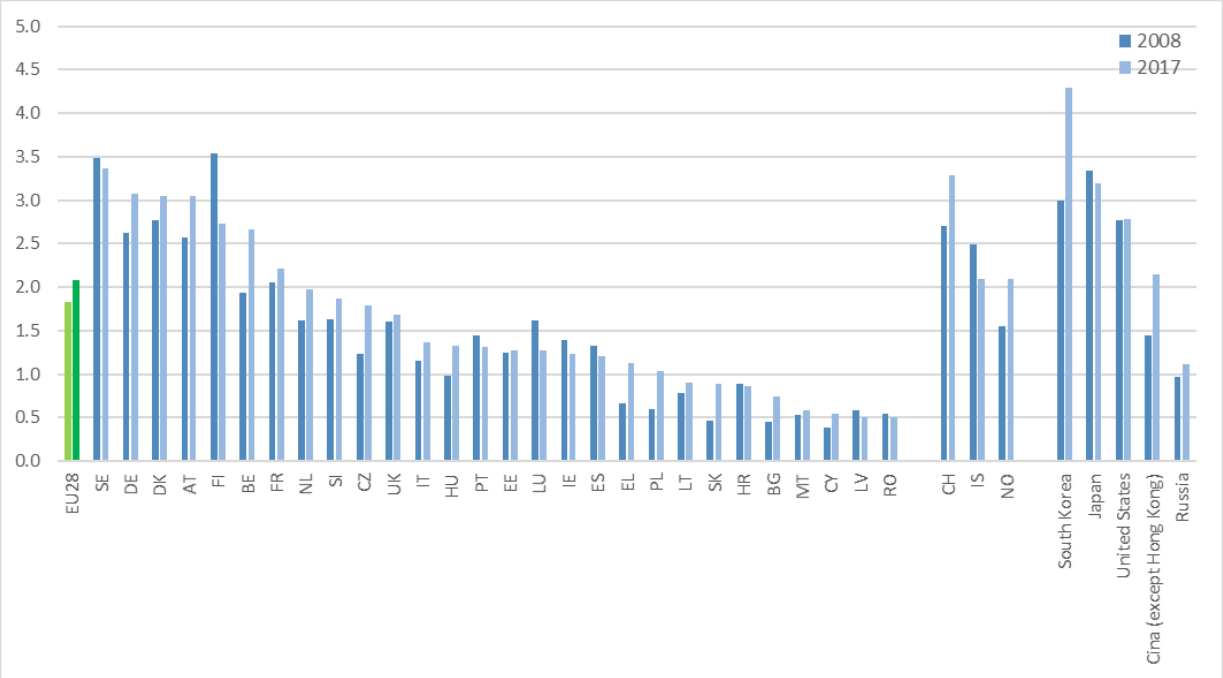
In order to allow a comparison of business R&D investments over different countries, the Business R&D intensity is used, which is defined as the share of R&D expenditure over the value added created in a certain country.

[15] Data is missing, in 2017, for UK.

At European level, the general data on R&D intensity do not show an encouraging trend, the value was at 2.06% of GDP in 2017, (European Commission, 2019e) hence the European target of 3% is still far to be reached. (European Commission, 2014).

At international level, in terms of GDP on R&D, Europe is lagging behind other major economies, such as South Korea, Japan, the US and China, as illustrated in Figure 5[16]. The vast majority of R&D investment is coming from business enterprises, followed by higher education and government sector. Major differences exist among MSs and also among regions within the same country. The latest European data show that the most dynamic regions[17] are located in Germany (ten regions), Austria and the UK (five regions each), Sweden (four regions), Belgium (three regions), Denmark, France and Finland (one region each). (European Commission, 2019e).

Figure 5 Gross domestic expenditure on R&D, by Country, 2008 and 2017 (%, GDP)



Data source: Eurostat (2017).

Concerning the transport sector, data from 2017[18]show that the R&D intensities in transport manufacturing (C29 and C30) are higher than in transportation and storage (H), following the same pattern as for the business R&D expenditure. R&D intensity in the automotive industry (C29) was at 8%, and 8.3% in the area producing other transport equipment (C30). The value was 0.1% in transportation and storage (H).

Croatia[19], Germany, Austria and Italy were the MSs with the highest automotive (C29) R&D expenditures as a proportion of value added. In 2017, Croatia was above 41%, the value for Germany was almost 25%, Austria 19.5% and Italy 10.4%. (Figure 6).

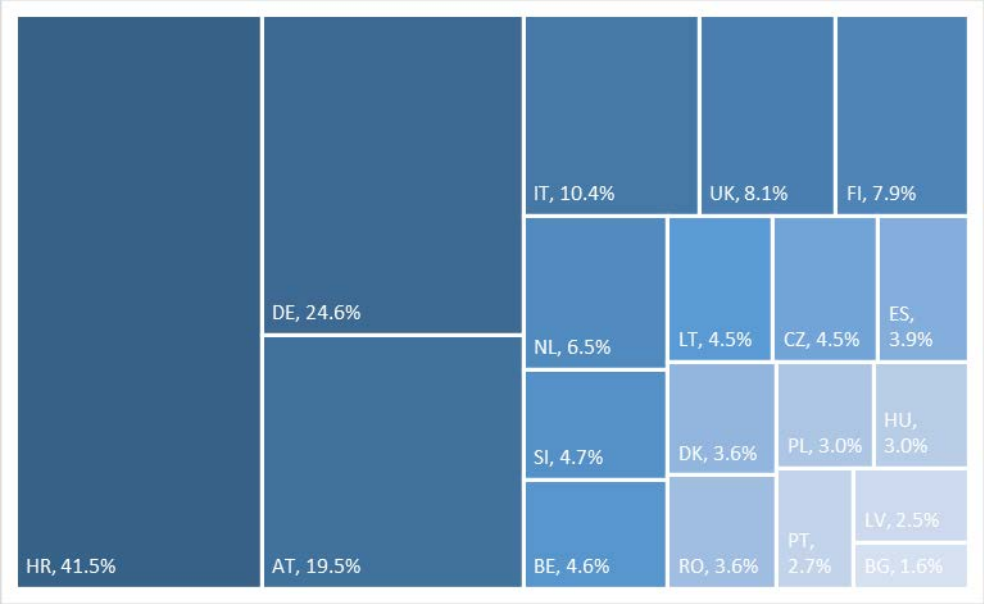
Figure 6 Business R&D intensity in the automotive economic activities (C29), in MSs (%, 2017)

[16] Data estimated, in 2008, for: AT, SE, UK. Provisional data, in 2017, for: DK, FR. Break in time series, in 2008, for: EL, PT, SI, Japan. Definition differs, in 2008 and 2017, for the United States.

[17] Identified as NUTS 2 regions.

[18] Data missing, in 2017, for: C29 (DK, EL, FR, LU, LV, MT, SE, UK), C30 (CY, CZ, DK, EL, FR, HU, LU, LV, MT, SE, UK), H (DK, FR, LU, UK).

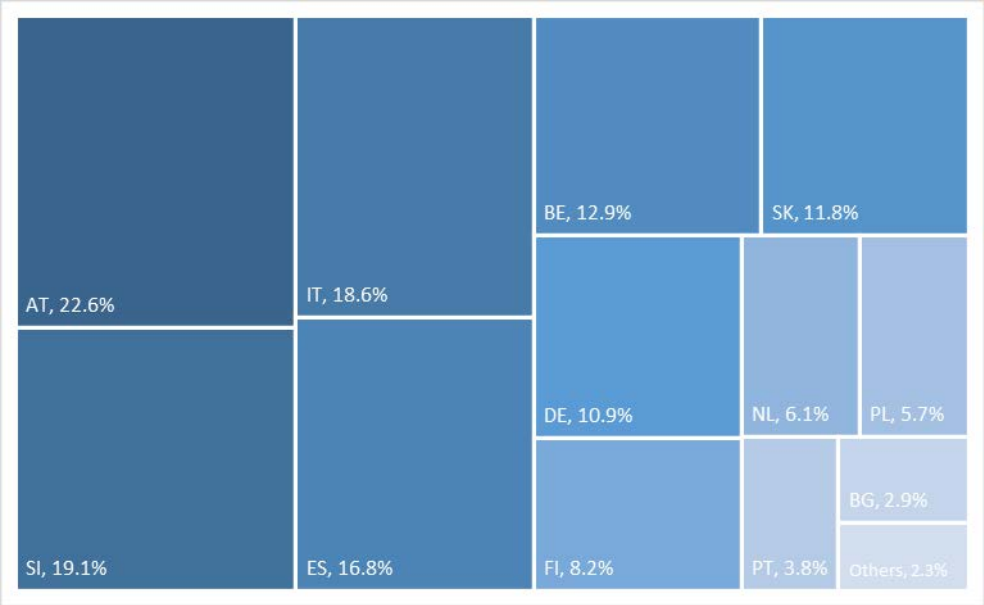
[19] Very high level of Business R&D intensity, for Croatia, has been observed, since 2008, in the sector producing motor vehicle manufacturing (C29).



Data source: Eurostat (2017).

With regard to C30 (Figure 7), there were similar values for Austria (22%), Slovenia (19%) and Italy (18.6%), followed by Spain, Belgium, Slovakia and Germany, all above 10% of R&D intensity.

Figure 7 Business R&D intensity in other transport equipment economic activities (C30), in MSs (%, 2017)



Data source: Eurostat (2017).

3.1.3 Government R&D expenditure

Government expenditure on R&D is captured by the Government Budget Appropriations for Outlays for Research and Development (GBAORD) indicator[20]. GBAORD is based on the NABS 2007 classification used by

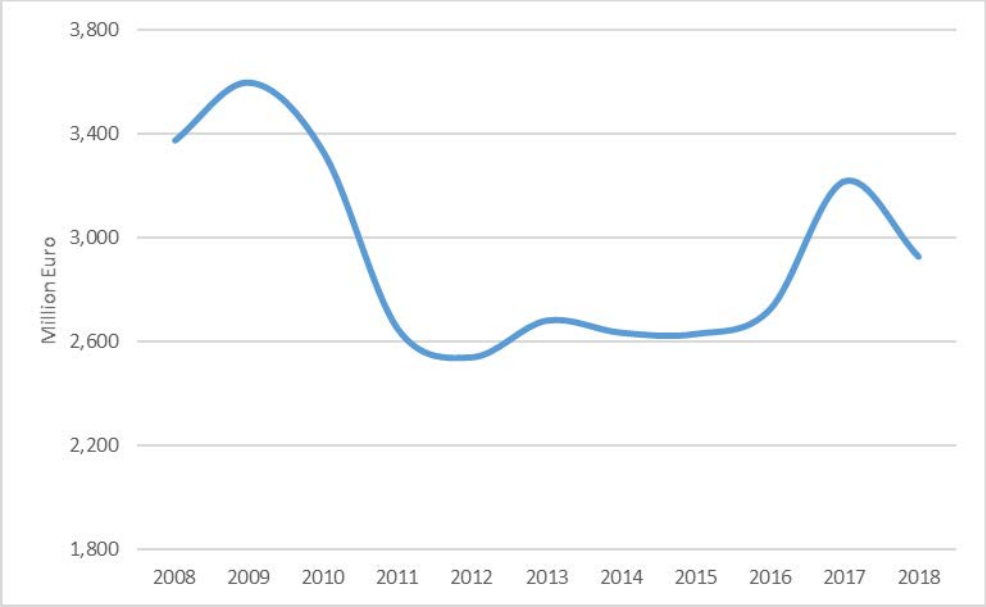
[20] Government spending allocated to R&D from central or provincial government budgets.

Eurostat and transport activities fall within the category NABS 04 "Transport, telecommunication and other infrastructures"[21] (see Annex 2).

The GBAORD evolution in the transport sector in the last year (2017-2018) indicates a European average decrease equal to 9%, from €3,300 million to €2,900 million[22], (see Figure 8). The distribution of GBAORD among MSs shows that almost the entire amount of funding originated from less than half of MSs (see Figure 9). In 2018, France accounted for almost 26%, the UK for 23% and Germany for 18.6%, being the only one among the three MSs to increase its share in the last year. A groups of countries, such as Spain, Sweden Poland, Italy and the Netherlands contribute to a lower extent to the European public R&D funding, ranging between 3% and 5.7% of the total spending.

Notwithstanding the relative low investment, compared to the business industry and the decrease experienced in the last year, still the European public commitment in transport R&D activities is higher than the major international competitors, as shown in Figure 10. In the last ten years, Europe has maintained its predominant role and only Japan, since 2017, has shown an important increase in governmental budget allocated to transport R&D.

Figure 8 Trend in European Transport GBAORD (million Euro, 2008-2018)

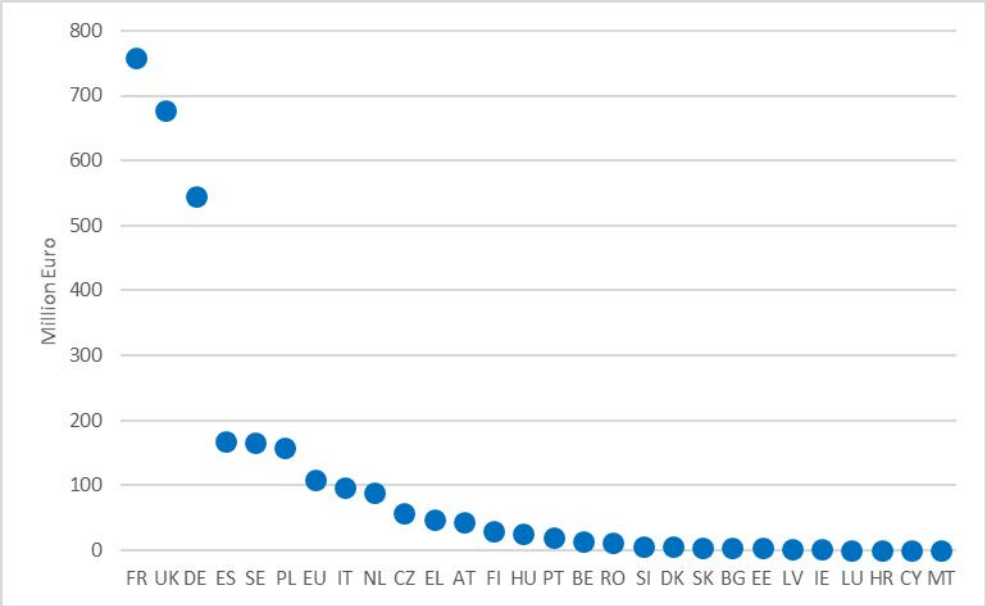


Data source: Eurostat (2018).

[21] NABS 04 "Transport, telecommunication and other infrastructures" includes other non-transport R&D appropriations such as telecommunication systems and water supply, while other NABS categories, as NABS 06 "Industrial production and technology", includes also transport-related activities, as the manufacturing of motor vehicles and other means of transport. This limitation - due to data aggregation - and the fact that this classification does not include information for transport sub-sectors, entails that results could be subject to underestimation.

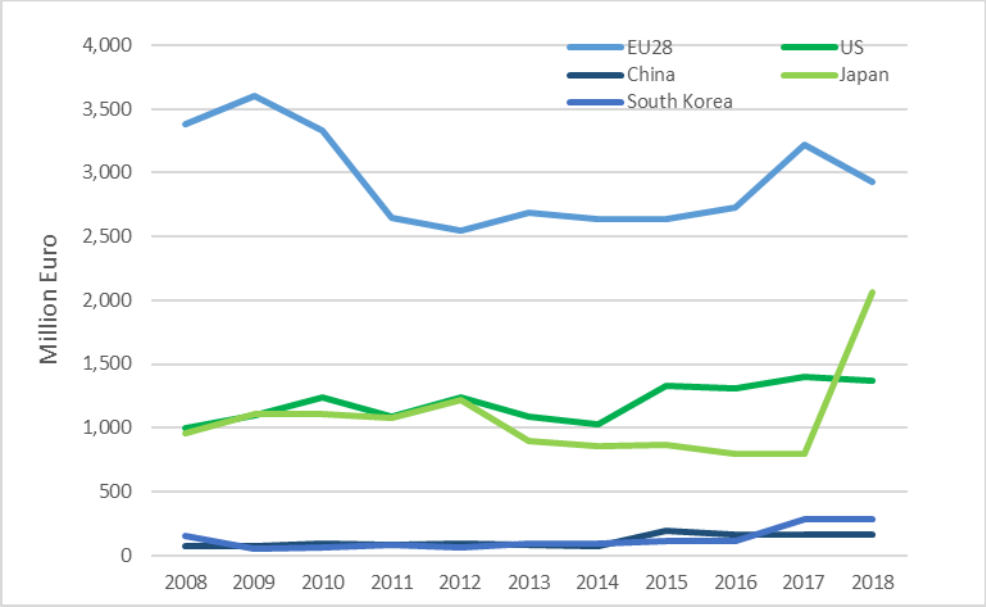
[22] Data missing, in 2018, for: LT; Provisional data, in 2018, for: AT, BE, CZ, DK, DE, EE, EL, ES, FI, HR, HU, IT, LV, MT, NL, PL, SI, SK; Estimated data, in 2018, for: DK, SE, UK; Values expressed in Current Euros.

Figure 9 GBAORD in MSs (million Euro, 2018)



Data source: Eurostat (2018).

Figure 10 Trend in International Transport GBAORD (million Euro, 2008-2018)



Data source: Eurostat (2018).

As already highlighted, the data provided through the GBAORD indicator fail to capture entirely the governmental R&D expenditures, due to methodological reasons and data quality. The work conducted in TRIMIS helps to partially overcome this data gap looking at R&D public funds allocated to projects and programmes, according to transport modes and STRIA Roadmaps. The total amount of European contribution, under the Horizon 2020 (H2020) Framework Programme, amounted to €3,900 million, over the entire period[23]. The allocation to the different modes of transport, based on the TRIMIS projects database, shows that road transport received around 34% of the total European funding in the transport sector within H2020. Air transport received 32%, followed by waterborne and rail, which received 8% and 4% respectively. An important share of the funding was received by multimodal projects, 22% of the total amount.

[23] Data are subject to underestimation considering the framework programme is still on-going

TRIMIS assesses the distribution of European funding among the STRIA roadmaps providing a comprehensive analysis, looking at economic and technological information for all the European projects (Gkoumas, et al., 2019a, 2019b; Ortega Hortelano et al., 2019; van Balen et al., 2020; Tsakalidis, et al., 2020b).

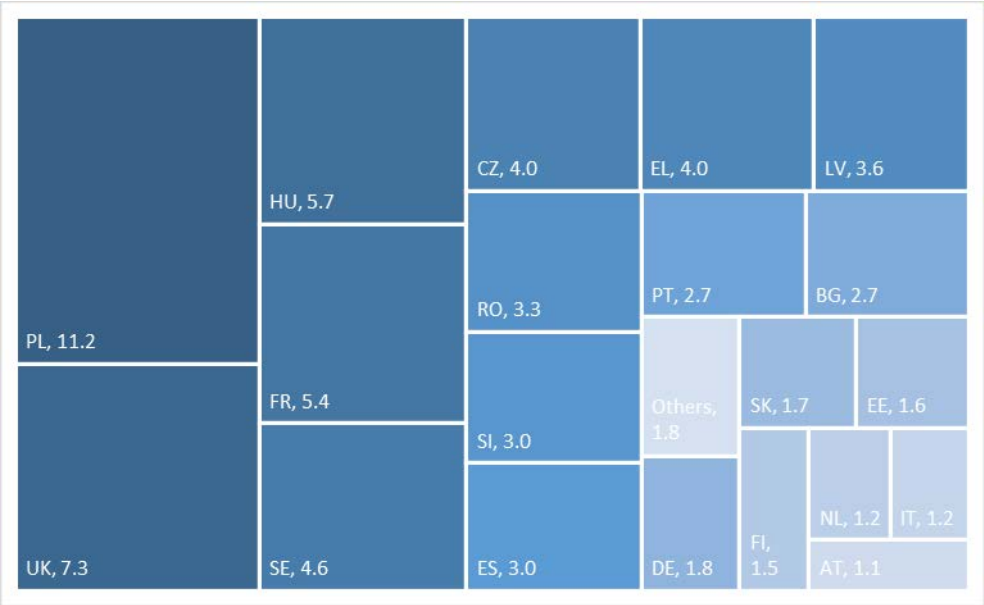
Still, disaggregated data on national public investment are not systematically collected, resulting in a scattered data, which hampers a comprehensive analysis.

3.1.4 Transport GBAORD as a share of total R&D government expenditure

This indicator provides information on the share of total government expenditure allocated to transport R&D over the total GBAORD in each MS. As already stated, this information needs to be considered cautiously due to its high level of aggregation[24].

For the transport sector, NABS 04, the latest figures[25] provide a clear picture of a heterogeneous situation across Europe. Poland had the highest value, 11.2%, followed by the UK, Hungary and France. Just below the first four countries, Sweden, Czechia and Greece follow with very similar shares, around or above 4% of governmental expenditure allocated to transport R&D.

Figure 11 Transport GBAORD as a share of total GBAORD in MSs (%, 2018)



Data source: Eurostat (2018).

3.2 Human resources

R&D activities cannot be performed without researchers and qualified personnel engaging themselves in such activity. Together with the financial indicator, this indicator provides information on the role that research is playing in a certain sector. According to the OECD definition, people under this category could perform more creative activities, "researchers", or supporting managers, administrators, etc. include under the general label of "R&D personnel" (Eurostat based on Frascati Manual, OECD 2002).

3.2.1 R&D Personnel

R&D personnel is defined by the OECD as the number of people undertaking transport research activities, this includes researchers and other personnel providing direct services, as described above.

[24] As described earlier in the text NABS 04 "Transport, telecommunication and other infrastructures" includes other non-transport R&D appropriations such as telecommunication systems and water supply, and NABS 06 "Industrial production and technology", includes also transport-related activities, as the manufacturing of motor vehicles and other means of transport.

[25] Data missing, in 2018, for: LT; Estimated data, in 2018, for: DK, SE; Different definition, in 2018, for: AT, FR.

The share of total R&D personnel, in Europe, is rather low, 1.3% of the total labour force in 2017. (European Commission, 2020a) Some MSs employ a relatively higher number of people with these functions, such as Denmark, Luxembourg, Finland and Austria, in all these countries R&D personnel works mainly in the private sector.

Concerning the transport sector, the last available figures are from 2017 when more than 309,000[26] R&D personnel worked in the European transport sector. In 2017, the majority of R&D personnel was employed in activities within the automotive industry (C29) with more than 214,000 R&D people, representing 69% of the total counting. Data show that R&D personnel in manufacturing of other transport equipment (C30) and transportation and storage (H) were considerably less ~81.500 (26%) and ~13.000 (4%) people, respectively[27] (Figure 12).

As it was observed for the R&D spending, also for this indicator, the European figures show a positive position compared to other countries in the word, such as Japan or Korea. A similarly positive trend was observed in China, where the number of R&D personnel were around 330,000 people in 2017[28].

Data on the gender dimension shows that men outnumber women, overall, in 2017. While, the presence of men performing R&D activities in transport was around 87.5% of the total counting, women representing around the 12.5%.

The count of the R&D personnel over the total number of people working in transport is relatively low, but some differences can be observed in relation to the three economic activities. While the European value for the transportation and storage (H) sector is 0.1%, slightly higher figures can be observed for the automotive industry (C29), for which the EU value in 2017 was around 4.7%, and for the share of R&D personnel in manufacturing of other transport equipment (C30), which reached around 6.5% of the total transport employment.

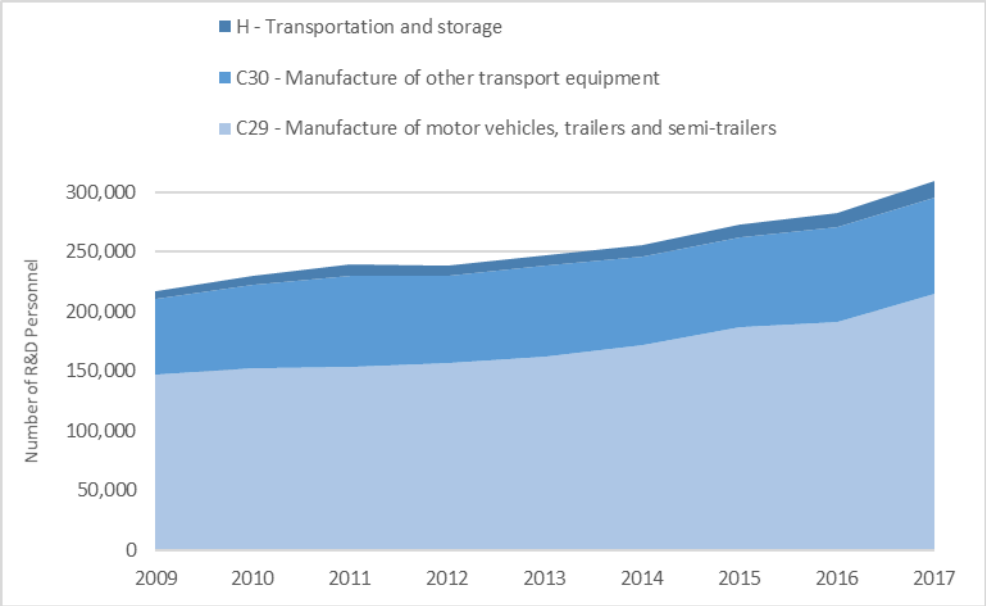
More detailed information about the MS differences can be observed in Figure 13, showing that Germany, Italy, the Netherlands and Slovenia have a relatively higher share of R&D personnel compared to the EU average, both in manufacturing of motor vehicles (C29), and in other transport equipment (C30).

[26] Based on JRC-TRIMIS elaborations for this report. The estimation, in 2017, measured in full-time equivalents (FTE) equals to 270.000.

[27] Data missing, in 2017, for: C29 (UK), C30 (UK), H (LU, UK). Confidential data, in 2017, for: C29 (EL, LV, LU, SE), C30 (EE, EL, LV, LU, SE), H (LV, PL, SI). Provisional data, in 2017, for: C29 (FR, DK), C30 (FR, DK), H (FR, DK).

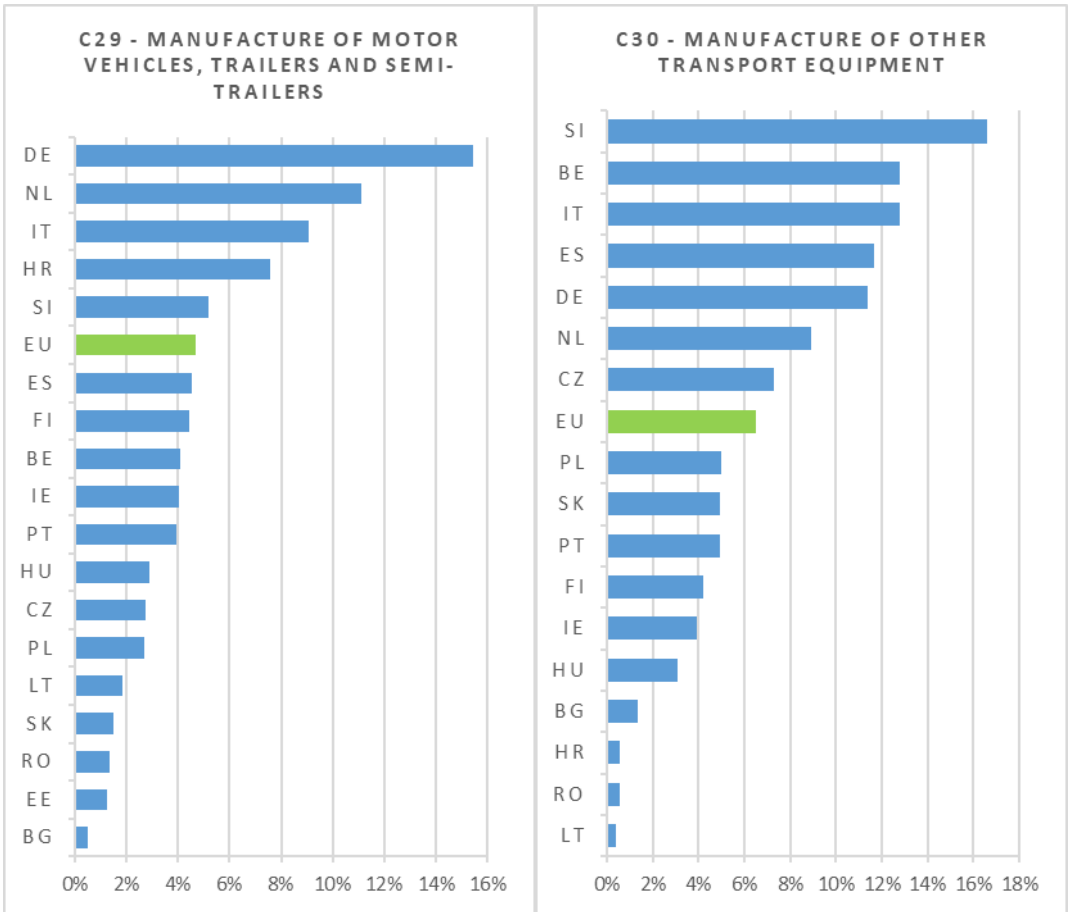
[28] Measured FTE. Data for US, in 2016, were expressed in headcount and amounted to ca. 170.000 people. (Eurostat, 2019b)

Figure 12 R&D personnel in transport related economic activities (number of people, 2009-2017)



Data source: Eurostat (2017).

Figure 13 Share of R&D personnel (headcount) over total transport employment, in the manufacturing economic activities (C29 and C30) (%, 2017)



Data source: Eurostat (2017).

3.2.2 Researchers

Researchers are employed to create new knowledge, products, processes and methods, as well as to manage the R&D projects (European Commission, 2020a).

During the last years the total number of researchers working in the EU-28 in 2017 increased to approximately 1.97 million[29]. In the last ten years the total number of researchers increased by 35.4%, with some MSs showing important growth, as in the case of Poland, Greece, the Netherland and Hungary. When comparing the European performance with the number of people devoted to research activities in the rest of the world, Europe was in the lead in 2017, as the number of researchers in China and the US were 1,74 and 1,37 respectively. In addition, their growth, between 2007 and 2017, was notable, reaching 22.3% and 20.6% respectively, though lower compared to Europe. At international level, South Korea was the country with highest increase in the number of total researchers showing an increase of 72.6% in ten years. In 2016, the majority of those researchers[30] working in Europe were employed in the private business sector and man researchers were more copious than female colleagues, representing 66.6% of the total number.

In 2017[31], there were around 120,000[32] transport researchers in the EU representing 44% of the total number of FTE personnel working in transport R&D globally. The majority of these researchers worked in the manufacturing of motor vehicles (C29) (84%), the manufacturing of other transport equipment (C30) (14%), while just 2% of the total number worked in transportation and storage (H). The data for 2017 did not show major changes compared to 2016, except for a slight increase in the number of researchers involved in R&D activities in the field of manufacturing of motor vehicles (C29), to the detriment of manufacturing of other transport equipment (C30). The vast majority of these researchers are men, accounting for 90% of the total number, with no major differences among the three economic activities.

The number of transport researchers in Europe has been higher in the last years compared to other countries globally. An exception is the one of China that showed, mainly in 2016 and 2017 an increasing number of people working in this domain (ca. 24,000 researchers). The number of people with this profession in Japan and Korea were approximately 96,000 and 36,000 respectively[33].

[29] Researchers measured in FTE

[30] Researchers measured in headcount

[31] Data missing, in 2017, for: C29 (FR, UK), C30 (FR, UK), H (FR, LU, UK) Confidential data, in 2017, for: C29 (EL, LV, LU, SE), C30 (EE, EL, LU, SE), H (BG, LVPL, SI). Provisional data, in 2017, for: C29 (DK), C30 (DK), H (DK).

[32] Researchers measured in FTE

[33] Data for Korea are from 2015. Data for the US, in 2016, were expressed in headcount and amounted to ca. 125.000 people. (Eurostat, 2019b)

3.3 Patents

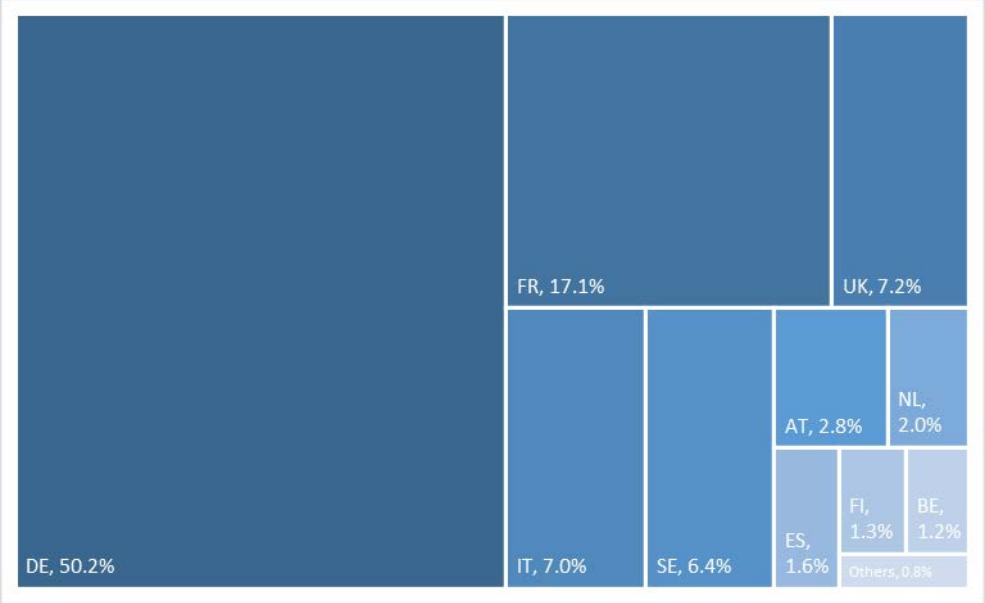
The number of patents associated to a certain sector, gives information on its technological activity and it is often used as R&D indicator.

In this report, patent applications to the European Patent Office (EPO) are considered for the automotive industry (C29) and for the manufacturing of other transport equipment, (C30)[34]. The last available data are from 2013 (European Commission, 2019b).

In 2013, more than 2,670 patents applications were submitted by the automotive industry (C29), and 961 by the other transport equipment manufacturing (C30). For both industries the trend from 2012 to 2013 was negative with a decrease of 18% (C29) and 12% (C30) respectively.

German and French companies led patenting activities, in these two economic activities, confirming the data from 2012. In the automotive industry (C29) patent applications originated from Germany (50%) and from France (17.1%), followed by the UK, Italy and Sweden. (see Figure 14).

Figure 14 Patents applications in the automotive economic activities (C29) (%, 2013)

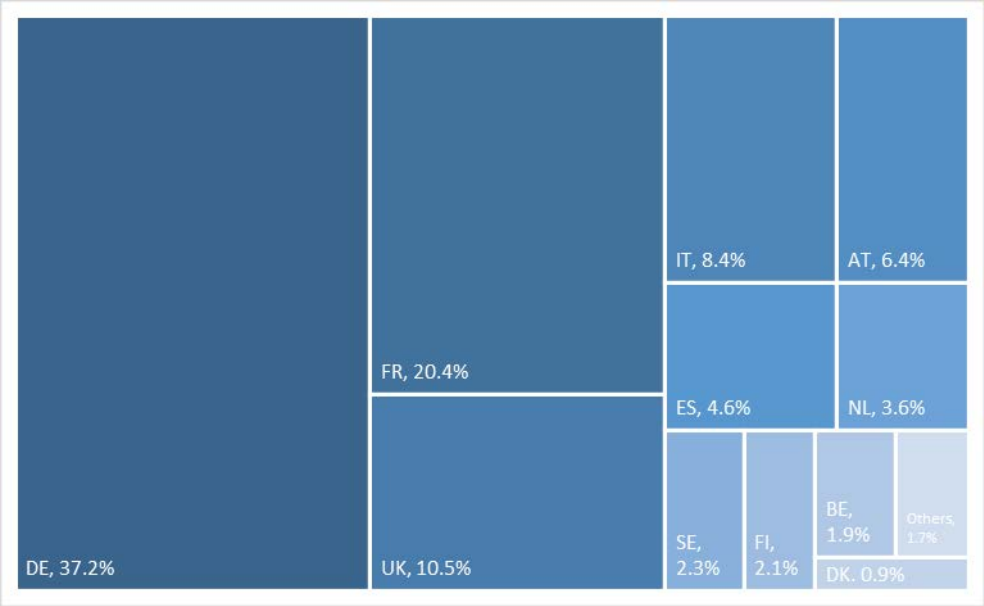


Data source: Eurostat (2013).

The importance of Germany is clear also when it comes to the development of rail, maritime and air equipment (C30) patents, although the share was lower, at 37.2%, than in the automotive industry. France had a high number of patents applications in this area, 20% of the total European number, followed by the UK, Italy and Austria (see Figure 15).

[34] No data is available for the transport service (H). Data missing, in 2013, for: C29 (EE,CY, EE, MT), C30 (CY, EL, HR, CY, LT, LU, MT, RO, SK)

Figure 15 Patents applications in the other transport equipment economic activities (C30) (%, 2013)



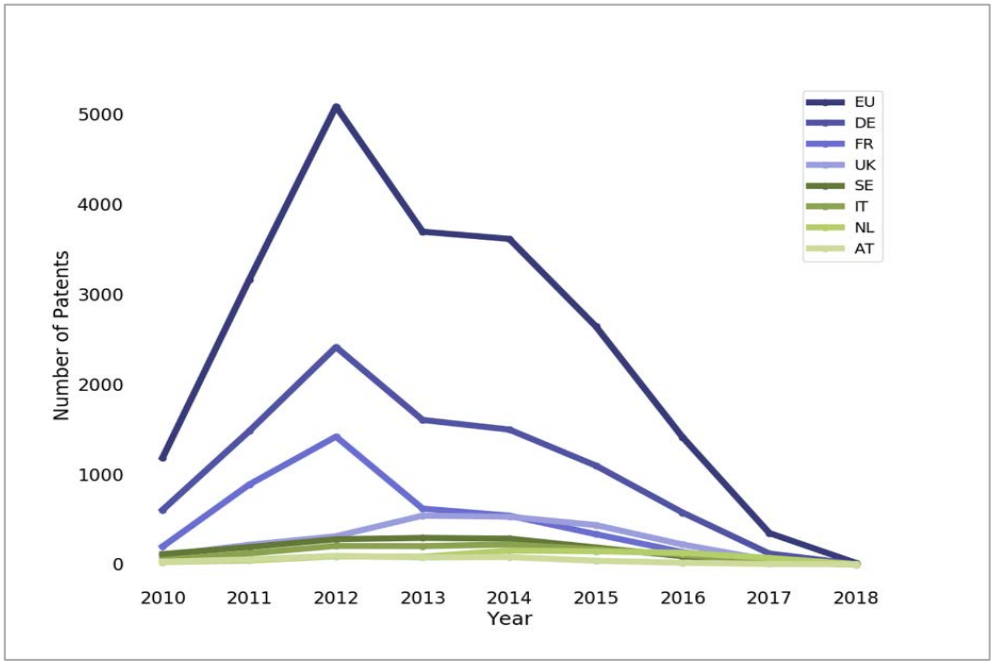
Data source: Eurostat (2013).

The automotive industry is the one with the highest number of green technologies patents as presented in the last edition of the "EU Industrial R&D Investment Scoreboard" (European Commission, 2019c). Between 2012 and 2015, 38.1% of the green patents filled in by the surveyed companies were developed within the transportation industry; most of those companies had their headquarters in Japan (30.9%), US (26.8%) and Germany (11.8%). It does not come as a surprise that these countries are the ones hosting Toyota, Ford, General Motors, Bosh and Volkswagen headquarters.

Moreover, it has been observed that, at European level, the automotive sector holds a competitive position in terms of patent activities that appear to be highly diversified. Beyond automotive technologies, a high number of patents is associated to green technologies (e.g. hybrid, batteries, fuel cells), autonomous cars, software, information technology hardware, electronics, etc. (European Commission, 2019c).

A transport patents database is being developed within TRIMIS, which includes granted patent applications to EPO. Transport patents are the ones associated to Cooperative Patent Classification (CPC) codes related to the whole transport industry. (Annex 6) The database includes patents associated to all transport modes, as well as multimodal ones and covers a time range from 2010 until 2018, with respect to their first application. Figure 16 shows the evolution in this period, with a clear peak in 2012, followed by a general decrease until 2018. The reason of such evolution is almost entirely due the fact that there is normally a big time lapse between the patent application and the moment it is granted, leading to a lag in the more recent years. Overall, the official European figures on patents applications and the TRIMIS ones are aligned for the comparable years.

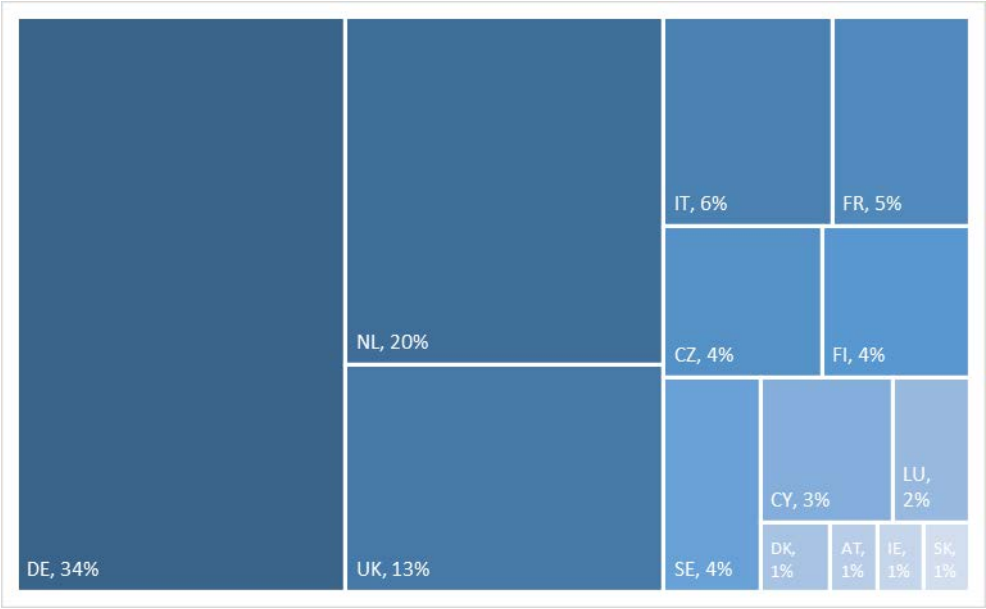
Figure 16 Evolution of patents granted, based on application year, in the transport sector, based on the TRIMIS Patents Database (2010-2018)



Source: TRIMIS

As previously highlighted, the vast majority of number of transport patents granted are limited to few MSs; this distribution is also clear in the TRIMIS patent database, showing the relevance, in 2017, of Germany, the Netherlands, the UK, Italy, France, Czechia, Finland and Sweden (Figure 17). These countries, together with Austria and Spain have been the ones that, between 2010 and 2018 have shown to be more active in terms of granted transport patents.

Figure 17 Patents granted in the transport sector, based on the TRIMIS Database (%, 2017)



Source: TRIMIS

4 European transport stakeholders view on Innovation capacity: the TRIMIS survey

This chapter shows the results of the 'Innovation Capacity of the European Transport Survey' conducted by TRIMIS.

4.1 Web survey results

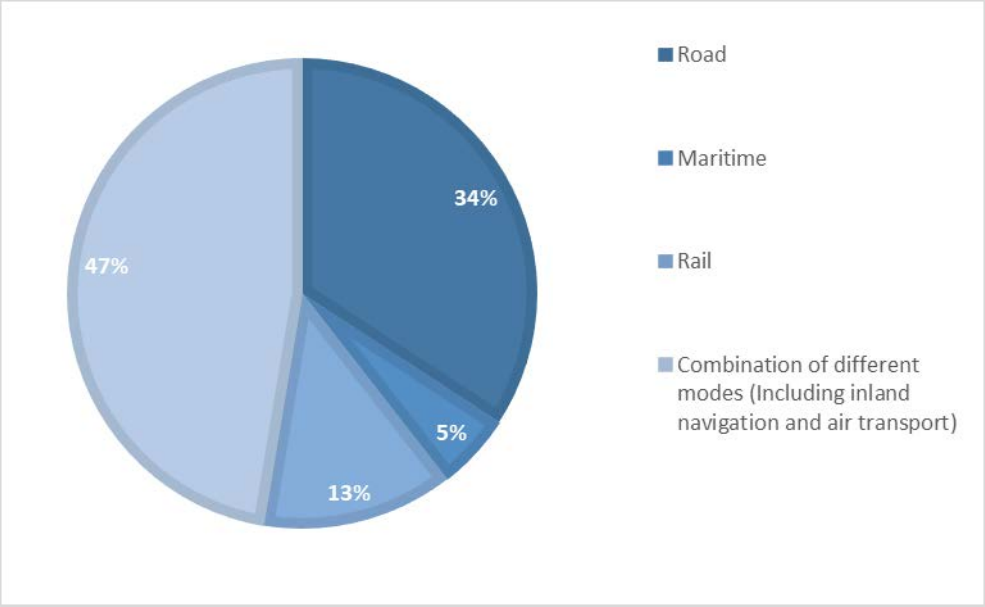
The participants to the web survey were 38 stakeholders that have been classified in five groups: transport and logistics providers, national ministries and agencies, universities and research institutes, regional or local entities and transport associations and organisations. Table 2 shows the profiles of the web respondents.

Table 2 Overview of Stakeholders participating in the Web survey

Stakeholders groups	Number of Respondents	Country where the stakeholder is based																			Transport Mode				
		AT	BE	BG	CH	CZ	DE	ES	FR	HR	IE	IT	LU	LV	MT	NL	PT	SE	SI	SK	UK	Air	Inland navigation	Maritime	Rail	Road
Transport and logistics providers	8 (21%)		x		x							x				x		x			x	x	x	x	x	x
National ministries and agencies	18 (47%)	x	x	x	x	x			x				x	x	x		x	x	x		x	x	x	x	x	x
Universities and research institutes	6 (16%)						x			x	x	x				x				x			x	x	x	x
Regional or local authorities	4 (11%)				x			x						x										x	x	x
Transport associations and organisations	2 (5%)		x	x																						x

The vast majority (79%) of the respondents were working in transport, infrastructure and mobility ministries in Europe, followed by representatives of the business sector, accounting for 8 (21%) respondents over the total number of the web survey participants. There were 6, 4 and 2 contributions from stakeholders working in universities and research institutes, in regional or local authorities and in transport associations or organisations respectively. All the participants had very high level of responsibility in their entities (e.g. principal researchers, professors, general managers, directors, etc.) and their activity was strictly linked to R&I activities. The respondents provided a wide geographical coverage, as 20 European countries were represented, of those 18 EU MSs, plus Switzerland and the UK[35]. Moreover, the label "combination of different modes" was included, as the responders declared to be involved in one or more transport modes activities as shown in Figure 18.

Figure 18 Web survey respondents, by transport mode

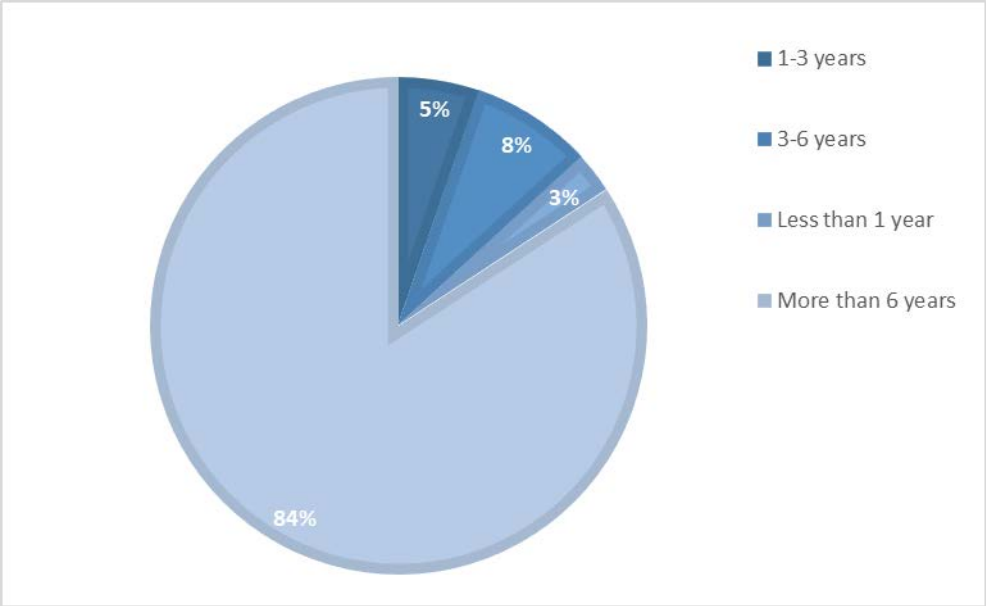


Source: TRIMIS

The transport stakeholders were asked to state their experience in the transport field, in terms of years worked in the transport sector. Figure 19 shows that 84% of the respondents have more than six years and 8% between three and six years of experience in the transport domain. These results allow us to be more confident in the overall analysis, having obtained responses from high-level experience respondents.

[35] The web survey was launched in November 2019 and closed in March 2020. At the period of writing this report UK was not an EU MS any more.

Figure 19 Web survey respondents, by years of experience in the transport sector



Source: TRIMIS

4.1.1. Innovation activities

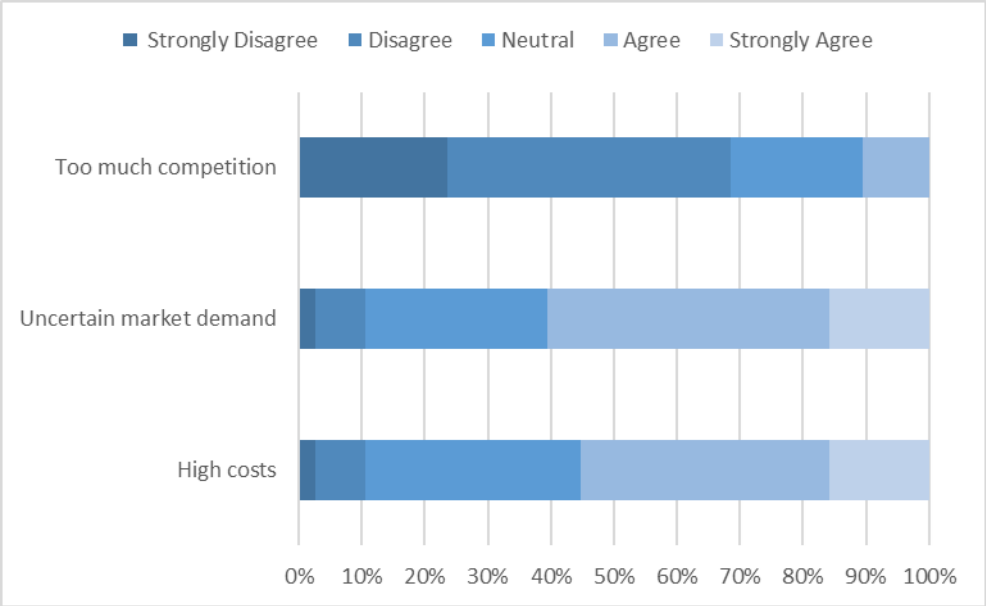
The key role of R&I in transport appears to be clear to the vast majority of the respondents, as 97% of participants agreed or strongly agreed that R&I activities increase the quality of goods and services provided. Moreover, 94% of the answers identify R&I as vital in boosting competitiveness. This part of the questionnaire appears as the one with the most uniformity among the answers, supporting the concept that R&I is clearly recognised as a key aspect among participants.

4.1.2 Innovation barriers

The following questions looked at barriers in engaging and performing R&I activities. The aim of these questions was to obtain information on the difficulties faced in their daily activities of this topic.

Three possible barriers were proposed: high costs linked to R&I activities, uncertainty in market demand and to high market competition. Out of 38 respondents, 23 (61%) declared that they agreed or strongly agreed that unclear demand dynamics could hamper R&I activities. The high cost factor was identified as obstructive by 55% of the respondents. On the contrary, a large number of respondents (69%) declared that they were in disagreement or strongly in disagreement with the statement about high level of competition in market and its negative impact on R&I. From the results it appears that the respondents identify a positive link between level of competition and engagement or development of R&I activities. The results suggest that, in general, market dynamics have a stronger influence on R&I activities, while the financial variable, high cost, is perceived slightly less important than the other factors (see Figure 20).

Figure 20 Innovation Barriers

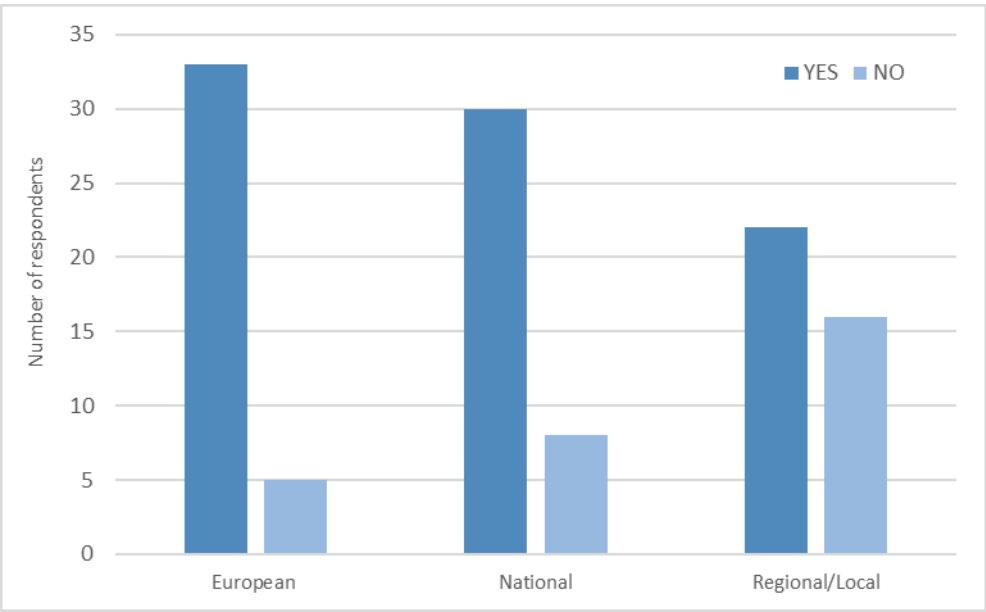


Source: TRIMIS

4.1.3 Innovation enablers

The following section looked at innovation enablers, considering financial means, the role of personnel, cooperation among private companies and the role of policy measures. Stakeholders were also asked about their experience with European, national, and regional and local funding means, in order to be more consistent in their answers. 87% of the respondents declared to have had experience with European funding, 79% with national ones and a slightly lower number (58%) with regional and local funding (see Figure 21).

Figure 21 Web survey respondents experience with R&I Funding

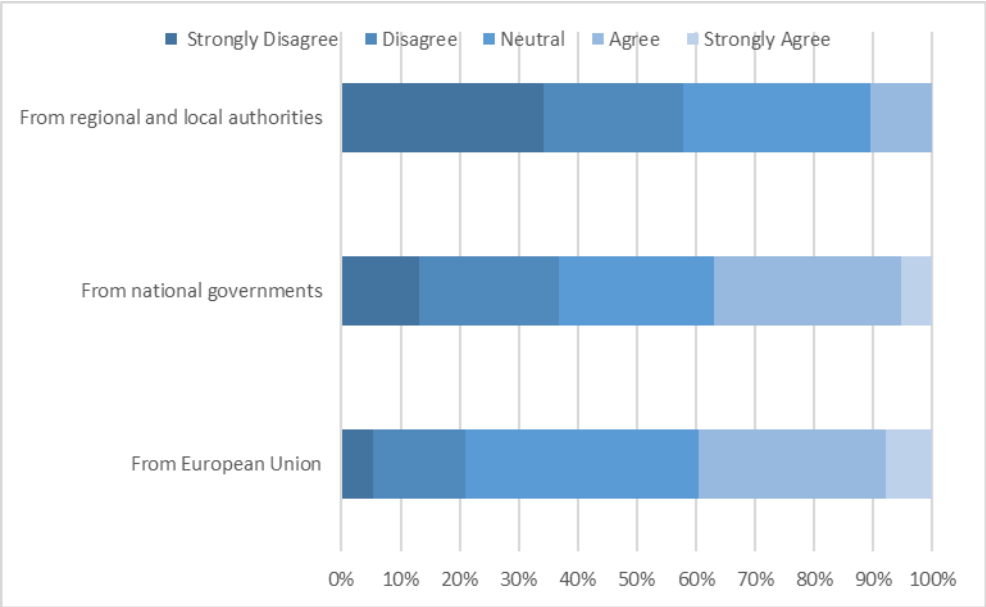


Source: TRIMIS

Respondents were first asked about the relevance they give to private budget, namely whether they would find sufficient company funding to develop R&I activities. A bit more than half, 58% of the respondents, were not in agreement or strongly in disagreement with such a statement, while 15 out of 38 could not really come up

with a clear position on the topic. Moreover, respondents were asked about their views on the role of public funding and expressed themselves in relation to the fact that this funding could be considered satisfactory to perform R&I activities or not. In general, this question did not show a clear pattern among the respondents. A slightly higher consistency was found in relation to the regional and local funding, 58% of the respondents thought that this type of funding was not satisfactory to perform R&I. The views on the European and national funding was quite scattered; 39% of respondents agreed that European funding is sufficient to perform R&I, but for the same number of respondents, 15, it was not possible to take a clear position on this topic. For what concerns national funding, the results show an even more fragmented picture, with 14 respondents expressing agreement or full agreement and 14 the exact opposite opinion, while 10 out of 38 chose an intermediate response, neither agreeing nor disagreeing (see Figure 22).

Figure 22 Satisfaction with European, national, regional and local funding



Source: TRIMIS

Respondents were then asked about their views on the researchers working in transport R&I and their presence, asking if they would consider qualified personnel enough, at present. In this case, it was not possible to infer a clear position from the respondents, since 17 answers were towards a general disagreement, 11 respondents agreed with the statement and 10 out of 38 did not have a clear standpoint.

A possible enabler to R&I activities is the cooperation among private firms. The majority of respondents (76%) agreed or strongly agreed with the view that cooperation is fundamental to perform R&I activities; 6 out of 38 (16%) remained neutral.

Policy measures have been identified by 84% of the stakeholders as possible enables to boost R&I activities. The question did not specify the type of policy measures, providing a broad spectrum of possibilities, such as European, national or local measures.

A few additional targeted questions were aiming at insights from the private sector stakeholder. In this frame, respondents working in the private sector were asked to express their opinion in relation to product, process, organisational and marketing innovations and their role in increasing competitiveness. 100% of the respondents stated that product and process innovations have a crucial role in increasing the company's competitiveness, while less agreement was found when looking at marketing innovations and even less with regard to organisational innovations (four and three out of five private companies respectively). Private companies' representatives were also asked about the importance they attribute to their internal company funding and to credit means to perform R&I activities. While it appeared that private companies, in general, do not consider their own funding sufficient to perform R&I activities, no clear opinion was retrieved from the answers received on the importance of credit and private equity.

4.2 Phone survey results

The web survey was followed up by phone interviews with those stakeholders that were willing to engage in providing additional insight on the topic; 9 respondents showed interest in participating in this second phase of the survey, which was conducted through phone interviews. The semi-structured phone interviews were analysed, transcribed, coded and different rounds of interpretation of the coding helped to define the results of this phase of the survey. To analyse the results obtained, a qualitative content analysis was used, complemented by descriptive statistics on the frequency of specific answers. Out of 9 respondents, 3 were private sector representatives and 6 belonged to the public sector.

While analysing the codes, it was possible to link the results to the main topics the questionnaire was looking at: the changes that the transport sector is facing and their impacts on R&I in terms of areas of interest, trends and most relevant R&I changes experienced in the last 5 years. The second topic was looking at the challenges that transport stakeholders are facing in their daily activities in performing R&I and the last aspect considered was the influence that policy has on transport research, investigating the role of policy measures in driving and boosting it.

The aim of this part of the survey was to gather valuable insight on the topic from transport stakeholders expressing views and opinions based on their own experience, hence no overall conclusions can be derived. Nonetheless, the results show that certain statements are recurrent in the answers provided, indicating therefore some common understanding on specific topics linked to transport R&I.

4.2.1 Changes and trends in transport R&I

When looking at the changes observed in the last five years by transport stakeholders in relation to R&I, it is interesting to observe that the answers, although different in their specific content and in the way they were formulated, can be clustered under a common view or understanding that shows a more structural change of transport R&I rather than of specific aspects.

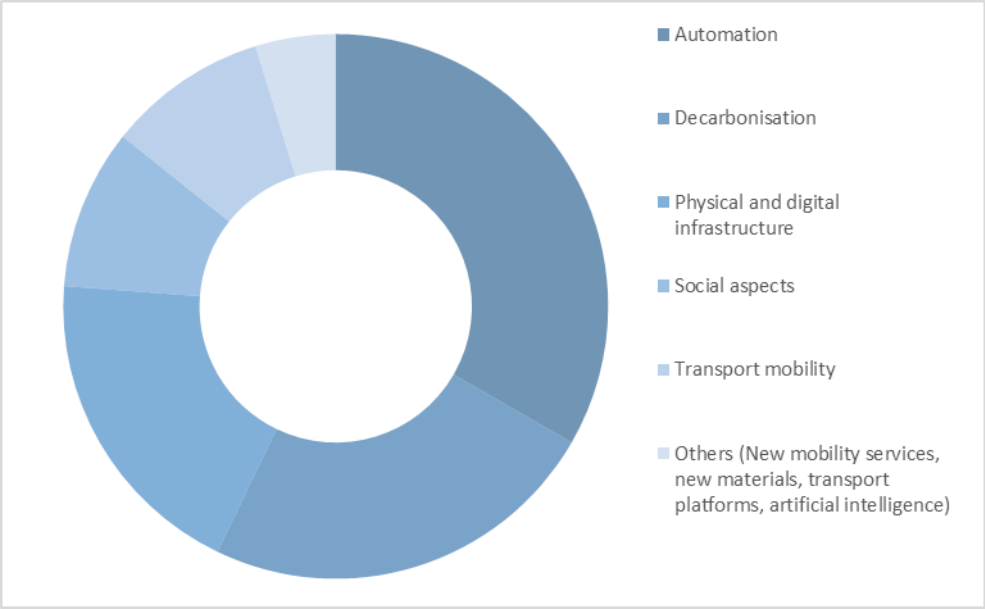
Some stakeholders experienced a different and new approach related to the planning process of transport activities, with a more conscious involvement of the different parties engaged in the transport chain and with increased attention to transport users. Within this new perspective, transport R&I and transport itself is part of a broader system, where environment, energy, economics and social aspects are captured and integrated.

Furthermore, it was highlighted that in some cases the role of regional and local authorities is changing, showing how local policy could influence, positively or negatively, R&I engagement.

Other specific elements mentioned by transport stakeholders were linked to digitalisation, environmental concerns, cybersecurity (this factor was pointed out by a rail expert, saying that freight rail transport is experiencing particular activity with respect to security issues and technological developments).

The participants were also asked about the R&I areas of interest and trends that they observed in the transport sector in general and in their specific field of activity. Figure 23 shows the areas that have been identified more frequently by the respondents, suggesting a common agreement. These trends are automation, decarbonisation and the key role played by environmental protection. These topics are considered relevant by many stakeholders, regardless of their field of expertise and their geographical distribution.

Figure 23 Trends in transport R&I



Source: TRIMIS

Seven out of 9 respondents have mentioned automation as a main trend, only one expert stated that automation in European rail transport is not proceeding at the same speed as in the other modes. Another dominant trend is transport decarbonisation, which is linked to electrification, circular economy, new recyclable materials and a greener approach of the overall transport sector in general, as stated by many of the people interviewed. Physical and digital infrastructure are also considered as being of high relevance at present and for the future, as they are the backbone of the transport system. Other trends, less frequently mentioned, are associated to social aspects, user acceptance and involvement in transport mobility and planning, research areas very much linked to each other. The respondents that mentioned these factors were referring to the need of having users and citizens very much aware of the transport sector dynamics, starting from the research phase up to the policy one, in order to engage them in the overall process. Research trends investigating mobility and planning are also strictly connected to the one of the social dimension (some participants who touched upon these aspects also mentioned urban and rural mobility aspects).

4.2.2 Challenges in transport R&I

This research is also looking at challenges that transport operators are facing every day, focusing on R&I activities. The main challenges mentioned are presented in Figure 24.

While the financial concern on how to fund transport research was generally considered as a minor issue and stated by only a few respondents, a remark was made in relation to funding access and management. In answering this question, 2/3 of the stakeholders expressed their concerns about the access to funding opportunities, due to the lack of or poor information, referring explicitly to the lack of knowledge on public funding opportunities. Moreover, the complexity in managing the project funding through the entire project development was also mentioned, though some respondents made a distinction between the easier European framework opposite to the more complex system of some countries. Some respondents, while analysing the challenges faced while trying to engage to and perform transport research, acknowledged the key role of TRIMIS as a unique and trusted reference point in their research activities.

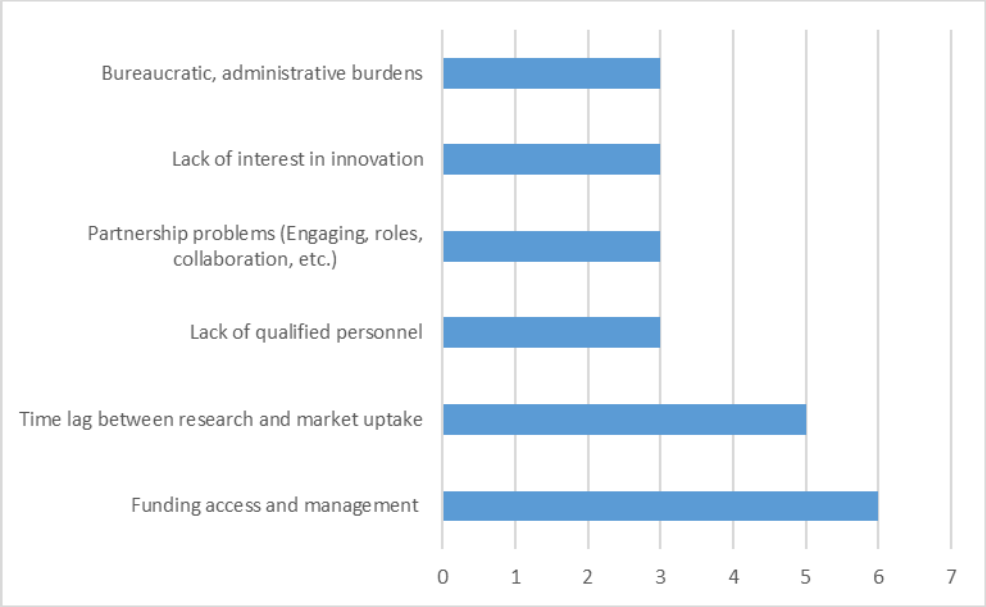
One of the most cited challenges that these stakeholders are facing is linked to the gap between the research phase and market penetration, which is considered as too long. The lengthiness of this process can decelerate the innovation dissemination with possible negative financial and economic consequences.

A major challenge is the lack of qualified researchers, mainly in some specific domains, that hampers knowledge creation and transfer. One stakeholder pointed out the difference between qualified researchers in private business, public bodies and universities, where in some cases public institutions lose skilled personnel because of budget issues. One respondent mentioned the difficulty to transfer knowledge due to a generation gap among researchers, especially in certain fields, such as infrastructure.

Quite a few respondents expressed their view on the challenges faced to get into the right research consortium, on the roles that the different partners can have, on the difficulty of small and medium enterprises (SMEs) to get access and participate in relevant projects without the support of "known" partners. One person declared that, although, quite often SMEs have easier access to regional or local funding, such funding, may not support very innovative concepts. Moreover, it was also highlighted that collaboration among private companies is more difficult to achieve and develop than the one with public bodies.

The administrative procedures, the bureaucratic implications and the regulatory framework can also be seen as problematic aspects that do not facilitate the engagement and commitment in R&I activities (5 over 9 participants have raised these points). A stakeholder pointed out the lack of tangible outcomes, which projects bring along sometimes, leading to results that are not always easily associated with practical applications and benefits in daily activities.

Figure 24 Challenges in transport R&I



Source: TRIMIS

Three stakeholders mentioned that for some sectors, such as logistics or infrastructure management, there could be very low interest in R&I, mainly due to the market dynamics, with very high competition and low profit margin, as clearly visible from the results presented in Chapter 3.

A transport stakeholder expressed also concerns about the management of data, mainly in big infrastructure projects.

4.2.3 Policy measures and transport R&I

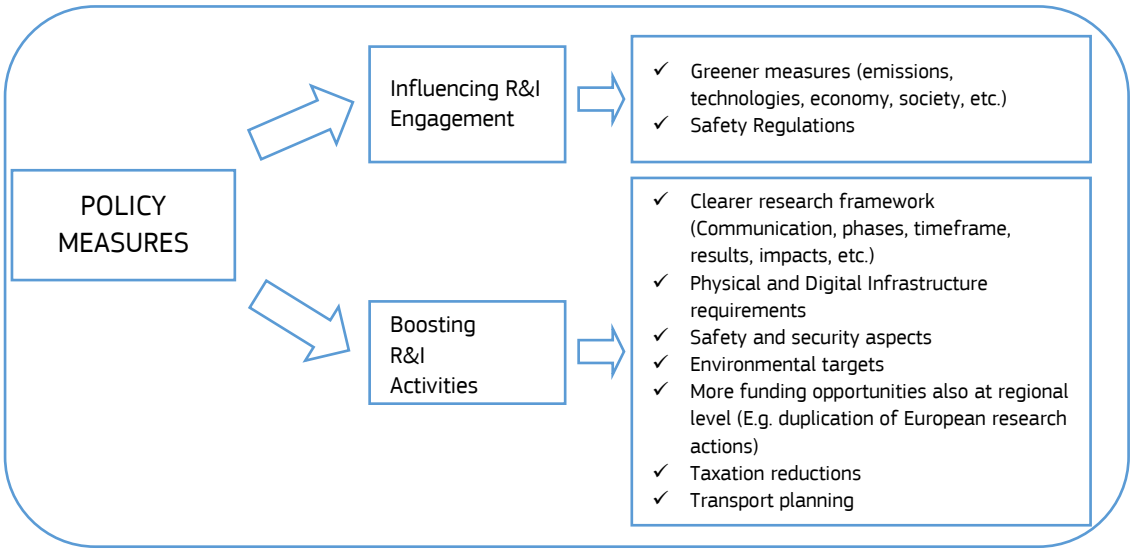
Policy measures were investigated from a dual perspective, looking at both their influence on R&I activities and their role as a stimulus to engage and develop such actions.

Firstly, respondents were asked to state whether policy measures, in the past years, have influenced their R&I activities and to which extent. The response was unanimous, with all of them providing a positive reply and elaborating further on which policies influenced them the most. All the stakeholders agreed, identifying environmental policies as the ones that most affected their business and hence their R&I activities. Some respondents were more precise in naming policy measures, such as the ones on green economy and transport decarbonisation, some others were more general referring to green technologies, climate measures, etc. Respondents, moreover, declared to have been influenced by policy measures addressing digitalisation, traffic safety and measures on traffic noise reductions.

Another question was related to policy measures that stakeholders expect to boost their R&I activities. The answers provided suggest a broad spectrum of policies that could enhance their commitment. One aspect, is the one related to the environmental aspects, such as emission targets, possible introduction of CO_2 taxation,

etc. Safety policy measures have been also mentioned as crucial ones when it comes to transport R&I. The development of physical and digital infrastructure policy measures is seen as key enabler for transport stakeholders; infrastructure has an overarching scope and it is a transversal topic, covering all modes of transport. Another contribution to transport R&I activities could be given by policies linked to mobility planning, mainly at regional or national level, which would orient transport researchers towards this field. The stakeholders interviewed expressed their views on the fact that a clearer policy framework for private companies, mainly SMEs, could contribute to ease their participation to R&I projects and activities, where they could adhere to a clear framework with more tangible outcomes. Figure 25 illustrates the main answers given during the phone interviews.

Figure 25 Policy measures and transport R&I



Source: TRIMIS

5 Conclusions

This report provides an assessment of the innovation capacity in the European transport, looking at R&D indicators, complemented by the results of the TRIMIS survey. The present report provides an update of the R&D indicators assessment, building on the 2019 TRIMIS work on the same topic, (Grosso et al., 2019) and complements the analysis with a qualitative survey that investigates transport stakeholders' point of view and experience in relation to transport R&I.

The main conclusions of this analysis are as follows:

- R&D activities are key in transport, where the private sector is mostly engaged. Business investments in R&D in the transport sector amounted to more than €47 billion in 2017; with the automotive industry leading the trend. Total European public investment in transport R&D in 2018 was equal to €2.9 billion, showing a decrease compared to the year 2017, when the total amount was around €3.3 billion. Transport researchers and R&D personnel, in 2017, amounted to 309.000 people working in the European transport sector, the majority of them working in the automotive industry. The researchers were roughly 40% of the total people counted.

The outcomes of the TRIMIS survey refer to the views and opinions of transport stakeholders based on their experience, geographical coverage and national or transport mode specificities. Although differences in experiences and views exist, some common understandings were retrieved from the web and phone survey.

- An almost unanimous opinion was expressed in relation the key role that R&I plays concerning the quality of services or goods provided. Moreover the competitiveness of the transport sector will be enhanced when R&I activities are performed. Although almost all the stakeholders recognised this element, still they also pointed out obstacles and barriers that slow down or prevent them to fully engage in such activities. In this view, effort is needed to help them in overcoming such obstacles.
- Financial means are at the core of transport R&I activities, showing the high commitment of the private sector that seems to recognise the vital role played by public funding. It is noteworthy that the main issue does not seem to be the funding availability, rather the difficulty to access and manage public funding. Scarce visibility of certain funding options is seen as a hampering factor. It would be therefore advisable to invest on focused communication and dissemination activities to ensure a broader and differentiated audience.
- Some stakeholders stated that the time lag between design, planning and market uptake is very often too long, leading to slowing down piloting activities and hence market distribution, which could create a cascade effect, decreasing market competitiveness and affecting company revenues. Market competition has been identified as a stimulus to R&I activities, Nonetheless collaboration among transport stakeholders does not always come as an easy task; mainly when private operators are involved that acknowledge, though, how fruitful R&I collaboration could be. Market dynamics, influence very much R&I activities and cannot be entirely steered, nonetheless the stakeholders interviewed stated that specific regulatory measures could streamline the overall research process and increase its effectiveness and efficiency.
- It is a shared opinion that qualified and skilled personnel is crucial to achieve high quality R&I outcomes, thought it also commonly observed that it is not always possible to count on sufficient qualified researchers, especially in the public sector. More information and data on the profile and characteristic of transport researchers could support the implementation of new employment measures, which could take into account their needs, skill requirements, etc. to create a more favourable and appealing working environment.
- The research trends identified by the transport stakeholders, at present, refer to automation, decarbonisation and digitalisation. Moreover, other relevant trends include social impacts, user acceptance and a participatory approach throughout the entire transport R&I development process, from planning to implementation and market uptake. Altogether, the identified trends may reflect a broader image of how the transport sector has changed or is evolving, showing signs of a more structural change. In this context, the transport sector is seen as a key part of an overall complex system comprising economic, environmental and social aspects. In this perspective policy is seen as key in the development of transport R&I, both as a driver and as an enabler to boost it.
- Stakeholders agreed on the key role played by policy measures, especially those linked to the introduction of greener technologies, environmental protection and safety conditions, which are at the core of the EC

strategy (i.e. The European Green Deal). Policy measures can also act as drivers for R&I activities, which could be both linked to specific topics, as the ones mentioned earlier, but they could also serve as a framework to facilitate stakeholders' engagement and participation in R&I activities. The analysis showed that there is a need for a clearer research framework, which could encompass several aspects, such as access to data and information, clearer dissemination and promotion means related to R&I initiatives and funding opportunities aiming at broadening the target audience, streamlining approach in administrative and bureaucratic procedures and increasing visibility of projects results, best practices and challenges faced.

The analyses performed in this report are subject to some limitations, namely:

- Limited data availability, mainly related to some transport sub-sector, geographical coverage, timeframe and public funding.
- Possible underestimations due to official statistical classifications. (R&I in other sectors can influence transport R&I, which are not captured in this work).
- Restricted sample of transport stakeholders.

Nonetheless, based on the results of this analysis, TRIMIS appears to be key within the transport R&I field, as it supports and promotes transport research being identified a one stop shop for the different transport stakeholders interested in approaching or deepening their knowledge in this domain, which was mentioned several times during the phone survey.

References

ASD-Aerospace and defence Industries Association of Europe (2019). ASD 2019 Facts and Figures. Available at: https://www.asd-europe.org/news-publications/facts-figures. (last accessed 14 April 2020).

Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. Nursing Plus Open, 2, 8-14.

Bryman, A. (2012). Social research methods, 4th Edition. Oxford university press.

European Commission (2014). Taking stock of the Europe 2020 strategy for smart, sustainable and inclusive growth, COM(2014)130final, Brussels. Available at: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52014DC0130. (last accessed 14 April 2020).

European Commission (2017a). EUROPE ON THE MOVE - An agenda for a socially fair transition towards clean, competitive and connected mobility for all COM(2017)0283 final. Brussels. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017DC0283&from=en. (last accessed 14 April 2020).

European Commission (2017b). Strategic Transport Research and Innovation Agenda (STRIA). Towards clean, competitive and connected mobility: the contribution of Transport Research and Innovation to the Mobility package Brussels, SWD(2017)223final. Available at: https://ec.europa.eu/transport/sites/transport/files/swd20170223-transportresearchandinnovationtomobilitypackage.pdf. (last accessed 14 April 2020).

European Commission (2018). EUROPE ON THE MOVE, Sustainable Mobility for Europe: safe, connected, and clean, COM(2018)293final, Brussels. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52018DC0293&from=EN. (last accessed 12 April 2020).

European Commission (2019a). The European Green Deal, COM(2019)640 final, Brussels. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1576150542719&uri=COM%3A2019%3A640%3AFIN. (last accessed 23 March 2020).

European Commission (2019b). Eurostat database. Available at: http://ec.europa.eu/eurostat. (last accessed 23 March 2020).

European Commission (2019c). The 2019 EU Industrial R&D Investment Scoreboard. Available at: https://iri.jrc.ec.europa.eu/scoreboard/2019-eu-industrial-rd-investment-scoreboard (last accessed 23 March 2020).

European Commission (2019d). European Innovation Scoreboard and Regional Innovation Scoreboard. Available at: https://ec.europa.eu/growth/industry/policy/innovation/scoreboards_en. (last accessed 23 March 2020).

European Commission, (2019e). Europe 2020 indicators R&D and innovation, Statistics Explained. Available at: https://ec.europa.eu/eurostat/statistics-explained/pdfscache/50448.pdf. (last accessed 14 April 2020).

European Commission (2020). Commission Work Programme 2020, A Union that strives for more Brussels, COM(2020) 37 final, Brussels. Available at: https://ec.europa.eu/info/publications/2020-commission-work-programme-key-documents_en (last accessed 24 June 2020).

European Commission (2020a). R & D personnel, Statistics Explained. Available at: https://ec.europa.eu/eurostat/statistics-explained/pdfscache/1202.pdf. (last accessed 14 April 2020).

European Union, (2019). Statistical pocketbook 2019-Transport in figures https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2019_en. (last accessed 23 March 2020).

Grosso, M., van Balen, M., Tsakalidis, A., Ortega Hortelano, A., Haq, G., Gkoumas, K., and Pekar, F., (2018). Assessing innovation capacity in the European transport sector - A methodological framework for a macro-level financial and socio-economic analysis, EUR 29415 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-96853-2, doi:10.2760/91285, JRC113633.

Grosso, M., van Balen, M., Ortega Hortelano, A., Haq, G., Gkoumas, K., Tsakalidis, A. and Pekár, F. (2019) Innovation Capacity of the European Transport Sector, A macro-level analysis, EUR 29749 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-03655-5, doi:10.2760/581596, JRC116565.

Gkoumas, K., Van Balen, M., Ortega Hortelano, A., Tsakalidis, A., Grosso, M., Haq, A. and Pekar, F., (2019a) Research and innovation in transport infrastructure in Europe, EUR 29829 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-09539-2, doi:10.2760/065365, JRC117581.

Gkoumas, K., Van Balen, M., Grosso, M., Marques Dos Santos, F., Tsakalidis, A., Ortega Hortelano, A., Haq, A. and Pekar, F., (2019b) Research and innovation in connected and automated transport in Europe, EUR 30009 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-14121-1, doi:10.2760/653853, JRC11827.

OECD (2002). Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development, The Measurement of Scientific and Technological Activities, OECD Publishing, Paris, https://doi.org/10.1787/9789264199040-en. (last accessed 14 April 2020).

OECD/Eurostat (2005). The Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, 3rd Edition. The Measurement of Scientific and Technological Activities, Éditions OCDE, Paris. Available at http://www.oecd.org/science/inno/2367580.pdf. (last accessed 14 April 2020).

OECD (2020). Technology and Patents database, Available at: https://stats.oecd.org/Index.aspx?DataSetCode=PATS_IPC (last accessed 23 March 2020).

Ortega Hortelano, A., van Balen, M., Gkoumas, K., Haq, G., Tsakalidis, A., Grosso, M., and Pekár, F.,(2019) Research and innovation in low emission alternative energy for transport, EUR 29936 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-12601-0, doi:10.2760/270433, JRC117599.

Tsakalidis, A., van Balen, M., Gkoumas, K., Ortega Hortelano, A., Grosso, M., Haq, G., Marques dos Santos, F., and Pekár, F., (2020a). Indicators for monitoring the Strategic Transport Research and Innovation Agenda: The TRIMIS indicator framework to assess transport research and innovation progress. EUR 30191 EN. Publications Office of the European Union, Luxembourg, 2020, ISBN 978-9276-18368-6, doi:10.2760/802211, JRC120323.

Tsakalidis, A., Van Balen, M., Gkoumas, K., Haq, A., Ortega Hortelano, A., Grosso, M. and Pekar, F., (2020b). Research and innovation in smart mobility and services in Europe, EUR 30212 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-18822-3, doi: 10.2760/79456, JRC120305.

Tsamis, A., Lohr, E., Gibson, G., Escher, G. (2016). Support to assessment of innovation capacities in the European transport sector. Final Report, Study Contract no. MOVE/C2/SER/2015-357/SI2.714653.

United Nations, (2015). Transforming our World: The 2030 Agenda for Sustainable Development. Available at: https://sustainabledevelopment.un.org/post2015/transformingourworld/publication. (last accessed 23 March 2020).

van Balen, M, Marques dos Santos, F, Gkoumas, K., Grosso, M., Ortega Hortelano, A., Tsakalidis, A., Haq, A., Pekár, F. (2020). Research and innovation on network and traffic management systems - An assessment based on the Transport Research and Innovation Monitoring and Information System (TRIMIS), EUR 30209 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-18608-3, doi:10.2760/205571, JRC120403.

Wiesenthal, T., Leduc, G., Cazzola, P., Schade, W., & Köhler, J. (2011). Mapping innovation in the European transport sector. An assessment of R&D efforts and priorities, institutional capacities, drivers and barriers to innovation. JRC Scientific and Technical Report.

Wiesenthal, T., Condeço-Melhorado, A., & Leduc, G. (2015). Innovation in the European transport sector: A review. Transport Policy, 42, 86-93.

List of abbreviations and definitions

ALT	Low emission alternative energy for transport
AT	Austria
BE	Belgium
BERD	Business Expenditure on Research and Development
BG	Bulgaria
CAT	Connected and automated transport
CY	Cyprus
CZ	Czechia
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
ELT	Transport electrification
EPO	European Patent Office
ES	Spain
EU	European Union
EU-28	European Union of 28 Member States
FI	Finland
FR	France
FTE	Full Time Equivalent
GBAORD	Government Budget Appropriations for Outlays for Research and Development
GDP	Gross Domestic Product
GERD	Gross domestic expenditure on R&D
H2020	Horizon 2020
HR	Croatia
HU	Hungary
ICT	Information and Communication Technology
IE	Ireland
INF	Transport infrastructure
IT	Italy
JRC	Joint Research Centre
LT	Lithuania
LU	Luxembourg
LV	Latvia
MS	Member State

MT	Malta
NABS	Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne
NL	The Netherlands
NTM	Network and traffic management systems
OECD	Organisation for Economic Co-operation and Development
PL	Poland
PT	Portugal
R&D	Research and Development
R&I	Research and Innovation
RO	Romania
SBS	Structural Business Statistics
SE	Sweden
SI	Slovenia
SK	Slovakia
SME	Small and medium enterprises
SMO	Smart mobility and services
STRIA	Strategic Transport Research and Innovation Agenda
TRIMIS	Transport Research and Innovation Monitoring and Information System
UK	United Kingdom
US	United States
VDM	Vehicle design and manufacturing

List of figures

List of tables

Annexes

Annex 1: Statistical classification of economic activities (NACE), Revision 2 transport-related sectors

The table below shows the transport related economic activities relevant for this analysis.

C29 - Manufacture of motor vehicles, trailers and semi-trailers
C29.1 - Manufacture of motor vehicles
C29.1.0 - Manufacture of motor vehicles
C29.2 - Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers
C29.2.0 - Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers
C29.3 - Manufacture of parts and accessories for motor vehicles
C29.3.1 - Manufacture of electrical and electronic equipment for motor vehicles
C29.3.2 - Manufacture of other parts and accessories for motor vehicles
C30 - Manufacture of other transport equipment
C30.1 - Building of ships and boats
C30.1.1 - Building of ships and floating structures
C30.1.2 - Building of pleasure and sporting boats
C30.2 - Manufacture of railway locomotives and rolling stock
C30.2.0 - Manufacture of railway locomotives and rolling stock
C30.3 - Manufacture of air and spacecraft and related machinery
C30.3.0 - Manufacture of air and spacecraft and related machinery
C30.4 - Manufacture of military fighting vehicles
C30.4.0 - Manufacture of military fighting vehicles
C30.9 - Manufacture of transport equipment n.e.c.
C30.9.1 - Manufacture of motorcycles
C30.9.2 - Manufacture of bicycles and invalid carriages
C30.9.9 - Manufacture of other transport equipment n.e.c.
G - Wholesale and retail trade; repair of motor vehicles and motorcycles
G45 - Wholesale and retail trade and repair of motor vehicles and motorcycles
G45.1 - Sale of motor vehicles
G45.1.1 - Sale of cars and light motor vehicles
G45.1.9 - Sale of other motor vehicles
G45.2 - Maintenance and repair of motor vehicles
G45.2.0 - Maintenance and repair of motor vehicles
G45.3 - Sale of motor vehicle parts and accessories
G45.3.1 - Wholesale trade of motor vehicle parts and accessories
G45.3.2 - Retail trade of motor vehicle parts and accessories
G45.4 - Sale, maintenance and repair of motorcycles and related parts and accessories
G45.4.0 - Sale, maintenance and repair of motorcycles and related parts and accessories
H - Transportation and storage
H49 - Land transport and transport via pipelines
H49.1 - Passenger rail transport, interurban
H49.1.0 - Passenger rail transport, interurban
H49.2 - Freight rail transport

H49.2.0 - Freight rail transport
H49.3 - Other passenger land transport
H49.3.1 - Urban and suburban passenger land transport
H49.3.2 - Taxi operation
H49.3.9 - Other passenger land transport n.e.c.
H49.4 - Freight transport by road and removal services
H49.4.1 - Freight transport by road
H49.4.2 - Removal services
H49.5 - Transport via pipeline
H49.5.0 - Transport via pipeline
H50 - Water transport
H50.1 - Sea and coastal passenger water transport
H50.1.0 - Sea and coastal passenger water transport
H50.2 - Sea and coastal freight water transport
H50.2.0 - Sea and coastal freight water transport
H50.3 - Inland passenger water transport
H50.3.0 - Inland passenger water transport
H50.4 - Inland freight water transport
H50.4.0 - Inland freight water transport
H51 - Air transport
H51.1 - Passenger air transport
H51.1.0 - Passenger air transport
H51.2 - Freight air transport and space transport
H51.2.1 - Freight air transport
H51.2.2 - Space transport
H52 - Warehousing and support activities for transportation
H52.1 - Warehousing and storage
H52.1.0 - Warehousing and storage
H52.2 - Support activities for transportation
H52.2.1 - Service activities incidental to land transportation
H52.2.2 - Service activities incidental to water transportation
H52.2.3 - Service activities incidental to air transportation
H52.2.4 - Cargo handling
H52.2.9 - Other transportation support activities
H53 - Postal and courier activities
H53.1 - Postal activities under universal service obligation
H53.1.0 - Postal activities under universal service obligation
H53.2 - Other postal and courier activities
H53.2.0 - Other postal and courier activities

Annex 2: NABS Classification - Transport, telecommunication and other infrastructures

The table below shows the transport related sectors relevant in this analysis.

NABS-CHAPTER 4: Transport, telecommunication and other infrastructures
This chapter includes R&D related to:
- Infrastructure and land development, including the construction of buildings;
- The general planning of land-use;
- Protection against harmful effects in town and Country planning.
This chapter also includes R&D related to:
- Transport systems;
- Telecommunication systems;
- General planning of Land-use;
- Construction and planning of building;
- Civil engineering;
- Water supply.
NABS-CHAPTER 4 does not include R&D related to other types of pollution than harmful effects in town (included in Chapter 2).

Annex 3: TRIMIS web survey

Innovation Capacity of the European Transport Sector

Introduction

The European Commission's 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 used to map transport technology trends and research and innovation (R&I) capacity.

Part of the TRIMIS activities is to assess private and public R&I engagement in the European transport sector.

With your help we would like to determine the state of transport innovation and where it's heading.

Survey Objectives

The questionnaire aims to gather information from transport stakeholders from the private and public sectors on:

Engagement in R&I activities,

Transport R&I trends,

Elements fostering and hampering innovation,

R&I personnel,

The role of policy measures in relation to transport R&I.

Insights on this topic would help us to understand business experiences and needs, and provide input for future policy making.

GENERAL INFORMATION

Organisation name	
Organisation **TYPE**	*Public/Private*
Size of your organisation	*0-9 people* *10-49 people* *50-249 people* *250 or more people*
Turnover in the last year	
Country where your organisation is established	
Years of working experience in your current organisation	*Less than 1 year* *1-3 years* *3-6 years* *More than 6 years*
Years of working experience in the transport sector	*Less than 1 year* *1-3 years* *3-6 years* *More than 6 years*
Main focus in your current activity	*Road Transport* *Rail Transport* *Maritime Transport* *Inland Waterways Transport* *Air Transport*
Do you have experience with the following R&I funding means?	*YES/NO*

European *National* *Regional/Local*	

INNOVATION IN THE TRANSPORT SECTOR

1. Innovative Activities

To what extent do you agree or disagree with the following statements?

To choose the options, please consider that 1. means Strongly Disagree and 5. means Strongly Agree.

	1	*2*	*3*	*4*	*5*
R&I is key to boosting competitiveness					
R&I is key to increasing the quality of the goods/services produced					
Product innovations are key to increasing competitiveness					
Process innovations are key to increasing competitiveness					
Organisational innovations are key to increasing competitiveness					
Marketing innovations are key to increasing competitiveness					

2. Innovation Barriers

To what extent do you agree or disagree with the following statements?

To choose the options, please consider that 1. means Strongly Disagree and 5. means Strongly Agree.

	1	*2*	*3*	*4*	*5*
High costs are a barrier to develop R&I activities					
Uncertain market demand is a barrier to develop R&I activities					
Too much competition in the market is a barrier to develop R&I activities					

3. Innovation Enablers

To what extent do you agree or disagree with the following statements?

To choose the options, please consider that 1. means Strongly Disagree and 5. means Strongly Agree.

	1	*2*	*3*	*4*	*5*
Private budget, in general, is sufficient to perform R&I activities					
Internal company funding, on its own, is sufficient to perform R&I activities					
Credit and private equity is needed to perform R&I activities					
Public financial support, from the European Union, is satisfactory to perform R&I activities					
Public financial support, from the National Governments, is satisfactory to perform R&I activities *Public financial support, from regional and local authorities, is satisfactory to perform R&I activities*					
There is enough highly qualified personnel to perform R&I activities					
Cooperation among private firms is fundamental for the development of R&I activities					
Policy measures (European, National, Local ones) boost R&I engagement					

4. Is there any additional R&I aspect that you would consider useful to look at? If so, please specify.

Thank you!

Thank you for participating in the TRIMIS Survey on Innovation Capacity in the Transport Sector.

The TRIMIS Team would like to complement this on-line survey with a phone call interview to better understand your answers during a short discussion. The phone interview will consist of 5 open questions. We can undertake the phone interview according to your availability.

Would you be available to be contacted for the phone interview? YES/NO

Please enter here your details, to be contacted.

Name and Surname

E-mail address

Telephone number (Land line, including country code)

Telephone number (Mobile line, including country code)

For further information on this topic, please download the TRIMIS Report on "Innovation Capacity of the European Transport" Sector here.

If you would like to know more about TRIMIS, visit our website: https://trimis.ec.europa.eu/

For comments, suggestions or questions, please contact us at EU-TRIMIS@ec.europa.eu

This Privacy Statement applies to this survey

TRIMIS_Survey_Privacy_Statement.pdf

Annex 4: Web survey respondent's overview

Stakeholders	Working Areas					Transport Mode					Type		Working Experience			
	Transport/ Logistics Providers	National Ministries/ Agencies	Universities/ Research Institutes	Regional/ Local authorities	Transport Associations/ Organisations	Air	IWW	Maritime	Rail	Road	Public	Private	<1	1 to 3	3 to 6	>6
1	■							■	■	■		■				
2	■					■	■		■	■	■					
3	■									■		■				
4		■				■		■	■	■	■					
5	■									■	■					
6				■				■	■		■					
7		■								■	■					
8		■				■		■	■	■	■					
9			■							■	■					
10		■					■		■	■	■					
11			■						■		■					
12			■				■		■	■	■					
13			■						■	■	■					
14		■								■	■					
15					■					■	■					
16		■				■	■		■	■	■					
17			■						■	■	■					
18					■					■	■					
19		■				■		■	■	■	■					
20		■				■		■		■	■					
21				■						■	■					
22		■								■	■					
23		■					■	■		■	■					
24		■							■		■					
25		■								■	■					
26				■						■	■					
27			■					■			■					
28		■					■	■		■	■					
29		■				■	■	■	■	■	■					
30		■								■	■					
31		■				■		■	■	■	■					
32	■							■				■				
33	■							■				■				
34		■				■		■	■	■	■					
35				■						■	■					
36	■							■				■				
37		■						■		■	■					
38	■								■		■					

Annex 5: TRIMIS phone survey

Innovation Capacity of the European Transport Sector

Date:

Field of activity (Road, rail, maritime, inland navigation, air):

FIRST PART: Transport R&I insights and trends	
1. According to you, which are the main R&I areas of interest and trends in transport in general and in your transport sector? (e.g. automation, new alternative fuels, electrification, smart systems, etc.)	
2. Which are the main changes you have experienced in your activity during the last 5 years in term of transport R&I?	
SECOND PART: Bottlenecks and future policy	
3. Some challenges have been identified in performing R&I activities, such as lack of funding, lack of qualified personnel, lack of collaboration with partners, lack of interest in innovating, etc. Can you comment on these? Are there any other challenges you see?	
4. Have policy measures, in recent years, influenced R&I engagement (In your company/Country)? Which was the impact of these measures at public/private level?	
5. Which policy measures do you envisage could boost R&I activities (in your company and in your transport sector/Country)? (e.g. reduce emissions, grants, reducing taxation, etc.)	
THIRD PART: Additional Information	
Please add any additional information you consider useful for the purpose of the present questionnaire.	

CONCLUSION

Thank you for participating in the interview.

Annex 6: Patents codes associated to the transport sector based on the cooperative patent classification

CPCs Codes	CPCs Description
B60B	VEHICLE WHEELS ; CASTORS; AXLES FOR WHEELS OR CASTORS; INCREASING WHEEL ADHESION
B60C	VEHICLE TYRES ; TYRE INFLATION; TYRE CHANGING OR REPAIRING; REPAIRING, OR CONNECTING VALVES TO, INFLATABLE ELASTIC BODIES IN GENERAL; DEVICES OR ARRANGEMENTS RELATED TO TYRES
B60D	VEHICLE CONNECTIONS
B60F	VEHICLES FOR USE BOTH ON RAIL AND ON ROAD; AMPHIBIOUS OR LIKE VEHICLES; CONVERTIBLE VEHICLES
B60G	VEHICLE SUSPENSION ARRANGEMENTS
B60H	ARRANGEMENTS OR ADAPTATIONS OF HEATING, COOLING, VENTILATING, OR OTHER AIR-TREATING DEVICES SPECIALLY FOR PASSENGER OR GOODS SPACES OF VEHICLES
B60J	WINDOWS, WINDSCREENS, NON-FIXED ROOFS, DOORS, OR SIMILAR DEVICES FOR VEHICLES; REMOVABLE EXTERNAL PROTECTIVE COVERINGS SPECIALLY ADAPTED FOR VEHICLES
B60K	ARRANGEMENT OR MOUNTING OF PROPULSION UNITS OR OF TRANSMISSIONS IN VEHICLES; ARRANGEMENT OR MOUNTING OF PLURAL DIVERSE PRIME-MOVERS IN VEHICLES; AUXILIARY DRIVES FOR VEHICLES; INSTRUMENTATION OR DASHBOARDS FOR VEHICLES; ARRANGEMENTS IN CONNECTION WITH COOL
B60L	ELECTRIC EQUIPMENT OR PROPULSION OF ELECTRICALLY-PROPELLED VEHICLES; MAGNETIC SUSPENSION OR LEVITATION FOR VEHICLES; ELECTRODYNAMIC BRAKE SYSTEMS FOR VEHICLES, IN GENERAL
B60M	POWER SUPPLY LINES, AND DEVICES ALONG RAILS, FOR ELECTRICALLY- PROPELLED VEHICLES
B60N	SEATS SPECIALLY ADAPTED FOR VEHICLES; VEHICLE PASSENGER ACCOMMODATION NOT OTHERWISE PROVIDED FOR
B60P	VEHICLES ADAPTED FOR LOAD TRANSPORTATION OR TO TRANSPORT, TO CARRY, OR TO COMPRISE SPECIAL LOADS OR OBJECTS
B60Q	ARRANGEMENT OF SIGNALLING OR LIGHTING DEVICES, THE MOUNTING OR SUPPORTING THEREOF OR CIRCUITS THEREFOR, FOR VEHICLES IN GENERAL
B60R	VEHICLES, VEHICLE FITTINGS, OR VEHICLE PARTS, NOT OTHERWISE PROVIDED FOR
B60T	VEHICLE BRAKE CONTROL SYSTEMS OR PARTS THEREOF; BRAKE CONTROL SYSTEMS OR PARTS THEREOF, IN GENERAL ; ARRANGEMENT OF BRAKING ELEMENTS ON VEHICLES IN GENERAL; PORTABLE DEVICES FOR PREVENTING UNWANTED MOVEMENT OF VEHICLES; VEHICLE MODIFICATIONS TO FACILITATE
B60W	CONJOINT CONTROL OF VEHICLE SUB-UNITS OF DIFFERENT TYPE OR DIFFERENT FUNCTION; CONTROL SYSTEMS SPECIALLY ADAPTED FOR HYBRID VEHICLES; ROAD VEHICLE DRIVE CONTROL SYSTEMS FOR PURPOSES NOT RELATED TO THE CONTROL OF A PARTICULAR SUB-UNIT
B60Y	INDEXING SCHEME RELATING TO ASPECTS CROSS-CUTTING VEHICLE TECHNOLOGY
B61B	RAILWAY SYSTEMS; EQUIPMENT THEREFOR NOT OTHERWISE PROVIDED FOR
B61C	LOCOMOTIVES; MOTOR RAILCARS
B61D	BODY DETAILS OR KINDS OF RAILWAY VEHICLES
B61F	RAIL VEHICLE SUSPENSIONS, e.g. UNDERFRAMES, BOGIES OR ARRANGEMENTS OF WHEEL AXLES; RAIL VEHICLES FOR USE ON TRACKS OF DIFFERENT WIDTH; PREVENTING DERAILING OF RAIL VEHICLES; WHEEL GUARDS, OBSTRUCTION REMOVERS OR THE LIKE FOR RAIL VEHICLES
B61G	COUPLINGS; DRAUGHT AND BUFFING APPLIANCES
B61H	BRAKES OR OTHER RETARDING APPARATUS PECULIAR TO RAIL VEHICLES; ARRANGEMENTS OR DISPOSITIONS OF BRAKES OR OTHER RETARDING APPARATUS IN RAIL VEHICLES
B61J	SHIFTING OR SHUNTING OF RAIL VEHICLES
B61K	OTHER AUXILIARY EQUIPMENT FOR RAILWAYS
B61L	GUIDING RAILWAY TRAFFIC; ENSURING THE SAFETY OF RAILWAY TRAFFIC
B62D	MOTOR VEHICLES; TRAILERS
B62H	CYCLE STANDS; SUPPORTS OR HOLDERS FOR PARKING OR STORING CYCLES; APPLIANCES PREVENTING OR INDICATING UNAUTHORIZED USE OR THEFT OF CYCLES; LOCKS INTEGRAL WITH CYCLES; DEVICES FOR LEARNING TO RIDE CYCLES
B62J	CYCLE SADDLES OR SEATS; ACCESSORIES PECULIAR TO CYCLES AND NOT OTHERWISE PROVIDED FOR, e.g. ARTICLE CARRIERS, CYCLE PROTECTORS

B62K	CYCLES; CYCLE FRAMES; CYCLE STEERING DEVICES; RIDER-OPERATED TERMINAL CONTROLS SPECIALLY ADAPTED FOR CYCLES; CYCLE AXLE SUSPENSIONS; CYCLE SIDE-CARS, FORECARS, OR THE LIKE
B62L	BRAKES SPECIALLY ADAPTED FOR CYCLES
B62M	POWERED PROPULSION OF SLEDGES OR ; SINGLE-TRACK; CYCLES; TRANSMISSIONS SPECIALLY ADAPTED FOR SUCH VEHICLES
B63B	SHIPS OR OTHER WATERBORNE VESSELS; EQUIPMENT FOR SHIPPING
B63C	LAUNCHING, HAULING-OUT, OR DRY-DOCKING OF VESSELS; LIFE-SAVING IN WATER; EQUIPMENT FOR DWELLING OR WORKING UNDER WATER; MEANS FOR SALVAGING OR SEARCHING FOR UNDERWATER OBJECTS
B63H	MARINE PROPULSION OR STEERING
B63J	AUXILIARIES ON VESSELS
B64C	AEROPLANES; HELICOPTERS
B64D	EQUIPMENT FOR FITTING IN OR TO AIRCRAFT; FLYING SUITS; PARACHUTES; ARRANGEMENTS OR MOUNTING OF POWER PLANTS OR PROPULSION TRANSMISSIONS IN AIRCRAFT
B64F	GROUND OR AIRCRAFT-CARRIER-DECK INSTALLATIONS SPECIALLY ADAPTED FOR USE IN CONNECTION WITH AIRCRAFT; DESIGNING, MANUFACTURING, ASSEMBLING, CLEANING, MAINTAINING OR REPAIRING AIRCRAFT, NOT OTHERWISE PROVIDED FOR; HANDLING, TRANSPORTING, TESTING OR INSPECTIN
E01B	PERMANENT WAY; PERMANENT-WAY TOOLS; MACHINES FOR MAKING RAILWAYS OF ALL KINDS
E01C	CONSTRUCTION OF, OR SURFACES FOR, ROADS, SPORTS GROUNDS, OR THE LIKE; MACHINES OR AUXILIARY TOOLS FOR CONSTRUCTION OR REPAIR
E01D	CONSTRUCTION OF BRIDGES, ; ELEVATED ROADWAYS; OR VIADUCTS; ASSEMBLY OF BRIDGES
E02C	SHIP-LIFTING DEVICES OR MECHANISMS
E21F	SAFETY DEVICES, TRANSPORT, FILLING-UP, RESCUE, VENTILATION, OR DRAINING IN OR OF MINES OR TUNNELS

GETTING IN TOUCH WITH THE EU

In person
All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at: https://europa.eu/european-union/contact_en

On the phone or by email
Europe Direct is a service that answers your questions about the European Union. You can contact this service:
- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696, or
- by electronic mail via: https://europa.eu/european-union/contact_en

FINDING INFORMATION ABOUT THE EU

Online
Information about the European Union in all the official languages of the EU is available on the Europa website at: https://europa.eu/european-union/index_en

EU publications
You can download or order free and priced EU publications from EU Bookshop at: https://publications.europa.eu/en/publications. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see https://europa.eu/european-union/contact_en).

KJ-NA-30326-EN-N

The European Commission's science and knowledge service

Joint Research Centre

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.

EU Science Hub

ec.europa.eu/jrc

@EU_ScienceHub

EU Science Hub - Joint Research Centre

EU Science, Research and Innovation

EU Science Hub

Publications Office of the European Union

doi:10.2760/592161

ISBN 978-92-76-21045-0