# Final Publishable Summary Report

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[2] The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

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## Executive Summary

The Innovation Union flagship initiative and Digital Agenda for Europe underlines the need for a strategic approach to innovation. The Commission's proposal for Horizon 2020 highlights smart, green and integrated transport as one of the six major societal challenges where European research and innovation can make a real difference. The Commission proposes a range of initiatives to implement the necessary actions. They will contribute to fulfilling the policy objectives and help meet the Transport challenge in Horizon 2020:

- **Making transport research and innovation more focused**
- **Better aligning efforts**
- **Beyond the comfort zone: breaking through technology lock-in**
- **Efficient deployment of innovative solutions**

Undoubtedly, innovation is a major driver in new growth models, which aims to increase productivity and raise living standards. Regions are key actors in this context, but their role in innovation is complex. Regions cannot simply replicate national policies. An important stakeholder of the innovation chain is SMEs who currently employ 55% of the EU workforce in transport, and their important role in the value chain is expected to expand.

METRIC, recognising the importance of regional innovation and the role of SMEs, address's the Horizon 2020 challenges, by suggesting a set of recommendations for strengthening the role of transport research and innovation at regional level. The project explores the transport innovation potential and capacity of NUTS 2 regions as well as the development of innovation roadmaps based on the comparative and competitive advantages of the regions.

METRIC maps the regional transport innovation capacity and identifies the competitive advantage of identified regions. Based on their strengths, guidelines for the preparation of regional innovation roadmaps (strategy plans) were also developed. METRIC bases its operating principles in three main blocks of activities:

**i) Mapping of the transport research and innovation activities**

**ii) Exploring the performance of the regional innovation frameworks and**

**iii) Analysing the main principles and typology for regional innovation**.

The project delivers a set of recommendations on innovative strategies for regions along with a set of innovation roadmaps based on best practices. The Smart Specialization Platform (S3P) approach has been used for the roadmaps, though a transport sector specific S3P strategy will also be also put forward. It is anticipated that this could be used as an instrument to support Structural Fund investments in R&I contributing to the development of the Cohesion Policy. The figure below illustrates the interrelation among METRIC project objectives:

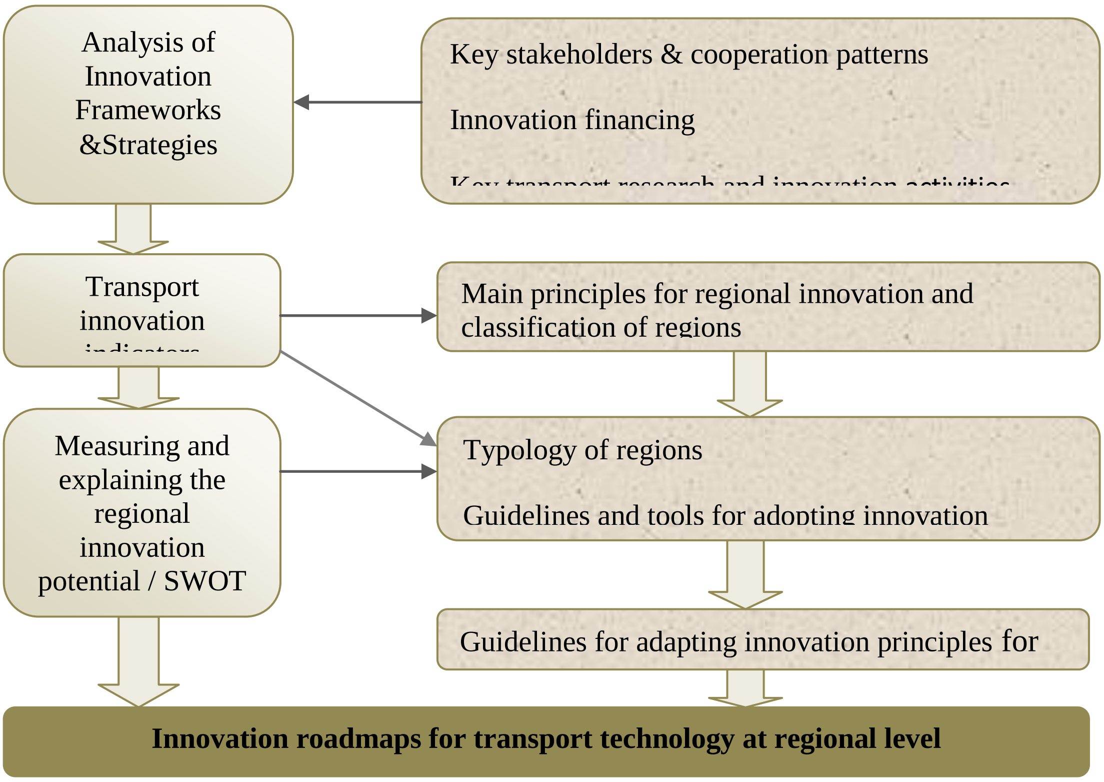



**Figure 1 Main Concept of METRIC**

## Project context and objectives

The main aim METRIC is to map the regional capacities in transport and innovation in order to provide recommendations on how to strengthen transport research at a regional level. The specific objectives are:

- To analyse innovation frameworks and the existing regional strategies for transport research
- To identify the main stakeholders involved in the innovation chain along with their cooperation patterns within the region but also with other regions
- To study the key transport research and innovation activities and their impact on regional competitiveness
- To map regional advantages in terms of distinct specialisation and areas of excellence and investigate the regions' strengths, weaknesses, opportunities, threats along with the drivers and barriers to innovation
- To build a typology of regional innovation and classification of regions
- To develop tools for adapting success factors for innovation
- To derive recommendations for enhancing the role of regional transport research and innovation
- To deliver a set of quantitative and qualitative indicators which can be used to measure regional transport research and innovation performance
- To develop innovation roadmaps based on the best practices

# Main Results

**Analysis of Innovation Frameworks &Strategies**

During the lifespan of METRIC different types of innovations, innovation classifications and innovation activities have been elaborated. Particular attention has been given to national and regional innovation systems concepts, governance and relevant policy issues. We have looked at the rationale for regional innovation policies, and have also analysed regional innovation policy implications. As part of the analysis of innovation frameworks and strategies we have described general indicators that have been used in several reports which measure innovation activities. This activity was the basis of the METRIC project, and was essential that an effective method of assessment was implemented as the results were used throughout the successive activities undertaken in the project.

The mapping process collected a ‘significant amount’ of useful indicators and indexes relating to European regions (quantitative data), as well as relevant policies, initiatives, strategies, clusters, actors, etc (qualitative data). These sets of quantitative data are mainly downloaded from Eurostat and Cluster Observatory websites. Due to the complexity of the data and these databases, all these sets were processed such that the data could be interpreted at a regional level and consequently included in the METRIC database.

By far the most information was available about innovative milieus and regional innovation systems for the automotive sector. Scientists have more attention to the transport sector rather than aerospace and transport and logistics sector. Additionally, there is more attention to technical innovations than non-technical innovations. This is probably why scientists focus more on the automotive and aerospace sectors, rather than the transport and logistics sector where, by in large, most innovations are non-technical. An in-depth analysis was completed to determine the characteristics of the transport sector, these were;

| | | |
|---|---|---|
| Automotive | Aerospace | Rail |
| Waterborne | Cross-modal | Transport Infrastructure |
| Intelligent Transport Systems | Logistics | |

Each of the analysed regions were different in terms of their respective characteristics of these aforementioned transport sub-sectors the analyses of the regions focused on, but not limited to, current investment strategies, policy implementation, availability of funding, infrastructure and recognised R&D activity at public and private levels.

The analysis demonstrated that the transport sector is not a homogenous sector, it consists of highly technical sub-sectors such as automotive and aerospace manufacturing and non-technical sub-sectors - principally the transport service providers (freight and public transport) and they all have different innovation systems. Based on the analysis of regional innovation milieu in 23 regions in 18 European countries it can be concluded that research on the regional innovation milieu and/or regional innovation systems is predominantly focused on the automotive sector and to a lesser extent to the aerospace sector. Cluster policies are often used to strengthen the competitiveness and innovation capacity of regions. Clusters were found predominantly in the automotive industry, but also in the aerospace, shipbuilding and rail industries. In the automotive and aerospace sectors these clusters are often organised around the value chain in the sector.

Further analysis was completed on a selection of programmes and research strategies identified from research work. We elaborated on relevant research and innovation strategies as well as regional operational programmes, approved by the European Commission. The transport related priorities in these strategies and programmes were identified and compared. This allowed the project to determine what type of innovation(s) is focussed upon in the transport sector, and how this varies across European regions. From this we were able to determine that there is significant difference in importance given to transport research in R&I Strategies of European regions and to transport and its aspects in Regional Operational Programmes.

The analysis provides a general description of research and innovation funding systems in EU28 and 4 selected associated countries (Iceland, Norway, Serbia and Switzerland). Particular attention is given to transport research and innovation activities in each analysed country, the framework for analysis of every country follows the same structure to allow ease of comparisons between countries.

We were able to conclude that there is a wealth of research into transport, within both the national research programmes in the majority of the 32 countries and in European Commission's Framework Programme. The analysis and findings of the 32 countries was presented in detail in the reports developed, this can be used by policymakers and researches to further understand the details of regional variations and specific approaches used. The reports also provide a sustainability assessment of transport research and innovation strategies and programmes. Key transport-specific research funding criteria for benchmarking transport research and innovation strategies and programmes have been suggested. We have also proposed 'guidelines' for developing and managing transport research and innovation programmes which could be adopted at regional level.

However, it is clearly evident that better data are needed in order to achieve a detailed study of how transport related research and innovation programmes are coordinated and how they could be interlinked across Europe at national and/or regional levels.

**Transport Indicators**

Understanding the sources and patterns of innovative activity is fundamental to developing and implementing appropriate policies. This can only be achieved by maximising the use of facts and figures that are available to achieve a view of the transport sector. In view of EU-wide studies on measuring innovation performance there are two major tools that have been developed. The first tool is the Innovation Union Scoreboard (UIS) which provides a comparable assessment of the innovation performance at the country level of the EU member states and other European countries. The second tool is the Regional Innovation Scoreboard (RIS) which is a regional extension of the Innovation Union Scoreboard.

The UIS uses a wide variety of indicators to measure innovation performance. It distinguishes between 3 main types of indicators – Enablers, Firm activities and Outputs. Within these main categories 8 innovation dimensions are defined and these dimensions are captured by 25 indicators (see figure 2).

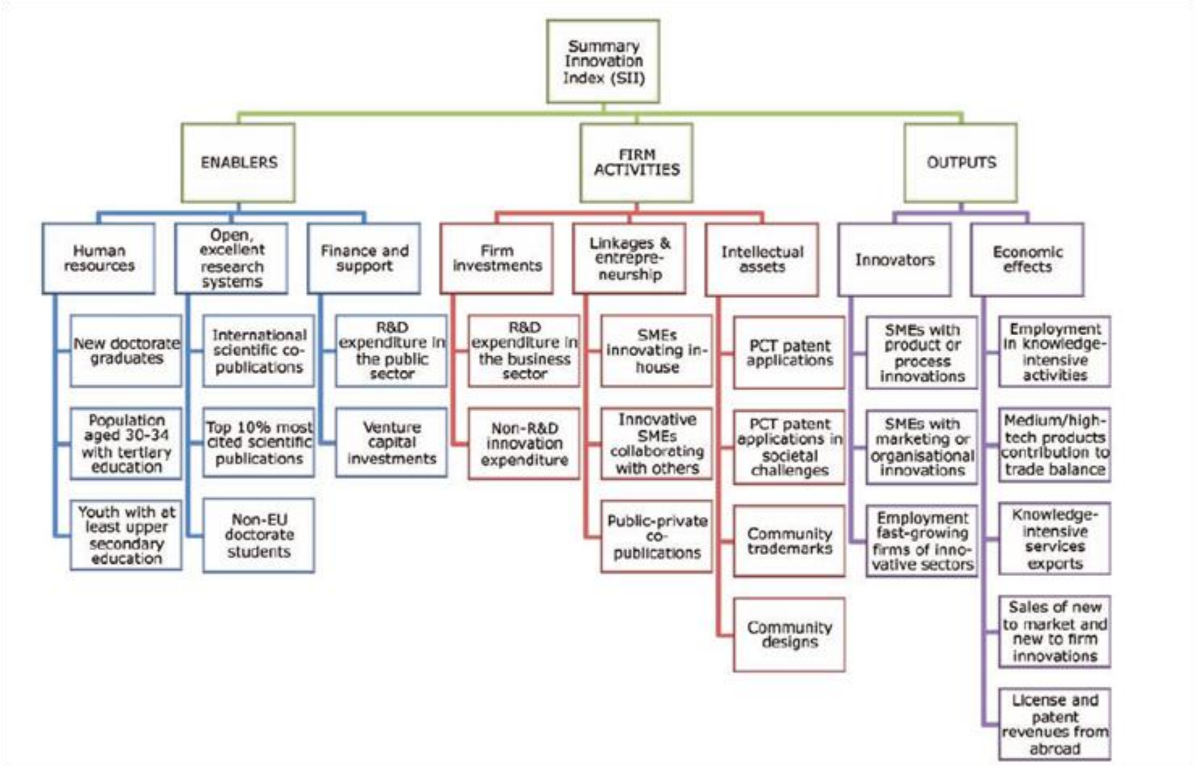



**Figure 2** **25 Indicators of Innovation Union Scoreboard**

As part of the analysis we wanted to measure regional transport innovation performance using the same indicators that are used in the Regional Innovation Scoreboard. However, the limited availability of regional level data was more problematic especially when regional data needs to be collected at sectoral level specifically in the transport sector. For several RIS indicators the data are not available at the transport sector level whereas data regarding relevant indicators to measure transport innovation performance are only available at country level. Consequently, data at regional level the RIS database includes 11 indicators (covering 4 years), while the UIS has 25 indicators. In view of these limitations it is proposed to adapt the RIS measurement framework into a framework that might be more appropriate to realizing the goals of the METRIC project as depicted in the framework below.

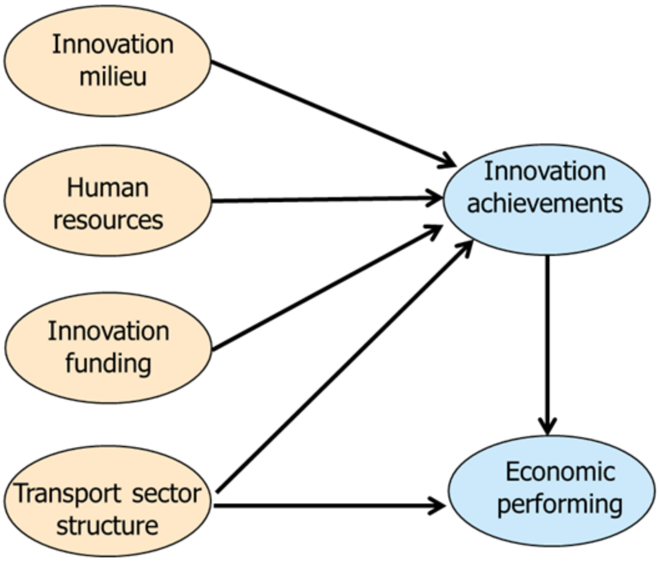



**Figure 3** **Proposed METRIC Framework**

The indicators that we proposed to operationalise were 'Innovation achievements', 'Economic performing', 'Transport sector structure', 'Innovation funding', Innovation milieu' and 'Human resources'. The selection of the indicators are briefly explained;

**INNOVATION ACHIEVEMENTS**

A major element in capturing the output of innovation activities is the generation of an *innovation,* defined as '*the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations'* (OECD, 2005).

An indication of the potential commercial value of innovations can be obtained from patents. Companies that patent their innovative ideas usually have high expectations about possible sales and profits from a new product. The introduction of a new product in the market seems, however, harder to evidence for successful innovation activities than the disposal of a patent. The following indicators can be proposed:

1. Enterprises that developed product innovations
2. Enterprises that developed service innovations
3. Enterprises that introduced process innovations
4. Enterprises that introduced organizational innovations
5. Enterprises that introduced marketing innovations
6. Patent counts
7. Enterprises that have introduced new or significantly improved products that were new to the market
8. Enterprises that have introduced new or significantly improved products that were only new to the firm

In terms of application of the indicators within the SEM-model a bipartition method will be used for indicators 1-5 in order to reduce them to 1 or two indicators. This is principally because product and process innovations are usually associated with technological innovations, while the others are considered as non-technological forms of innovation.

ECONOMIC PERFORMING

In developing indicators for 'economic performing' two types of indicators were distinguished:

1. General indicators that express the economic impact of innovation achievements in general terms;
2. Specific indicators that express the economic impact of innovation achievements explicitly.

There are also indicators defined to capture the economic success of innovations (see table 1 below). These indicators can be qualified as, what we defined as specific indicators, because they are, more or less, directly related to innovation performances. A major problem of these indicators is availability of regional data for these indicators, data is largely unavailable, either due to data not being collected at the regional level or because they are not collected at all.

| **Innovation Union Scoreboard (UIS)** | **Regional Innovation Scoreboard (RIS)** |
| --- | --- |
| ***Measurement in 2012*** | |

| | |
|---|---|
| 1. Employment in knowledge-intensive activities (manufacturing and service) as % of total employment | Employment in knowledge-intensive services as % of total employment<br>Employment in medium-high and high-tech manufacturing as % of total workforce |
| 2. Medium and high-tech product exports as % total product exports | Regional data not available |
| 3. Knowledge-intensive services exports as % total service export | Regional data not available |
| 4. Sales of new to market and new to firm innovations as % of turnover | |
| 5. License and patent revenues from abroad as % of GDP | Regional data not available |
| ***Measurement in 2014*** | |
| 1. Employment in knowledge-intensive activities (manufacturing and service) as % of total employment | Employment in medium-high and high-tech manufacturing and knowledge-intensive services as % of total workforce |
| 2. Contribution of medium-high and high-tech product exports to the trade balance | Regional data not available |
| 3. Knowledge-intensive services exports as % total service exports | Regional data not available |
| 4. Sales of new to market and new to firm innovations as % of turnover | Similar (only for SMEs) |
| 5. License and patent revenues from abroad as % of GDP | Regional data not available |

**Table 1Indicators in UIS and RIS to measure economic effects of innovation, 2012/2014**

General indicators are key economic indicators (e.g. added value, employment, productivity, export) to express the economic performance of the transport sector in a region. Since innovations are intended to contribute to growth in added value, employment, productivity and export it is justifiable to include these indicators as proxy for measuring economic effects. In view of this the proposed indicators for measuring the economic effects of innovation achievements are predominantly general indicators, except for indicator ‘Firm’s turnover from innovations’. The following indicators are proposed:

1. Growth in gross value added (GVA) in the transport sector
2. Growth in employment in the transport sector
3. Growth in labour productivity in the transport sector
4. Growth in export of the transport manufacturing industry
5. Firms’ turnover from innovations (as % of total turnover)

<u>TRANSPORT SECTOR STRUCTURE</u>

The transport sector in a region can be described through various characteristics that collectively lead to a regional transport sector profile. Regional variations in the transport sector profile may explain differences in the innovation capacity and innovation performance. The following indicators can be proposed:

1. Number of SMEs in the transport sector
2. Share of services in transport sector activity
3. Number of fast growing companies
4. Business demography: new start-ups

## INNOVATION FUNDING

The availability of funding is a major enabler to start and develop innovation activities. Funds can be acquired from both inside or outside the company, where finance from outside the company can include finance from private and public sources. The results from CIS 2010 shows that 22% of all companies (across all economic sectors, both innovating and non-innovating companies) have a lack of finance from outside the company and was highlighted as an important factor that could hamper innovation activities. R&D expenditures are a measure for R&D capacity in a region and R&D capacity influences regional innovation potential. The category of 'public R&D expenditures' a funding source that can be highlighted (and is of particular interest for EU R&D policies) are the EU funds expenditures in the Framework Programme for Research and Technological Development (FP). The rationale for such an indicator is that organisations compete for funding based on criteria of excellence. For this reason, organisations that are successful in attracting FP funds are usually considered as innovation. The following indicators can be proposed:

1. Firms that receive public subsidies to innovate
2. Public R&D expenditures
3. Business R&D expenditures
4. FP funding:
    a. the total amount of subsidies received
    b. the leverage
    c. the number of participations from the private sector
    d. percentage of SME participation in private sector

## INNOVATION MILIEU

An innovative milieu has been interpreted as an incubator of innovations and innovative companies within a given region. The approach of an innovation milieu assumes that opportunities for innovation are strongly influenced by the spatial environment and focuses on external conditions within the region. The key elements of the concept of an innovative milieu include: cooperation information exchange between regional actors, repeated face-to-face contacts, engagement of actors from different branches of economy (companies, universities, local authorities etc.), the awareness of actors belonging to a coherent unity and regional culture. It is challenging to measure these elements. To overcome this difficulty we can include indicators that can be considered as proxy-variables for the above mentioned elements of the innovative milieu.

## HUMAN RESOURCES

Knowledge workers are increasingly important for the economy. Therefore the educational level of the labour force provides an indication of the regional strength regarding the availability and quality of human resources. The following indicators can be proposed:

1. Number of highly educated persons employed in the transport sector
2. Number of persons working in a Science and Technology occupation in the transport sector
3. Employment in technology and knowledge-intensive sectors within the transport sector
4. Education level of the total labour force

This gross list of indicators was used as input indicators for the structural equation model (SEM model) to obtain scores for regions on their transport innovation performance allowing comparison of regional scores. Therefore the following indicators can be proposed:

1. Level of transport specialisation
2. Cluster quality
3. Urbanisation index

This gross list of indicators has enabled METRIC to describe, measure and explain transport innovation performance of regions (at NUTS 2 level). This regionalisation of data, multiple indicators could be developed for each of the main factors we defined to describe and measure transport innovation performance and its explanatory factors. The limited availability of regional data regarding the transport sector has put restrictions on the type of indicators that could be constructed. Consequently, the data of some indicators that were considered of key relevance had to be transformed, mostly from country to NUTS 2 level.

**Measuring & Explaining Regional Innovation Potential**

As previously indicated the data sources for the analysis were:

- Eurostat.
- Joint Research Centre of the European Commission.
- Cluster observatory.

The data was collected at NUTS 2 level for the transport sector. This sector was divided in two subsectors:

- The manufacturing subsector sector: manufacture of motor vehicles, trailers and semi-trailers (NACE 34, C29) and manufacture of other transport equipment (NACE 35, C30).
- The transport service subsector: transport and storage (H), land transportation and transport via pipelines ((NACE 60, H49), water transport (H50), air transport (H51), warehousing and support activities for transportation, postal and courier activities (H52, H53)

As previously mentioned, not all data are available at the NUTS 2 level, this particularly applied to Community Innovation Survey (CIS) data from Eurostat, which were only available at the national level. To regionalize the CIS data a regionalization technique, proposed in the Regionalization Innovation Scoreboard 2014, was used. This technique uses country and regional level data on employment and number of firms at 2-digit industry level. This regionalisation technique calculates, for each country, the regional distribution of firms with a particular innovation characteristic.

However, for the SEM analysis it is necessary to know the share of firms with a particular innovation characteristic at the NUTS 2 level. For this, an additional step had to be added to the CIS "regionalization" technique: dividing the number of firms in the region with a particular innovation characteristic by the total number of firms in the region. During the course of this approach it was observed that several missing values (regional level). As the SEM analysis is vulnerable to missing values and missing numbers make it impossible to calculate innovation scores. At first various imputation techniques were used. Which imputation technique was used depends on the level of data availability in the previous and/or following year. In most cases the following imputation techniques were applied (in the order as below):

- If the regional data for the previous and the following year were available, the average of both years was imputed.
- If no previous or following year was available, the closest year was imputed corrected with the ratio between the NUTS 2 level and that at the higher aggregate NUTS 1 level.
- If no data at the NUTS 2 level were available, data on the NUTS 1, or even the country level were imputed.

A database was built containing 284 NUTS 2 regions, after checking for missing values we decided to remove 33 regions from the database because these regions had too many missing values Overall, 251 NUTS2 regions remained for the analysis, a significant number to allow for the activities in the project. These regions were:

- All NUTS 2 regions in Greece (13), Switzerland (7), Croatia (2) and Ireland (2).
- Some countries with one NUTS 2 region: Cyprus,  Iceland, Luxembourg and Malta.
- Some small NUTS 2 regions in other countries:
    - Portugal: Região Autónoma dos Açores (PT20) and Região Autónoma da Madeira (PT30)
    - Spain: Ciudad Autónoma de Ceuta (ES63) and Ciudad Autónoma de Melilla (ES64)
    - Finland: Åland (FI20).

The indicators that were used in the analysis are displayed in the below table. Most of the indicators are divided into indicators for the transport sector as a whole, the manufacturing subsector and the services subsector.

| | | Available for: | | |
|---|---|---|---|---|
| No. | | Transport sector as a whole | Manufac-turing subsector | Services subsector |
| 1A | Share of innovative enterprises 2010 | yes | yes | yes |
| 1B | Share of highly innovative enterprises 2010 | yes | yes | yes |
| 16 | Average number of patents per year (2006-2008) per 100.000 employees (2008) | yes | yes | no |
| 17 | Share of enterprises that have introduced new or significant improved products that were new to the market (2010) | yes | yes | yes |
| 18 | Share of enterprises that have introduced new or significant improved products that were only new to the firm (2010) | yes | yes | yes |
| 21 | Growth (%) value added  transport sector 2008-2011 | yes | yes | yes |
| 22 | Growth (%) employment transport sector 2008-2011 | yes | yes | yes |
| 23 | Growth (%) labour productivity  transport sector 2008-2011 | yes | yes | yes |
| 25 | Share of turnover form innovations 2010 | yes | yes | yes |
| 31 | Average firm size 2010 | yes | yes | yes |
| 32S | Share transport services employment in transport employment 2008 | yes | yes | yes |
| 32M | Share transport manufacturing employment in transport employment 2008 | yes | yes | yes |
| 41 | Share of product and/or process innovative enterprises that received any public funding 2008 | yes | yes | yes |
| 42 | Public R&D as share of GDP 2008 | yes | yes | yes |
| 43 | Business R&D as share of GDP 2008 | yes | yes | yes |
| 44 | Transport research as share of total FP7 EC funding | no | no | no |
| 45 | Share of government R&D spending on transport 2008 | yes | no | no |
| 51 | Level of transport specialisation 2008 | yes | yes | yes |

| | | | | |
|---|---|---|---|---|
| 52 | Cluster quality 2008 | yes | yes | yes |
| 53 | Population density 2008 | yes | yes | yes |
| 54 | Share of product and/or process innovative enterprises engaged in any type of co-operation 2008 | yes | yes | yes |
| 61 | Share of high educated persons in total transport employment 2008 | yes* | yes* | yes |
| 62 | Share of persons employed in science and technology in total transport employment 2008 | yes* | yes* | yes |
| 63S | Share of employment in technology and knowledge-intensive sectors in transport services 2008 (NACE H and N79) | no | yes | yes |
| 64 | Share of population who have successfully completed university of university-like education 2008 | no | no | no |

*Manufacturing employment covers all manufacturing sectors.

**Table 2 Number and name of indicator used in the SEM analysis**

This model consists of a system of causal relationships between variables specifying direct effects and an indirect effect together, combined with the fact that these factors are not directly measurable but need to be ‘measured’ via indicators of these factors for which data are available justifies the use of a Structural Equation Modelling (SEM) approach. Considering the quality of data and the aspiration to have multidimensionality in the measurement of factors gave rise to adjust the initial model. In order to keep sufficient richness in the measurement of ‘Transport sector structure’ alternative indicators were considered and the indicator ‘Level of transport specialization’ was added to the factor ‘Transport sector structure’. However, it should be noted that the indicator ‘level of transport specialization’ does not represent the internal structure of the transport sector, but rather the role of the transport sector in the total economic structure of a region.

Similar issues appeared regarding the factor ‘Human resources’, as this indicator is closely related to innovation milieu or even considered as a key aspect of innovation milieu, it was decided to remove the factor ‘Human resources’ as an individual entity, but it’s indicators were included in the factor ‘Innovation milieu’.

Consequently, the structural model used for the SEM-analysis was limited to three explanatory (or exogenous) factors, i.e. Innovation Funding, Innovation Milieu and Transport Sector Structure, and two factors to be explained (endogenous factors), i.e. Innovation Achievements and Economic Performing (see figure below).

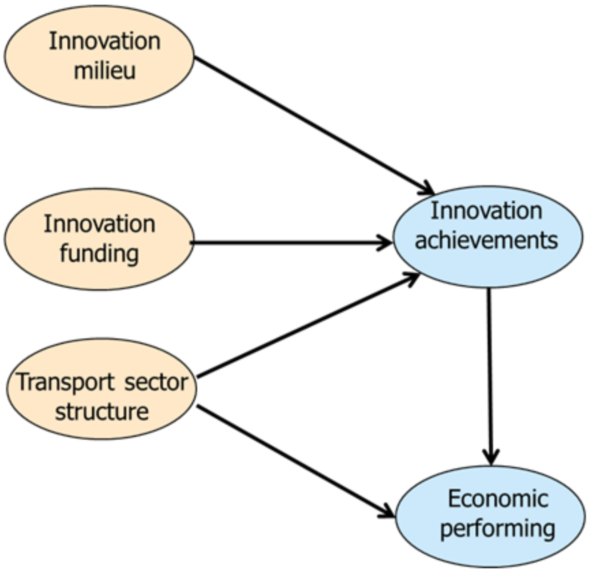



**Figure 4** **Refined Framework to realise SEM Analysis**

The structural and measurement model was defined for three different analysis scenarios for analysis - the total transport sector, the service activities in the transport sector and the manufacturing activities. In view of differences in their innovation behaviour and performance, the SEM-analysis has not only performed for the transport sector as a whole, but also for manufacturing and services subsectors. A region may show a good innovation performance in transport manufacturing, while the transport service companies may have a weak innovation performance. It is important to note that the innovation performance of the total transport sector can be a result of very different performances in the two subsectors.

Several correlations appeared to have a negative sign, although these indicators were all scaled in the same direction. Since the inconsistency of correlations between indicators appeared to have a different pattern for the indicators of the total transport sector, the manufacturing transport sector and the services transport sector the final selection of indicators of the analysis is as shown in table below;

| | Total model | Services model | Manufac-turing model |
|---|---|---|---|
| **Achievements** | | | |
| 1A - Share of innovative enterprises | X | | |
| 1AS - Share of innovative enterprises (services) | | X | |
| 1AM - Share of innovative enterprises (manufacturing) | | | X |
| 1B - Share of highly innovative enterprises | X | | |
| 1BS – Share of highly innovative enterprises (services) | | X | |
| 1BM - Share of highly innovative enterprises (manufacturing) | | | X |
| 16 - Average number of patents per year and per 100.000 employees in total transport sector | X | | |
| 16M - Average number of patents per year per 100.000 employees in manufacturing subsector | | | X |
| 17 - Share of enterprises that have introduces new or significant improved products that were new to the market | X | | |
| 17M - Share of enterprises that have introduces new or significant improved products that were new to the market (manufacturing) | | | X |
| 17S - Share of enterprises that have introduces new or significant | | X | |

| | | | |
|---|---|---|---|
| improved products that were new to the market (services) | | | |
| 18 - Share of enterprises that have introduced new or significant improved products that were only new to the firm | X | | |
| 18M - Share of enterprises that have introduced new or significant improved products that were only new to the firm (manufacturing) | | | X |
| 18S - Share of enterprises that have introduced new or significant improved products that were only new to the firm (services) | | X | |
| 25 – Share of turnover form innovations | X | | |
| 25M – Share of turnover form innovations (manufacturing) | | | X |
| 25S – Share of turnover form innovations (services) | | X | |
| | | | |
| **Economic performing** | | | |
| 21 - Growth (%) value added transport sector | X | | |
| 21S - Growth (%) value added transport sector (services) | | X | |
| 21M - Growth (%) value added transport sector (manufacturing) | | | X |
| 22 - Growth (%) employment transport sector | X | | |
| 22S - Growth (%) employment transport sector (services) | | X | |
| 22M - Growth (%) employment transport sector (manufacturing) | | | X |
| 23 – Growth in labour productivity transport sector | X | | |
| 23S - Growth (%) labour productivity (services) | | X | |
| 23M - Growth (%) labour productivity (manufacturing) | | | X |
| | | | |
| **Sector structure** | | | |
| 31 - Average firm size | X | | |
| 31M - Average firm size (manufacturing) | | | X |
| 31S - Average firm size (services) | | X | |
| 32S - Share transport services employment in transport employment | | | |
| 32M - Share transport manufacturing employment in transport employment | X | | X |
| 51 - Level of transport specialisation | X | | |
| 51M - Level of transport specialisation (manufacturing) | | | X |
| 51S - Level of transport specialisation (services) | | X | |
| | | | |
| **Funding** | | | |
| 41 - Share of product and/or process innovative enterprises that received any public funding | X | | |
| 41M - Share of product and/or process innovative enterprises that received any public funding (manufacturing) | | | X |
| 41S - Share of product and/or process innovative enterprises that received any public funding (services) | | X | |
| 42 - Public R&D as share of GDP | | | |
| 42M - Public R&D as share of GDP (manufacturing) | | | |
| 42S - Public R&D as share of GDP (services) | | X | |
| 43 - Business R&D as share of GDP | X | | |
| 43M - Business R&D as share of GDP (manufacturing) | | | X |
| 43S - Business R&D as share of GDP (services) | | X | |
| 45 - Share of government R&D spending on transport | | | |
| | | | |
| **Innovation milieu** | | | |
| 44 - Transport research as share of total FP7 EC funding | X | X | X |
| 52 - Cluster Quality | X | | |
| 52M - Cluster Quality (Manufacturing) | | | X |
| 52S - Cluster Quality (Services) | | X | |
| 53 Population density | X | X | X |
| 54 - Share of product and/or process innovative enterprises engaged in any type of co-operation | X | | |
| 54M - Share of product and/or process innovative enterprises engaged in any type of co-operation (manufacturing) | | | X |

| | | | |
|---|---|---|---|
| 54S - Share of product and/or process innovative enterprises engaged in any type of co-operation(services) | | | |
| 61 - Share of high educated persons in total transport employment | X | | |
| 61M - Share of high educated persons in total manufacturing employment | | | |
| 61S - Share of high educated persons in transport service employment | | | |
| 62 - Share of persons employed in science and technology in total transport employment | X | | |
| 62M - Share of persons employed in science and technology in total manufacturing employment | | | X |
| 62S - Share of persons employed in science and technology in total transport service employment | | X | |
| 63S - Share of employment in technology and knowledge-intensive sectors in transport services (NACE H and N79) | | | |
| 64 - Share of population who have successfully completed university of university-like education | X | X | |

**Table 1 Selection of indicators for the three models**

The final model specification for the two-step AMOS analysis is depicted below. The figure shows the causal relations between the exogenous factors (innovation milieu, innovation funding, transport sector structure) and the endogenous factors ‘Innovation Achievements’ and ‘Economic Performing’. The double arrows indicate that these factors are mutually correlated which is required to control the effect of each individual exogenous factor on the endogenous factor for the effects of the other exogenous factors. In this way the ‘pure’ effect of each exogenous factor on the endogenous factor can be estimated. In this example we can see the SEM-model path co-efficients for the total transport sector;

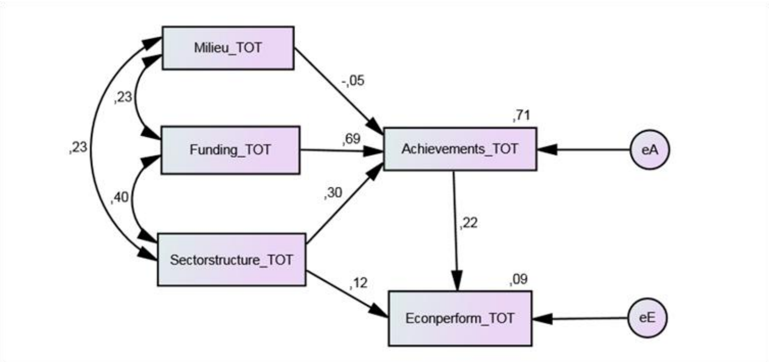



**Figure 5 SEM model path and coefficients for total transport sector**

The above results demonstrates how funding is the most determinant (0.69) for ‘Innovation achievements’, followed by ‘Sector structure’ (0,30). The role of ‘Innovation milieu’ should be interpreted as negligible as the path coefficient is close to zero. It also shows that ‘Innovation achievements’ are a significant determinant for ‘Economic performing’ of a regions transport sector. There is a direct effect of ‘Sector structure’ on ‘Economic performing’ (0,12) as well as an indirect effect incurred via ‘Innovation achievements’.

It is also possible to undertake individual innovation performance of regions and make comparisons between regions. The below map shows the relative scores of the regions on ‘Innovation achievements, it has two categories representing regions above the European average and two categories reflect the scores below the European average. The high performing regions are predominantly in Germany, with regions in Portugal and Sweden also scoring well. On the other hand regions in France, Spain, Norway, Hungary and in particular in Finland, Poland, Romania and Bulgaria are at the lower end of the scores.

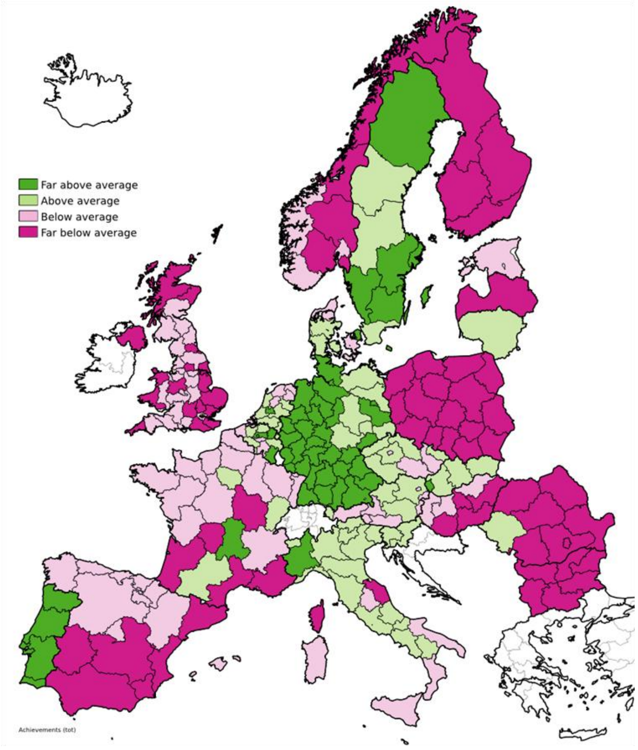



**Figure 6** **Scores of regions on 'Innovation achievements' in the total transport sector**

A major observation from our analysis is that the relative innovation performance of regions is strongly determined by the definition of the transport sector. First the innovation performance of regions was measured for the total transport sector, i.e. the transport manufacturing and service activities together. This definition is obviously relevant to map the innovation performance of regions in general. However, because manufacturing and service activities are so different, and most likely, also the innovation behaviour of these subsectors, it made sense to also look at the innovation performance of these subsectors separately.

The METRIC-project was faced with using secondary data, and as experience of the Regional Innovation Scoreboard (RIS) have shown, there is limited availability of data. It took great efforts to obtain regional data for all indicators that were initially proposed to be included in the SEM-model. For several indicators the data appeared too incomplete to keep them in the analysis, while for other indicators, a lot of data imputation was needed. Considering the great emphasis the European Commission places to innovation policy and research it is recommended to extend and improve the data collection to support research in this field.

**Regional SWOT**

This explores the strengths, weaknesses, opportunities and threats by way of analysis of gathered data and partners' knowledge of the regions to realise transport innovations at regional level. For each country analysis a strong and weak performing innovation region was chosen. The strengths and weaknesses were determined by the scores of the indicators previously used. Opportunities and threats were assessed by using the regional knowledge of METRIC partners and a concise review of trends in the transport sector.

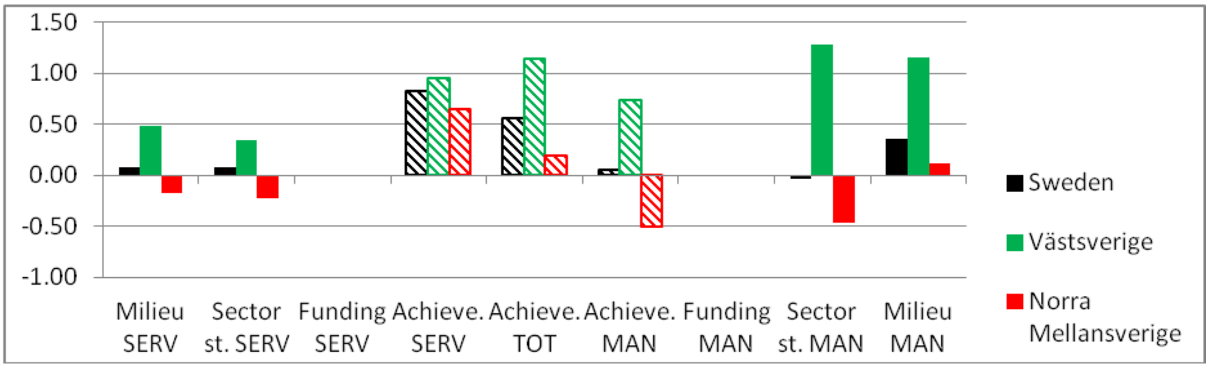
It is difficult to generalise the results of the SWOT-Analysis as regions are diverse in the manner of construct, this was particularly evident for the opportunities and threats. Previously activity undertaken had already indentified strengths and weaknesses indicators which were used to as part of the assessment, allowing for superficial generalisations.

The SWOT-analysis builds upon the results of the SEM-analysis. That is to say, the strengths and weaknesses of regions are directly derived from the SEM-results. This means that the scores of regions based on the indicators regarding the explanatory factors (Innovation Funding, Transport sector structure and Innovation Milieu) are used to point out which specific elements of Innovation Funding, Transport sector structure and Innovation Milieu are strong or weak in a region. The SWOT also went on further to analyse and focus on opportunities and threats within innovation performance.

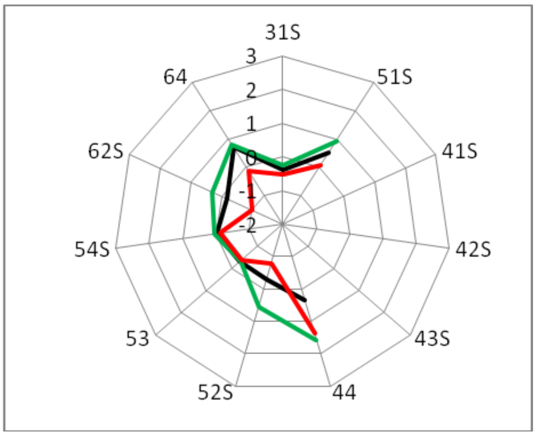
Whilst strengths and weaknesses reflect the current facts regarding Innovation Funding, transport sector structure and Innovation Milieu, opportunities and threats relate to external factors that could influence conditions allowing regions to increase their innovation performance. These developments can include global and transport market trends and factors. Although these developments may have a varied impact, it is, in view of the project objectives, valuable to focus on those developments that affect the Innovation Funding, Transport sector structure and Innovation Milieu, as these were defined as key factors relevant to influencing innovation performance. The review takes into account the automotive, ship building, aviation, freight transport and passenger services. The analysis was performed in three parts:

1. A bar chart in which the scores on innovation performance and innovation milieu, sector structure and funding.
2. A spider diagram in which scores for indicators used in the SEM-analysis are shown. From this spider diagram strengths and weaknesses for each region are derived.
3. The SWOT-analysis itself in the form of a table with strengths, weaknesses, opportunities and threats.

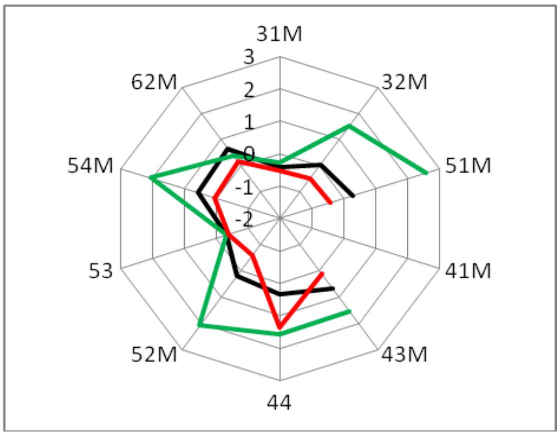
The below graph, tables and diagrams reflects the SWOT analysis of Sweden.



**Transport Services**




**Transport Manufacturing**




| **Västsverige** (strong innovation region) | **Norra Mellansverige** (weak innovation region) |
|---|---|
| *Strengths*<br><br>• High specialisatoin in transport research (44).<br>• High cluster quality (52M & 52S).<br>• Strong manufacturing sector (32M & 51M).<br>• High share of co-operative enterprises in manufacturing (54M).<br>• High business R&D expenditures in manufacturing (43M). | *Strengths*<br><br>• High level of specialisaton in transport research (44). |
| *Weaknesses*<br><br>• The region has just about an average score on scientific and technological emplyoment in the manufacturing (62M). | *Weaknesses*<br><br>• Low cluster quality (52S & 52M).<br>• Low share of persons employed in science and technology in service sector (62S).<br>• Low share of co-operative enterprises in manufacturing (54M) |
| *Opportunities*<br><br>• Smart, green, sustainable transport systems.<br>• Exploitation of strengths in transversal technologies.<br>• Encourage greater cooperation between the region's large firms and SMEs. | *Opportunities*<br><br>• Exploit regional strength in ICT for smart transport innovations.<br>• Cross-border collaborations. |
| *Threats*<br><br>• Lock-in and dependency on the existing (non-transport) industrial base.<br>• Dominance of large firms which may have relatively low loyalty to the region. | *Threats*<br><br>• Retention of younger science and technology professionals.<br>• Increasing marginalisation of the region as a whole. |

**Figure 7** **Example SWOT Analysis (Sweden)**

The results of the SWOT-analysis are different for each region, each region has its own characteristics and are often in a different phase of economic development. Although the SWOT-analyses are region specific it is possible to look for commonalities among the strengths and weaknesses because these are based on indicator scores of SEM-analysis. The opportunities and threats for achieving transport innovations in the regions are also not unambiguous, particularly at regional level. There are several challenges for the development of the European transport sector as a whole, these could be summarised as;

1) the environmental challenge: the need to shift from a sector that heavily depends on fossil fuels, and hence causing negative environmental impacts, to a more sustainable sector,
2) the mobility challenge: accommodating growing transport demand taking into account that infrastructure is reaching its performance limits and possibilities to build new infrastructure are limited and,
3) the competitiveness challenge: safeguarding the position of transport as a major economic sector in Europe, currently generating 7% of Gross Domestic Product (GDP) and employing 12 million people (transport service and vehicle and equipment manufacturing employment together).

**Main Principles for Transport Innovation**

The main principles were developed using factor analysis performed with variables describing regional economic structure, their frameworks and socio-economic aspects. Factors form groups of correlating aspects allowing the capture of characteristic patterns of economic and socio-economic innovation-related aspects in the occurrence of innovation and "non-innovation

To measure the regional innovation potential in transportation, a new approach was developed. Tis method was based on two standard instruments created by the European Commission to measure innovation: Innovation Union Scoreboard (IUS) and Regional Innovation Scoreboard (RIS). The indicators of these two instruments are adapted so that they were tailored to the measurement of innovation potential in the transport sector.

Data for the single indicators were collected for 261 European NUTS 2 regions from both Eurostat and the CIS sources. In order to meet comparability requirements of the heterogeneous European regions, they have been divided into the three groups of less developed (65), transition (48) and more developed regions (148) – according to the division of Europe by GDP, the same approach used by the European Commission. The first step was to complete missing value(s) and was completed in two steps for data from Eurostat:

1. Types of regions have been built based on thematically related indicators with all regions having values; e.g. different variables related to patent development were used to build types of regions according to their patent activities.
2. Indicators with missing values for individual regions need to be supplemented -> regions received an average value of their associated group from step one for the related indicator.

Several principles related to innovation potential have been identified. Although causality cannot be uniquely determined, the correlation between innovation potential measured by previously described variables can be linked to certain aspects which might influence, support or accompany innovation of transport on a regional level

- **Company size** is related to innovation potential on a regional level, although innovation might be located in small and medium enterprises located in the surroundings of big companies. This could be due to big companies acting as economic growth engines affecting innovation activities in the regional industry.

- **Public funds for R&D** and **financial proportion of R&D in the region/ enterprise** are related to innovation leading to the conclusion that innovation needs investment – whether from policy or public sector. Regions along the identified European axis of innovation are often hosting special locations for innovation, such as centres or technology parks, partially linked to regional clusters.

- **Specialization** of industries is related to innovation providing a two way interpretation: specialized industries might be a precondition for innovation, while in turn innovation might be necessary to sustain specialized companies by renewing uniqueness in products, services and processes thereby enabling competitiveness.

- **Level of education** can be interpreted as a precondition of innovation providing high-skilled labour force. At the same time education level reflects labour market and socio-economic levels of the region.

- **Teachers and employees in technical/ scientific professions** point to the fact that innovation in transportation, as measured, is closely linked to science and technology serving as a precondition for the innovation-oriented regional economy, which in turn attracting a corresponding labour force.

- A **dense transportation network** accompanied by innovation potential could also be interpreted as a characteristic of an established, mature economic region.

- **Proportion of innovative companies** seems to be an obvious aspect related to high innovation potential. On the other hand it leads to the conclusion that innovation is related to and driven by certain companies leading to a high innovation potential – while others, maybe the majority of companies are not actively innovating.

Particular correlations of innovation and funding with aspects of economic success have been found, e.g. a low unemployment rate. Innovation activity goes along with a dynamic economy: innovation is beneficial for the regional economy overall. Another main aspect of maintenance of innovation activities appeared; even established high innovative regions invest continuously in innovation either within the private economy aspect or through public funding.

In summary, a regional economic structure is beneficial where, economic specialization, dynamic and high level of education and skills come together – with specific focus on technical and science sector. As factors differ concerning their regional impact there is an identified need to investigate which factors affect different types of regions.

**Guidelines for adapting innovation principles**

The project has developed a toolbox which, uses identified indicators, to allow regions to benchmark themselves against European regions as well as the European average. In addition, regions are assigned into one of 10 European innovation types and can thus compare with regions that have the same characteristics. The region gets practical suggestions for action and identifies best-practice regions

This toolbox has been designed only. A practical implementation, as it would have recommended, is not part of the project context. This toolbox should be further developed and can be implemented electronically in a user-friendly manner which would increase the practical value of this Toolbox.

Indicators for innovation potential and milieu and Basic Conditions can be measured by the following indicators. The checklist includes a column with the respective European average for each indicator. The last column is where the respective value of a region can be entered:

| | Indicator | EU ø | Your value |
|---|---|---|---|
| **Transport Innovation** | Specialisation in Transport research as % of total FP7 EC funding | 4.62 | |
| | Cluster Quality as average cluster star rating according to European cluster observator | 1.2 | |
| | Share of product and/or process innovative enterprises engaged in any type of co-operation as share of total population | 8.2 | |
| | Educational level (tertiary) of total labour force (18-64) as percentage of total labour force | 23.9 | |
| | Share of government R&D spending on transportation as percentage of total R&D | 3.7 | |
| | Share of highly-educated (tertiary level) persons employed in the transportation sector as share of total employed persons | 16.9 | |
| | Share of persons employed in science and technology in the transportation sector as share of total employed persons | 19.5 | |
| | Employment in technology and knowledge-intensive sectors in the transportation sector as percentage of total employment | 4.7 | |
| | Average number of patents per year per 100,000 employees in the transportation sector | 23.9 | |
| | Share of innovative enterprises (which introduce product/ process innovation every year) in the transportation sector as percentage of total transportation enterprises | 39.0 | |
| | Share of enterprises that have introduced new or significantly-improved products that were new to the market as percentage of total transportation enterprises | 6.4 | |
| | Share of enterprises that have introduced new or significantly-improved products that were only new to the firm as percentage of total transportation enterprises | 12.1 | |
| | Growth added value in the transportation sector (%) | 3.0 | |
| | Growth employment in the transportation sector (%) | -3.7 | |
| **Basic Conditions** | Total intramural R&D expenditure at all sectors as percentage of GDP | 1.5 | |
| | Employment rates total +15 years (%) | 52.1 | |
| | GDP in million euro | 49092.3 | |
| | Infrastructure (road, rail, waterways) in km per area ($km^2$) | 1.7 | |
| | Households in densely populated areas (Thousands) | 417.1 | |
| | Land use for service and residential ($km^2$) | 1440 | |
| | Patent applications at the European Patent Office per million inhabitants | 79.8 | |
| | Average firm size as number of employees | 13.7 | |
| | Share of public R&D in percentage of GDP | 0.3 | |

| | | | |
|---|---|---|---|
| | Share of business R&D in percentage of GDP | 2.6 | |
| | Human Resources in science and technology as percentage of population | 29.0 | |
| | Persons aged with tertiary education attainment as percentage of population | 26.1 | |
| | Stock of vehicles except trailers and motorcycles (Thousands) | 1039.6 | |
| | Inhabitants killed at road accidents per million inhabitants | 80.1 | |
| | Euro per inhabitant as percentage of EU average | 96.8 | |
| | Risk of poverty rate as percentage of total population | 15.9 | |
| | Income of households: disposable income in € | 14044.3 | |
| | Unemployment rates +25 years (%) | 7.9 | |
| | Youth ratio total (%) | 0.3 | |
| | Population density | 359.0 | |

A list of the indicators with the region types and their average values are provided in the below table. The most important indicators per region type have been colour coded. "Most important" means the indicators described for this region type and have had the strongest influence on the formation of the region types. The colour varies and depends upon on the evaluation against the European average; green means 'above European average' and red corresponds to 'under European average'. The table allows regions to quickly classify itself without an online-tool and can also be compared to the region type-specific averages. All indicators and values are from the METRIC own database and Eurostat.

| Indicator | Region type 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Share of public R&D in percentage of GDP | 0.1 | 0.1 | 0.3 | 0.2 | 1.3 | 0.2 | 0.3 | 0.3 | 0.2 | 0.4 |
| Share of business R&D in percentage of GDP | 0.6 | 0.9 | 0.9 | 2.0 | 3.5 | 2.9 | 1.3 | 1.1 | 5.2 | 8.6 |
| Income of households: disposable income in € | 4248.4 | 8925.2 | 14986.7 | 15153.8 | 17933.2 | 16820.9 | 19076.4 | 16541.4 | 17041.4 | 18528.6 |
| Share of enterprises that have introduced new or significantly-improved products that were only new to the firm as percentage of total transportation enterprises | 5.3 | 11.6 | 6.6 | 12.4 | 7.7 | 12.4 | 13.0 | 12.4 | 25.6 | 21.5 |
| Euro per inhabitant as percentage of EU average | 29.8 | 57.2 | 94.1 | 103.1 | 102.4 | 142.4 | 180.2 | 101.4 | 139.1 | 115.9 |
| Share of product and/or process innovative enterprises engaged in any type of co-operation as share of total population | 4.4 | 9.7 | 3.9 | 5.8 | 9.1 | 9.2 | 14.2 | 14.4 | 8.4 | 4.2 |
| Share of innovative enterprises (which introduce product/ process innovation every year) in the transportation sector as percentage of total transportation enterprises | 22.1 | 37.8 | 30.6 | 40.9 | 37.4 | 39.1 | 42.1 | 33.5 | 71.7 | 61.2 |
| Human Resources in science and technology as percentage of population | 21.5 | 20.5 | 29.7 | 20.7 | 30.4 | 33.7 | 43.2 | 34.7 | 36.7 | 32.0 |
| Persons aged with tertiary education attainment as percentage of population | 20.1 | 18.5 | 30.6 | 14.7 | 26.3 | 28.8 | 42.6 | 34.2 | 30.4 | 26.8 |
| Share of enterprises that have introduced new or significantly-improved products that were new to the market as percentage of total transportation enterprises | 3.6 | 6.1 | 3.5 | 9.2 | 4.7 | 9.4 | 7.0 | 5.9 | 10.0 | 6.9 |
| Youth ratio total (%) | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Unemployment rates +25 years (%) | 8.8 | 11.5 | 17.1 | 6.8 | 8.5 | 5.0 | 7.6 | 5.3 | 7.0 | 5.3 |
| Land use for service and residential (km$^2$) | 1122.2 | 1092.0 | 962.6 | 1173.9 | 1038.2 | 1426.8 | 4720.2 | 1718.5 | 3294.1 | 1034.6 |
| Infrastructure (road, rail, waterways) in km per area (km$^2$) | 1.3 | 1.1 | 0.5 | 0.7 | 2.1 | 2.0 | 7.0 | 2.8 | 0.9 | 0.8 |
| Patent applications at the European Patent Office per million inhabitants | 4.5 | 8.1 | 33.2 | 54.0 | 69.0 | 140.0 | 109.0 | 74.5 | 95.4 | 215.7 |
| Average firm size as number of employees | 8.9 | 8.3 | 4.7 | 8.4 | 17.2 | 11.3 | 16.1 | 16.0 | 37.2 | 23.7 |
| Population density | 137.4 | 85.2 | 184.0 | 175.2 | 151.4 | 218.9 | 3223.8 | 374.6 | 1385.8 | 234.9 |
| Employment rates total +15 years (%) | 48.3 | 45.3 | 47.1 | 45.2 | 49.6 | 59.9 | 55.3 | 55.9 | 55.5 | 56.9 |
| Growth employment in the transportation sector (%) | -4.4 | -2.0 | -9.8 | -2.6 | -36.5 | -4.3 | 4.8 | -2.3 | 1.8 | 13.7 |
| Inhabitants killed at road accidents per million inhabitants | 119.5 | 121.0 | 64.2 | 76.4 | 83.7 | 63.4 | 38.8 | 62.4 | 51.2 | 62.2 |
| Total intramural R&D expenditure at all sectors as percentage of GDP | 0.5 | 0.7 | 1.2 | 1.0 | 1.6 | 2.1 | 2.8 | 1.7 | 2.7 | 2.3 |
| Risk of poverty rate as percentage of total population | 20.5 | 15.5 | 19.1 | 18.3 | 13.9 | 12.0 | 16.0 | 15.3 | 13.4 | 14.4 |
| Stock of vehicles except trailers and motorcycles (Thousands) | 914.6 | 508.3 | 1737.3 | 1801.3 | 1540.0 | 721.1 | 988.5 | 801.7 | 964.9 | 1193.1 |
| GDP in million euro | 17712.5 | 25999.3 | 66863.7 | 72023.3 | 63029.6 | 44286.2 | 141852.2 | 37148.1 | 60540.6 | 64055.6 |
| Growth added value in the transportation sector (%) | 1.5 | 5.6 | -4.5 | 7.9 | -0.7 | 1.4 | -2.1 | -1.2 | 13.5 | 11.0 |
| Households in densely populated areas (Thousands) | 399.0 | 396.2 | 383.1 | 404.1 | 326.8 | 259.3 | 630.8 | 494.8 | 1370.9 | 301.9 |
| | | | | | | | | | | |
| Cluster Quality as average cluster star rating according to European cluster observatory | 0.9 | 1.3 | 0.7 | 0.8 | 1.5 | 1.7 | 1.7 | 0.6 | 2.1 | 2.2 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Educational level (tertiary) of total labour force (18-64) as percentage of total labour force | 30.9 | 18.1 | 27.4 | 17.4 | 24.9 | 14.0 | 23.7 | 28.1 | 34.5 | 25.5 |
| Share of government R&D spending on transportation as percentage of total R&D | 1.5 | 5.1 | 2.8 | 4.8 | 1.8 | 1.9 | 7.3 | 8.5 | 2.0 | 2.3 |
| Share of highly-educated (tertiary level) persons employed in the transportation sector as share of total employed persons | 20.8 | 11.9 | 16.5 | 10.2 | 19.7 | 6.8 | 22.4 | 28.2 | 25.7 | 16.7 |
| Share of persons employed in science and technology in the transportation sector as share of total employed persons | 15.7 | 18.1 | 19.5 | 17.7 | 22.1 | 20.4 | 28.0 | 15.3 | 20.0 | 23.4 |
| Employment in technology and knowledge-intensive sectors in the transportation sector as percentage of total employment | 4.8 | 5.2 | 4.3 | 4.7 | 4.4 | 4.1 | 4.8 | 4.4 | 4.7 | 6.8 |
| Average number of patents per year per 100,000 employees in the transportation sector | 22.5 | 0.9 | 26.0 | 2.3 | 71.8 | 18.5 | 51.0 | 5.1 | 15.1 | 22.5 |

above European average

under European average

The determined main principles serve as preconditions for, and are results of, innovation at the same time. After the region has entered its own values, it is assigned to a region type. There is a secondary Database contained in the background of the METRIC repository which contains the main principles of innovation and the associated indicators. Furthermore, it also contains the region type-specific average values. Use of this database results in an assessment, this assessment takes place at two levels. The first level provides regional comparison with the average values of the region type. Based on this comparison the exact strengths (above average) and weaknesses (below average) of the region are listed. At the second level, the region determines what main principles are the focus of strategic planning. In the instance where there are fewer indicators per main principle and above average, the more emphasis should be made on this main principle. An outcome of this two-stage assessment will allow the development or planning of strategies and guidelines.

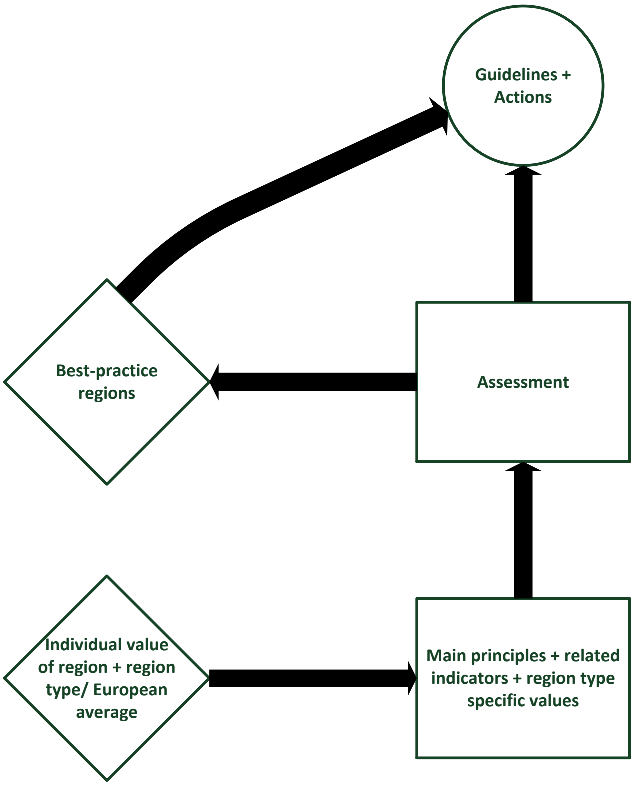



**Figure 8** **Multi level process of regional assessment**

A region should be able to compare itself with the average values of its region type. Knowing its strengths and weaknesses the region can derive recommendations for action. Typical actions could include implementation of tax advantages to attract big companies or other incentives that result in investment into private/public research. Promoting entrepreneurship and attracting high-skilled workers in the region are other reasonable actions to increase transportation innovation.

Innovation potential in transport service is different to transport industries; nevertheless there is a huge potential for process innovation, which could increase energy efficiency and reduce emissions thereby contributing to European goals. In order to support these kinds of innovation further research, new strategies and approaches should be developed.

The crucial role of investment in innovation – in the triangle of 1. Education/Skills; 2. R&D; and 3. Enterprises (products/processes) – was one of the main result of the analysis. Whether from policy or the private sector funding for innovation needs to address these fields in a consistent way.

**Transport Innovation Roadmaps**

The main aim of the transport innovation roadmaps is to support regions identify specific areas of interest related (to transport), to guide the regions in the initial steps and to provide practical assistance with development of smart specialisation strategies. The developed transport innovation roadmaps are structured around the ten technological fields that have been identified in the Strategic Transport Technology Plan. The barriers and challenges regarding each sector follow an analytical process which highlights key issues that are relevant to the 6-step approach of the smart specialisation structure.

Additionally, it also builds on previous activity undertaken in the course of the project, more specifically, the regional transport innovation scoreboard (selection of indicators presented, innovation performance (achievements), the innovation potential and a composite index developed to benchmark regions according to their innovation activity in the transport sector based on a selection of relevant indicators.

The European Strategic Transport Technology Plan (European Commission, 2012a) could be considered as the research and innovation complement of the transport White Paper. There are 4 key identified actions to improve research and innovation of the STTP, these include:

- strengthening the links of research and innovation with transport policy,
- aligning better the efforts of individual sectors,
- overcoming technology lock-in and institutional 'silo' thinking, and
- eliminating barriers faced by new market entrants including assets and investment requirements.

In the context of strengthening the transport innovation systems, three general transport research and innovation areas are also proposed. These have been used as the basis for the development of the transport roadmaps, combined with the expected contribution to achieve the white paper goals and are reflected in the table below;

| Research and innovation area | Field | The ten White Paper goals (summarised for readability) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Low-emission city transport and logistics | Low-carbon fuels in aviation and maritime transport | Freight; modal shift from road transport | EU-wide high-speed rail network | Multimodal TEN-T core network | Long-term comprehensive network | Traffic-management systems in all modes | Multimodal transport information | Close to zero fatalities in road transport | Towards 'user pays' and 'polluter pays' |
| **Clean, efficient, safe, quiet and smart transport means** | *Clean, efficient, safe, quiet and smart* ***road vehicles*** | ■ | | | | | | | | ■ | |
| | *Clean, efficient, safe, quiet and smart* ***aircraft*** | | ■ | | | | | ■ | | | |
| | *Clean, efficient, safe, quiet and smart* ***vessels*** | | ■ | ■ | | | | | | | |
| | *Clean, efficient, safe, quiet and smart* ***rail vehicles*** | | | ■ | ▪ | | | | | | |
| **Infrastructure and smart systems** | *Smart, green, low-maintenance and climate-resilient* ***infrastructure*** | | | ■ | ■ | ■ | ▪ | | | ■ | |
| | *Europe-wide* ***alternative fuel distribution*** *infrastructures* | ■ | ▪ | ▪ | | | | | | | |
| | ***Efficient modal traffic-management*** *systems (incl. capacity and demand management)* | | ■ | ■ | ▪ | ▪ | | ■ | ▪ | ▪ | ▪ |
| **Transport services and operations for passengers and freight** | *Integrated* ***cross-modal information*** *and management services* | | ▪ | ▪ | | ▪ | ▪ | | ■ | | |
| | ***Seamless logistics*** | ▪ | ▪ | ■ | | | | | ▪ | | |
| | *Integrated and innovative* ***urban mobility and transport*** | ▪ | | | | | | | ▪ | ■ | |

■ Major contribution anticipated from this priority field to reach the White Paper's goal

▪ Some contribution anticipated from this priority field to reach the White Paper's goal

**Figure 9: Transport innovation fields presented in the STTP (European Commission, 2012a)**

The purpose of the roadmaps is to highlight the importance of these specific transport areas. Furthermore, they also provide information about key relevant technologies, stakeholders, barriers, regulation, governance, policies and other relevant issues. Where possible the roadmaps have identified the most appropriate tools that could also support the implementation of appropriate mechanisms advancing the progress towards the regional/European research and innovation STTP objectives.

Sector-specific roadmaps have created as for each identified area, there are different issues that affect each sector but there are some commonalities such as financing, lack of funding and high investment costs, and demand-led innovations for particular sectors etc. more detailed information contained within the appropriate METRIC reports. The 10 sectors which the roadmaps are below:

1. Clean, efficient, safe and smart Road Vehicles
2. Clean, efficient, safe and smart Aircrafts
3. Clean, efficient, safe and smart Rail vehicles
4. Clean, efficient, safe and Smart vessels
5. Smart, green, low-maintenance and climate resilient infrastructure
6. EU-wide alternative fuel distribution infrastructures
7. Efficient modal traffic-management systems
8. Integrated cross-modal information and management systems
9. Seamless logistics
10. Integrated and innovative urban mobility and transport

Each roadmap provides appropriate justification for investment within the identified sector with identified sector-related barriers and challenges, it proposes what actions could be undertaken to benefit the sector with links to possible governance/stakeholder involvement could provide a combined effort to achieving the aims. Furthermore each roadmap provides specific examples for priory setting combined with proposals to identify the right policy mix to allow combining identified mechanisms to overcome the challenges and barriers and achieve the aims of the transport White Paper.

The activity undertaken in the METRIC project and its results can support the development of strategies that will strengthen the transport sector. The regional transport innovation scoreboard (http://fp7metric.sf.bg.ac.rs/index.html) has been developed to specifically support the development of strategies by regions to make available investment in specific areas that allow regions to complement its strengths and overcome barriers in transport sector related areas. It has used a range of indicators to successfully achieve this, however the indicators have been somewhat limited due to the lack of availability of or missing data for several variables which resulted in their exclusions due to the negative effects which would have occurred within the repository. A list of the indicators can be seen below;

| **Categories** | **Indicators** |
|---|---|
| Achievements | Share of innovative enterprises 2010 |
| | Share of highly innovative enterprises 2010 |
| | Average number of patents per year (2006-2008) per 100.000 employees (2008) |
| | Share of enterprises that have introduced new or significant improved products that were new to the market (2010) |
| | Share of enterprises that have introduced new or significant improved products that were only new to the firm (2010) |
| | Share of turnover from innovations 2010 |
| Economic performing | Growth (%) value added transport sector 2008-2011 |
| | Growth (%) employment transport sector 2008-2011 |
| | Growth (%) labour productivity transport sector 2008-2011 |
| Sector structure | Average firm size 2010 |
| | Share transport sector employment in total transport employment 2008 |
| | Level of transport specialisation 2008 |
| Funding | Share of product and/or process innovative enterprises that received any public funding 2008 |
| | Public R&D as share of GDP 2008 |
| | Business R&D as share of GDP 2008 |
| | Share of government R&D spending on transport 2008 |
| Innovation milieu | Transport research as share of total FP7 EC funding |
| | Cluster quality 2008 |
| | Share of product and/or process innovative enterprises engaged in any type of co-operation 2008 |
| | Share of employment in technology and knowledge-intensive sectors in transport services 2008 (NACE H and N79) |

All the data can be seen in the Scoreboard of repository where users can differentiate between services and manufacturing, choose to view them either in the form of maps or in the form of tables.

The recommendations for the development of RIS3 strategies are presented in the form of roadmaps for the ten innovation fields that have been identified in the Strategic Transport Technology Plan and in combination with the 'Guide on regional transport innovation strategies' it can offer useful support for the design of RIS3 strategies.

The evaluation tools summarise the outputs of other activities undertaken in METRIC and offer information relevant to regional transport innovation performance in terms of achievements, regional transport innovation potential and current state of smart specialisation applications. Finally, the Transport Innovation Repository – available here: http://fp7metric.sf.bg.ac.rs/ – includes all the data that has been collected and indicators that have been used during the METRIC project.

The METRIC project can help regions or countries to (a) define specific transport RIS3 priorities using a six-step strategy guide, (b) position themselves on transport innovation maps structured around ten innovation areas, (c) evaluate their innovation status and potential using the scoreboard and transport innovation indicators and (d) use benchmarking to compare themselves with other regions.

## Impact

**Impacts related to the Work Programme**

| Call Objectives | METRIC's responses |
|---|---|
| Analyse the framework within which transport research and innovation takes place (institutional, policy, programmes and financing, skills base, infrastructure, etc.) as well as existing strategies at regional level. | **WP2 has mapped the transport elements at regional and national scales. It has been possible to determine the RTD infrastructure of the transport sector and specific RTD activities that have been undertaken at a regional level. This has led to understanding and definition of the structure of the innovation milieu by identifying regional infrastructure of R&D units and actors involved supporting innovations.** |
| Identify actors involved at various levels in regional transport research and innovation, as well as co-operation and collaboration patterns within the region and the linkages out of the regions ("collaborating to compete"). | **Following on from the mapping exercise of the relevant actors, METRIC has also identified how regional policies are able to stimulate, encourage collaboration between regions and how particular linkages are beneficial at the regional and European level yielding collaborative/individual innovation. An extensive literature review was completed, the relevance and impact of active clusters was also taken into account to understand the innovation milieu. The strengths, similarities and differences were identified which supported the determination of regional innovation objectives and specific mechanisms that have proved to increase innovation in transport research.** |
| Explore the main transport research and innovation activities at regional level as well as their impact (for instance on the | **After successfully analysing the RTD Infrastructure at country and regional level, it was possible to define and determine the key indicators that define the analysis of** |

| | |
|---|---|
| regional competitiveness), areas of distinct specialisation, and either established or potential areas of excellence. | **regions as part of both the SEM model analysis and the SWOT assessment of regions also. This has led to identified regions of best practice as well as 'corridors' of high/low innovation performance. Furthermore, it has identified regions that are 'specialised' in particular transport sub-sectors through the analysis of data, the SEM model and the METRIC repository.** |
| Define the strengths, weaknesses, opportunities and threats at regional level, as well as main drivers and obstacles to innovation. | **The SWOT analysis analysed a selection of regions, as the time to analyse all regions would be significantly protracted and there were limitations in terms of the availability of data, the analysis identifies strong and weak regions. It identifies regions which could develop possible opportunities to enhance the transport sector frameworks and observations of best practice. The SEM model has allowed ranking of regions in terms of good, average and poor performance, this has enabled analysis of general common indicators for regions.** |
| To provide concrete recommendations for strengthening the role of transport research and innovation at regional level for example in form of road maps. | **In order to define recommendations, main principles for (successful) regional innovations were defined, the definition of principles considered different region types. 10 different typology of regions were defined, the characteristics for each region were defined formulating the generic principles as success factors for enhancing regional innovation. In support of these success factors, a guide has been developed providing and supporting regional stakeholders with tools for benchmarking their region against a determined EU average. Following interpretation and alignment to EU strategies, a series of roadmaps have also been developed, these roadmaps identify and highlight recommendations based on observed best practice. The roadmaps address the specific sub-sectors of the transport sector such as, automotive, aerospace, rail, ITS, waterborne, etc.** |
| To develop a series of specific, quantitative and qualitative indicators describing the transport research and innovation performance at regional level. | **An extensive list of indicators were developed which allowed METRIC to measure and explain the performance of regions. Both quantitative and qualitative indicators have been defined allowing a more informed understanding of innovation and its performance within EU regions. Defining the indicators to explain regional innovation performance. The use of the collated data resources in the SEM model also allowed the identification of innovation potential. The indicators were core to completing a detailed SWOT analysis on a limited number of regions highlighting the** |

| | |
|---|---|
| | **best practice scenarios of transport within transport and its sub-sectors of regions.** |

**Policy Impact**

The outcomes of the METRIC project can act as a complementary mechanism for regions to further understand their innovation performance in the transport sector. The regional analysis has determined generic principles as success factors that can enhance regional innovation performance and is further complemented by a more informed understanding of the strengths and opportunities within regions through identified best practice. The tools developed support transport stakeholder in developing, enhancing and implementing measures to increase the innovation performance of the transport sector and can identify specific areas of regions where opportunities could be fully realised. Existing transport support mechanisms have been analysed with identification of mechanisms which, if implemented, could improve the performance and development of innovation of transport at the regional level. The use of METRIC outputs, repository, guidance and roadmaps can assist stakeholders with gaining a detailed understanding of the performance of their own region, thereby allowing identification of strengths, opportunities, and threats to their transport performance and environment. These support measures have been principally designed to increase regional growth for regions and the business community through support measures to increase transport research and innovation.

**Research Impact**

The research undertaken in the METRIC project has, with the use of limited available data resources, determined the performance of regions, developed tools that could be used to enhance, improve and provided recommendations on implement existing and/or new measures for the transport sector. The generation of new knowledge, not previously undertaken, has increased the knowledge within the research arena. The research undertaken has provided a macro view of the transport sector at the NUTS 2 level, and can be used to analyse and determine specific measures to improve and/or enhance measures to increase innovation performance of the transport sector.

The approach used has identified several pitfalls in terms of the availability of data, but this has not detracted from completing a comprehensive assessment of regions. The mapping analysis extensively details the capability of regions and it is possible to identify how these capabilities are aligned to EU priorities and at the higher level can support the vision of future research activities, funding priorities in order to support the EU transport strategic approach to priorities.

**Socio-economic Impact**

The activities undertaken as well as the results and outputs achieved in the METRIC project can assist with improving economic and economic competitiveness by proposing recommendations and actions within the transport sector. Furthermore, the developed tools can be used by stakeholders, at the regional level, to maintain and enhance innovation levels of the transport industry within a given region. Better understanding of barriers and drivers of the transport capacity are more understood through the analysis of RTD frameworks, regional initiatives and the development/use of regional industry clusters.

METRIC can support the decision making process for the development and implementation of innovation development support measures which yields tangible benefit to industry and, in the long term, members of the public and society as a whole. Usage of METRIC tools by policy makers could generate localise solutions that could gain the regional environment, the tools take into account existing data (to assess past actions) and best practices recognised in the activities of the METRIC project. It is anticipated that the use of the tools could define transport related priorities, implement appropriate funding mechanisms and engage with the all regional stakeholders, both public and private. If the right mix of investment and engagement occurs it could be possible to increase regional development thereby increasing the regional economic position and creation of new jobs.

## Dissemination & Exploitation

**International Conference – Supporting EU Regional Transport Innovation**

The final event of the METRIC – "Supporting EU Regional Transport Innovation" took place at the European Commission's Berlaymont building on 19th March 2015. The METRIC event provided participants the opportunity to understand research results that have been achieved as well as specific considerations and approaches that have been used during the projects lifespan. Furthermore the aim of the event was to raise awareness and to encourage active participations through the stakeholders in attendance, ultimately contributing to shaping a consensus among various stakeholders. The event addressed issues related to regional transport research and innovation activities.

The METRIC project partners presented the results of their respective activity undertaken during the lifespan of the project, more specifically the mapping activities of regional transport innovation frameworks, measuring and explaining the performance of regional innovation frameworks, meta-analysing main principles and typology for regional innovation, as well as on regional strategy plan and recommendations. In addition, invited experts shared experiences of implementing smart specialization strategies issues and provided industry perspectives on regional innovation and research activities in transport sector. There was also a panel discussion involving presenters from industry, the EC and the METRIC project Consortium.

The event was attended by approximately 50 participants with representations from the European Commission, EU regional representatives, the scientific community and other relevant other projects, as well as policy makers from several different European countries.

**Project public website**: www.metricfp7.eu

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