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Assessing innovation capacity in the European transport sector

A methodological framework for a macro-level financial and socio-economic analysis

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

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Contents

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Abstract

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

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

- Cooperative, connected and automated transport;
- Transport electrification;
- Vehicle design and manufacturing;
- Low-emission alternative energy for transport;
- Network and traffic management systems;
- Smart mobility and services; and
- Infrastructure.

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

The assessment of transport research and development (R&D) is one of the main activities within the TRIMIS project. The objective of this report is to present the methodological framework that will be used to map private and public investment in transport R&I, and to define associated socio-economic aspects.

This report examines transport R&D capacity in the European Union (EU) from a macro-level perspective. After providing the background to the analysis, a review of existing literature is presented. The methodology follows an integrated approach: a quantitative and a qualitative assessment that will build on each other. This approach provides a sound quantitative base that will be complemented and integrated with qualitative input from transport stakeholders.

The assessment of private and public R&D investments in EU transport benchmarks current transport expenditure and determines future investment needs. Moreover, it identifies socio-economic factors such as organisations engaged in transport R&D, types of innovations and number of active transport researchers.

The methodological framework outlined in this report is the starting point for the assessment of EU transport R&D capacity from a financial and socio-economic perspective.

1 Introduction

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

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- Infrastructure.

In May 2018, the EC published the third "Europe on the move" policy package (European Commission, 2018a) which included objectives for Europe to become a world leader in innovation, digitalisation and decarbonisation. According to the Vice-President responsible for the Energy Union, Maroš Šefčovič, key technological solutions together with other measures will help achieve zero emissions, zero congestion and zero accidents. The role of innovative technology is therefore considered fundamental to a mobility system that is safe, clean, connected and automated.

R&I plays an important role in shaping the future transport system, ensuring the European transport industry maintains its global competiveness. Within this framework, the EC adopted the working document "Towards clean, competitive and connected mobility: the contribution of Transport Research and Innovation to the Mobility package" (European Commission, 2017b), that support transport R&I by tackling many issues contained in the STRIA Roadmaps.

In order to define future policy strategies and decrease the risk of funding dispersion, it is important to have a clear understanding of market readiness and penetration for new transport technologies, the actors involved, and the available funding sources.

A macro-level financial and socio-economic assessment of innovation capacity in the EU as a whole, and at the Member State (MS) level, will provide an overview of the status of European transport R&I and will present the context for the STRIA Roadmap capacity assessment.

1.1 Purpose of the study

This report presents the methodological framework for the financial and socio-economic assessment of EU transport research and development (R&D) capacity.

The current analysis includes an overview of the transport sector, considering the main differences that characterise the market structure of each transport sub-sector. This macro-level analysis can assist in the definition of the European transport R&D capacity and provides the basis for the STRIA Roadmap capacity assessment.

Within the framework of TRIMIS, the methodology presented here will contribute to the definition of Key Performance Indicators (KPIs) for the transport R&I Scoreboard (Tsakalidis et al., 2018). The method is essential to identifying R&D capacity gaps and developing appropriate policy measures.

Moreover, whereas most TRIMIS analyses focus on one or more STRIA Roadmaps, the macro-level analysis will provide the context of transport R&D in Europe. In doing so, it will be easier to understand the relative importance and trends of the various Roadmaps.

1.2 Methodology and structure of the report

This report outlines a methodology to assess innovation capacity in the European transport sector taking into consideration investments and socio-economic factors. It will identify innovation trends for each transport mode.

In this analysis, innovation capacity is defined as the potential to produce innovations, which is influenced by factors such as R&D, skills, technology, etc. (Suarez-Villa, 1996, Porter and Stern, 2001).

The methodology presented in this report will analyse macro-level European transport R&D focusing on R&D as one of the main measures of innovation.

The approach employ a quantitative and a qualitative methodology. The quantitative analysis uses Eurostat data, while the data used in the qualitative assessment will be collected from public and private stakeholder interviews and a questionnaire survey.

The report is divided into four chapters. Chapter 1 briefly introduces the topic. Chapter 2 presents the results of previous research. Chapter 3 outlines the proposed methodological framework while Chapter 4 defines the limitations of the proposed analysis and identifies areas for future work.

2 Literature review of transport research and development capacity assessment

2.1 Introduction

A company's decision to invest in research activities is influenced by the availability of financial and human resources, expected return on investment and the competitive advantage of undertaking research.

The transport sector is not exempt from these dynamics and, depending on the transport mode, the innovation propensity may vary (Wiesenthal et al., 2015).

Past studies have considered transport R&I and have assessed innovation capacity from different perspectives. For example, Konings and Louw (2014) analysed transport innovation mapping at the national and regional scale, whereas Condeço et al. (2013) studied the link between transport innovation and competitiveness of the sector.

This chapter presents the findings of previous transport R&D studies. The identification and analysis of past research follow a structured approach in which precise boundaries are set. Bearing in mind that data is constantly being updated, it is considered necessary to limit the literature review to the last ten years. Likewise, the geographical scope is defined as Europe, covering both individual EU MSs and the EU as a whole.

Furthermore, the report aims to provide a detailed analysis for each transport sub-sector (e.g. road, rail, aviation and waterborne) as they have different economic and market structures (Wiesenthal et al., 2015).

2.2 Reviewed studies

Wiesenthal et al. (2011) identified specific innovation activities for all transport modes and provided a comprehensive analysis of drivers and barriers to innovation, including an assessment of R&D public and private investments.

The study examined both private and public investments in transport. For each areas a different methodological approach was followed. The private R&D investment analysis involved a bottom-up approach consisting of five steps:

1. identification of key players by sub-sector and or technology group;
2. gathering of information on R&D investments;
3. estimation of non-transport related R&D activities and breakdown in sub-sector;
4. estimation of R&D investments for greenhouse gas emission reduction and single technologies; and
5. summing up of individual companies R&D investments by mode, technology group and single technology.

Regarding public R&D investments, official supranational datasets such as Eurostat Government Budget Appropriations or Outlays (GBAORD) were used to estimate the total R&D budget. Table 1 provides a list of the main sources of information and data used in their analysis.

Table 1. Overview of key data sources and their main characteristics

Database	Private and or Public	Main subject covered	Classification
EU Industrial R&D Investment Scoreboard	Private	R&D investments	Industry Classification Benchmark (ICB)
Business Enterprise Research and Development (BERD)	Private	R&D expenditures	NACE_R1
Government Budget Appropriations or Outlays on R&D (GBAORD)	Public	R&D appropriations	Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets (NABS)92 and NABS07
International Energy Agency (IEA) RD&D statistics	Public	RD&D budget	Energy technologies
European Patent Office (EPO) United States Patent and Trademark Office (USPTO)	Public	Patent applications (for EPO) Patents granted (for USPTO)	(International Patent Classification) IPC NACE_R1
Eurostat	Private	R&D personnel and researchers	NACE_R1
Eurostat Gross Domestic Expenditure on R&D (GERD)	Private and public	Total intramural R&D expenditure	NABS92 and NABS07
Community Innovation Survey (CIS)	Private mainly	Innovation-related topics	NACE_R2 (for CIS 2008) NACE_R1 (for CIS 2006)

Source: Wiesenthal et al., 2011

One major drawback was that the classification scheme adopted (i.e. Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets) (NABS 2007), did not provide a clear distinction between transport activities and services.

In order to minimise this effect, a bottom up estimation of R&D investments by transport mode and research area was undertaken. The study provides invaluable information on the identification of stakeholders in transport research. Moreover, the analysis identified different typologies of actors, classified according to their nature, (i.e. private, public, institutional, platforms) and sorted by country of origin.

Hyard (2013) took a different approach and identified a taxonomy of non-technological innovation trajectories for sustainable transport. Hyard stated that sustainable transport innovations consist of both technological and non-technological innovations. He identified non-technological innovations to be the most promising for sustainable transport. These were classified into three categories: pricing, regulation and infrastructure. Hyard concluded that for policy making the two typologies of innovations need to be combined to obtain an effective result in the transport sector.

The EU's Seventh Framework Programme for Research (FP7) financed the project *FUTRE,* Future prospects on Transport evolution and innovation challenges for the competitiveness of Europe Support Action (Condeço et al., 2013). The project addressed many topics including an assessment of European transport industry innovation capacity and competitiveness. After defining the concept of innovation and framing the transport market structure, R&D transport investment by MSs and for the overall European territory was measured. In *FUTRE,* the level of innovation was measured using R&D investments and patents applications. The public budget allocated to transport R&D was estimated using

Eurostat's GBAORD indicator, while for private investments the Eurostat's Business Expenditure on R&D (BERD) database was used together with the results of the 2010 Community Innovation Survey (CIS). Following the methodology of Wiesenthal et al. (2011), the *FUTRE* project also used a bottom-up approach to estimate R&D for a list of sub-sector transport companies.

The FP7 project METRIC, Mapping European Transport Regional Research and Innovation Capacities (Konings and Louw, 2014), aimed to provide innovation Roadmaps for transport technology at the regional level (NUTS 2) in Europe. The project - among other activities - assessed transport innovations and identified related innovation indicators and European regional characteristics and differences. The indicators were grouped in six main categories: innovation achievements; economic performing; transport sector structure; innovation funding; innovation milieu; and human resources. Under these categories, twenty-eight indicators were used. For each indicator a detailed explanation of their features was provided. Using the *METRIC* project as a base, Konings and Louw (2016) analysed further European regional innovation performance and presented a method to measure transport innovation performance in 251 European regions. A Structural Equation Model was applied to the total transport sector, to the transport manufacturing sector and the transport service sector; this distinction was necessary due to the differences between the two types of businesses and the overall sector.

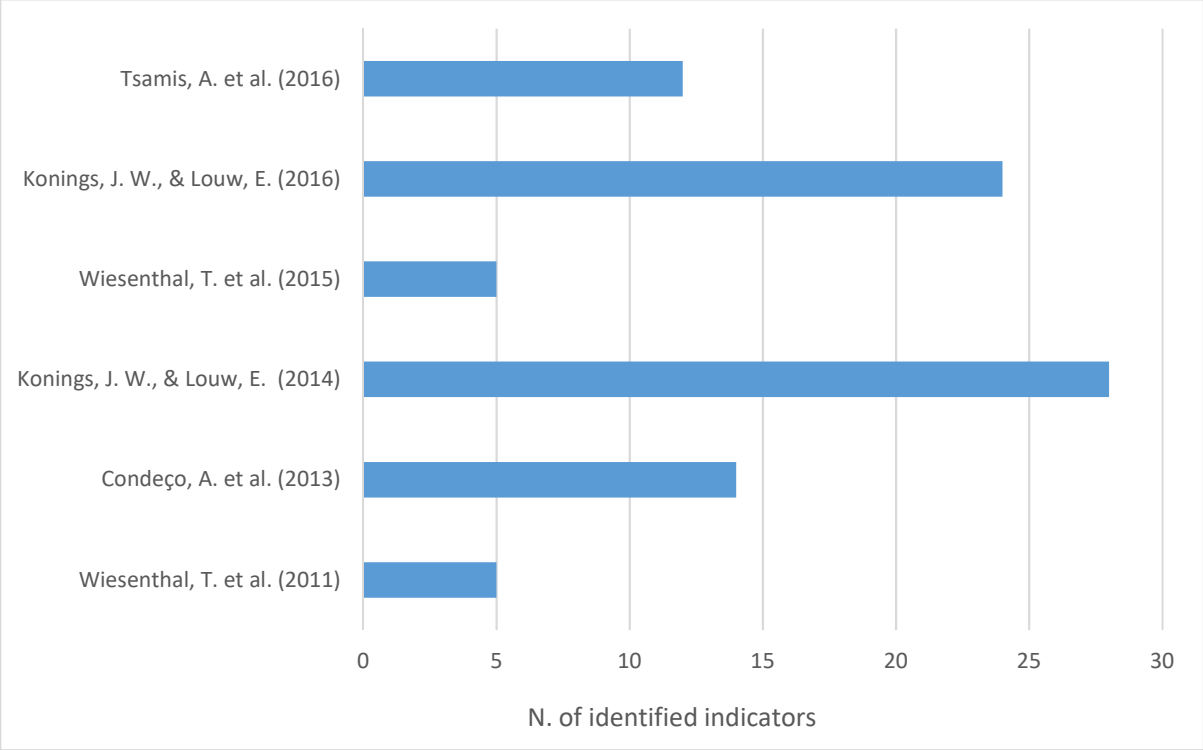
Wiesenthal et al. (2015) examined the transport sector using a combined qualitative and quantitative approach. The qualitative assessment was used to examine factors influencing the level of innovation while the quantitative analysis focused on R&D investments of manufacturers of transport equipment, transport services and transport infrastructure construction companies. While the qualitative analysis considered each transport sub-sector, in the quantitative part, the transport R&D investment assessment focused on the company level. Starting from the available information included in the Industrial R&D Investment Scoreboard (European Commission, 2018b) the authors used a bottom–up approach to examine in more detail each transport sub-sector.

A study by the consultancy Ricardo, provides an alternative overview of the performance of European transport innovation (Tsamis et al., 2016). It examined the performance of MSs and compared Europe with other regions of the world. The analysis reviewed a list of European and international information sources to identify the most useful and representatives transport innovation indicators. In their study, the authors identified twelve transport specific indicators. Once the dataset was developed at the European level, the study took into consideration international comparisons. Interviews with transport experts were organised to support the analysis and to improve understanding of transport innovation capacity and trends.

Annex 1 presents a list of the reviewed studies.

A review of the literature has shown that studies with different objectives and methodological approaches have an impact on the choice and number of indicators (see Figure 1). Despite these differences, a number of common indicators were used, namely: private and public investments, patents, human resources involved in such activities. These indicators are easily accessible and provide an overview of key socio-economic aspects.

Figure 1. Number of indicators identified in previous relevant literature



In addition to these common indicators, authors reflected on issues such as transport R&D competitiveness (Condeço et al., 2013) when general transport economic indicators were included in the analysis. In Konings and Louw (2014, 2016) European regional differences in transport R&D were examined and innovation indicators investigated. Some studies included a taxonomy for the identified indicators, which is either based on innovation achievements and economic performance (Konings and Louw, 2014, 2016) or on innovation input, innovation process and innovation output, innovation context and innovation impact (Tsamis et al., 2016).

The approach presented in this report builds on the previously established methodologies and proposes a mixed-method approach that is based on quantitative and qualitative insights on transport R&D.

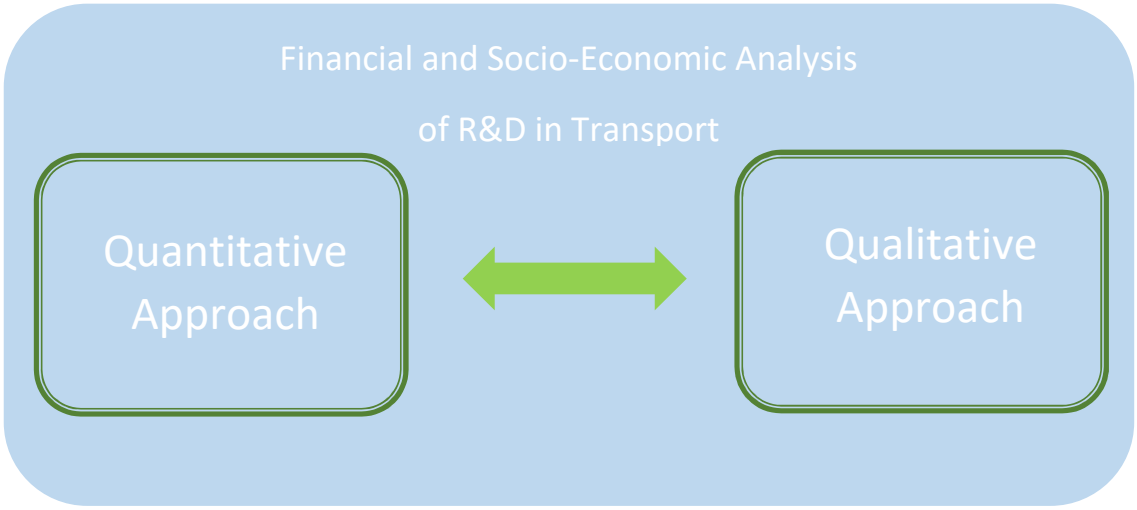
Moreover, the analysis carried out on the basis of the present methodology will produce an up-to-date assessment of European transport R&D capacity at the macro-level. This assessment will complement the analysis of R&D capacity within the seven STRIA Roadmaps. It is a first attempt to analyse macro-level financial and socio-economic dynamics within the framework of the seven STRIA Roadmaps and it aims to contribute to the definition of future transport research priorities.

3 Methodological framework

While R&I measurement at European and MS level (e.g. European Innovation Scoreboard and Regional Innovation Scoreboard) (European Commission, 2018c) is well developed, the analysis of specific sectors is less common. The focus of this methodology is on the entire transport sector and its sub-sectors. This analysis is fundamental to providing the context for each STRIA Roadmap capacity assessment.

The work will follow a methodological framework which is presented below (see Figure 2). The analysis will contribute to the definition of the TRIMIS KPIs and scoreboard ensuring a continuous provision of relevant data on transport R&D.

Figure 2. Methodological framework



The proposed methodology involves a quantitative and a qualitative approach. The quantitative approach will be based on data gathering and elaboration of macro-level statistics that highlight European and MS status of transport R&D. The research will focus on collecting the recent and complete economic data on private and public transport R&D expenditures and of human resources involved in these activities. A detailed explanation of the proposed methodology is provided here.

Similar information will be gathered through the involvement of selected stakeholders and MS representatives. The data collected will validate the quantitative analysis and complement it with strategic information and insight not available from statistical data. For this purpose, the private and public sector, including EU and MS representatives and other relevant transport stakeholders, will participate in the analysis.

3.1 Quantitative approach

The proposed quantitative analysis consists of three steps: the identification of the main sources of information, the development of an ad hoc database and the analysis of the information collected. For each of these three steps a detailed explanation is provided below.

Figure 3. Quantitative methodological steps

3.1.1 Identification of data sources

The identification of data sources depends on the purpose of the analysis. Taking this into consideration, defined criteria are used in the data selection procedure. Data sources should contain as much as possible updated and comprehensive data covering the EU and MSs.

Financial and socio-economic data and information on the human resources involved in transport R&D should satisfy the selection criteria. The lack of a comprehensive database and data heterogeneity (in terms of scope, level of details and geographical coverage) would "… impede the exact definition of the status quo of innovation efforts in the European transport sector" (Wiesenthal et al., 2011).

The information will be combined and integrated, attempting to overcome these drawbacks. Nevertheless, a quantitative comparison is often challenging due to a mismatch with regard to geography, time frame, methodology or lack of coordination in data collection.

Based on the research topic and on the defined criteria, the following data sources have been selected to extract the transport innovation indicators.

Eurostat is the main source of information (European Commission, 2018d) as it collects various information from the following datasets:

- *Eurostat – Science and Technology Statistics:* the data collected are on private and public R&D activities and are provided for the entire EU of 28 MSs (EU28) with a sectorial level disaggregation based on the Statistic Nomenclature for the Economic Activities (NACE), up to 3 digits, covering 2005-2016. Annex 2 presents a detailed list of the transport activities relevant for this study, according to NACE Rev.2 classification.
- *Eurostat - Community Innovation Surveys (CIS):* this dataset refers to a biennial survey involving private companies, with a sector classification up to NACE Rev.2, 3 digits; the last survey available was conducted in 2014 and includes data from EU MS, EU candidate countries, EU and European Free Trade Association (EFTA) countries.
- *Eurostat - Structural Business Statistics (SBS):* in this dataset, updated up to 2016, a broad range of data is included, looking at general economic indicators, not necessarily related to R&D. Nonetheless, the level of data disaggregation per sector is the most detailed, NACE Rev.2, 4 digits, and helps define the transport sector, as well as the transport sub-sectors.
- *Eurostat - Human Resources in Science and Technology (HRST):* the data contained in this dataset relates to the jobs and education linked to science and technology. Some of this data is available from 1994 until 2017 and covers the entire EU28.

- *Eurostat - Patents:* the database contains patent applications granted by the European Patent Office, (EPO), by the United States Patent and Trademark Office (USPTO) and also triadic patent families. The classification is based on NACE Rev.2, 3 digits and the most recent data are from 2013.

In addition, the EC JRC provides a relevant source of information which is the:

JRC - Industrial R&D Investment Scoreboard (European Commission, 2018b): the dataset contains economic and financial data from private companies from the EU and worldwide. In the 2017 Edition, 2,500 companies were included from 43 countries. The report is produced annually and is based on company data from each company's Annual Report and grouped according to the Industry Classification Benchmark (ICB) classification.

Additional sources of information can also be used to complement the analysis. The main supplementary sources identified are:

- EC – Innobarometer
- EC – European Innovation Scoreboard
- EC – Regional Innovation Scoreboard
- Organisation for Economic Co-operation and Development (OECD) - Science, Technology and Patents database
- UNITED NATIONS - World Intellectual Property Office (WIPO) database
- OECD - International Energy Agency (IEA) database
- United Nations Educational, Scientific and Cultural Organization (UNESCO) - Science, Technology and Innovation database.

Annex 3 presents detailed information on the identified information sources.

3.1.2 Database building - Selection and definition of the indicators

The identification of data sources is the starting point of the financial and socio-economic analysis. The next step is to identify suitable indicators.

The selection process considers a set of criteria that are used to facilitate and validate the final list of indicators. According to the approach suggested by the EC (European Commission, 2009) and used also in Tsamis et al. (2016), all the indicators should be RACER, which means: Relevant, Accepted, Credible, Easy to monitor and Robust against manipulation.

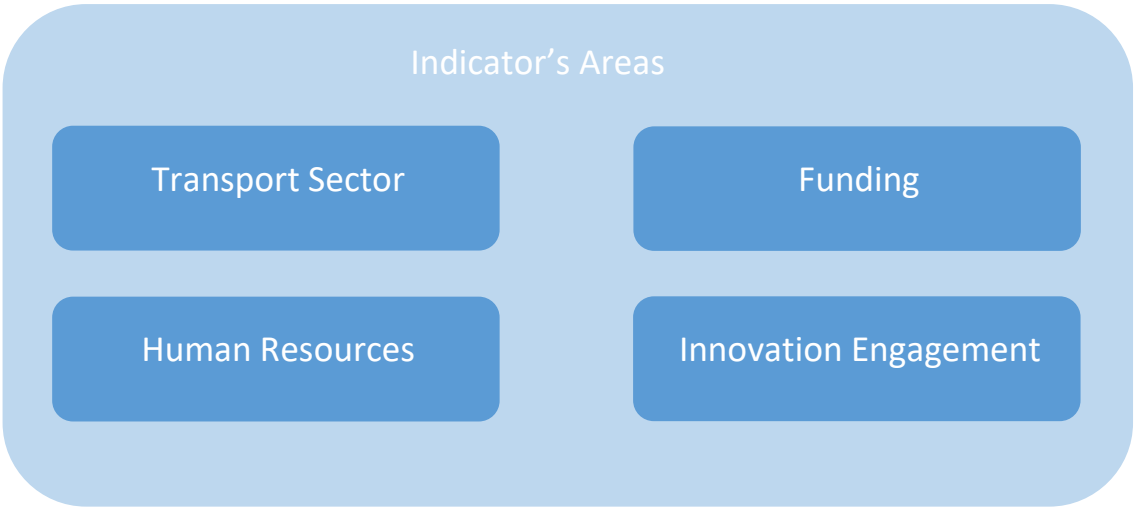
Within the present framework these criteria should be conceived as:

- Relevant: the indicators should be linked to R&D in the transport sector or transport sub-sectors. According to the different sources used, different sectorial classifications are used (e.g. NACE, NABS);
- Accepted: the indicators should have been considered in previous analyses as well as commonly agreed among the JRC, DG MOVE, DG RTD and STRIA Working Group and MS Representatives;
- Credible: the indicators should come from reliable sources, such as the institutional sources identified earlier or expert judgement, and unambiguous and easy to interpret also for non-transport specific audience;
- Easy to monitor: the indicators should be easily accessible and allow for updates;
- Robust against manipulation: the indicators should be clear in their meaning with specified measurement unit, not allowing for misunderstanding or manipulations.

According to the RACER criteria, possible financial and socio-economic indicators have been identified, which are listed and described later in the text.

The twenty-four identified indicators can be grouped according to a systematic approach that conceptually links the indicators based on their content (see Figure 4). The taxonomy identifies four areas that the indicators cover: transport sector, human resources, funding and innovation engagement.

Figure 4. Taxonomy of Indicators



For the purpose of the analysis, the methodology applied examines each transport mode at European (EU 28, if available) and MS level considering the most up-to-date data. This level of information is provided by Eurostat, based on NACE Rev.2 classification.

This classification allows a 4 digit specification of the 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 4 digit codes have been considered, while in many cases the 2 digit level was the only available disaggregation. The transport activities mainly belong to the following NACE Rev.2 categories: C29, C30, G and H. Annex 2 provides a detail description of each category.

A description of the identified indicators is presented next. Annex 4 provides a full overview of data availability and a more detailed description for each of the listed indicators.

Table 2. Financial and socio-economic KPIs –European macro-level

Area of Indicator	***Indicator***	***Description***
Funding	***Business expenditure on R&D (BERD)***	BERD represents the component of 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 (OECD, 2015)
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) by NABS 2007 socio-economic objectives***	The GBAORD indicator is a way of measuring 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 of government expenditure
Transport sector	***Turnover***	It comprises the totals invoiced by the observation unit during the reference period, and this corresponds to market sales of goods or services supplied to third parties
Transport sector	***Number of enterprises***	Count of the number of enterprises active during at least a part of the reference period
Transport sector	***Personnel costs***	These costs are defined as the total remuneration, in cash or in kind, payable by an employer to an employee in return for work done by the latter during the reference period
Transport sector	***Value added at factor costs***	It is the gross income from operating activities after adjusting for operating subsidies and indirect taxes
Human resources	***Total R&D personnel in business enterprise***	Total number of persons employed in research in a specific sector
Human resources	***Number of persons employed***	Total number of persons who work in the observation unit, as well as persons who work outside the unit who belong to it and are paid by it
Human resources	***Total R&D researchers in business enterprise***	Total number of researchers employed in a specific sector

Area of Indicator	***Indicator***	***Description***
Innovation engagement	***Patent applications to the EPO***	Data refer to patent applications filed directly under the European Patent Convention or to applications filed under the Patent Co-operation Treaty and designated to the EPO
Innovation engagement	***Patents granted by the USPTO***	USPTO data refers to patents granted
Innovation engagement	***Innovative enterprises***	Innovative enterprises are those who had innovation activities during the reference period
Innovation engagement	***Product innovative enterprises only***	Product innovative enterprises are those who introduced new or significantly improved goods and/or services, during the reference period
Innovation engagement	***Process innovative enterprises only***	Process innovative enterprises are those who implemented new or significantly improved production process, distribution method or supplying activity, during the reference period
Innovation engagement	***Organisation and/or marketing innovative enterprises only***	Organisational innovative enterprises are those who implemented at least one new organisational method in the enterprises business practices, workplace organisation or external relations, during the reference period
Innovation engagement	***Product and/or process AND organisation and/or marketing innovative enterprises only***	See definitions above
Innovation engagement	***Marketing innovative enterprises***	Marketing innovative enterprises are those who implemented, during the reference period, at least one new marketing concept or strategy that differs significantly from enterprises' existing marketing methods and which has not been used before
Innovation engagement	***Innovation activities and expenditures in the enterprises***	Enterprises involved in innovation activities, during the reference period
Innovation engagement	***Public funding in the enterprise***	Enterprises that received public funding for innovation (At different governmental levels: EU, Central Government, local or regional level, etc.), during the reference period
Innovation engagement	***Types of co-operation of the enterprises***	Enterprise engaged in co-operation, during the reference period

Area of Indicator	***Indicator***	***Description***
Innovation engagement	***Importance of the reasons to not innovate and of the barriers to innovation in the enterprises***	Enterprise stating the importance of not to innovate and the related barriers to innovation
Innovation engagement	***Environmental benefits due to innovation in the enterprises***	Enterprise stating the importance of environmental benefits due to innovation

All the identified indicators are collected for the most recent years and updated periodically; this data contributes to the creation of the TRIMIS Transport R&D financial and socio-economic database.

3.1.3 Data analysis and elaborations

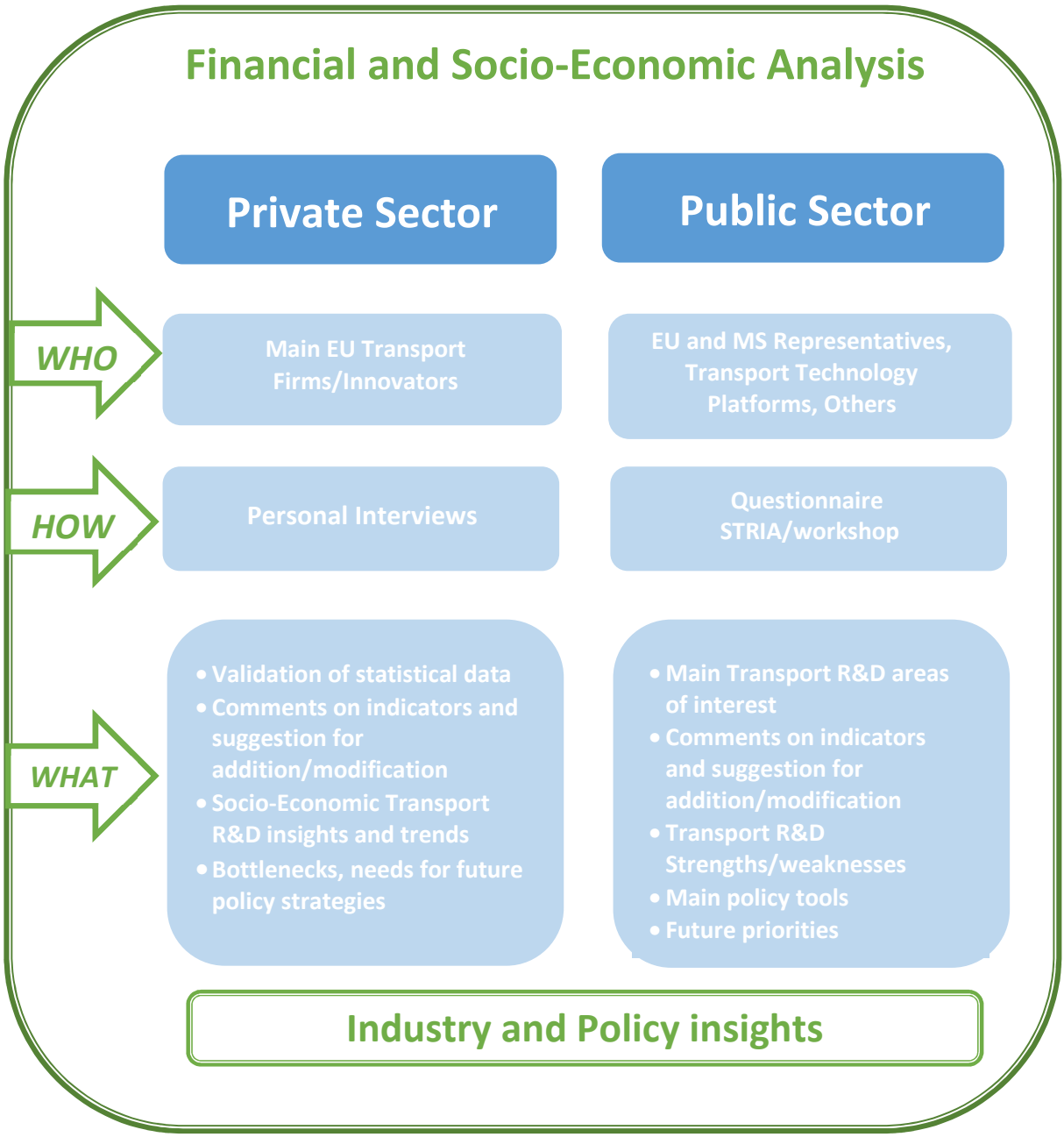
The data collected through the indicators are used to produce a detailed and complete financial and socio-economic analysis that will be presented in the annual *Transport R&D Capacity Report*. The report will be structured following the taxonomy proposed above, and will group and analyse indicators accordingly. It will provide a general overview of the state of current R&D capacity in European transport at a macro-level and will be updated annually to present progresses.

The analysis will provide information on the European situation and offer detailed information at the MS level. It will contribute to the production of *Country Profiles* that will be updated each year. Considering the relevance and the amount of data collected, this macro-level analysis will complement and support the data that will be collected and analysed for each of the seven STRIA Roadmaps. This information will provide the basis of the *Transport R&D financial and socio-economic database* and will be the main reference point for further analysis.

3.2 Qualitative approach: Involvement of private and public sectors

This section discusses the methodological path that will be followed to develop the qualitative analysis. Figure 5 outlines how the private and public sectors are involved. The aim of their involvement is to gain an understanding from transport innovators who have the expertise to provide insights on transport innovation trends. In addition, EU and MS representatives and other relevant transport stakeholders will be engaged. The topics of research are related to financial and socio-economic issues within the framework of transport R&D; the methodological approach changes according to the characteristics of the two main groups involved.

Figure 5. Qualitative methodological approach



3.2.1 Private sector involvement

The involvement of private companies is important because it allows the results of the quantitative analysis to be validated. It also complements the analysis with qualitative elements that cannot be obtained from statistical data.

To this extent, it is important to select appropriate experts to interview who represent the main transport innovators in Europe.

An initial list of the possible experts will be taken form the EU Industrial R&D Investment Scoreboard (European Commission, 2018b) that provides economic and financial data and analysis of leading European and international corporate R&D investors. Starting from this initial source, and through desk analysis and personal contacts, it will be possible to obtain a definitive list of experts to interview, which will comprise the most representative EU

companies. The number of interviews may vary based on the willingness to participate and also to ensure a broad transport mode and geographical coverage.

After an initial exploratory phase of contacts and engagement, it will be possible to define the schedules for the interviews that will examine the following topics:

(a) *Validation of statistical data*: the involvement of the transport expert will be after the data collection and elaboration of the financial and socio-economic indicators. Once the dataset has been produced, it will be possible to present it to transport experts for review allowing the addition of specific company input and experiences.
(b) *Comments on indicators and suggestion for addition and/ or modification*: while reviewing the quantitative analysis, the transport experts will be able to comment on the identified indicators and provide suggestions and, or modifications. Their input and detailed knowledge of the transport sector and their engagement in innovation activities can be included in the analysis.
(c) *Socio-Economic Transport R&D insights and trends*: a major contribution from the experts should come from their knowledge and insights of the transport R&D sector. They will be requested to provide detailed information of the current situation and their views on future needs and trends.
(d) *Bottlenecks and needs for future policy strategies:* within the framework of the interview the experts will be asked to list and explain which are the current and future bottlenecks that they can identify, together with a list of needs that should be addressed from the industry and/ or from policy makers.

Nevertheless, the respondent will have the possibility to adapt the interview, which can be done face-to-face or through phone-call, (depending on the availability of the stakeholder to be interviewed). The respondent will be guided through the questionnaire and can review the minutes of the interview.

The proposed approach will provide the possibility to have thorough information from the most relevant stakeholders with a high level of detail. The personal interviews allow additional insights that are difficult to obtain from on-line surveys or questionnaires. A possible risk is that the data gathering could take longer than expected, and that unavailability of the contacted people could prolong or preclude a comprehensive analysis. To prevent this risk, the definition of the questionnaire and the identification of the contacts will start as soon as possible.

3.2.2 Public sector involvement

It is also essential to include the public sector in the qualitative assessment of EU transport R&D.

The representatives of the responsible EC services (DG MOVE, DG RTD) and STRIA Governance Group MS representatives will be contacted together with the European Transport Technology Platforms representatives (TTPs) and other transport stakeholders. It is important to have their engagement in data gathering and elaboration to validate results.

Considering the relatively high number of participants, it is necessary to produce a semi-structured questionnaire, which will be sent by e-mail, followed by direct contact for clarifications.

Once the data are gathered and elaborated, the results will be presented to the respondents, to discuss, validate and complement the results. This could take place within the framework of the STRIA Governance Group or specific workshops.

The main aspects that will be taken into consideration are:

(a) *Main Transport R&D areas of interest*: the respondents will be able to outline the main areas of transport R&D that are currently being implemented or are under discussion. This information can be compared to the results of the quantitative analysis.

(b) *Comments on indicators and suggestions for addition and/or modification*: as for the private sector, comments on the identified indicators will assist in the revision of future reports.
(c) *Transport R&D strengths and/ or weaknesses*: based on their national or thematic experience, the respondents will be asked to express what they believe are the strengths and weakness of transport R&D activities (e.g. Lack of financing, qualified people and supporting policy measures, etc.).
(d) *Main policy tools*: the interviewed representatives will be asked to provide and describe the current policy tools that are put in place in their countries that contribute to the enhancement of transport R&D.
(e) *Future priorities*: based on their MS policy background and on their personal expertise and perceptions, the respondents will be asked to illustrate what are the main future priorities and possible policy measures.

The engagement of STRIA MS representatives will ensure the coverage of the entire EU. Additionally, having other stakeholder representatives will enrich the content of the analysis.

The limitations of this approach are related to the difficulty in engaging equally with all identified stakeholders. This will be minimised by contacting public sector representatives as soon as possible and by following the process very closely.

The outcome of the qualitative assessment will contribute to the development of an annual *Transport R&D Capacity Report*, moreover the results obtained from interviews, questionnaire and stakeholder meetings will also be used for the *Country Profiles*.

The first part of the analysis will examine the quantitative assessment in order to develop the database on which to elaborate and complement the qualitative analysis. Moreover, after a data quality check, it will be possible to detect possible gaps that could be potentially minimised through the insights provided by the stakeholders engaged in the study. The two methodological approaches need to be interdependent from each other allowing a complete transport R&D financial and socio-economic capacity assessment.

It is worth noting that the qualitative analysis needs to be defined and integrated with other TRIMIS activities in order to take advantage of existing synergies and to optimise resources. With this aim, the interviews and the discussion in the framework of the STRIA Governance Group or specific workshop will be organised and coordinated with other relevant TRIMIS activities.

4 Conclusions

This report outlines a methodology to assess European financial and socio-economic status of transport R&D for the entire transport sector and its sub-sectors. By providing a sectoral overview, this analysis will serve as an important backdrop for specific STRIA Roadmap capacity assessments. Moreover, the analysis will contribute to establishing and updating Country Profiles and the TRIMIS Transport R&D financial and socio-economic database.

Methodologies used in past studies have been taken into consideration. The conclusions of these studies have been useful to identify important gaps and weaknesses, such as data access and availability. The proposed methodology attempts to overcome these concerns by proposing an R&D capacity assessment combining quantitative and qualitative approaches.

The approach outlined will provide insights into the current R&D financial engagement of European private and public sector. It provides the means for assessing the present status and can contribute to defining future investments needs and R&D priorities.

However, the proposed methodology has a number of limitations:

- limited availability data to perform the analysis;
- incompleteness of data that prevents an homogeneous analysis in terms of geographical coverage, scope, timeframe, etc.; and
- Lack of disaggregate data to allow a comprehensive sub-sectoral analysis.

It will also be necessary to address other aspects linked to human resources engaged in R&D in transport, such as occupation characterisation and skills needed in future transport research.

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List of abbreviations and definitions

BERD	Business Expenditure on R&D
CIS	Community Innovation Survey
DG MOVE	Directorate-General for Mobility and Transport
DG RTD	Directorate-General for Research and Innovation
EC	European Commission
EFTA	European Free Trade Association
EPO	European Patent Office
EU	European Union
EU28	European Union of 28 Member States
FP7	7th Framework Programme
GBAORD	Government Budget Appropriations for Outlays for Research and Development
GERD	Gross Domestic Expenditure on R&D
GDP	Gross Domestic Product
HRST	Human Resources in Science and Technology Statistics
ICB	Industry Classification Benchmark
IEA	International Energy Agency
IPC	International Patent Classification
JRC	Joint Research Centre
KPI	Key Performance Indicator
MS	Member State
NABS	Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne
NUTS	Classification of Territorial Units for Statistics
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
R&I	Research and Innovation
SBS	Structural Business Statistics
STRIA	Strategic Transport Research and Innovation Agenda
TRIMIS	Transport Research and Innovation Monitoring and Information System
TTPs	European Transport Technology Platforms
UNESCO	United Nations Educational, Scientific and Cultural Organization
USPTO	United States Patent and Trademark Office
WIPO	World Intellectual Property Office

List of figures

List of tables

Annexes

Annex 1: List of reviewed studies

Title	Authors	Year of Publication	Geographical Coverage	Sectors	Database Classification	N. of identified indicators
Mapping innovation in the European transport sector. An assessment of R&D efforts and priorities, institutional capacities, drivers and barriers to innovation.	Wiesenthal, T. et al.	2011	EU	Transport and Logistics	Eurostat-NACE Rev.2 (C29, C30, G45, H), Eurostat-NABS 04	5
FUTRE, The European innovation system in transport and the current state of the competitiveness of the EU transport sector	Condeço, A. et al.	2013	EU	Transport and Logistics	Eurostat-NACE Rev.2 (C29, C301, C302, C3030, C309, H), OECD-ISIC Rev. 3	14
METRIC, Mapping and explaining the performance of regional innovation frameworks-WP3	Konings, J. W., & Louw, E.	2014	EU-Regional Level	Transport and Logistics	Eurostat-NACE Rev.2 (C29, C30, H)	28
Innovation in the European transport sector: A review	Wiesenthal, T. et al.	2015	EU	Transport and Logistics	Eurostat-NACE Rev.2 (C29, C30, G45, H), Eurostat-NABS 04	5

Title	Authors	Year of Publication	Geographical Coverage	Sectors	Database Classification	N. of identified indicators
Mapping the transport innovation performance of regions in Europe.	Konings, J. W., & Louw, E.	2016	EU-Regional Level	Transport and Logistics	Eurostat-NACE Rev.2 (C29, C30, H)	24
Support to assessment of innovation capacities in the European transport sector. Final Report	Tsamis, A. et al.	2016	EU	Transport and Logistics	Eurostat-NACE Rev.2 (C29, C301, C302, C303, C304, C309, H, H49, H50, H51, H52, H53)	12

Annex 2: 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 - Transporting 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 3: Relevant sources

Database Name	Organisation/ Institution	Last available Data	Geographical Coverage	Topics/Areas covered	Periodicity	Methodological approach	Private/Public	Database Time frame	Database Classification
Structural Business Statistics (SBS)	Eurostat, EC	2016	EU 28	All economic sectors	Yearly		private/public	2008-2016	NACE Rev.2
Community Innovation Survey (CIS) [Science and technology statistics]	Eurostat, EC	2014	EU 28 + Candidate Countries, European Union, EFTA countries	All economic sectors	Biennial	Oslo Manual, OECD/Eurostat, 2005	private	2004-2014	NACE Rev.2
Statistics on Research and Development (R&D) [Science and technology statistics]	Eurostat, EC	2016	EU 28 + Candidate Countries, EFTA Countries, the Russian Federation, China, Japan, the United States and South Korea	Business enterprise, government, higher education, private non-profit	Biennial (Yearly for the main indicators)	Frascati Manual, OECD 2015	private/public	2003-2016	NACE Rev. 2
Human Resources in Science & Technology (HRST) [Science and technology statistics]	Eurostat, EC [Labour Force Survey, Data Collection on education Systems]	2017	EU 28 + Candidate Countries, EFTA Countries, EU MS	HRST Stock, Education, Jobs	Yearly	The Manual on the Measurement of Human Resources Devoted to Science and Technology - Canberra Manual, OECD/Eurostat 1995	private/public	2008-2017	NACE Rev. 2, ISCO-08, ISCED, NUTS 1&2

Database Name	Organisation/ Institution	Last available Data	Geographical Coverage	Topics/Areas covered	Periodicity	Methodological approach	Private/Public	Database Time frame	Database Classification
Patent	Eurostat, EC	Different according to type of source	EU 28 + EU MS, Candidate and EFTA Countries (Iceland, Liechtenstein, Norway, Switzerland, Turkey), Russia, South Africa, Canada, United States, Mexico, Brazil, China (except Hong Kong), Hong Kong, Japan, South Korea, Taiwan, India, Singapore, Israel, Australia, New Zealand, world.	Patent applications / granted by EPO, patents granted by USPTO and triadic patent families	Yearly	IPC	private	1977-2013	NACE Rev.2
Industrial R&D Investment Scoreboard	JRC, EC	2017	EU+ World	All economic sectors	Yearly	Financial Annual Reports	private	2004-2017	
World Intellectual Property Office (WIPO)	United Nations	2017	WIPO's MS	Patent applications / by EPO, patents granted by USPTO and triadic patent families	Yearly	IPC	private	2004-2017	

Database Name	Organisation/ Institution	Last available Data	Geographical Coverage	Topics/Areas covered	Periodicity	Methodological approach	Private/Public	Database Time frame	Database Classification
Data on public R&D expenditure from the International Energy Agency (IEA)	IEA	2017	IEA 's MS	Energy R&D budgets			private/public		
Data on Science, Technology and Innovation	UNESCO	2017	71 Countries	All economic sectors	Biennial	Oslo Manual, OECD/Eurostat, 2005	private	2010-2017	
Innobarometer	EC	2016	Finland, Austria, Czech Republic, Hungary, Lithuania, Switzerland, Romania, Slovakia, Portugal, Ireland, Croatia, Slovenia, Netherlands, Greece, France, Belgium, Denmark, Cyprus, Estonia, Luxembourg, Bulgaria, Malta, Sweden, Latvia, Germany, Italy, Spain, Poland, United Kingdom, United States	All economic sectors	Yearly		private	2001-2016	NACE Rev.2

Database Name	Organisation/ Institution	Last available Data	Geographical Coverage	Topics/Areas covered	Periodicity	Methodological approach	Private/Public	Database Time frame	Database Classification
European Innovation Scoreboard	EC	2017	EU Member States	All economic sectors	Yearly		private/public	Different according to indicators	NACE Rev.2
Regional Innovation Scoreboard	EC	2016	220 regions in Austria, Belgium, Bulgaria, Croatia, Czech Republic Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Norway Poland, Portugal, RomaniaSerbia, Slovakia Slovenia, Spain, Sweden, Switzerland, United Kingdom	All economic sectors	Biennial		private/public	Different according to indicators	NACE Rev.2 for NUTS 2
Science, Technology and Patents database	OECD	Different according to indicators	OECD Countries	All economic sectors	Yearly	Frascati Manual, OECD 2015	private/public	Different according to indicators	ISIC Rev. 4

Annex 4: Financial and socio-economic KPIs - description and availability

Indicator	Business expenditure on R&D (BERD)
Description	BERD represents the component of 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 (OECD, 2015)
Data Availability (At Sector Level)	NACE REV.2, 2/3 digits level (C29, C30, C301, C302, C303, C304, C309, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2005-2016
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Million Euro, Euro per inhabitant
Data Source	Eurostat

Indicator	Business R&D Intensity
Description	Total business R&D spending as % of GDP
Data Availability (At Sector Level)	NACE REV.2, 2/3 digits level (C29, C30, C301, C302, C303, C304, C309, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2005-2016
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Percentage of gross domestic product
Data Source	Eurostat

Indicator	Total GBAORD by NABS 2007 socio-economic objectives
Description	GBAORD indicator is a way of measuring government support for research and development activities. GBAORD include all appropriations (government spending) given to R&D in central (or federal) government budgets. Provincial (or State) government posts are only included if the contribution is significant. Local government funds are excluded
Data Availability (At Sector Level)	NABS 2007 Socio-economic activities (NABS 04) (Annex 5)
Data Availability (Timeframe)	2004-2017
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Million Euro, Euro per inhabitant
Data Source	Eurostat

Indicator	Total GBAORD as a % of total general government expenditure
Description	Percentage of government expenditure
Data Availability (At Sector Level)	General (No economic sector specification available)
Data Availability (Timeframe)	1980-2016
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Percentage of government expenditure
Data Source	Eurostat

Indicator	Number of persons employed
Description	Total number of persons who work in the observation unit (inclusive of working proprietors, partners working regularly in the unit and unpaid family workers), as well as persons who work outside the unit who belong to it and are paid by it (e.g. sales representatives, delivery personnel, repair and maintenance teams). It excludes manpower supplied to the unit by other enterprises, persons carrying out repair and maintenance work in the enquiry unit on behalf of other enterprises, as well as those on compulsory military service
Data Availability (At Sector Level)	NACE REV.2, up to 4 digits level (C29, C30, G45, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2005-2016
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Total number of persons
Data Source	Eurostat-SBS

Indicator	Turnover
Description	It comprises the totals invoiced by the observation unit during the reference period, and this corresponds to market sales of goods or services supplied to third parties; it includes all duties and taxes on the goods or services invoiced by the unit with the exception of the VAT invoiced by the unit to its customer and other similar deductible taxes directly linked to turnover; it also includes all other charges (transport, packaging, etc.) passed on to the customer. Price reductions, rebates and discounts as well as the value of returned packing must be deducted
Data Availability (At Sector Level)	NACE REV.2, up to 4 digits level (C29, C30, G45, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2005-2015/2016
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Million Euro
Data Source	Eurostat-SBS

Indicator	Number of enterprises
Description	Count of the number of enterprises active during at least a part of the reference period
Data Availability (At Sector Level)	NACE REV.2, up to 4 digits level (C29, C30, G45, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2005-2015
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Total number of enterprises
Data Source	Eurostat-SBS

Indicator	Personnel costs
Description	These costs are defined as the total remuneration, in cash or in kind, payable by an employer to an employee (regular and temporary employees as well as home workers) in return for work done by the latter during the reference period. Personnel costs also include taxes and employees' social security contributions retained by the unit as well as the employer's compulsory and voluntary social contributions. Personnel costs are made up of wages and salaries and employers' social security costs
Data Availability (At Sector Level)	NACE REV.2, up to 4 digits level (C29, C30, G45, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2005-2015
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Million Euro
Data Source	Eurostat-SBS

Indicator	Value added at factor costs
Description	It is the gross income from operating activities after adjusting for operating subsidies and indirect taxes. Value adjustments (such as depreciation) are not subtracted
Data Availability (At Sector Level)	NACE REV.2, up to 4 digits level (C29, C30, G45, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2005-2015
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Million Euro
Data Source	Eurostat-SBS

Indicator	Total R&D personnel in business enterprise
Description	Number of persons employed in research in a specific sector
Data Availability (At Sector Level)	NACE REV.2, 2/3 digits level (C29, C30, C301, C302, C303, C304, C309, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2005-2016
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Total number of persons
Data Source	Eurostat -Statistics on research and development

Indicator	Total R&D researchers in business enterprise
Description	Number of researchers employed in a specific sector
Data Availability (At Sector Level)	NACE REV.2, 2/3 digits level (C29, C30, C301, C302, C303, C304, C309, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2005-2016
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Total number of researchers
Data Source	Eurostat -Statistics on research and development

Indicator	Patent applications to the EPO
Description	Data refer to applications filed directly under the European Patent Convention or to applications filed under the Patent Co-operation Treaty and designated to the EPO. Patent applications are counted according to the year in which they were filed at the EPO and are broken down according to the IPC. They are also broken down according to the inventor's place of residence, using fractional counting if multiple inventors or IPC classes are provided to avoid double counting
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30)
Data Availability (Timeframe)	1977-2013
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Number of patents
Data Source	Eurostat- Patent

Indicator	Patents granted by the USPTO
Description	USPTO data refers to patents granted while EPO data refers to patent applications. Data are recorded by year of publication as opposed to the year of filing used for the EPO data. This is because patents in the US (at least in the past) were only published once they were granted. Patents are allocated to the country of the inventor, using fractional counting in the case of multiple inventor countries. The methodology used is not harmonised with that of Eurostat and therefore the comparison between EPO and USPTO patents data should be interpreted with caution
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30)
Data Availability (Timeframe)	1977-2010
Data Availability (Geographical Coverage)	EU 28
Unit of Measurement	Number of patents
Data Source	Eurostat- Patent

Indicator	Innovative enterprises (By main types of innovation and specific types of innovation)
Description	Innovative enterprises had innovation activities during the period 2012-2014, including enterprises with on-going and abandoned activities. In other words, enterprises that had innovation activities during the period under review, regardless of whether the activity resulted in the implementation of an innovation, are innovation-active
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2014
Data Availability (Geographical Coverage)	MSs involved in the survey
Unit of Measurement	Number of enterprises
Data Source	Eurostat- CIS2014

Indicator	Product innovative enterprises only (By main types of innovation and specific types of innovation)
Description	Product innovative enterprises are those who introduced, during 2012-2014, new or significantly improved goods and/or services with respect to their capabilities, user friendliness, components or sub-systems. Changes of a solely aesthetic nature and the simple resale of new goods and services purchased from other enterprises are not considered as innovation
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2014
Data Availability (Geographical Coverage)	MSs involved in the survey
Unit of Measurement	Number of enterprises
Data Source	Eurostat- CIS2014

Indicator	Process innovative enterprises only (By main types of innovation and specific types of innovation)
Description	Process innovative enterprises implemented new or significantly improved production process, distribution method or supplying activity during 2012-2014
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2014
Data Availability (Geographical Coverage)	MSs involved in the survey
Unit of Measurement	Number of enterprises
Data Source	Eurostat- CIS2014

Indicator	Organisation and/or marketing innovative enterprises only (By main types of innovation and specific types of innovation)
Description	Organisational innovative enterprises implemented at least one new organisational method in the enterprises business practices, workplace organisation or external relations
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2014
Data Availability (Geographical Coverage)	MSs involved in the survey
Unit of Measurement	Number of enterprises
Data Source	Eurostat- CIS2014

Indicator	Product and/or process AND organisation and/or marketing innovative enterprises only (By main types of innovation and specific types of innovation)
Description	See descriptions above
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2014
Data Availability (Geographical Coverage)	MSs involved in the survey
Unit of Measurement	Number of enterprises
Data Source	Eurostat- CIS2014

Indicator	Marketing innovative enterprises (By main types of innovation and specific types of innovation)
Description	Marketing innovative enterprises implemented at least one new marketing concept or strategy that differs significantly from enterprises' existing marketing methods and which has not been used before. It requires significant changes in product design or packaging, product placement, product promotion or pricing. In addition, it excludes seasonal, regular and other routine changes in marketing methods
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2014
Data Availability (Geographical Coverage)	MSs involved in the survey
Unit of Measurement	Number of enterprises
Data Source	Eurostat- CIS2014

Indicator	Innovation activities and expenditures in the enterprises
Description	Enterprises involved in innovation activities
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2014
Data Availability (Geographical Coverage)	MSs involved in the survey
Unit of Measurement	Number of enterprises, percentage of enterprises
Data Source	Eurostat- CIS2014

Indicator	Public funding in the enterprise
Description	Enterprises that received public funding for innovation (At different governmental level: EU, Central Government, local or regional level, etc.)
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2014
Data Availability (Geographical Coverage)	MSs involved in the survey
Unit of Measurement	Number of enterprises, percentage of enterprises
Data Source	Eurostat- CIS2014

Indicator	Types of co-operation of the enterprises
Description	Enterprises engaged in co-operation
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2014
Data Availability (Geographical Coverage)	MSs involved in the survey
Unit of Measurement	Number of enterprises, percentage of enterprises
Data Source	Eurostat- CIS2014

Indicator	Importance of the reasons to not innovate and of the barriers to innovation in the enterprises
Description	Enterprises stating the importance of not to innovate and the related barriers to innovation
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2014
Data Availability (Geographical Coverage)	MSs involved in the survey
Unit of Measurement	Number of enterprises, percentage of enterprises
Data Source	Eurostat- CIS2014

Indicator	Environmental benefits due to innovation in the enterprises
Description	Enterprises stating the importance of environmental benefits due to innovation
Data Availability (At Sector Level)	NACE REV.2, 2 digits level (C29, C30, H, H49, H50, H51, H52, H53)
Data Availability (Timeframe)	2014
Data Availability (Geographical Coverage)	MSs involved in the survey
Unit of Measurement	Number of enterprises, percentage of enterprises
Data Source	Eurostat- CIS2014

Annex 5: NABS Classification - Transport Sector

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).

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