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Innovation capacity in the European transport sector

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

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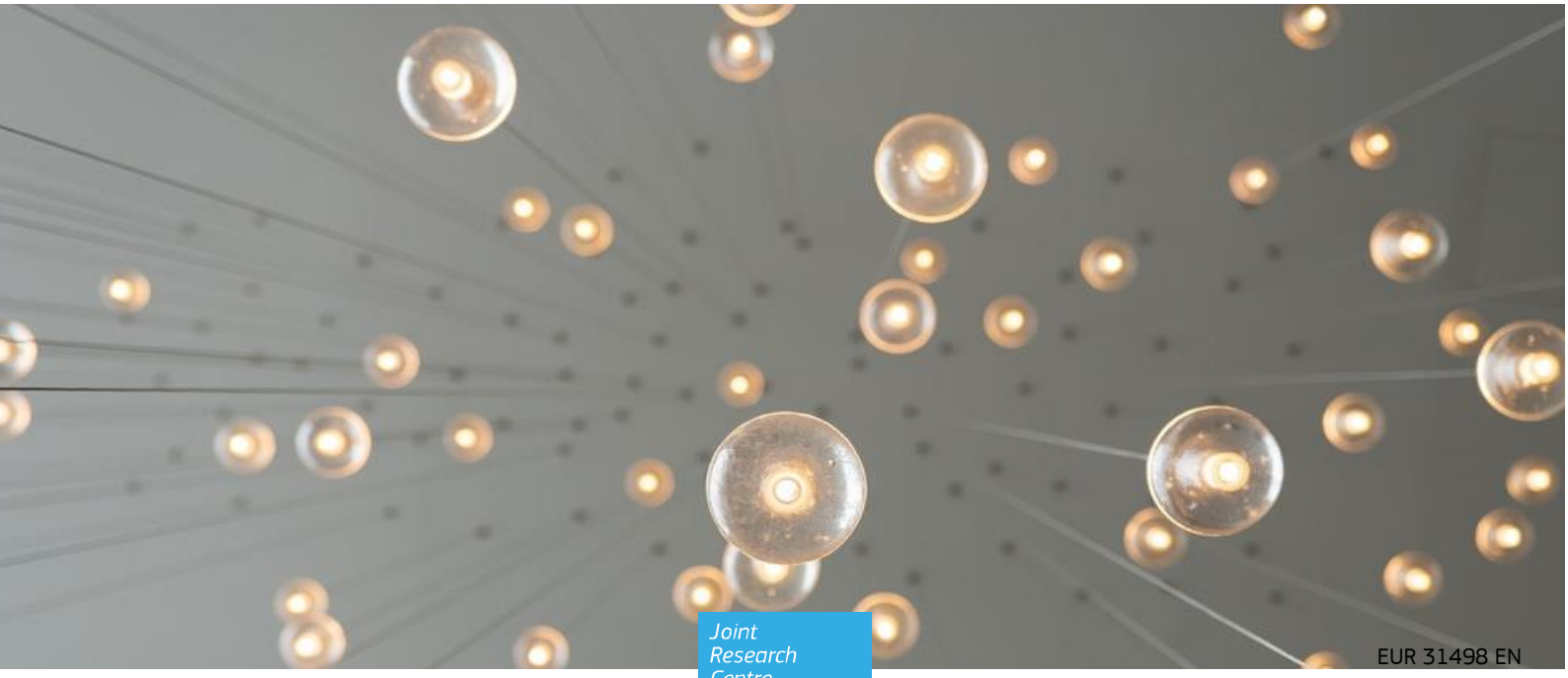

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Contents

Abstract

TRIMIS provides periodical assessments of transport innovation capacity through a macro-level indicators analysis at EU level. This report presents an updated review of the overall innovation capacity, including indications on private and public investment on transport research and innovation (R&I), presence of transport researchers and R&I personnel, patents, innovation capacity bottlenecks, etc. It offers a general view on the transport sector innovation engagement, supporting the reflection on main sector's trends and possible research and policy measure to support its enhancement.

Acknowledgements

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Executive summary

This report provides an assessment of the innovation capacity of the EU transport, looking at research and development (R&I) indicators.

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 Strategy on Sustainable and Smart Mobility[5] pursues 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 key conclusions

The main conclusions of this analysis are the following:

The private sector maintains its key role in R&I activities in the transport sector, which in 2019 amounted to €38 billion, where most of the investments came from the automotive industry, followed by the industry dealing with other transport equipment manufacturing and only minimally by the transportation and storage sector.

The total EU public investments is substantially lower, being equal to €2.4 billion in 2020, showing 25% decrease compared to 2010.

In 2019, 250.000 researchers and R&I personnel worked in the transport sector, equal to 1,8% of total people employed, their majority being employed in the automotive sector, with a strong prevalence of male occupation, 87.4% of the total number.

The number of granted patents associated to the transport sector was approximately 71.4 thousand submitted in all EU countries (EU-27) in the period 2010-2020. Most of the granted patent applications, 42.5%, are associated to transport vehicles.

More than half of the transport companies that participated to the last CIS 2018 survey declared to have initiated innovation activities, showing the high interest of these companies in trying to improve the quality of services or goods provided.

The type of innovation introduced in the transport companies, in the last years, are mainly associated to processes and products innovations, rather than organizational or marketing ones.

Although financial support can be received by governmental bodies, at local, national and EU level, still it is not considered enough from the transport companies and this aspect can constitute a real barrier to engage and enhance R&I activities. The same is valid for internal financial resources that are often scarcely allocated to R&I activities, as they may not be considered fundamental or other operational needs prevail when allocating funding.

[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, 2017a)

[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, 2017b)

[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 (2019).

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

Market cooperation can be seen as driver for R&I activities, nonetheless collaboration among transport stakeholders is not always a granted fact, mainly for companies working in the transportation service sector, while data highlight a higher level of cooperation in the automotive and other vehicles manufacturing industries.

Other major barriers to innovate are linked to market dynamics, which cannot be entirely steered by the industry, such as uncertain market trends or the lack of qualified and skilled personnel.

The outcome of the present report provides a clear picture of the innovation capacity of the transport sector in EU, highlighting a general negative trend compared to the previous years. Still the aspects and elements analysed are those on which further reflections and actions could be taken to make the transport sector more innovative and competitive.

Related and future JRC work

TRIMIS was launched, by the JRC, in 2017 on behalf of DG MOVE and DG RTD and since then it has published a number of Science for Policy and Technical reports[6] that directly support the STRIA process and the related roadmaps. This report provides a macro-level assessment of the overall innovation capacity in the European transport sector. It does so by identifying and assessing R&I indicators, updating the first TRIMIS Report on Innovation Capacity in Europe[7] (Grosso et al., 2020). TRIMIS will continue with a periodic assessment of the EU transport R&I capacity.

Quick guide

The report is structured as follows:

Chapter 1 provides a general introduction to the topic. Chapter 2 defines the methodological approach used. Chapter 3 shows the results of the innovation capacity assessment in EU and Chapter 4 provides indications on the transport sector innovation engagement. Chapter 5 presents the conclusions of the analysis.

[6] European Commission, (2017c). TRIMIS Transport and Research and Innovation Monitoring and Information System, https://trimis.ec.europa.eu

[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

1 Introduction

The importance of research and innovation (R&I) is widely recognised at European level leading to EU policies and actions in all economic domains. The role of R&I is to support the development of better services and products, so that the EU economy could remain globally competitive and support the wellbeing of European citizens.

The European Green Deal (European Commission, 2019) frames a policy perspective on R&I initiatives. The document sets ambitious target for the transport sector, aiming at its emissions reduction and at increasing efficiency through a list of measures. It also acknowledges that a key role in this direction is played by R&I.

This TRIMIS report provides an overview of the transport innovation capacity in EU, based on the most recent available data, building up on previous work on the topic (Grosso et al., 2018, 2019, 2020) and fitting within the TRIMIS portfolio activities which are undertaken at the European Commission's Joint Research Centre (JRC). TRIMIS is an integrated transport policy-support tool that operates as a knowledge management system offering open-access information about transport-related R&I initiatives in EU and beyond. TRIMIS contains around 9000 R&I European and nationally-funded projects in its continuously updating database.

2 Methodological approach

This research maps transport innovation capacity at EU level. It reflects on the drivers and bottlenecks of transport-related R&I, enabling comparisons between transport sectors and member states countries. Based on previous TRIMIS work on the topic, (Grosso et al, 2018, 2019, 2020) and on earlier literature (Wiesenthal et al., 2011 and 2015; Tsamis et al., 2016), this analysis looks at R&I indicators and analyses the relevant EU scene providing an up to date overview of the transport sector performances.

In this report innovation capacity assessment is developed using a list of indicators referring to R&I funding, human resources engaged in R&I and patenting activities. Business sector innovation engagement is also presented through the use of the Community Innovation Survey (CIS). The survey provides the data for all the sectors, but it enables to distinguish specific information about the transport industry.

The list and definition of indicators presented in this analysis are shown in Table 1.

Table 1 R&I Indicators

Area of Indicator	Indicator	Description
Funding	Business expenditure on R&I (BERD)	BERD represents the component of Gross domestic expenditure on R&I (GERD) incurred by units belonging to the business enterprise sector. It is the measure of intramural R&I expenditures within the business enterprise sector during a specific reference period
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&I in central government budgets
Human resources	Total R&I personnel in business enterprise	Total number of persons employed in research in a specific sector
Human resources	Total R&I 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).

The Oslo Manual definition of innovation is used in this report: "…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 ones[9] and refer to the transport sector in the EU 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).

[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 Spring 2022.

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 classification.

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].

The main source of information is Eurostat (European Commission, 2022a), namely the following datasets:

- Structural Business Statistics (SBS);
- Research and Development;
- Community Innovation Survey.

Moreover, additional information was collected from:

- EC – Industrial R&I Investment Scoreboard (European Commission, 2021a);
- EC – European Innovation Scoreboard (European Commission, 2022b);
- Organisation for Economic Co-operation and Development (OECD) – Science, Technology and Industry Outlook (OECD, 2020);

The reporting year is 2019, as most recent data were not consistently available, however more up to date information is presented, when possible. The geographical scope covers EU-27 countries. Direct comparison with previous editions of TRIMIS similar assessment cannot be performed as earlier EU-28 countries were analysed, including hence United Kingdom. Finally, the results should be treated as a general overview and not a precise estimation as for some variables have a high number of missing data.

[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. 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).

3 Assessment of the innovation capacity in the EU transport sector

This section presents the analysis of the following R&I indicators: funding indicators, human resources and patents.

3.1 Funding

Private and public funding are essential to develop R&I, which hereafter are illustrated through Business Expenditure on R&I (BERD) and Government Budget Appropriations for Outlays for Research and Development (GBAORD).

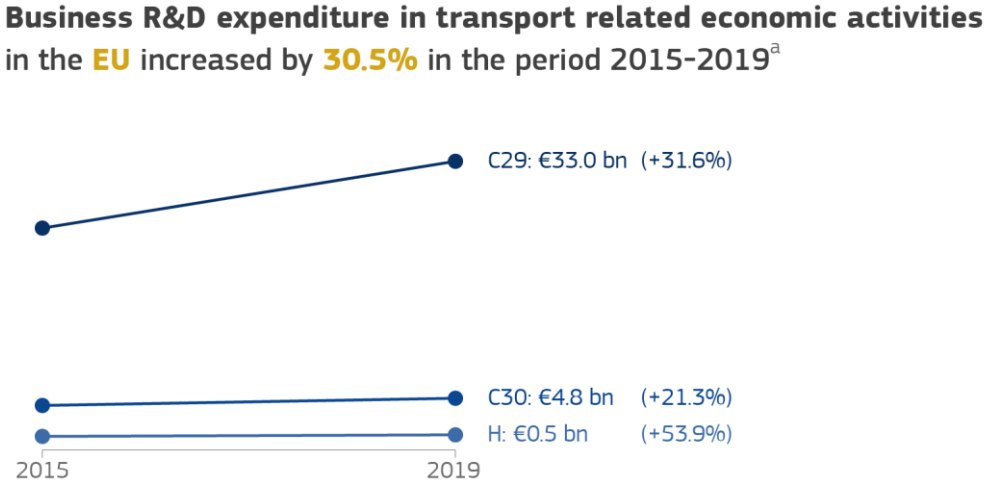
3.1.1 Business R&I expenditure

Business R&I expenditures are the component of Gross Domestic Expenditures on R&I, of a business sector, namely the transport one (OECD/Eurostat, 2005).

At the moment of writing this report, few data are available for the year 2020, higher quality data are ensured for 2019. Even though the data do not cover all of the EU-27 MS countries[11], 2019 has been selected as the most updated reference period.

The total transport business R&I expenditure in 2019 amounted to more than €38 billion[12], up from approximately €30 billion in 2015 (**Errore. L'origine riferimento non è stata trovata.**). In 2019, the production of motor vehicles (C29) accounted for almost €33 billion of the total expenditures, i.e. 86.0%[13] of all transport-related expenditures on R&I. The construction of other transport equipment (C30) was around 12.7% or €4.8 billion, while 1.3% (€0,52 billion) came from transportation and storage (H).

Figure 1 The change of the business R&I expenditure in transport related economic activities (billion Euro, 2015-2019)



- [a] *Due to data unavailability, values for FR, LU, LV and NL are not included in the chart. For SE only H category is included and for EE only C29.*
- *Data source:* Eurostat and TRIMIS elaboration.

In 2019, Germany was the largest investor in all the transport sectors, accounting for nearly €30.4 billion of all transport-related expenditures on R&I, equal to 79% of the total expenditures.[14] In the manufacturing of motor vehicles (C29) expenditures of Germany exceeded €28 billion (85% of total), while Italy invested €1.7

[11] Data missing, in 2019, for: C29 (FR, LU, LV, NL, SE), C30 (EE, FR, LU, LV, NL, SE), H (EE, FR, LU, NL). For CY all the values were zero, hence it is not represented the analysis.
[12] Based on JRC-TRIMIS elaborations for this report, in Current Euros.
13 Due to data unavailability, EE, FR, LU, LV, NL and SE are not included in this calculation.
14 Based on MSs data availability

billion (5% of total), and Austria, Spain and Czechia invested €0.66 (2% of total), €0.54 (1,7% of total), and €0.52 billion (1,6% of total), respectively. Germany had the highest expenditures also in the industry producing other transport equipment (C30) – nearly €2 billion (41% of total), while Italy had €1.5 billion (31% of total) and Spain €0.6 billion (14% of total). Germany's expenditures in transportation and storage (H) were almost €140 million (27% of total), Greece spent €85 million (16% of total), while Spain, Italy and Belgium invested between €70 and €80 million each (respectively 14% and 15% of total). It is important to highlight that for 2019 data for some countries, including France, were not available in none of the three transport sectors considered.

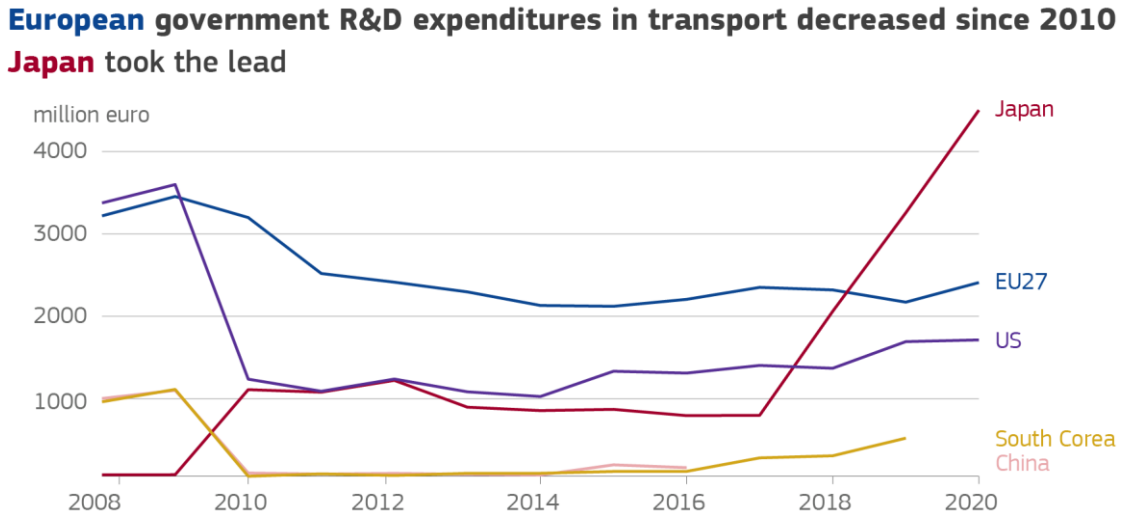
According to the EU Industrial R&I Investment Scoreboard[15], EU is leading the automotive R&I activities, at international level. In EU, in 2020, 33.6 % of total business R&I spending was in the automobiles and other transport sector showing nonetheless a decrease of 7.2%, which might be related to the Covid-19 pandemic. United States (US) and China continue with their lower level of investment, allocating respectively 5.6% and 9.3% of their total spending in these activities. (European Commission, 2021a)

3.1.2 Government R&I expenditure

The Government Budget Appropriations for Outlays for Research and Development (GBAORD) is the indicator that provides information on government expenditure on R&I[16].

The GBAORD evolution in the transport sector in the last ten years (2010-2020) indicates a decrease from €3,200 million to €2,400 million[17], (see Figure 2). The distribution of GBAORD among MSs indicates that almost the entire amount of funding originated from few ones. In 2020, France accounted for almost 31% and Germany for 28.7%. Spain, Italy, Sweden follow with public R&I funding around 7% of the total EU spending. At international level EU and Japan show higher public expenditure in transport R&I, as shown in Figure 2. Other major economies show much lower level of investments.

Figure 2 Trend in International Transport GBAORD (million Euro, 2008-2020)



- *Data source:* Eurostat and OECD

As already highlighted, the data provided through the GBAORD indicator fail to capture entirely the governmental R&I expenditures, due to methodological reasons and data quality. The work conducted in TRIMIS

[15] Data reported are from 2020 ensuring consistency with the overall data timeframe reported in this report.

[16] Government spending allocated to research and development from central or provincial government budgets. NABS 04 "Transport, telecommunication and other infrastructures" includes other non-transport research and development 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. (see Annex 2)

[17] Data missing for: LT; For FR, SE data are estimated by Eurostat; Values expressed in Current Euros.

helps to partially overcome this data gap looking at R&I 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 €6,900 million, over the entire period[18]. The allocation to the different modes of transport, based on the TRIMIS projects database, shows that air transport received around 40% of the total European funding in the transport sector within H2020. Road transport received 26.4%, followed by waterborne and rail, which received 7.7% and 6.5% respectively. An important share of the funding was received by multimodal projects, 19.2% of the total amount.

3.2 Human resources

R&I capacity is captured also by means of analysing information on the personnel involved in research activities. Based on the OECD definition "R&I personnel" can be identified as the following groups: researchers, supporting managers and administrators" (Eurostat based on Frascati Manual, OECD 2002).

3.2.1 R&I Personnel

The overall share of total R&I personnel, in EU, account for 1.4% of the total labour force in 2020. (European Commission, 2021b) Some MSs, e.g. Denmark, Belgium, Finland or Luxembourg, employ a relatively higher number of people with these functions, mainly in the private sector.

Concerning the transport sector, the last available figures, from 2019, indicate that 250,000[19] R&I personnel worked in this sector, performing R&I related activities, which equal to 1.8% of total number of people employed in the sector. It should be noted however, that due to unavailability of the data, this number does not cover personnel employed in the following countries: Cyprus, Estonia, France, Luxembourg, Latvia, Netherlands nor Sweden.

In 2019, the majority of R&I personnel in the European countries[20] was employed in tasks within the automotive industry (C29) with almost 200,000 R&I people, representing 79% of the total personnel. Data show that R&I personnel in manufacturing of other transport equipment (C30) and transportation and storage (H) were considerably less: approximately 43.000 (17%) and 10.000 (4%) people, respectively (Figure 3).

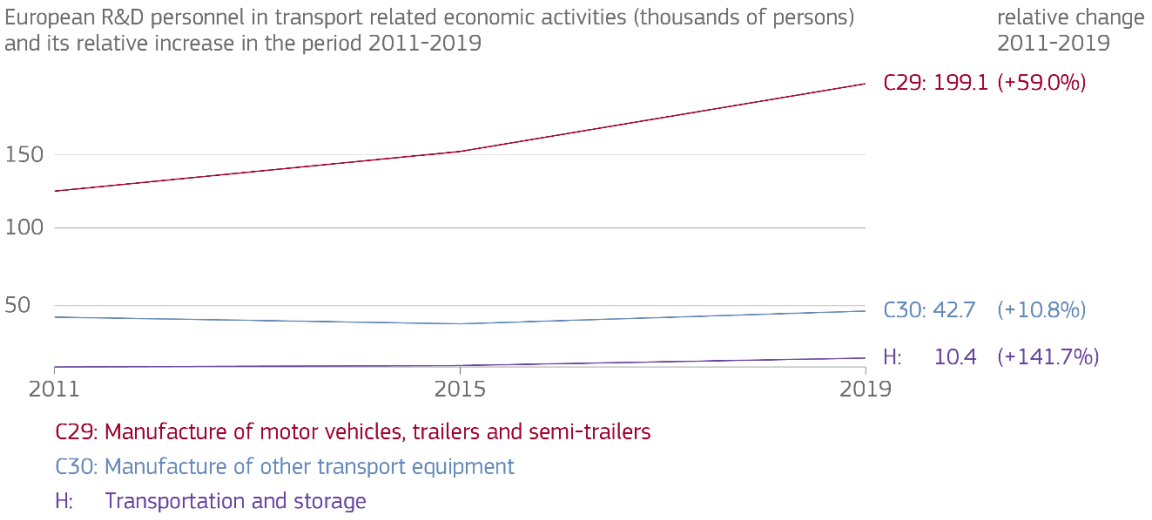
Figure 3 R&I personnel in transport related economic activities (number of persons, 2011-2015-2019)

[18] The figures reported in this report are based on the TRIMIS database and according to TRIMIS methodology in place. This values should be supplemented by national data about public investment. TRIMIS is continuously collecting these data, however the process is far from being complete and would not provide a realistic estimate.

[19] Based on JRC-TRIMIS elaborations for this report. The estimation, in 2019, measured in full-time equivalents (FTE) equals to 228.000.

[20] Due to data unavailability, EE, FR, LU, LV, NL and SE are not included in this calculations. For CY all the values were zero, hence it is not represented the analysis.

The number of transport related R&D personnel increased by 50% since 2011
The majority is employed in tasks within the automotive industry (C29)



- *Data source:* Eurostat

Data on the gender dimension show that men outnumber women. The presence of men performing R&I activities in transport was around 87.4% of the total counting.

The number of people that work on R&I is relatively low compared to the rest of people employed in the transport sector: only 0.2% of the total number of people in transportation and storage (H) and a total of 4.5% of those employed in the automotive industry (C29), and in the manufacturing of other transport equipment (C30).

3.2.2 Researchers

Researchers are employed to create new knowledge, products, processes and methods, as well as to manage the R&I projects (European Commission, 2021b).

In 2019, there were nearly 150,000[21] transport researchers in the EU, without including those employed in France[22] or the Netherlands[23] among other countries for which data is missing[24]. The majority of these researchers (82.4%) worked in the manufacturing of motor vehicles (C29), the manufacturing of other transport equipment (C30) (15.2%), while just 2.4% of the total number worked in transportation and storage (H). About 17% increase of transport researchers could be observed from the years 2017-2019, while the distribution among the transport sectors remained unchanged. Transport researchers are predominantly men, 89% of the total number.

An international comparison with the major economies shows EU as better positioned compared to China, which reported ca. 127,000 researchers in 2019, to Japan and Korea that employed respectively 96,000 and 41,000 researchers in their transport activities.

3.3 Patents

The number of patents complements the overview of the state of innovation capacity of organizations active in a given sector and as such it is often an R&I indicator (see e.g. Grosso et al. 2020). This section is based on transport-related database which is being developed within TRIMIS. It includes granted patent applications to the European Patent Office linked to all transport modes, as well as multimodal ones. They were identified

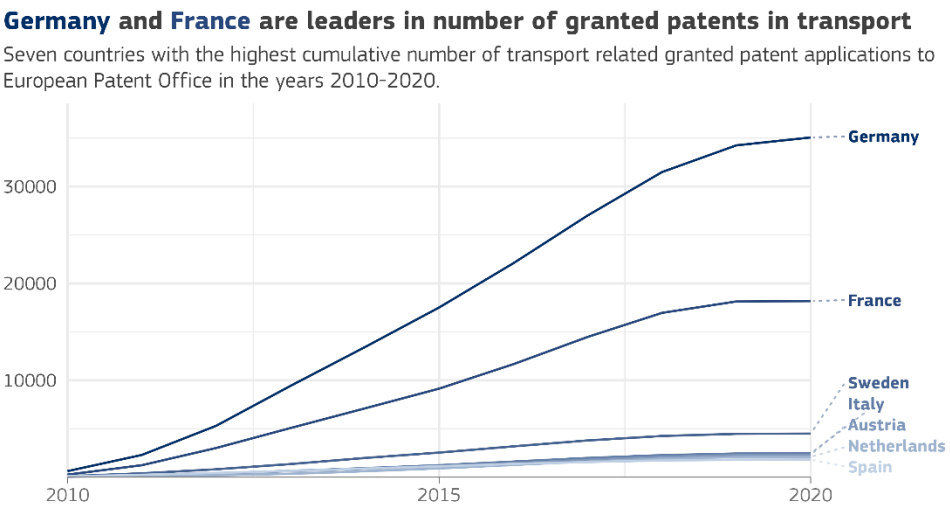
[21] Researchers measured in FTE
[22] The last recorded data (2013) indicates over 28,000 researchers employed in France
[23] The last recorded data (2018) indicates over 3,000 researchers employed in the Netherlands
[24] Due to data unavailability, EE, FR, LU, LV, NL and SE are not included in this calculations. For CY all the values were zero, hence it is not represented the analysis

using the relevant Cooperative Patent Classification (CPC) codes related to the whole transport industry and all transport modes (see Annex 3 for the detailed list). The analysed dataset includes patent submissions from all 27-EU MSs and covers a time range from 2010 until 2020, with respect to their first application. It should be noted that the European patent grant procedure takes about three to five years from the date an application is filed[25].

Figure 4 shows the total (cumulated) number of granted patents by EU MSs. It shows that nearly half of European granted patents in transport were submitted in Germany (Figure 5) - over 35 thousand out of approximately 71.4 thousand submitted in all EU countries (EU-27). The second country is France - nearly 18.2 thousand, 25.5% of all EU granted patents in transport. The total numbers of granted patents in other EU countries are significantly lower – less than 4.5 thousand in Sweden and 1.8-2.4 in Italy, Austria, the Netherlands and Spain. Granted patents from all the remaining twenty EU MSs represent only 6.8% of all EU patents (4.8 thousand granted patent applications). This figure shows unequal distribution of innovation activities expressed by successful patent applications in transport sector.

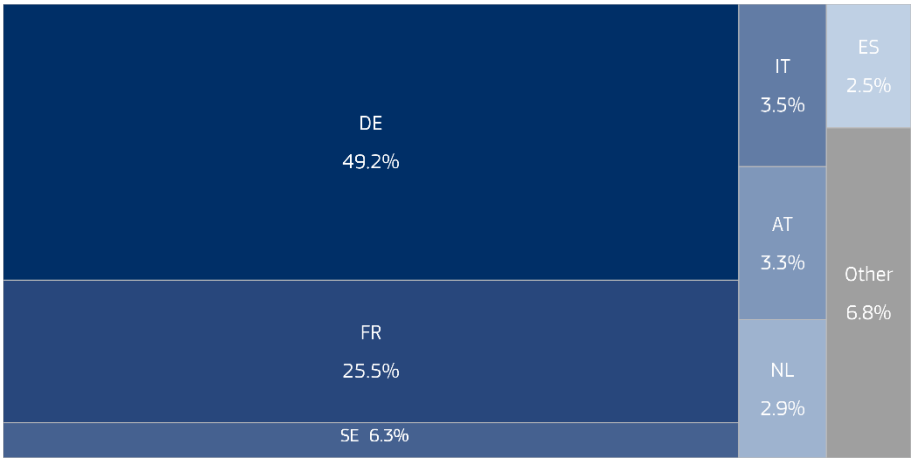
Figure 4 Cumulative number of patents from major European countries (2010-2020)

[25] https://www.epo.org/service-support/faq/own-file.html



- *Data source:* European Patent Office and TRIMIS

Figure 5 Distribution of granted, transport-related patents by country in EU (2010-2020)



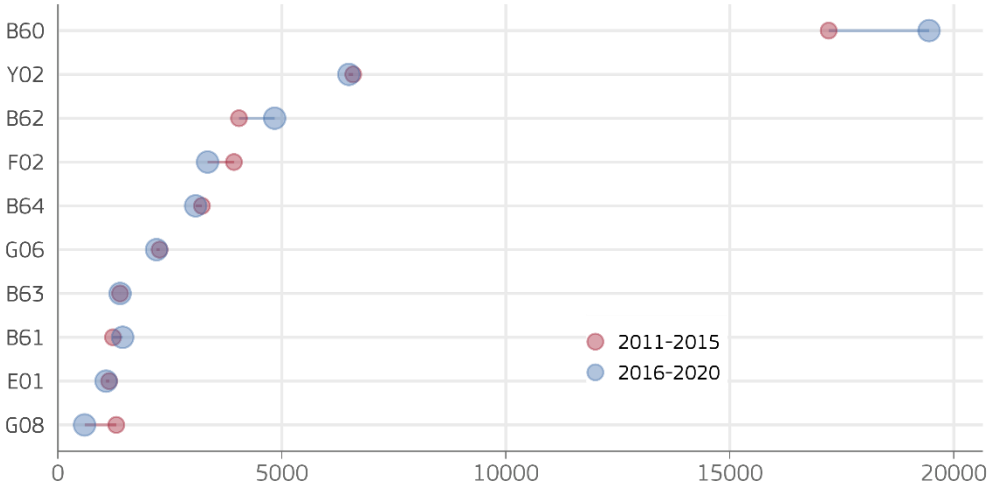
- *Data source:* European Patent Office and TRIMIS

Figure 6 shows distribution of granted patents in transport in the relevant CPC categories and its potential changes between 2011-2015 and 2016-2020. Most of the granted patent applications are associated to category B60 (Vehicles): over 17.2 thousand in the first and nearly 19.5 thousand in the second period. In total, 42.5% of all transport related granted patent applications in EU countries are associated to this category. All the other categories contain significantly lower number of successful grant applications. Importantly, the division of granted patent applications in transport sector by CPC categories did not change between the two analysed five-year periods of time.

Figure 6 Distribution of transport-related patents by CPC categories and their change (2011-2015 vs 2016-2020)

Patents structure by category is relatively stable

Number of granted, transport-related patents in EU countries in the years 2011-2015 and 2016-2020.



Data source: European Patent Office and TRIMIS

4 Innovation engagement

To assess the level of innovation of the EU transport companies, additional innovation engagement indicators have been identified. These indicators are extracted from CIS survey data (European Commission, 2022a) which covers the period 2016-2018. They provide the latest information on innovation types, the role played by public financial aids, the research and innovation spending and the level of innovation cooperation.

4.1 Innovative enterprises

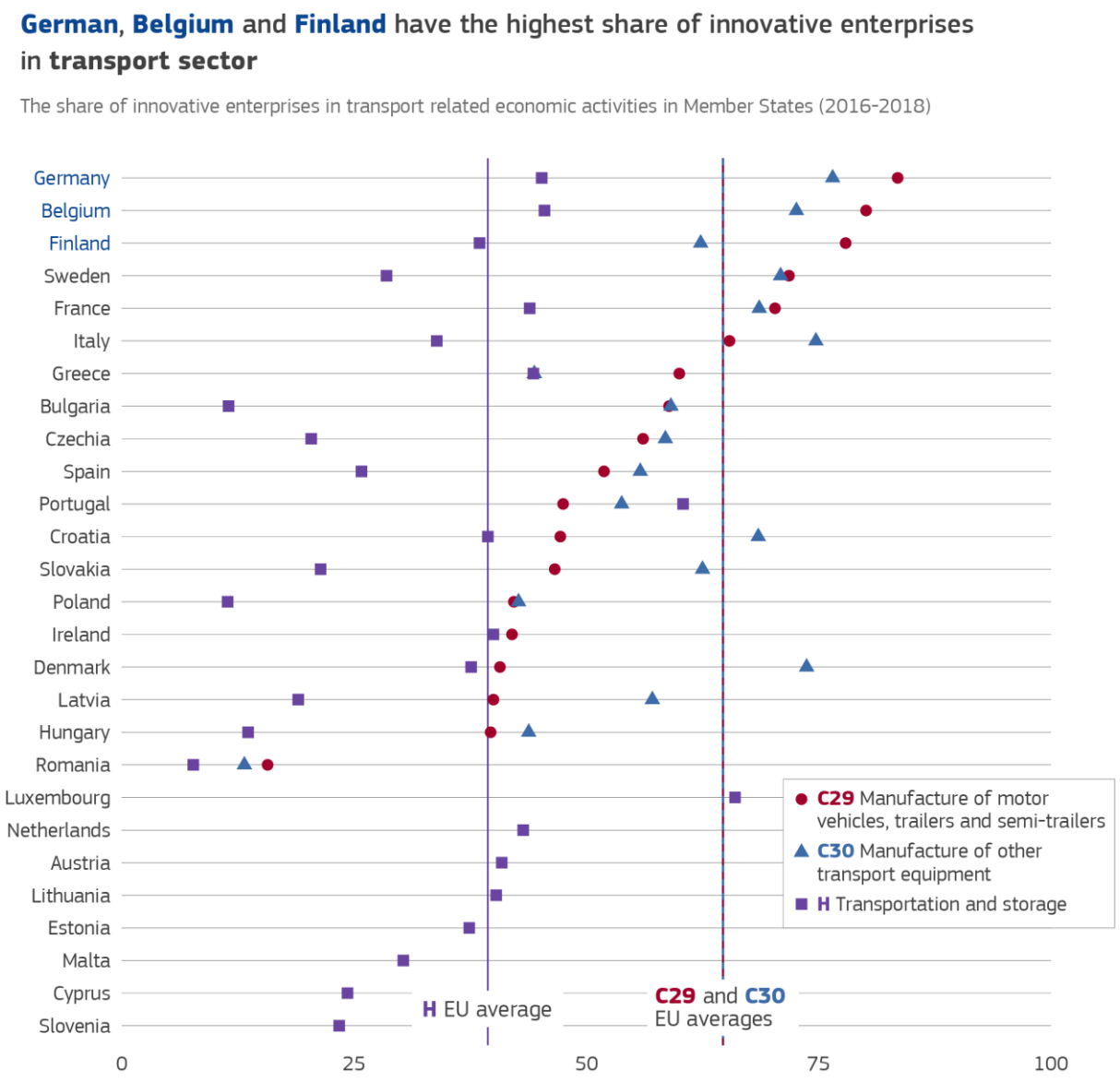
An important information about the level of engagement of private companies in research activities is provided by the indicator showing the number of companies that have declared to have undertaken innovation activities in a specific time period. The innovation activities could be successful, on-going or abandoned, as defined by Eurostat (European Commission, 2022a). This specification highlights the propensity of these firms to engage in innovation activities, regardless of the positive outcomes of the initiatives undertaken.

In the 2018 CIS survey, nearly two thirds of companies working in the manufacturing of transport parts and components (C29 and C30) declared to have undertaken innovation activities[26]: 64.7% of companies belonging to the vehicle manufacturing activities in C29 and the same share of companies belonging to the category C30. These values do not differ very much from the data of the previous survey, covering the period 2014-2016. In the previous edition of the survey, 62.7% of companies belonging to C29 and 66.3% of those in C30 declared to engage in innovation. As for the transportation and storage economic activities (H), the share in the 2018 CIS survey was lower, 39.4% of the companies interviewed, up from 38.8% in the previous survey (see Figure 7).

The highest shares of companies which engaged in innovative activities in transport sectors are among German, Belgium and Finnish ones. The share of innovative companies in transportation and storage (H) is the highest in Luxembourg and Portugal.

26 Data missing for: C29 and C30: AT, CY, EE, LT, LU, MT, NL, SI; data missing only for C30: IE.

Figure 7 Innovative enterprises in transport related economic activities in member states (%, 2016-2018)



Data source: CIS Survey (2018)

4.2 Innovation types

The types of innovation can be related to the good or service produced and/or to the production process. The innovation introduced on the product will significantly change the good or service manufactured by mean of improvements of its characteristics or usage. The product may change in relation to technical specifications, components and materials, incorporated software, etc.

This section provides information on the typologies of innovation which transportation companies worked on. Figure 8 presents the CIS 2018 survey results with a focus on the three transport economic activities groups C29, C30 and H, looking at product and process innovations. They need to be read with caution as the data is available only for a selection of MSs[27].

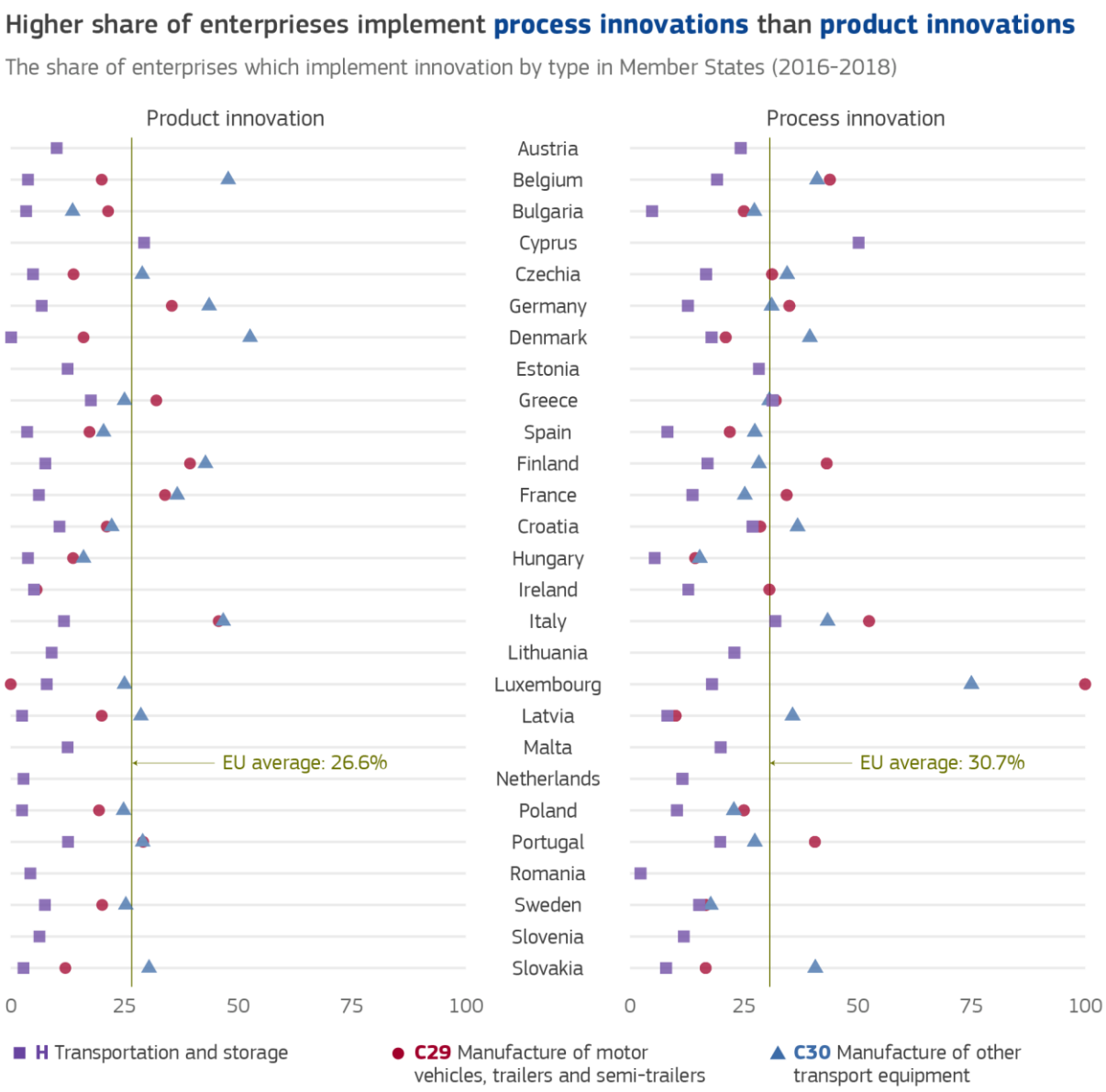
27 Data missing for Product innovation for categories C29 and C30: AT, CY, EE, LT, MT, NL, RO, SI; Additionally, data missing for IE in the category C30 and for LU for category C29;

In CIS 2018, among the transport companies interviewed, a relatively small number declared to have developed a **product innovation**. On average, 26.6% of companies in the automotive industry (C29) had innovative products. The highest share (38.9%,) was reported in EU companies which belong to the transport equipment category (C30), while this share was only 8.6% of those operating in transportation and storage (H). The most innovative in terms of product innovations in the automotive industry (C29) were enterprises from Italy (45.7% of all surveyed companies) followed by Finnish, German and French ones. More than 50% of Danish companies were active in innovation in the area of production of other transport equipment (C30), followed by Belgian enterprises (47.8%), German and Finish ones (43.6% and 42.8%, respectively). In transportation and storage (H), the highest share of companies, which were implementing product innovation, was in Cyprus (27.6%) and Greece (17.6%).

Process innovation represent product or services where the innovative element is introduced in the method used, by means of new techniques, new equipment or software. Transport companies that have introduced process innovation between 2016 and 2018 were more numerous in the automotive industry (C29 – 36.7%) and in the industry producing other transport equipment (C30 - 34.5%), while this type of innovation was introduced less frequently in the transportation and storage (H), with 20.4% of companies having declared so. Nevertheless, process innovation was declared slightly more often than product innovation (30.7% and 26.6%, respectively). The highest share of companies in the automotive industry (C29) which worked on process innovation was observed in Luxembourg (100% of surveyed companies) and in Italy (52.5%). In the industry producing other transport equipment (C30) it was noted in Luxembourg (75%) followed by Italy, Belgium and Slovakia (40.7-43.4%). In transportation and storage (H) they were companies from Cyprus (over 50%), Greece and Italy (31,3%-31,9%).

27 Data missing for Process innovation for categories C29 and C30: AT, CY, EE, LT, MT, NL, RO, SI; Additionally, data missing for IE in the category C30.

Figure 8 Types of innovations implemented in transport related economic activities in member states (%, 2016-2018)



Data source: CIS Survey (2018)

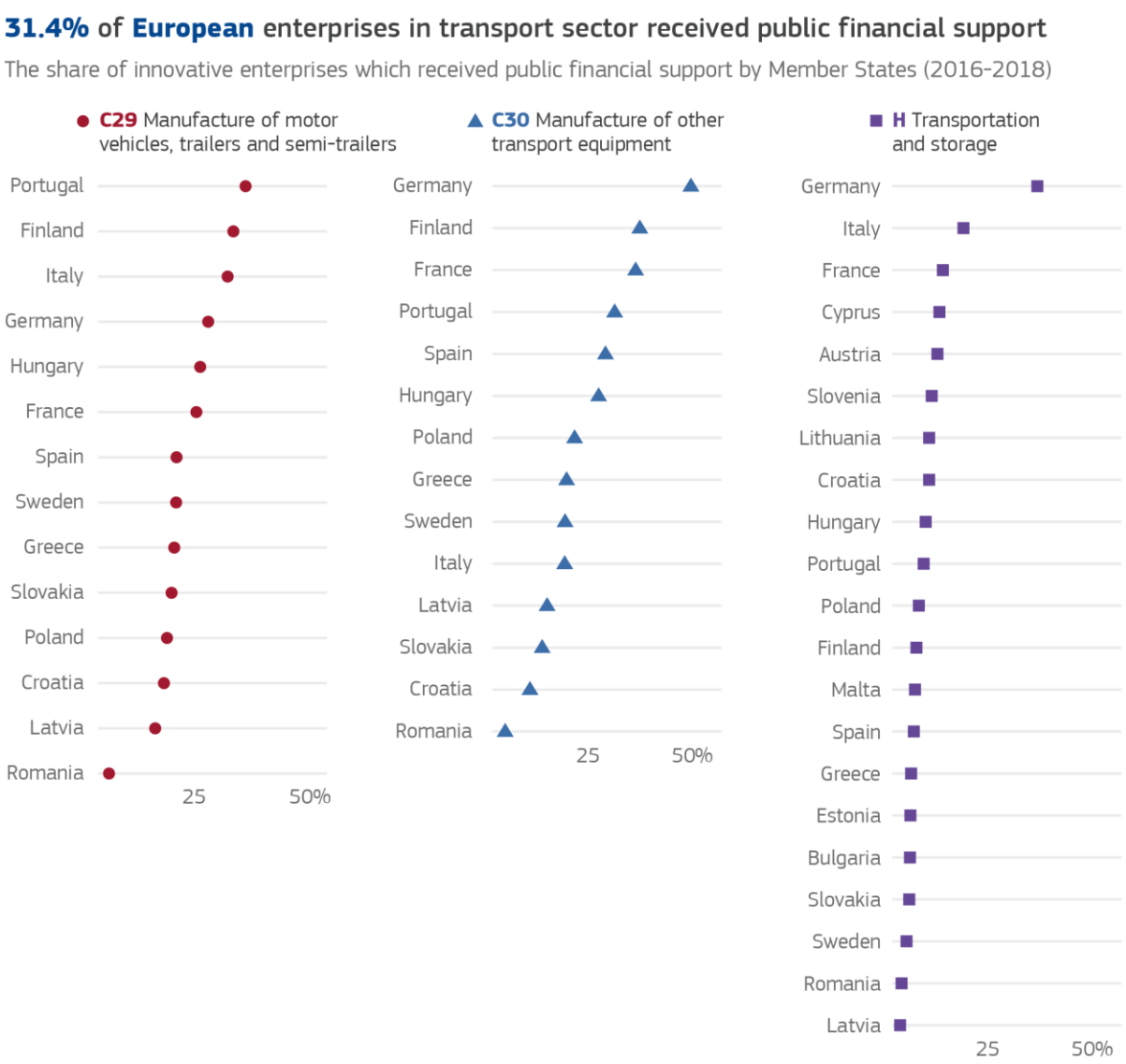
4.3 Public financial support

The CIS 2018 survey investigated if companies, which implemented innovations, received public financial support to do so. The public financial support could be either European, national, regional or local and it could be granted by means of tax credits or deductions, grants, subsidised loans, loan guarantees, etc.

During the period 2016-2018[28], 31.4% of surveyed EU companies acting in transport sector received public financial support. This share is higher for enterprises working in the automotive industry (C30 – 34.6%) than those which operate in manufacture of motor vehicles (C29 – 27.8%) or transportation and storage (H – 26,7%) (see Figure 9)

28 Data missing for C29 and C30 in case of: AT, BE, BG, CY, CZ, DK, EE, IE, LT, LU, MT, NL and SI. For H data is missing in case of: BE, CZ, DK, IE, LU, NL.

Figure 9 Public financial support in transport related economic activities in member states (%, 2016-2018)



Data source: CIS Survey (2018)

When comparing the results of CIS 2018 with the previous editions, CIS 2014 and 2016, a general decline can be observed for all the industries related to transport activities producing motor vehicle (C29) and for transportation and storage (H).

4.4 Cooperation with partners

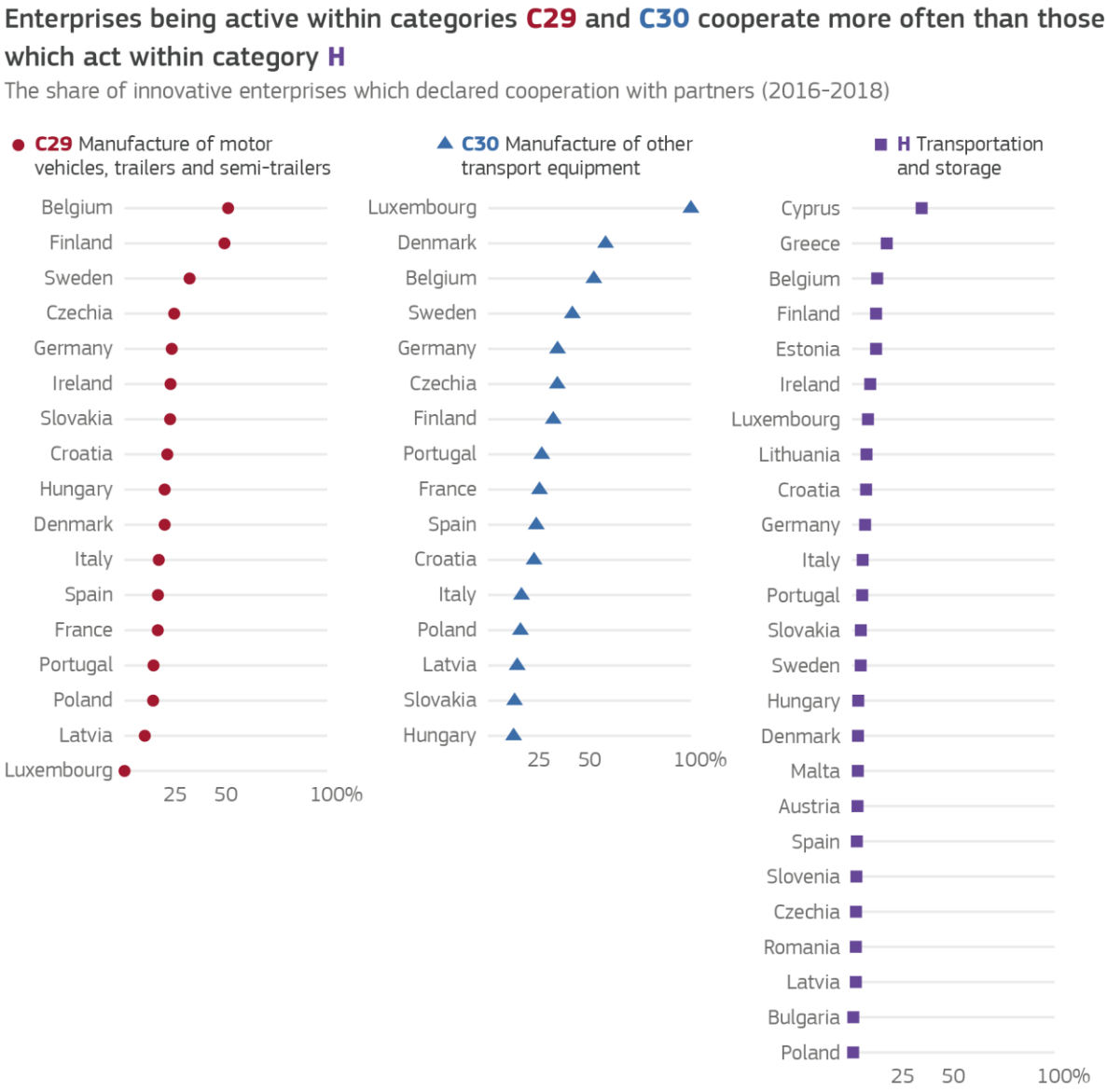
Cooperation with partners is fostering business innovation, improving economic performance and efficiency, reducing costs, providing access to additional resources or new markets. CIS 2018 survey was looking at cooperation with other private firms, within the sector, with suppliers or clients, with universities or governmental bodies, at local, national, European and international level.

Overall, the declared level of cooperation of companies within the transport manufacturing (C29 and C30) is higher than of the transportation and storage ones (H)[29]. Data from CIS 2018 show that the cooperation among automotive firms (C29) in EU was the highest in Belgium (51% of companies declared cooperation in the period covered by the survey, i.e. 2016-2018) and Finland (49%). In case of enterprises active in the manufacturing of other transport equipment (C30) all surveyed companies from the Luxembourg, and over half of those from

29 Data missing for C29 and C30: BG, CY, MT, NL, SI. Additionally, IE data is missing for C30.

Denmark (58%) and Belgium (52%) declared cooperation. In case of cooperation declared by the firms working in transportation and storage (H) these shares were significantly lower. Apart from Cyprus (34%), only in case of Greece, Estonia, Belgium and Finland the share exceeds 10% (12-17%; see Figure 10).

Figure 10 Co-operation in transport related economic activities in member states (%, 2016-2018)



Data source: CIS Survey (2018)

4.5 Barriers to innovations

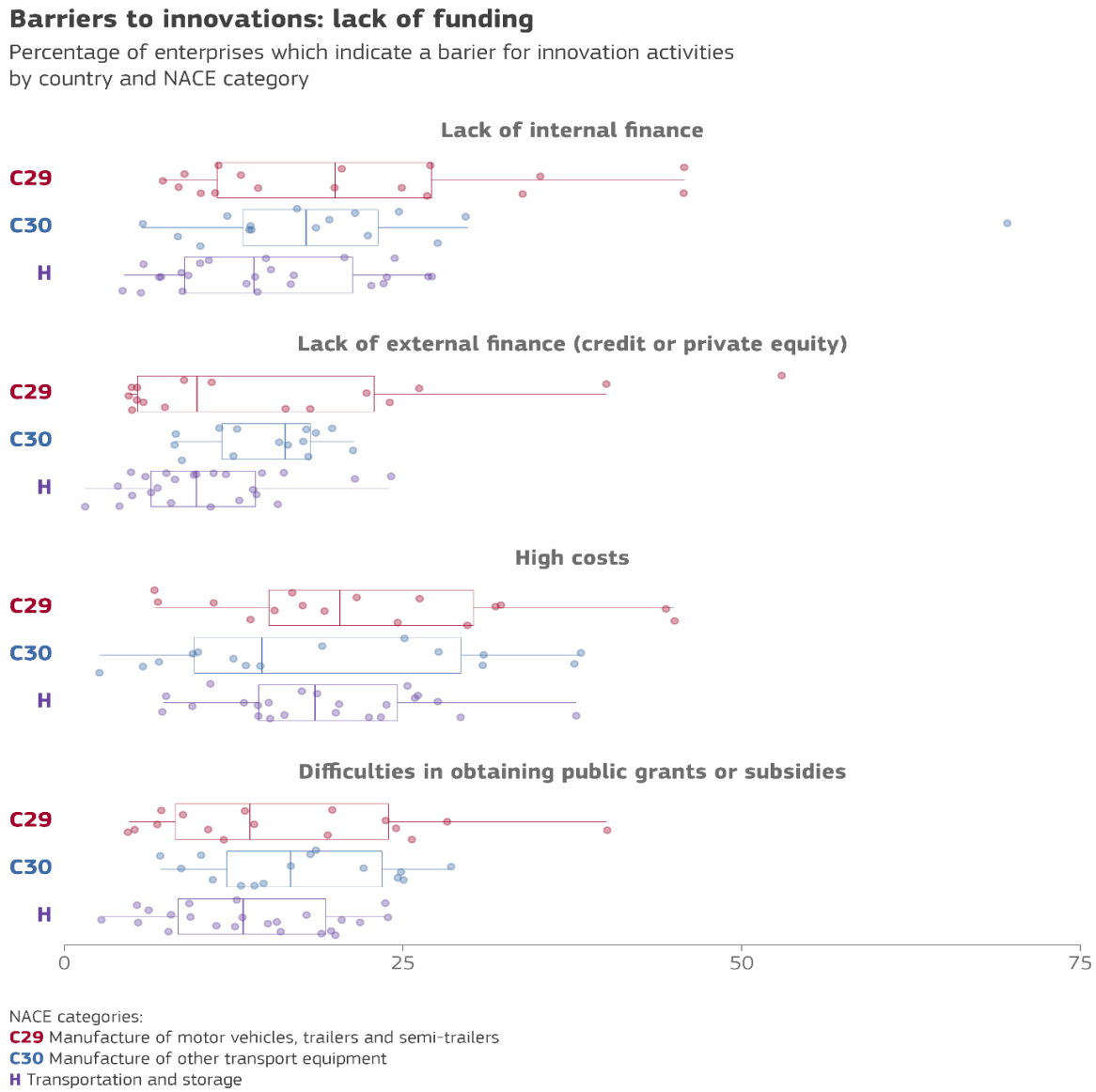
This section presents the main barriers that prevent or slow down innovation engagement, based on the responses to the CIS 2018 survey. Selected factors hampering innovation activities have been grouped into three main thematic areas: barriers related to funding and costs, to market structure and to access to relevant expertise, expressed by the presence of qualified personnel along with an access to external knowledge.

Lack of funding

Lack of funding could be either linked to shortage of company financial means or missing private or public external support.

Lack of internal finance, together with high costs[30], has been found as one of the major barriers among transport companies (Figure 11). The share of companies that indicate these particular barriers is higher for those that operate in the automotive industry (C29). Nevertheless, the differences are more visible when comparing particular countries, rather than when comparing companies operating within different categories. In case of the two other factors related to the lack of funding (external finance and difficulties to obtain public grants or subsidies), the share of companies declaring so is lower.

Figure 11 Share of enterprises indicating that lack of funding and companies' costs are important barrier for innovating, in transport related economic activities (%, 2016-2018)



Data source: CIS Survey (2018)

30 Data missing, for C29 and C30: AT, BE, CY, DE, EE, LT, LU, MT, NL, SI. In case of category H data missing for BE, DE and NL.

Market structure

Goods and services demand, competition in the different market segments and the degree of collaboration with business partners are among the relevant innovation barriers/drivers related to the transport market dynamics.

These three aspects have been investigated in CIS 2018 survey and the answers received by transport companies are summarised hereafter (Figure 12).

High competition[31] seems to be the most challenging issue among those related to the market structure. It affects even more companies in transportation and storage (H), than those in the manufacturing industry (C29 and C30). This is a structural element that characterizes the transportation and storage sector, where the competition among companies is mostly played at financial and quantity level rather than at service's quality level.

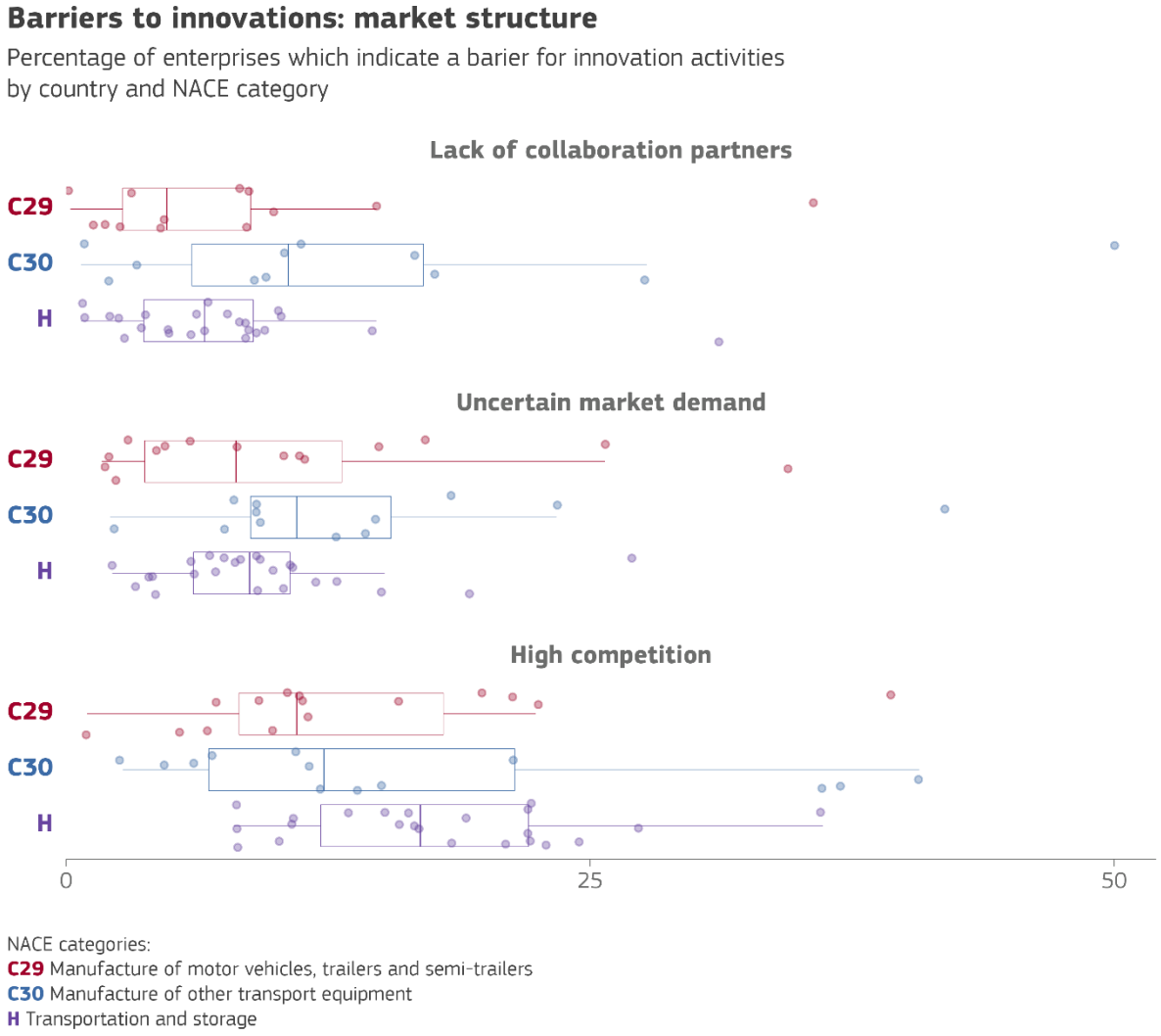
The risk of uncertainty associated to market demand[32] is perceived as another important reason preventing transport companies to engage in innovation activities. However, this barrier is felt less important comparing to the high competition one, with the exception of companies working in manufacturing of other transport equipment (C30) that perceived it as the most demanding.

Lack of collaboration[33] with partners could also compromise the degree of business innovation. Nevertheless, the average level of concern was in general lower comparing with other issues listed in this section. The highest share of companies concerned about lack of collaboration refer to those acting in producing other transport equipment (C30), followed by transportation and storage (H).

Unfortunately, the scarce number of answers to this question combined with missing data for many countries entails a low representativeness of the results.

31 Data missing, for C29 and C30: AT, BG, CY, CZ, EE, LT, LU MT and SI. Additionally missing data for IE (C30) and CZ (H).
32 Data missing, for C29 and C30: AT, BG, CY, EE, EL, LT, LU, MT, SI.
33 Data missing, for: C29 (AT, BG, CY, EE, EL, FR, LT, LV, MT, SI), C30 (AT, BG, CY, EE, EL, FR, IE, LT, LV, MT, SI)

Figure 12 Share of enterprises indicating that market elements are important barrier for innovating, in transport related economic activities (%, 2016-2018)



Data source: CIS Survey (2018)

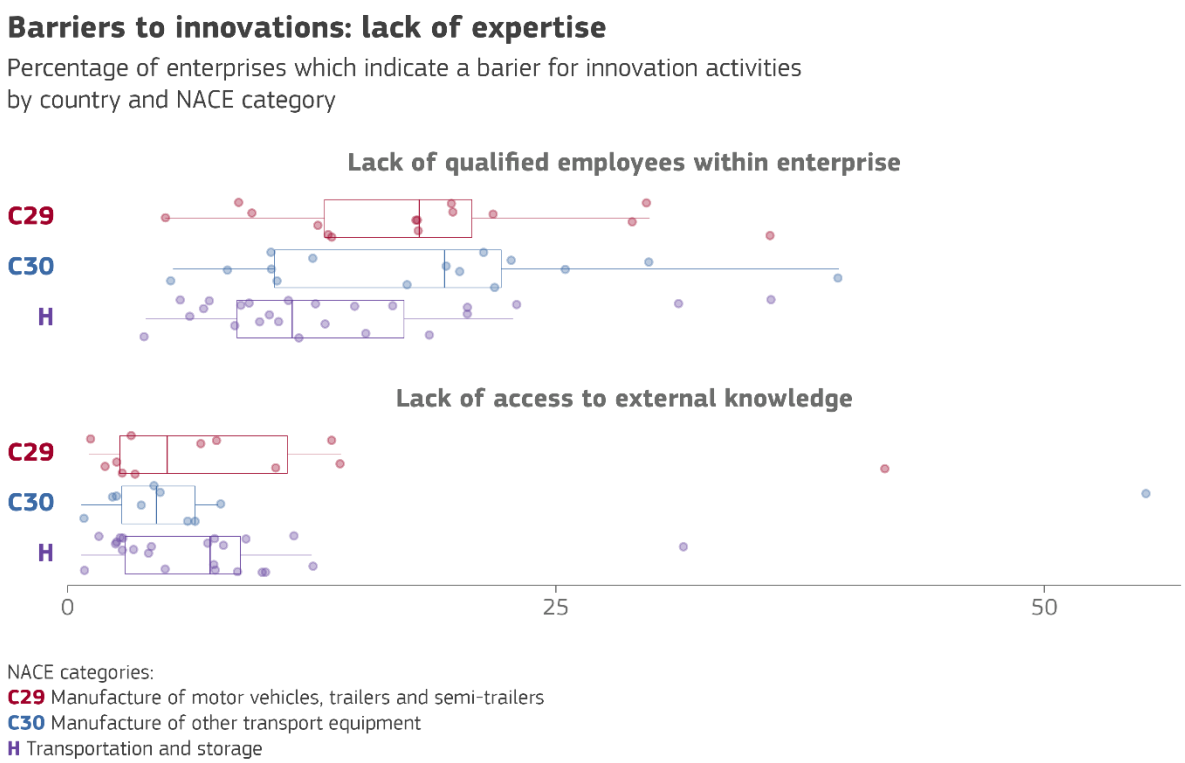
Lack of qualified employees

Highly qualified personnel is essential to perform R&I activities and its shortage could be seen as a hampering factor to innovate.

This factor has been identified in CIS 2018 survey[34] and recognised as relevant by on average 16% of EU companies working in the automotive industry (C29) 12% of the ones in the manufacturing of other transport equipment (C30) and 13% in transportation and storage (H).

34 Data missing, for: C29 (AT, CY, EE, EL, LT, MT, SI), C30 (AT, CY, EE, EL, IE, LT, MT, SI)

Figure 13 Share of enterprises indicating that lack of qualified employees is an important barrier for innovating, in transport related economic activities (%, 2016-2018)



Data source: CIS Survey (2018)

5 Conclusions

This report provides an assessment of the innovation capacity in the EU transport, looking at general R&I indicators. The report provides an update of the R&I indicators assessment, building on the 2020 TRIMIS work on the same topic (Grosso et al., 2020).

The main conclusions of this analysis are as follows:

The private sector maintains its key role in R&I activities in the transport sector, which in 2019 amounted to €38 billion, where most of the investments came from the automotive industry, followed by the industry dealing with other transport equipment manufacturing and only minimally by the transportation and storage sector.

The total EU public investments are substantially lower, being equal to €2.4 billion in 2020, showing a decrease compared to the previous years.

In 2019, 250.000 researchers and R&I personnel worked in the transport sector, their majority being employed in the automotive sector, with a strong prevalence of male occupation.

The number of granted patents associated to the transport sector was approximately 71.4 thousand submitted in all EU countries (EU-27) in the period 2010-2020, Most of the granted patent applications, 42.5%, are associated to transport vehicles.

More than half of the transport companies that participated to the last CIS 2018 survey declared to be engaged into innovation activities. This shows high interest in trying to improve the quality of services or goods provided. The type of innovation introduced in the transport companies in the last years are mainly associated to processes and products innovations, rather than organizational or marketing ones.

Although some financial support can be received by governmental bodies, at local, national and EU level, transport companies still do not consider it enough. This aspect can constitute a real barrier to engage and enhance R&I activities. The same is valid for internal financial resources that are often scarcely allocated to R&I activities, as they may not be considered fundamental or other operational needs prevail when allocating funding.

Market cooperation can be seen as driver for R&I activities, nonetheless collaboration among transport stakeholders should not be taken for granted. This is true in particular for companies working in the transportation service sector. Simultaneously, data show higher level of cooperation in the automotive and other vehicles manufacturing industries.

Other major barriers to innovate are linked to market dynamics, which cannot be entirely steered by the industry. This is true, for example for uncertainty of market trends or the lack of qualified and skilled personnel.

The outcome of the present report provides a clear picture of the innovation capacity of the transport sector in EU. It highlights a general negative trend compared to the previous years, which could be also partially due to the COVID pandemic. Still the aspects and elements analysed are those on which further reflections and actions should be taken to make the transport sector more innovative and competitive.

When reading this report it is important to bear in mind that data availability constitutes a limitation, as information is still very scattered among EU MSs and not always very up to date for all the transport sub-sectors considered. Although acknowledging these limitation, this TRIMIS analysis appears to be a unique reference point within the transport R&I field.

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List of abbreviations and definitions

AT	Austria
BE	Belgium
BERD	Business Expenditure on Research and Development
BG	Bulgaria
CIS	Community Innovation Survey
CPC	Cooperative Patent Classification
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
EPO	European Patent Office
ES	Spain
EU	European Union
EU-27	European Union of 27 Member States
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
GERD	Gross domestic expenditure on R&I
H2020	Horizon 2020
HR	Croatia
HU	Hungary
IE	Ireland
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
OECD	Organisation for Economic Co-operation and Development
PL	Poland
PT	Portugal
R&I	Research and Innovation
RO	Romania
SBS	Structural Business Statistics
SE	Sweden
SI	Slovenia
SK	Slovakia
STRIA	Strategic Transport Research and Innovation Agenda
TRIMIS	Transport Research and Innovation Monitoring and Information System
US	United States

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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

nnex 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&I 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&I 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&I related to other types of pollution than harmful effects in town (included in Chapter 2).

Annex 3: 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

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