



JRC SCIENCE FOR POLICY REPORT

Towards an integrated monitoring and assessment framework for the Strategic Transport Research and Innovation Agenda

Using TRIMIS as a policy support mechanism

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

2018

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JRC Science Hub

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JRC112360

EUR 29314 EN

PDF	ISBN 978-92-79-92583-2	ISSN 1831-9424	doi:10.2760/788905
Print	ISBN 978-92-79-92582-5	ISSN 1018-5593	doi:10.2760/872205

Luxembourg: Publications Office of the European Union, 2018

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How to cite this report:

Tsakalidis, A., van Balen, M., Gkoumas, K., Grosso, M., Haq, G. and Pekar, F., *Towards an integrated monitoring and assessment framework for the Strategic Transport Research and Innovation Agenda: Using TRIMIS as a policy support mechanism*, EUR 29314 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-92583-2, doi:10.2760/788905, JRC112360

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Towards an integrated monitoring and assessment framework for the Strategic Transport Research and Innovation Agenda: Using TRIMIS as a policy support mechanism

The Transport Research and Innovation Monitoring and Information System (TRIMIS) is an open-access transport information system. The TRIMIS database contains transport research and innovation projects and programmes that are arranged according to the seven Strategic Transport Research and Innovation Agenda (STRIA) roadmaps that were adopted by the European Commission in May 2017. The roadmaps cover: 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. This report provides the overall methodological framework formulated for the assessment and monitoring of the implementation and development of STRIA.

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Acknowledgements

The views expressed here are those of the authors and may not, under any circumstances, be regarded as an official position of the European Commission. The Joint Research Centre (JRC) is in charge of the development of TRIMIS, and the work has been carried out under the supervision of the Directorate-General for Mobility and Transport (DG MOVE) and the Directorate-General for Research and Innovation (DG RTD) that are co-leading the Strategic Transport Research and Innovation Agenda (STRIA).

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Executive summary

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

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

- cooperative, connected and automated transport;
- transport electrification;
- vehicle design and manufacturing;
- low-emission alternative energy for transport;
- network and traffic management systems;
- smart mobility and services; and
- infrastructure.

TRIMIS tracks the status quo and developments in research and innovation (R&I) in the field of transport, and identifies innovative technologies and assesses their potential future impact. This process involves: updating and maintaining a R&I database on transport technologies and innovations; constant monitoring and assessing transport sector technology performance using a set of key performance indicators (KPIs); supporting the assessment of the transport sector performance and maturity status; identifying new technologies and opportunities that may have an impact on the transport sector, through an inventory of scientific developments of new and emerging technologies; and highlighting mature technologies that are close to market introduction.

Within the STRIA context, TRIMIS aims to:

- Monitor progress of the STRIA and support the development of STRIA roadmaps through the STRIA governance process (steering group).
- Prepare and update 'technology mapping' (state-of-the-art, barriers and potential of technologies) following the STRIA roadmaps structure.
- Define and update 'capacities mapping' (financial and human resources).
- Assess funded research projects in the field of transport (with a focus on the STRIA roadmaps).
- Assist in reporting of progress of the STRIA against defined KPIs and scoreboards.
- Identify opportunities for new STRIA roadmaps or propose modifications to the existing ones.
- Monitor socio-economic developments and assess their influence on transport technology and innovation.
- Facilitate the effective functioning of an extensive network of industry stakeholders, Member State (MS) experts and authorities, research organisations, industrial and financial communities, information collection points, etc.

This report presents the methodological overview of a TRIMIS step-by-step development process, which includes the necessary input identification and collection, the setup of an assessment framework and the production of policy support outputs.

Specifically, the framework enables TRIMIS to:

- Monitor the progress of the actions and targets set by the STRIA working groups.
- Measure the effectiveness of R&I actions.

- Measure the efficiency of R&I actions and identify any duplication, by linking national and European projects and programmes to the actions, leading to comprehensive capacity maps.
- Identify gaps in R&I efforts.

Policy context

The development of STRIA needs to be underpinned by an effective monitoring and reporting scheme that supports its development, implementation, monitoring and revision. TRIMIS aims to become the main analytical support tool for STRIA. It maps transport technology trends and research and innovation capacities, and monitors progress against the targets set for all the transport sectors. TRIMIS has been designed as an open-access information and knowledge management system and is intended to fulfil multiple roles: horizon scanning, monitoring progress against research and innovation (R&I) roadmaps, mapping technologies and capacities in the EU transport sector, information dissemination and the development of toolboxes, etc. As well as acting as a general source for information and data on transport research and innovation, TRIMIS facilitates information exchange between partners and serves as a monitoring system of progress against the seven STRIA roadmaps.

The EC has recently started the process of updating the STRIA roadmaps, in close cooperation with the MSs and industry stakeholders. The JRC is supporting this process by providing input to the definition of updated action plans for short-, medium- and long-term R&I initiatives. The present report contributes to this process through the provision of recommendations to policymakers.

Key conclusions

This report introduces the STRIA monitoring and assessment framework. Applying the framework when (re)developing the STRIA roadmaps ensures that all roadmaps are equal in terms of structure, completeness, and policy relevance. The need for a framework became clear after an evaluation of the existing roadmaps. A range of issues emerged, showing that TRIMIS was limited in its ability to monitor and assess the STRIA roadmaps, including where omissions, inconsistencies, and a lack of harmonisation can be found between roadmaps. This report contributes to improving the STRIA roadmaps, which in turn improves the analytical capabilities of TRIMIS and the policy relevance of STRIA.

Main findings

After evaluating the initial seven STRIA roadmaps, the following issues were identified:

- Actions were identified but no indicators.
- Indicators were identified but no actions.
- Lack of clarity regarding the problem that is addressed.
- No harmonisation between roadmaps in terms of timelines and type of actions.
- No baseline values were set for monitoring purposes.
- Indicators were selected for which no sources exist that could enable monitoring efforts.
- Indicators were selected that require substantial resources to enable monitoring.
- The indicators that were proposed are unbalanced in terms of the addressed thematic fields (e.g. there is a strong focus on economics but not on environmental aspects).
- Unclear who bears the responsibility for STRIA roadmap actions, making the roadmaps less actionable.

Adopting the proposed framework in future updates of the STRIA roadmaps should resolve these issues.

Related and future Joint Research Centre work

TRIMIS — including the work carried out for this report — has benefitted from ongoing work at the JRC on sustainable transport and sustainable energy systems. Synergies will continue to be explored with related projects on connected and automated transport, electrification, emissions control and initiatives in the context of the Strategic Energy Technology Plan, including the Strategic Energy Technologies Information System (SETIS, available at: <https://setis.ec.europa.eu>). The JRC will further develop TRIMIS by adding more functionalities to the TRIMIS online platform and carrying out scientific research to analyse transport R&I in the areas of STRIA roadmaps. It will also continue to provide support to the STRIA governance process and, on the basis of its research, provide recommendations to policymakers.

Quick guide

This report provides an overview of the development of the STRIA monitoring and assessment framework that uses TRIMIS as an integrated analytical support tool for the monitoring of European transport R&I. It outlines the methodology that will be used for the assessment of transport R&I and provides conclusions and recommendations for policymakers and identifies future research areas.

1. Introduction

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

In order to address current socio-economic challenges within an ever-changing complex and competitive environment, the transport sector requires new technological developments. This will be achieved through R&I, which allows new quality standards in relation to the mobility of people and goods, thereby ensuring European competitiveness.

To decarbonise transport and mobility, the EC has identified the need to overcome barriers and seize opportunities, arising through the promotion of transport R&I. Towards this goal, STRIA has identified priority areas with specific actions for future R&I, outlined in seven roadmaps:

- 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 implementation of STRIA must be supported by an effective monitoring and information mechanism. The JRC has developed TRIMIS to provide a holistic assessment of technology trends; transport R&I capacities; publish information and data; and to develop analytical tools on the European transport system. TRIMIS was funded under the Horizon 2020 Work Programme 2016-2017 on smart, green and integrated transport (European Commission, 2017c).

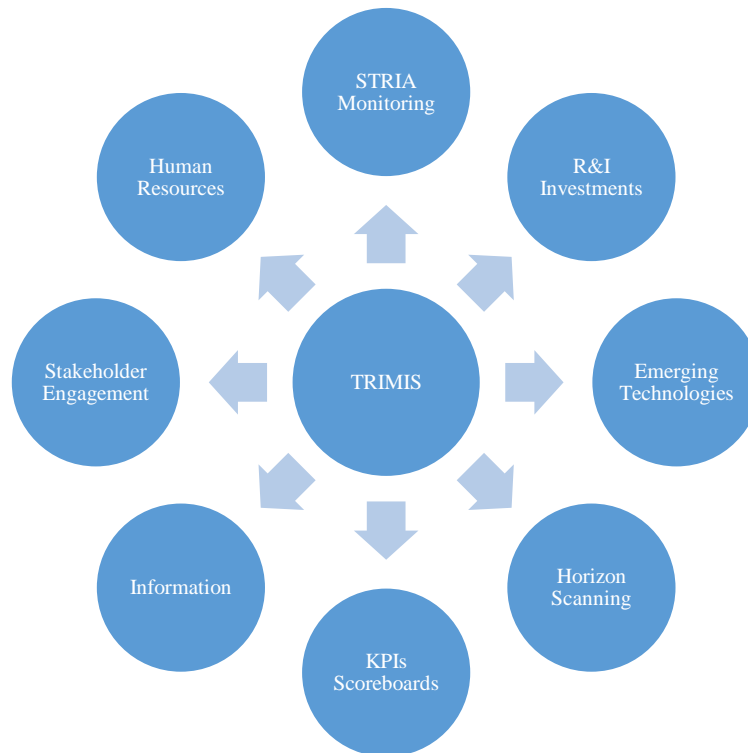
TRIMIS is a new tool that benefits the entire European transport system. It is an open-access information and knowledge management system that consists of a database of transport projects and programmes, as well as an inventory of transport technologies and innovations. As part of the TRIMIS initiative, information on the status of transport R&I will be collated and disseminated to ensure systematic horizon scanning. Progress on the implementation of the seven roadmaps will be monitored against a set of relevant key performance indicators (KPIs) and scoreboards (Tsakalidis et al., 2018a).

This report provides an overview of the development of the STRIA monitoring and assessment framework that uses TRIMIS as an integrated analytical support tool for the monitoring of European transport R&I. It outlines the methodology that will be used for the assessment of transport R&I and provides conclusions and recommendations for policy makers as well as identifying future research areas.

1.1. Development of TRIMIS

TRIMIS has been developed as a policy tool to support the monitoring and implementation of the STRIA by mapping transport technology trends and R&I capacities in the European Union (EU) (see Figure 1). It has been designed as an open-access information and knowledge management system to undertake: horizon scanning, monitor progress against STRIA roadmaps, map technologies and capacities in the EU transport sector and support information dissemination and the development of a set of policy tools. As well as acting as a general source of information and data on transport R&I, it facilitates information exchange between stakeholders.

Figure 1. TRIMIS main features and functionalities



Source: Tsakalidis et al., 2018.

TRIMIS focuses on a number of priority areas outlined in the seven STRIA roadmaps, where public intervention at the European level can create added value in order to overcome socio-economic weaknesses, increase competitiveness and meet EU energy and transport strategy goals. In particular, it covers the following aspects of the transport sector:

- policies;
- data analysis;
- funding information;
- public and private investments;
- capacity and technology mapping;
- horizon scanning;
- news/updates.

Moreover, TRIMIS tracks the status quo and developments in R&I in the field of transport, and identifies innovative technologies and assesses their potential future impact. This process involves:

1. Updating and maintaining a transport research and innovation database that includes projects and programmes on transport technologies and innovations. This repository provides an input for the assessment of KPIs in transport R&I and links to established EU tools and initiatives (e.g. SETIS and Innovation Radar). It provides a communication channel between TRIMIS and transport stakeholders, allowing additions and amendments to the database with an automated link to existing EC repositories, i.e. CORDIS¹.

¹ <https://cordis.europa.eu/>

2. Monitoring and assessing transport sector technology performance using a set of KPIs to monitor the European innovation capacities for each STRIA roadmap. As well as monitoring the progress of European R&I projects to support the assessment of the transport sector performance and maturity status.
3. Identifying new technologies and opportunities that may have an impact on the transport sector through an inventory of scientific developments of new and emerging technologies relevant to the future of the EU transport sector.
4. Highlighting mature technologies that are close to market introduction.

The specific objectives of TRIMIS within the STRIA context are presented in the following section.

1.2. Specific objectives of TRIMIS within the STRIA context

Within the STRIA context, TRIMIS aims to:

- Monitor progress of the STRIA and support the development of STRIA roadmaps, and STRIA governance (steering group).
- Prepare and update 'technology mapping' (state-of-the-art, barriers and potential of technologies) following the STRIA roadmaps structure.
- Define and update 'capacities mapping' (financial and human resources).
- Assess funded research projects in the field of transport (with a focus on the STRIA roadmaps).
- Assist in reporting of progress of the STRIA against defined KPIs and scoreboards.
- Identify opportunities for new STRIA roadmaps or propose modifications to the existing ones.
- Monitor socio-economic developments and assess their influence on transport technology and innovation.
- Facilitate the effective functioning of an extensive network of industry stakeholders, MS experts and authorities, research organisations, industrial and financial communities, information collection points, etc.

The JRC is responsible for the development of TRIMIS under the supervision of the EC DG MOVE and DG RTD that are co-chairing STRIA working group (WG). The WGs are composed of topic experts, who are mainly responsible for developing the STRIA roadmaps. The participants are thus specifically selected for each roadmap and come from various industries and MSs.

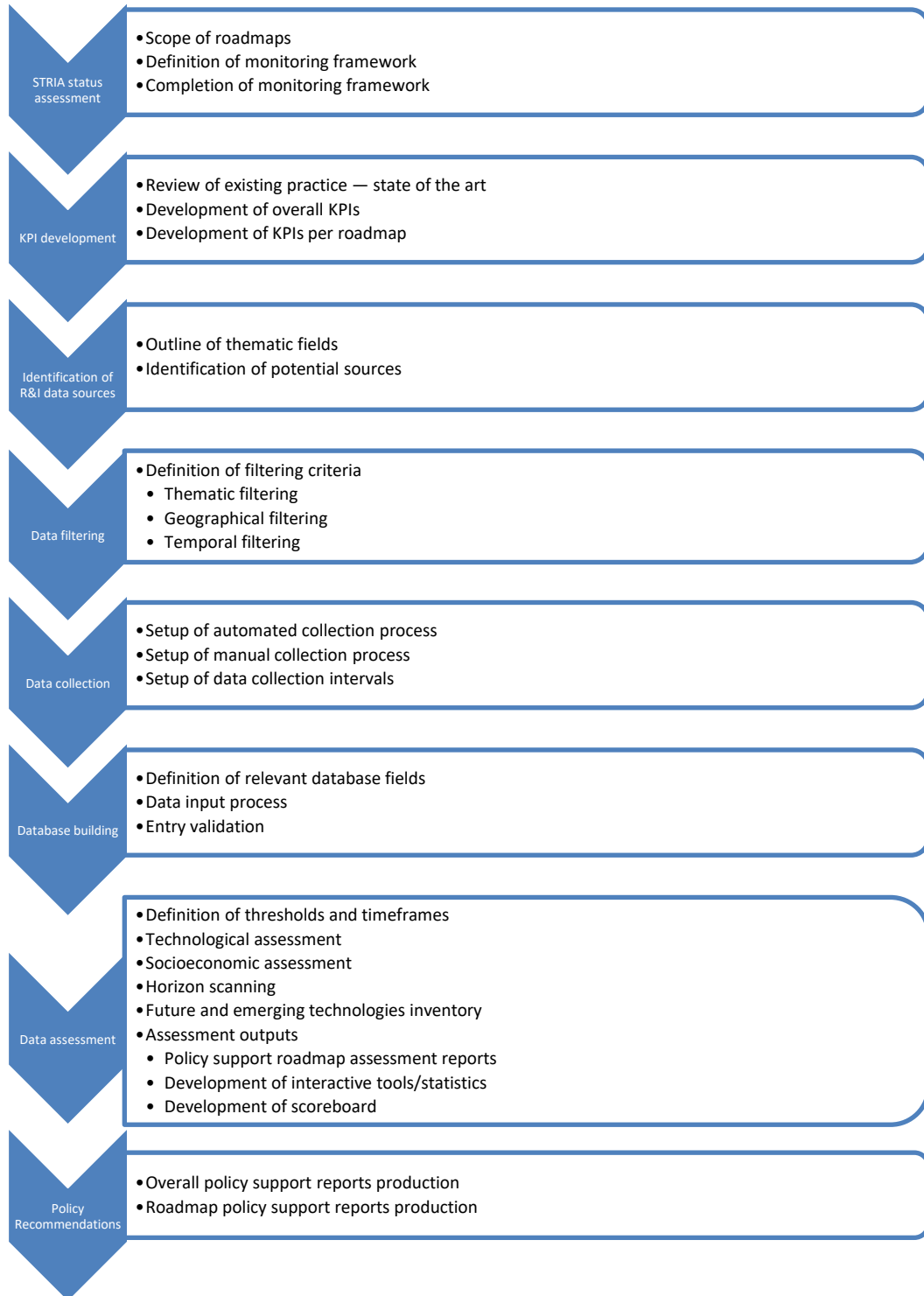
1.3. Structure of the report

The report is divided into four chapters, including this introductory chapter on the role of TRIMIS within the STRIA context. Chapter 2 presents the overall methodological framework formulated for the assessment and monitoring of the implementation and development of STRIA, Chapter 3 presents the findings of an initial overall structural and consistency evaluation of the existing STRIA roadmaps, while Chapter 4 is devoted to conclusions and planning.

2. Methodological approach

The development of TRIMIS is based on a step-by-step process. This includes the setting up of an assessment framework, the necessary input identification, collection of data and the production of policy support outputs. Figure 2 outlines the steps involved in the proposed TRIMIS methodology.

Figure 2. TRIMIS methodology



Source: JRC

2.1. STRIA status assessment

2.1.1. Context and initial findings

The STRIA roadmaps were developed by selected experts prior to the launch of TRIMIS and the creation of STRIA WG. For each roadmap, the experts highlighted challenges, objectives and actions to be implemented in the short-, medium- and long-term.

The STRIA roadmaps serve as the primary reference for TRIMIS to monitor the progress of the main transport R&I areas. Although the roadmaps provide a comprehensive insight into the ambitions for seven fields of transport R&I, they are incomplete as monitoring instruments. After evaluating the initial seven STRIA roadmaps, the following issues were identified as needing to be addressed to ensure comprehensive and efficient monitoring by TRIMIS:

- Actions were identified but no indicators.
- Indicators were identified but no actions.
- Lack of clarity regarding the problem that is addressed.
- No harmonisation between roadmaps in terms of timelines and type of actions.
- No baseline values were set for monitoring purposes.
- Indicators were set for which no sources exist that could enable monitoring efforts.
- Indicators were set that require substantial resources to enable monitoring.
- The indicators that were proposed are unbalanced in terms of the addressed thematic fields (e.g. there is a strong focus on economics but not on environmental aspects).
- Unclear who bears the responsibility for STRIA roadmap actions, making the roadmaps less actionable.

Importantly, STRIA roadmaps are subject to periodic updates, during which the STRIA WG determine which challenges, objectives and actions are still relevant. The updates can cause a major overhaul of the roadmaps and the consistency between them. This, in turn, further complicates monitoring efforts. At the same time, the updating process provides an opportunity to tackle the above issues.

TRIMIS proposes a framework to adjoin the STRIA roadmaps so that monitoring efforts can be optimised. The sections below describe in detail what elements need to be considered to create consistent and complete STRIA roadmaps. The framework is therefore instrumental in achieving the monitoring ambitions as defined in the 'Mobility Package' (European Commission, 2017b). Moreover, the framework follows the principles as set out by the 'Better Regulation Guidelines' (European Commission, 2015b) to enable better policy.

The following points can be achieved when STRIA roadmaps are updated in line with the framework:

- monitor the progress of the actions and targets set by the STRIA WGs;
- measure the effectiveness of R&I actions;
- identify duplication of R&I actions, by linking national and European projects and programmes to the actions, leading to comprehensive capacity maps; and
- identify gaps in R&I efforts.

2.1.2. Monitoring framework

Table 1 provides an overview of the key elements of the monitoring framework identified by TRIMIS. It is recommended that every STRIA roadmap, in addition to a roadmap report, includes a monitoring table that follows the structure below. Suggestions to add,

remove or alter variables can be made to improve the framework’s relevance. The next section expands on the current elements and the associated taxonomy.

Table 1. Key elements of the STRIA monitoring framework.

Section	Responsibility	Variable	Values
A Record	TRIMIS	RM_KPI_ID	Unique ID
		Record status	Active/Inactive
		Date added	Date
		Date removed	Date
B Action	STRIA WG	STRIA Roadmap	CAT/TRE/VDM/ALT/NTM/SMO/INF*
		Challenge/Problem	String
		Objective	String
		Required R&I action	String
		Thematic area	String
		Stakeholder responsible	String
		Instrument	String
		Financing required	Value
C Category	STRIA WG	Category infrastructure	Yes/No
		Category knowledge	Yes/No
		Category policy	Yes/No
		Category technology	Yes/No
D Mode of transport	STRIA WG	Road transport	Yes/No
		Rail transport	Yes/No
		Water transport	Yes/No
		Air transport	Yes/No
		Multimodal transport	Yes/No
E Spatial reference	STRIA WG	Spatial reference node	Yes/No
		Spatial reference urban	Yes/No
		Spatial reference flows	Yes/No
		Spatial reference undefined	Yes/No
F KPI	STRIA WG TRIMIS support	Indicator	String
		Type of indicator	Nominal/Ordinal/Scale
		Type of effect	Input/Output/Impact
		Unit	String
		Source	String
		Expert validation required	Yes/No
		Current value	Value
		Target 2020	Value
		Target 2025	Value
		Target 2030	Value
		Target 2035	Value
		Target 2040	Value
		Target 2050	Value
G Project	TRIMIS	Associated project 1	TRIMIS project ID
		Associated project 2	TRIMIS project ID
		Associated project n	TRIMIS project ID

*STRIA roadmaps database abbreviations. **CAT:** Cooperative, connected and automated transport; **TRE:** Transport electrification; **VDM:** Vehicle design and manufacturing; **ALT:** Low-emission alternative energy for transport; **NTM:** Network and traffic management systems; **SMO:** Smart mobility and services; **INF:** Infrastructure.

Source: JRC

(a) Record

To maintain a complete overview of the roadmap and monitoring efforts, it is important to map each individual action, even when it is no longer relevant (e.g. after a roadmap update). Therefore, each action will receive a unique record ID, date of insertion, date of omission, and it will be noted whether the action is actively monitored or not.

(b) Action

The basic elements, as defined by the STRIA WG, are the specific actions that need to be performed under each roadmap. Each action relates to a STRIA theme, a challenge, problem or objective, and a stakeholder who is responsible for the implementation of the action.

Moreover, the WG can identify the thematic area under which the action falls and the expected financing that is needed to reach the targets. Also, the instrument (e.g. a specific research fund) that is considered to execute the initiative can be indicated.

(c) Category

The proposed actions can differ in content and goals, but typically are part of a broader group of actions. The framework proposes four different categories of actions. The categories are defined as follows:

1. Infrastructure: all actions that aim to create physical or digital infrastructure, which can include IT systems, software development, control centres and deployment of sensors, etc.
2. Knowledge: all actions that aim to improve the availability of information and human skills, including training, studies, awareness-raising efforts and stakeholder forums, etc.
3. Policy: all actions that aim to change the legal framework, including amendments to national law, EU directives or regulations, standardisation efforts, and regional policies, etc.
4. Technology: all actions that aim to improve the technological and/or market readiness of an invention, including fundamental research, pilot studies and patent applications, etc.

Combined, these categories cover the actions that were found in the initial STRIA roadmaps. The categorisation enables the monitoring team to better understand the focus of each roadmap.

(d) Mode of transport

For each action, it should be indicated which transport mode is addressed. This enables the monitoring team to better understand which modes are targeted by the roadmaps. Besides the main modes of transport, also multimodal transport is included.

(e) Spatial reference

For each action the spatial focus should be indicated. It is expected that for many actions no specific spatial reference is considered. For some research actions, however, there is a strong focus on an infrastructure node, urban area or flows. An infrastructure node concerns areas like terminals, airports, and logistics areas. Urban relates to research with a focus on cities or metropolitan areas. Flows concerns research that specifically focus on transport along stretches, such as platooning or traffic management. This section allows the monitoring team to understand on which spatial level transport is researched. When assigning actions to spatial levels, it is noted that the most granulated level should be selected. For instance, if an action proposes pilot projects in 15 cities spread across the EU, this action would still be seen as urban rather than international.

(f) Key performance indicators

The KPI section presents the indicators that measure the status of the action. The indicator should be selected, the measurement unit set, and the current and target

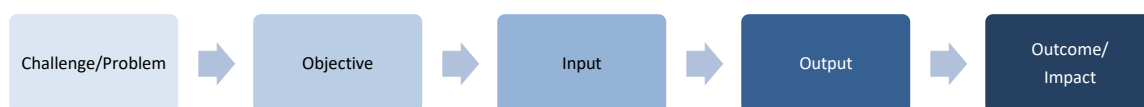
values should be defined. The target values can be defined for multiple years or a selection of them, depending on the timeframe of the action.

Importantly, a data source should be listed that can be used to monitor progress. If no adequate source is currently available, this should be stated.

The experts are also asked to indicate the type of indicator (nominal, ordinal, scale), so that the monitoring team can assess the profile of the measuring efforts — i.e. if the emphasis lays on qualitative or quantitative variables.

Equally, the experts should indicate if the indicator measures an input, output or outcome/impact. Figure 3 below shows an intervention logic and the three respective levels that can be measured.

Figure 3. Generic intervention logic of STRIA roadmaps



Source: JRC

The **input** covers everything that goes into an action, including resources and activities, such as money and staff. **Outputs** are the direct effects of the input, such as the number of publications, patent applications, sensors installed, technology level upgrade, etc. **Outcomes/impacts**, finally, are the high-level changes that the action would like to achieve. These can include improved road safety, pollution reduction and higher industry resilience, etc.

Although it is generally more difficult to measure outputs and outcomes than inputs, it is important that such indicators are included as well. This enables the monitoring team to evaluate the progress of the roadmap and to highlight where potential interventions may be needed.

(g) Project

In this section, the TRIMIS database is linked to the STRIA actions. By understanding which R&I projects and programmes are contributing to the roadmap action, it is possible to identify gaps and to highlight potential over- or under-investments. Since the TRIMIS database includes both MS and European projects, this mapping exercise can contribute to a better understanding of research efforts and policy recommendations on the distribution of resources.

2.2. Key performance indicator development and use

This step of the TRIMIS methodological approach includes the development of overall KPIs on transport R&I, as well as KPIs for each STRIA roadmap. The final list of KPIs will be used to monitor and assess the implementation of the STRIA roadmaps. For transport R&I, overall KPIs will be developed (e.g. level of investment in R&I, covering both the private and public sector, trends in patents and number of researchers active in the transport sector), together with a set of roadmap-specific KPIs intended to be used for the assessment of:

- technology status and trends;
- economic factors;
- environmental impacts;
- deployment status;
- safety and security.

2.3. Identification of research and innovation data sources

The identification of R&I data sources that contain relevant transport data is the next step in the methodology. To achieve this goal, the relevant thematic fields will be outlined as a preparatory stage; the STRIA and its seven roadmaps provide the thematic framework within which relevant data sources will be identified. After the identification is completed, the potential sources and their characteristics are registered in a database for further reference. The main categories of data sources include:

EU research and innovation databases

The EC tracks EU-funded research in publicly available and internal databases such as CORDIS, Compass, and SESAM. These databases include a spectrum of information for projects and programmes both completed and ongoing (e.g. theme, duration, partners, budget, state-of-the-art, methodology and outputs). These databases comprise the basis of data collection sources due to their credibility, volume and depth of information and the frequency of updates.

EU Member State research and innovation databases

At the national level, EU Member States keep track of funded research projects in country-specific databases. These databases may include information on projects and programmes both completed and on-going e.g. theme, duration, partners, budget, state-of-the-art, methodology and outputs. These databases serve as complementary data sources, provided that possible language and organisational barriers are solved.

International research and innovation databases

A number of countries with advanced economies worldwide show high investments in R&I activities within the field of transport and include funded projects and programmes in databases managed at the national or international level. For example, the following databases are of relevance:

With more than one million records of transportation research worldwide, the Transport Research International Documentation (TRID) is the world's largest and most comprehensive bibliographic source of transportation research information. It combines the records from Transportation Research Boards (TRB) Transportation Research Information Services (TRIS) Database and the Organisation for Economic Cooperation and Development's (OECD) Joint Transport Research Centre's International Transport Research Documentation (ITRD) Database.

The Australian Transport Index (ATRI), an extensive database of information on land transport publications.

The Japan Science and Technology Agency's (JST) J-GLOBAL database and Web portal, is a useful source for Japan R&I documentation and results, including research projects.

European patent register

The European Patent Office (EPO) is responsible for the examination of patent applications and the grant of European patents, also providing patent information to the public. Due to the application process and the time required by EPO to integrate datasets from reporting national authorities, there is a potential delay in data availability that should be taken into account within the data collection process.

National patent registries

Even though there is a tendency towards applications for European patents, national patent registries provide a complementary source of patent data to the EPO.

European statistical authority

Eurostat is the EU statistical office and its mission is to provide high quality statistics for Europe. European-level statistics enable comparisons between countries and regions,

providing support to decision-makers at EU level, in MSs, in local government and in business.

National statistical authorities

National statistical authorities can be the source of statistics at a lower spatial level. They are therefore important for national purposes in Member States whereas EU statistics are essential for decisions and evaluation at European level.

European financing bodies

Various European financing bodies, such as the European Investment Bank (EIB) are involved in strategic investments and funding of projects, promoting innovation and development at every level, in line with contemporary trends in the fields of environment, sustainability and climate change, etc. They also support investment in infrastructure projects and small- and medium-sized enterprises (SMEs), focusing on sustainable growth and supporting long-term competitiveness. Databases of financed projects and initiatives can provide useful transport research and innovation data.

National EU Member State financing bodies

National financing bodies promote scientific research integrating national research in the international scientific and research framework. Databases of financed projects and initiatives can provide useful Member State-specific transport research data.

European research entities

Major European research entities are responsible for undertaking advanced research at the European level as well as collaborating with national and international partnerships.

The JRC is the EC science and knowledge service which employs scientists to carry out research in order to provide independent scientific advice and support to EU policy. The range of work carried out at the JRC also includes the compilation of a large number of databases in addition to the development of software and modelling tools. These resources are either available to the public and to specific research groups. In addition, the JRC publishes several hundreds of scientific publications each year. In pursuing its mission to provide scientific and technical support to policy-makers, the JRC generates inventions and technologies, most of them protected by patents. Selected patents are listed on the JRC website.

There are also other examples of European research entities, such as the European Space Agency (ESA). The ESA undertakes research through programmes designed to find out more about the earth and its immediate space environment, including research and innovation on navigation systems that is relevant to the field of transport.

National research entities

Several national research entities conduct and promote research both at national and at European level and can showcase achievements in various application-oriented scientific research areas. They also engage in national and international cooperative ventures. As in the case of European research entities, they can provide useful data in the field of transport research and innovation.

European Union bodies: Research and innovation-related reporting

Apart from the JRC research projects, other EU entities (e.g. DG RTD and the European Parliamentary Research Service) undertake thematic research and reporting on topics that are of interest to TRIMIS.

National bodies: Research and innovation-related reporting

National R&I bodies co-exist with national research entities and can provide additional services which can assist in the creation of research ventures, research exploitation and the creation of start-ups. They can also provide useful transport research and innovation data focused on the local conditions.

Theme-specific associations

Theme-specific associations are formed by stakeholders sharing common interests in a specific sector. They promote specific objectives, and they reflect and communicate the role of the stakeholders in current topics. They also engage in sector-specific R&I activities. They can provide theme and sector specific reports and aggregated data.

Research public-private partnerships (PPPs)

European research PPPs, such as the Fuel cells and Hydrogen Joint Undertaking (JU) and the European Green Vehicles Initiative aim at accelerating research, development and demonstration of technologies. The PPPs can potentially serve as additional data sources of projects relevant to TRIMIS.

Industry and private sector

Industry-led research is one of the driving forces of the transport sector in terms of new technologies development and innovation. Both public and private, industry R&I can prove a useful source of relevant data and information and reveal current and future trends. Private sector R&I activity in many cases are complementary to public R&I actions, since the private sector focuses on technological applications with potential future revenues that in some cases are not covered by publicly-funded research. SMEs are also involved in transport-related research on specific innovative projects that may lead to significant applications.

Academia

Academic institutions are one of the main pylons of innovative research. Basic research is conducted among academic institutions worldwide, both individually and as part of consortia including other academic and research institutions, industry, private and public sector entities providing a cross thematic and multi-stakeholder field of collaboration. Academia can provide aggregated research data and on-demand specific data concerning past and on-going research activities, research policies, funding and implementation of projects and also reports on economic and research status and future planning. In addition, digital libraries developed by academic institutions can be a source of R&I data.

Academic and research spin-offs

Academic and research spin-offs combine university scientific knowledge production with entrepreneurship activities, in order to provide commercially available innovative products or services, through a transfer of knowledge or technology from the university to the spin-off company. This is a trend that has been in constant development since its inception, providing a promising alternative for innovation. Spin-offs can provide, on a case-by-case basis, information and data on current R&I developments.

Charitable funds

Charitable funds support R&I both through funding researchers and programmes and by creating research entities for the promotion of thematic research. The funding and project databases maintained by the funds may provide useful information on relevant R&I.

2.4. Data filtering

After the R&I data sources have been identified, a definition of the necessary filtering criteria is required for the selection of appropriate data to be collected and added to the TRIMIS database. These criteria can be divided into a series of categories, i.e. thematic, spatial, temporal and econometric.

Thematic filtering

The definition of the relevant themes is a precondition for successful data collection. TRIMIS is a policy support tool focusing on transport R&I. Sources and data are initially

filtered to ensure that they fall within the transport R&I field and are relevant to a particular thematic area.

Spatial filtering

TRIMIS is focused on the EU MSs, with the addition of the European Research Area (ERA) member countries and a number of countries with the biggest economies worldwide showing high investments in transport R&I activities.

Temporal filtering

A temporal framework is selected, and data falling within the specified framework are filtered as potentially selectable. The temporal filtering will be applied in order to ensure the inclusion of up-to-date data and information and the exclusion of data and information that are outdated or currently have low impact in the field of transport R&I.

2.5. Relevant data collection

After the necessary filtering, data and information are collected and stored in the TRIMIS database. Data collection can be partly automated and partly manual. In cases where an automated collection procedure is technically feasible, the necessary processes are set up digitally, whereas for cases where an automated process is not technically feasible, a manual process is applied.

Set-up of automated collection process

An automated collection process will be set up, linking other existing repositories with content falling into the TRIMIS scientific framework and STRIA roadmaps. Provisions to avoid duplicate or obsolete entries will also be ensured.

Set-up of manual collection process

Apart from the automated data collection process, data will be collected manually from registered TRIMIS users and through specific research by the TRIMIS development team.

Set-up of data collection intervals

The successful application of TRIMIS will require a database that is updated on a regular basis. Specifically, automated data collection intervals will be set in accordance with the update intervals of other databases. For manually inserted data, the assessment will occur at set intervals after review by the TRIMIS development team. Additionally, the TRIMIS development team will insert data manually based on a regular scanning of the relevant publicly available information.

2.6. Database building

The main aim of TRIMIS is the provision of monitoring and information along with an assessment of transport R&I data. TRIMIS currently includes two distinct transport R&I databases, one concerning programmes and one concerning projects. In both databases, for each data record, a series of database fields is required in order to ensure the availability of information to the end-users and the transport R&I assessment based on set KPIs that will lead to the final scoreboards and visual tools production.

Definition of relevant database fields

All relevant database fields are defined to suit programme and project characteristics respectively and to ensure completeness of the available information of each record. Data stored in the databases will be used towards the goal of R&I monitoring and assessment.

Data input process

After the data collection process is completed, data will be stored in one of the databases according to their category, i.e. programme or project.

Entry validation

In order to ensure data accuracy and avoid incomplete or erroneous entries and repetition, a review and validation process will take place for all new database inputs obtained through automatic or manual data collection processes.

2.7. Data assessment

Data assessment is one of the main TRIMIS methodological steps allowing the preparation of the final policy support outputs.

2.7.1. Analysis goals

This activity will involve undertaking an analysis of the developments of transport R&I based on the data included in the TRIMIS framework. The information obtained in the database will be used to assess impacts, model changes on the transport system, identify technology trends and support the prioritisation and monitoring of STRIA. During this step, all the preparatory work concerning data and their assessment prerequisites are already completed. The available data undergo their final assessment under the scope of the seven STRIA roadmaps objectives using a set of relevant KPIs developed at the previous step. Data that will be assessed will be gathered from the TRIMIS projects database and other potentially relevant sources already identified during the previous steps.

2.7.1.1. Roadmap objectives

The STRIA currently comprises seven distinct roadmaps. From each roadmap a set of objectives can be identified. Each objective can be accompanied by a set of KPIs, thresholds and timeframes. In case one or more of those characteristics is missing, it will be developed in order to support the assessment process.

2.7.1.2. Key performance indicators

The qualitative aspects of the STRIA objectives must be quantified in order to be assessed. For each of the seven roadmaps and STRIA as a whole, a set of relevant KPIs will be developed to be used during the data assessment process, as described in section 2.2. The existing literature provides a wide selection of relevant KPIs that can be complemented with KPIs specifically developed for STRIA and TRIMIS.

2.7.1.3. Thresholds and timeframes

The development of KPIs will support the quantification of the roadmap objectives, but the assessment process will also require the identification of appropriate thresholds and timeframes that will define the scale and temporal dimension of the assessment. Figure 4 presents the data assessment framework under the scope of the STRIA roadmaps objectives.

2.7.2. Assessment process

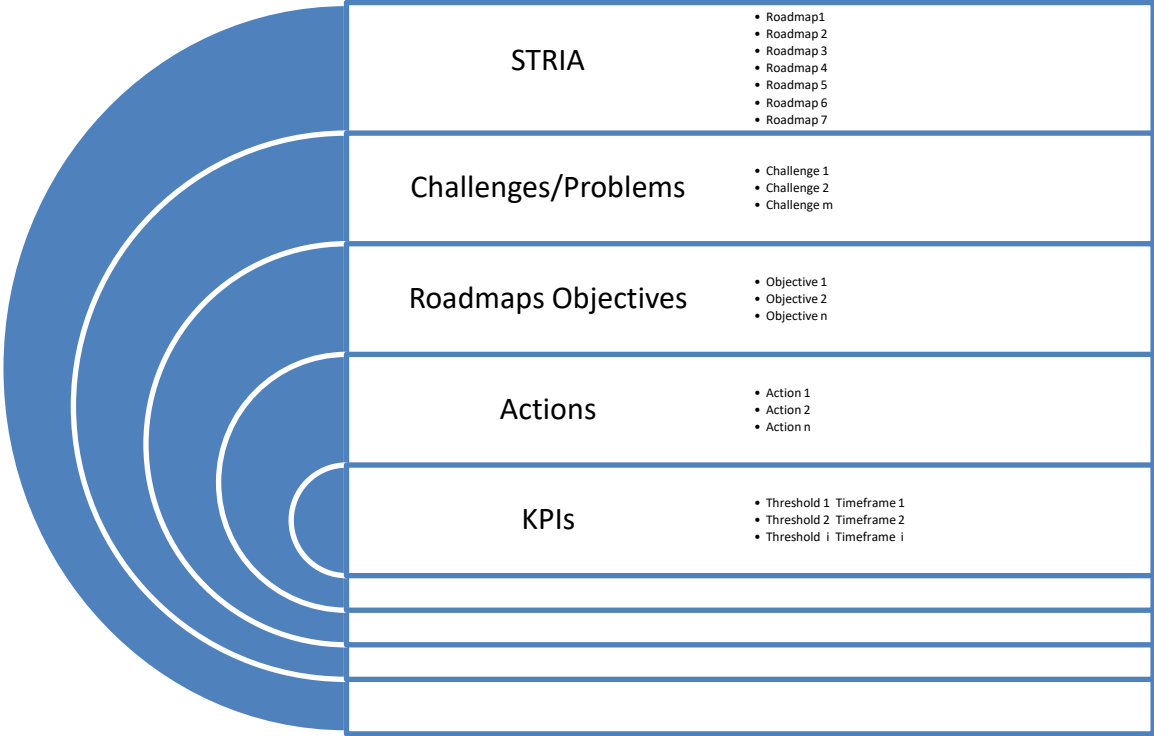
The data assessment process covers two dimensions that will lead to the necessary policy support output, namely the technological and socio-economic assessment. The technological assessment will focus on the technical aspects of the data available while the socio-economic assessment will focus on the social and economic impacts and their influence on the relevant R&I capacities of the transport sector.

2.7.2.1. Technological assessment

The technological assessment is one of the main features of the roadmap assessment process. To this end, all transport R&I data provided by the previous steps will be assessed based on the technological KPIs developed. The assessment will present the status and trends of the various technologies falling under each of the seven STRIA

roadmaps and will provide feeds to the horizon scanning process framework and the inventory of new and emerging technologies and trends (NETT) in transport.

Figure 4. Data assessment framework under the scope of the STRIA roadmaps objectives



Source: JRC

2.7.2.2. Socio-economic assessment

The aim of this activity is to provide an estimate and monitor the private and public R&I investments in the transport sector and monitor financial and human resources as well as socio-economic aspects, if possible based on data collected both at MS and EU level.

2.7.2.3. Horizon scanning process framework

This activity will involve developing a methodology to allow the systematic scanning of transport R&I developments. It will examine methods used by similar initiatives (e.g. SETIS). The methodology will outline a list of key sources of information, searchable keywords, type of projects/news/information (e.g. EU/MS funded projects, opportunities for funding, new technologies) to be included in the database and a timetable of how often actions will be undertaken. This information will be included in an appropriate methodological guide.

2.7.2.4. New and emerging technology and trends inventory

A NETT inventory involves developing and maintaining an inventory of new and emerging transport technologies and trends taking into consideration the approaches adopted by similar projects (e.g. Low Carbon Energy Observatory and Future Emerging Technologies).

The inventory will be also reviewed by stakeholders (e.g. R&I community, academia and industry). Based on the feedback received, the inventory will be potentially revised, and will provide an accurate snapshot of transport R&I.

2.7.3. Policy support output

For the assessment of the outputs, scoreboards will be developed that will visually present the outcomes of the TRIMIS database. Additionally, a set of interactive tools will be developed and integrated in order to assist the output assessment and monitoring of transport R&I. The application of the scoreboards will be defined taking also into account existing scoreboards such as the DG MOVE EU transport scoreboard and the DG RTD innovation scoreboard as well as the Research and Innovation Observatory.

2.7.3.1. Policy support roadmap assessment reports

A series of roadmap assessment reports will be produced based on the data analysis, providing policy support to all stakeholders involved in the development and implementation of STRIA. Three types of reports can be identified:

- STRIA status assessment reports.
- Roadmap-specific assessment reports, updated if necessary.
- Overall STRIA roadmaps assessment reports, assessing the overall performance of STRIA based on the set targets.

2.7.3.2. Interactive tools/statistics

The data analysis will provide the necessary information and input feed for interactive tools and statistics visualisations that will be found online at the TRIMIS official portal.

2.7.3.3. Scoreboard

Finally, a TRIMIS Transport R&I Scoreboard will be developed based on the data analysis step measuring the implementation and development of STRIA and its roadmaps.

2.8. Policy recommendations

The final step of the methodology includes the provision of transport policy recommendations relevant to STRIA. The final recommendations will cover two main areas:

Capacity maps and technology assessment:

- Support the EC policy Directorates-General (DG) by defining research and funding priorities, based on innovation cycle information and potential impacts of technologies.
- Define the socio-economic impacts of transport innovation.
- Map the economic structure of transport innovation in Europe and beyond.
- Highlight the pace and direction of transport innovation, including its impacts on safe, clean, and connected transport.
- Evaluate the competitive position of transport R&I in Europe and in each MS vis-à-vis the rest of the world.

STRIA roadmap monitoring:

- Track implementation progress of STRIA roadmaps, including the identification of lagging aspects.
- Suggest actions to ensure STRIA roadmap implementation by the set deadlines.
- Compare the respective development of STRIA roadmaps.
- Assist policy DGs with (re)prioritising STRIA roadmaps implementation and further development.

3. Conclusions

This report outlines the STRIA monitoring and assessment framework, which involves the following key elements:

- STRIA status assessment.
- KPI development and use.
- Identification of R&I data sources.
- Data filtering.
- Relevant data collection.
- Database building.
- Data assessment.
- Policy recommendations.

Applying the framework when updating the STRIA roadmaps will ensure that all roadmaps are equal in terms of structure, completeness, and policy relevance.

The need for a monitoring and assessment framework became clear after an initial evaluation of the existing roadmaps. A range of issues emerged, showing that TRIMIS was limited in its ability to monitor and assess transport R&I and the progress of STRIA. These issues include omissions, inconsistencies and the lack of harmonisation between roadmaps.

This report therefore contributes towards the redevelopment of the STRIA roadmaps, which in turn improves the analytical capabilities of TRIMIS and the policy relevance of STRIA.

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List of abbreviations and definitions

ATRI	Australian Transport Index
CORDIS	Community Research and Development Information Service
DG MOVE	Directorate-General for Mobility and Transport
DG RTD	Directorate-General for Research and Innovation
EC	European Commission
EIB	European Investment Bank
EPO	European Patent Office
ESA	European Space Agency
EU	European Union
FETT	Future and emerging transport technologies
ITRD	International Transport Research Documentation
JRC	Joint Research Centre
JST	Japan Science and Technology Agency
JU	Joint Undertaking
KPI	Key performance indicator
NETT	New and emerging technologies and trends
OECD	Organisation for Economic Co-operation and Development
PPP	Public-private partnerships
R&I	Research and innovation
SESAM	SED, ESS, ARI, MCA requirements implementation project
SETIS	Strategic Energy Technologies Information System
SME	Small- and medium-sized enterprises
STRIA	Strategic Transport Research and Innovation Agenda
TRB	Transportation Research Board
TRID	Transport Research International Documentation
TRIMIS	Transport Research and Innovation Monitoring and Information System
TRIS	Transportation Research Information Services
WG	Working group

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Publications Office

doi:10.2760/788905

ISBN 978-92-79-92583-2