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TRIMIS as a support tool for transport research and innovation horizon scanning

*Working towards an
integrated European
Commission horizon
scanning scheme*

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Abstract

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 classified according to the seven Strategic Transport Research and Innovation Agenda (STRIA) roadmaps that were adopted by the European Commission (EC) 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; infrastructure.

One of the objectives of TRIMIS is to support Transport Research and Innovation (R&I) horizon scanning. The Joint Research Centre (JRC) has developed a capacity for foresight and horizon scanning. Within the TRIMIS framework, horizon scanning is a structured and systematic collaborative exercise that contributes to the identification of new and emerging technologies and trends, helps to assess current and future research needs, and feeds into the broader JRC horizon scanning system with regard to transport.

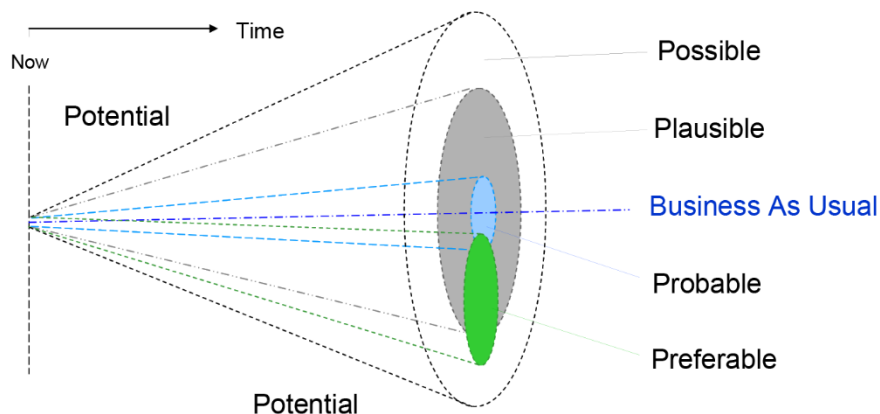
TRIMIS therefore aims to support the establishment of an anticipatory and adaptive culture in the field of European transport R&I, providing insights to users and contributing to a higher-level strategic framework. This report provides a first overview of the TRIMIS horizon scanning methodology and identifies areas for further development.

1 Introduction

Decision-makers continually need to adapt to complex and ever-changing environments. To support them in this process a number of tools exist that improve their ability to spot, interpret and adapt to changes.

Horizon scanning is among the available foresight methods, allowing for a better preparation for future and emerging events (Patton, 2005). The purpose of horizon scanning is “to provide timely awareness of what is new or changing – to identify risks, as well as opportunities, that these phenomena can create” (Krzysztofowicz et al., 2018). It thus gives insight into a series of potential futures as schematically presented by the futures cone in Figure 1.

Figure 1. Futures presented through the futures cone.



Source: Voros, 2003.

Importantly, horizon scanning enables stakeholders to discuss early on, what the intended and unintended effects of the identified developments may be. By doing so, the process bridges the gap between anticipatory thinking and evidence-informed decision-making.

Within the European Commission's (EC) activities, a series of existing horizon scanning and foresight exercises related to projects exist. These projects either focus exclusively on horizon scanning or partly incorporate horizon scanning and foresight functionalities. Within the policymaking framework, horizon scanning may refer to a twofold policy tool serving to key functions, namely (Habegger, 2009):

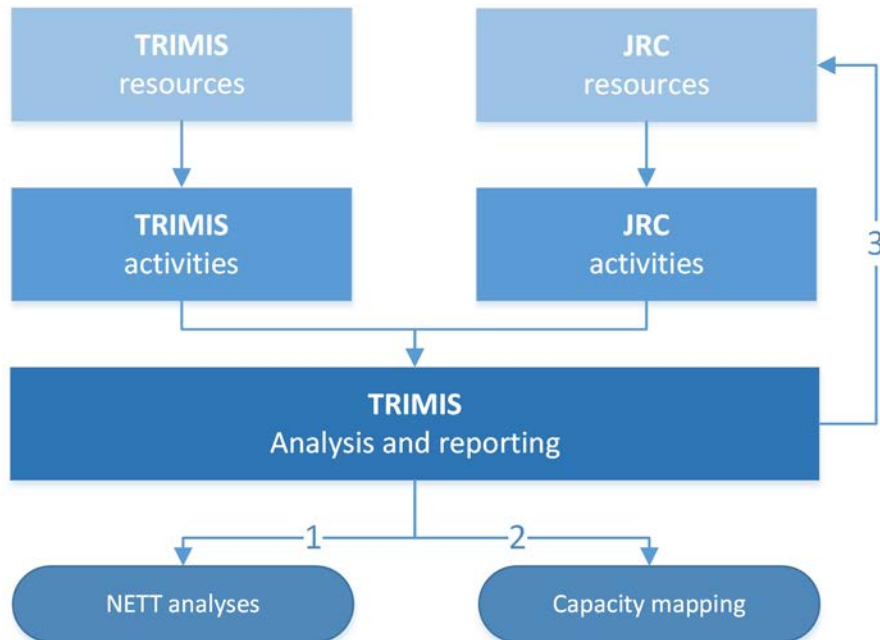
- Information: by informing policy makers about emerging trends and developments covering an involved actor's external environment;
- Policy development: through the promotion of network creation and information flow, while underpinning a shared overview of desired futures that will support the emergence of new and innovative policies.

With reference to the transport sector, TRIMIS is the EC instrument for mapping transport technology trends and R&I capacities. It supports the implementation and development of the Strategic Transport Research and Innovation Agenda (STRIA) that was adopted by the EC in May 2017 (Tsakalidis *et al.*, 2018). To assess the future of transport, including future investment needs, TRIMIS also engages in horizon scanning. By doing so, TRIMIS supports policy makers and transport stakeholders in identifying new opportunities for technological advancement.

The TRIMIS horizon scanning process is the topic of this report. The process is presented in Figure 2 below, showing how horizon scanning relates to other key outputs. Firstly, it acts as input for the assessment of new and emerging technologies and trends (NETT) in

transport. Secondly, helps the better understanding of future research capacity needs and gaps. Finally, feeds back into the general JRC horizon scanning system to provide more specific information on the future of transport.

Figure 2. TRIMIS horizon scanning process.



Source: Own elaboration.

The structure of this report is as follows. Chapter 2 reviews the role of horizon scanning in the European Commission. Based on this context the TRIMIS method is developed. Chapter 3 specifies which sources will be used, what activities shall be undertaken and expected outputs. Chapter 4 presents the discussion points and conclusions.

2 Horizon scanning at the Joint Research Centre

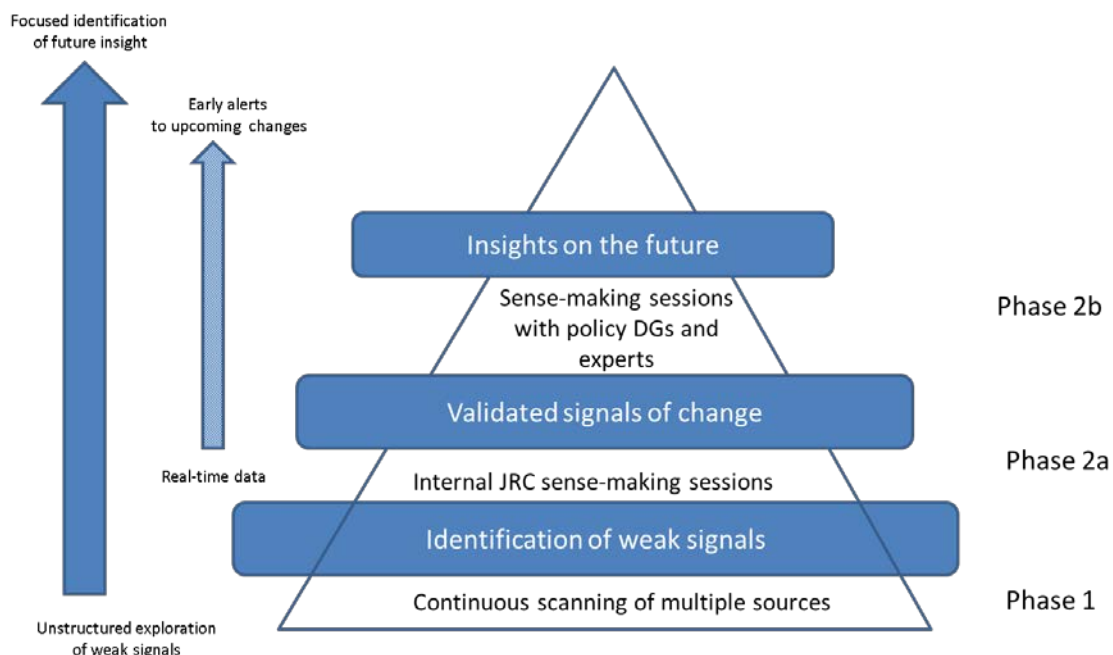
Since 2011, horizon scanning has been incorporated in the JRC annual management planning. The 'Scanning the Horizon Bulletin' was the first product of the Science Advice to Policy, Innovation and Horizon Scanning unit. Six issues were published between November 2011 and November 2014 plus a special issue on the future of cars. While the bulletin is not produced any longer, it did foster an awareness on the significance of foresight within the JRC and the need for a systematic cross-disciplinary assessment of developments with potential future policy implications. This chapter expands on these initiatives as a backdrop to explain the TRIMIS horizon scanning approach in the following section.

Currently, there are two major foresight platforms active at the JRC, namely the Horizon Scanning @ JRC Platform and the Megatrends Hub that are described below. The detailed institutional backdrop related to the introduction of horizon scanning within JRC activities can be found in Annex I.

2.1 Horizon Scanning @ JRC Platform

The current JRC horizon scanning scheme is based on collection of information and its collective analysis ("sense-making") with a possibility to involve experts from within and outside the JRC and wider Commission staff. Figure 3 outlines an overview of the JRC horizon scanning process that supports the transition from unstructured exploration of weak signals to future identification of future insight.

Figure 3. JRC horizon scanning process.



Source: JRC.

There are three potential roles across the Horizon Scanning @ JRC pilot participants:

1. Scanners
2. Aggregators
3. Workshop participants

Scanners are required to do on-going scanning of various sources including already existing specialised scanning systems, scientific publications, conferences, reports,

patents, trade and business publications, magazines and newspaper, social media, etc. The scanning process covers all JRC focus areas, but for the purpose of the pilot and the methodology.

According to the development team, the additional effort should not exceed half an hour per week, since scanning should be part of a daily routine. The extra effort corresponds to the identification of potential weak signals from the bulk of daily-received information and the uploading of this information to a dedicated web space with the potential addition of the scanners' comments.

In parallel with Scanner activity, an Aggregator undertakes a regular assessment of the collected items and adds explanations and further signal clustering for improved sense-making in a format suitable for the workshops where participants will try to cluster different items together in order to potentially identify emerging weak signals. In their final form, the horizon scanning items will contain standardised information on:

- description
- list of sources
- possible general future implications
- potential policy implications

and where applicable additional information such as:

- likely timeframe
- importance rating
- actors involved

The role of workshop participants is to read the relevant horizon scanning items and cluster them in bigger groups to identify potential weak changes that are taking place. Their role requires a series of activities before and during the workshop. About a week before the workshop, each participant receives a set of items that need to be read in order to create several clusters. During a scan workshop, participants take turns to present their clusters (e.g. title, premise, and numbers) while the facilitator records the cluster. The group discusses the cluster and once finished, the facilitator moves the discussion to the next cluster. After all clusters have been discussed, important ideas and topics that emerged during the meeting are posted and ranked for further reference.

Training and support is offered along with help with sense-making and dissemination efforts, including validation workshops, structuring and prioritisation of the findings and their integration in the JRC processes towards increasing JRC foresight capacity.

Part I of the pilot involves the collection of scanning items. A dedicated Connected Commission space has been developed on the EC intranet, where users can submit horizon scanning items. EC employees are encouraged to submit their contributions on the Connected Commission platform once they come across intriguing information with a potential added value to the horizon scanning scheme. The platform functionalities are online at the Horizon Scanning Submit page and the Horizon Scanning Network page.

Horizon Scanning Submit is the Connected Commission space for submitting horizon scanning items i.e. factual information coming from a large variety of sources, as explained above, that will allow the potential identification of weak signals.

Horizon Scanning Network is the Connected Commission discussion space for those involved in the horizon scanning pilot project. More information, recent news, upcoming events recent horizon scanning items and discussion functionalities are available.

2.2 Megatrends Hub

The JRC Foresight, Behavioural Insights & Design for Policy Unit developed the Megatrends Hub⁽¹⁾. This is a dynamic collective intelligence system, which serves as a knowledge management platform. The platform will be updated by assessing and monitoring potential factors of change through literature review and with events and forecasts identified through horizon scanning in the JRC or insights from outside experts.

The term 'megatrends' covers long-term driving forces that are observable now, having a potentially significant influence on the future. Currently, 14 global megatrends of European importance are assessed through the Megatrends Hub:

1. Diversifying inequalities
2. Climate change and environmental degradation
3. Increasing significance of migration
4. Growing consumerism
5. Aggravating resource scarcity
6. Increasing demographic imbalances
7. Expanding influence of east and south
8. Accelerating technological change and hyperconnectivity
9. Changing nature of work
10. Diversification of education and learning
11. Shifting health challenges
12. Continuing urbanisation
13. Increasing influence of new governing systems
14. Changing security paradigm

For each Megatrend a series of monitoring and assessment features is provided:

1. Developments
2. Forecasts
3. Potential implications
4. Indicators
5. Relevant EC work
 - (a) Policy documents and projects
 - (b) Applicable models (through the MIDAS portal)
 - (c) Related Connected communities
6. Related horizon scanning items
7. Other Resources
8. Related EU Media Monitoring RSS feeds (daily, selected by relevant keywords)
9. Related research and innovation (through Tools for Innovation Monitoring-TIM)
10. Related trends

The Megatrends Hub is open to the public through its online platform, supporting its role as a dynamic collective intelligence system. Users are invited to contribute to this

(1) https://ec.europa.eu/knowledge4policy/foresight_en

foresight activity by sending to the JRC their input by either confirming or signalling changes on the megatrends. It relies on the provision of news, peer reviewed publications, analyses, official reports or other types of information relevant to the 14 Megatrends from any reputable source.

2.3 Tools with a potential to support horizon scanning

In addition to foresight platforms, a series of tools with the potential to support horizon scanning activities exist across the EC. These are presented below.

2.3.1 Research and Innovation Observatory (RIO)

The Research and Innovation Observatory (RIO) is an EC initiative within the Innovation and Growth science areas. The JRC in collaboration with DG Research and Innovation developed RIO for the monitoring and analysis of European R&I developments to support better policy-making. The RIO-PSF website is a source of information for European and national policy makers as well as other stakeholders in the field of R&I policy; users have access to Country Analysis, Policy Support Facility, Statistical Data and a Library (European Commission, 2017a).

2.3.2 Europe Media Monitor (EMM)

The EC JRC's Competence Centre on Text Mining and Analysis has developed Europe Media Monitor (EMM), a family of applications constantly monitoring and analysing a large number of news reports from thousands of news sources in more than sixty languages daily (European Commission, 2018). With advanced information extraction techniques, EMM identifies information in the news, categorises it, localises it, and determines who is involved and what is reported, aggregates the information, issues alerts and produces intuitive visuals of the information.

2.3.3 Tools for Innovation Monitoring

Tools for Innovation Monitoring² (TIM) enable users to extract knowledge and intelligence from datasets containing textual information (European Commission, 2016). Currently there are four active online tools, namely:

- TIM Technology, which includes specific technology watch systems to map areas of science and innovation.
- TIM Edge, a monitoring system intended to track emerging technologies listed in thematic fields as they progress towards market applications.
- TIM Energy, used for mapping technologies and innovations in the field of energy.
- TIM Cyber Security, used for the mapping of cyber-security through different domains and dimensions.

TIM Technology Editor, an additional development tool restricted to EU institutions' staff, explores science and innovation through gathering scientific literature, patent data, news articles and data from R&D projects funded by the EU.

2.3.4 ESPAS

Finally, the European Strategy and Policy Analysis System (ESPAS) is an additional potential source. It is an inter-institutional project of the European Parliament, the EC, the Secretariat General of the Council of the European Union and the European External Action Service aiming at strengthening the EU forward planning capacities. ESPAS provides a framework for cooperation and consultation at administrative level, on a voluntary basis, that will allow the involved parties to work together on medium and

² <http://www.timanalytics.eu/>

long-term trends relating to the EU (European Union, 2016a). In this context the Open Repository Base on International Strategic Studies (ORBIS) has been developed. It is an on-line open library on long-term trends publications, which is intended to be the first global foresight hub including the largest library of prospective studies (European Union, 2016b).

3 TRIMIS horizon scanning approach

As highlighted in the section above, the JRC launched several horizon scanning tools and systems to support policy-makers. This section expands on the need for a complementary horizon scanning exercise in the field of transport, and how TRIMIS will perform this function.

3.1 General horizon scanning application approach

TRIMIS contributes to STRIA through different activities. The identification of future gaps in research funding and the analysis of technologies with high innovation potential require a thorough understanding on how the future evolves. This is the primary reason for which horizon scanning is introduced.

An added benefit of investing in foresight capabilities is that TRIMIS can provide in-depth information on transport developments to the existing JRC horizon scanning initiatives. This topical focus makes that TRIMIS can reinforce existing tools.

The proposed Horizon Scanning methodology adheres to three guiding principles as introduced by Krzysztofowicz et al. (2018). Adhering to them improves the relevancy and efficiency of the horizon scanning exercise:

- **Inclusiveness:** foresight frequently is an individual and sporadic exercise, which makes that important signals may be missed (Habegger, 2009). Horizon scanning should be a collective sense-making process that incorporates the expertise of a broad number of people, and not just individual opinion.
- **Incorporation in current priorities:** Relevance depends on the extent to which it relates to current thinking, strategies and concerns. The Horizon Scanning activities therefore will align strongly with the STRIA roadmaps and provides input to the STRIA working groups.
- **Timeliness:** Horizon scanning should strike a balance between identifying issues that are neither too distant nor too near. If the focus lays on too distant and uncertain issues, they may be disregarded as irrelevant. If issues are too near, they are already known, and thus of limited relevance for a horizon scanning process.

In line with these guiding principles, the proposed horizon scanning system includes a systematised process with the following elements (Patton, 2005):

1. Data collection from the organisation's external environment in raw format
2. Data formatting and item input to a database
3. Organisation of gathered items on a regular time interval for further reference and handling
4. Scan meetings organisation, including the processes of
 - (a) Item clustering
 - (b) Cluster ranking and evaluation if fit for further analysis
5. Filtering of items reaching the final stage
6. Distribution of the outputs through either:
 - (a) Pull mechanism
 - (b) Push mechanism

A sample Horizon Scanning item could include the following information and structure:

- Title
- Scanner details

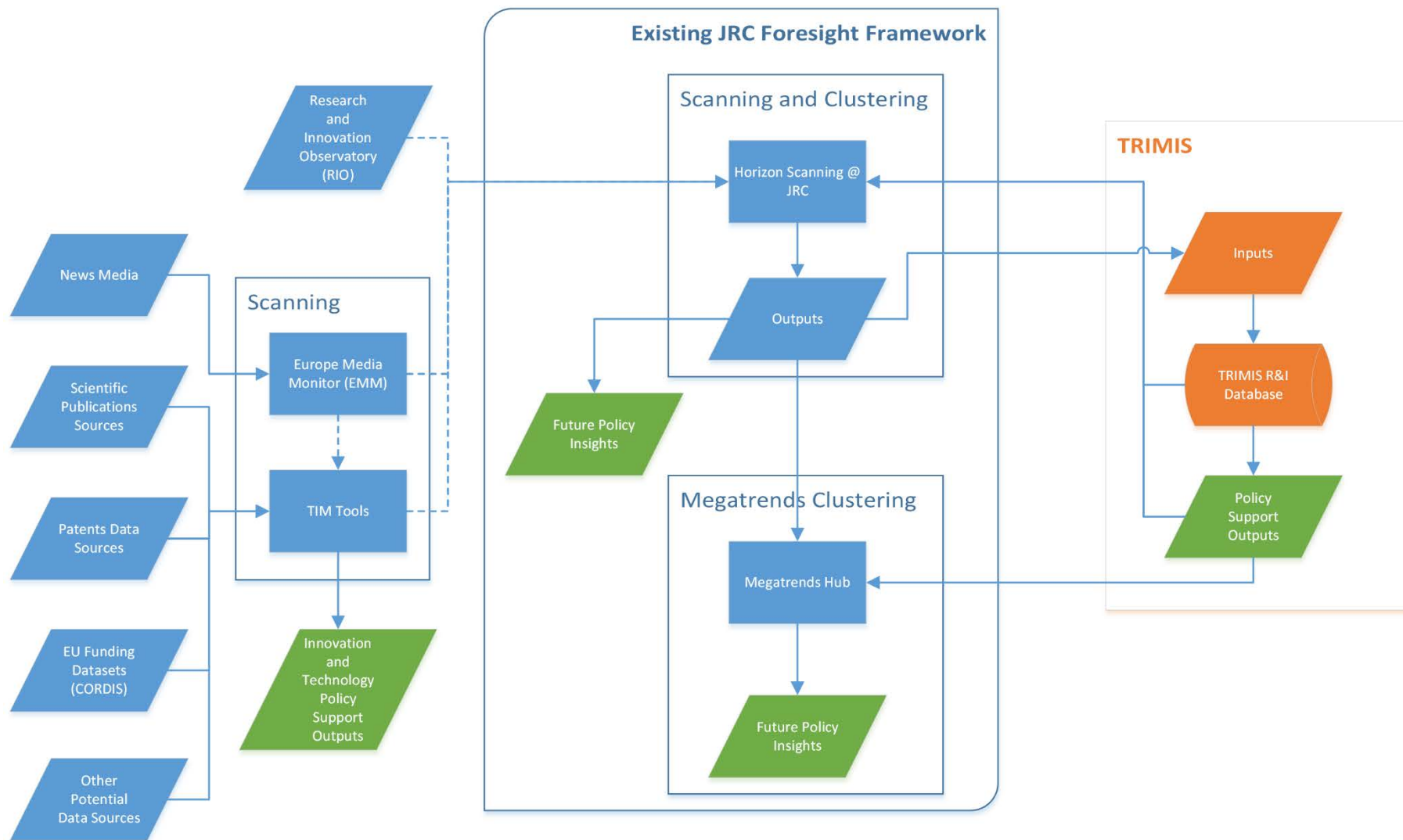
- Source
- Web address
- One sentence summary
- Description
- Implications

An example of applying the scheme described above within TRIMIS is detailed in sections 3.2-3.4.

3.2 TRIMIS horizon scanning resources

As stated before, horizon scanning is a structured and systematic activity mainly based on manual research (i.e. desk-based analysis) that is supported by automated data mining and semantic analysis. It will support the successful establishment of an anticipatory and adaptive culture in the field of transport R&I and EU research, providing insights to the TRIMIS users and contributing to a higher-lever strategic framework. Figure 4 presents the TRIMIS horizon scanning in relation to JRC horizon scanning.

Figure 4. TRIMIS within the JRC horizon scanning context.



Source: Own elaboration.

3.3 TRIMIS horizon scanning activities

Horizon scanning contributions need to be from a reliable source, be concise, avoid generic statements and highlight something with a potential future impact on the field of transport, and by extension to the society and EU policy. TRIMIS horizon scanning contributions should be prepared following a common format presented in Table 1. Contributions will be sent to TRIMIS to be reviewed, stored in the TRIMIS database and forwarded through the appropriate channels to the JRC horizon scanning scheme. The scanner name providing the contribution should be included so that they can be reached for additional clarifications.

Table 1. Horizon scanning information sheet.

Field	Description
HS_ID	Identification number of horizon scanning sheet
Item	Short indicator of issue/theme/technology/event/legislation
Keywords	Small number of identifying keywords/tags
Date	Track of last update
STRIA_RM	Identification of relevant STRIA roadmap(s) that will be impacted, or absence of relevant STRIA roadmap(s)
Mode of transport	Road/Rail/Water/Air or Multimodal
Relevant geography	Node/Urban/Flows/not applicable
Timescale	Short/medium/long term
Summary	Short summary of the issue/theme
Description	Why is this important and what is changing
Impacts	Possible future consequences or impacts
Policy implications	Contribution of technology, e.g. to achieve policy objectives
Importance rating	Significance of technology, etc. in light of policy objectives
Actors involved	Organisations that are, or need to be, involved to deliver the technology
Source	Source(s) of information

Source: Own elaboration

The labelling of items according to STRIA roadmaps supports analysts in selecting those developments that are of interest for a specific field of transport innovation. The same applies to 'mode of transport' and 'relevant geography' variables. Moreover, the inclusion of a more extensive tagging system in the TRIMIS horizon scanning information sheet enables more focused internal analyses, supporting specifically the STRIA framework, by both linking advances and potential disruptions to current roadmaps.

The contributions forwarded to the JRC horizon scanning scheme will include a selection of the above elements, as presented in Table 2 allowing a wider scanning without setting technological, modal, spatial, societal or other limits, while focusing on transport.

Table 2. Horizon scanning information to be forwarded to the JRC horizon scanning scheme.

Field	Description
Title	A short and specific title
Summary	Short summary of the issue/theme
Description	Why is this important and what is changing? Possible future consequences or impacts
Date	When did the source material appear
Source	Source(s) of information

Source: Own elaboration

A large amount of information can follow from the horizon scanning exercise. A framework is therefore proposed to structure the data and facilitate the process of deriving insights from the horizon scanning sheets. The framework is shown in Table 3 below. It brings together four important dimensions: 1) timeframe, 2) STRIA roadmap, 3) mode of transport, and 4) importance rating. In the rows, both the timeframe and

STRIA roadmaps are mentioned as the basic grouping variables. The columns show the modes of transport and can be amended to cover a number of themes if necessary. In each cell the number of the horizon scanning sheet that is relevant for that specific roadmap, mode of transport and timeframe is mentioned. The shape of the figure in which the number is mentioned is indicative of the issue's importance rating, which can be either low, medium or high.

Table 3. Horizon scanning integrative framework (illustration).

Time	RM	Road	Rail	Water	Air	Multi	Themes
Short term	CAT	①	②				
	ALT						
	EV						
	VDM				③		
	NTM						④
	SMO		⑤			⑥	
	INF						
Medium term	CAT						⑦
	ALT				⑧		
	EV						
	VDM						
	NTM		⑨				
	SMO			⑩			
	INF						⑪ ⑫
Long term	CAT						
	ALT	⑬ ⑭					
	EV						
	VDM						
	NTM				⑮		
	SMO					⑯	
	INF						

Abbreviations: RM: STRIA Roadmaps; CAT: Cooperative, connected and automated transport; ALT: Low-emission alternative energy for transport; EV: Transport electrification; VDM: Vehicle design and manufacturing; NTM: Network and traffic management systems; SMO: Smart mobility and services; INF: Infrastructure.

Importance rating: ○ = low / □ = medium / ⬡ = high

Source: Own elaboration

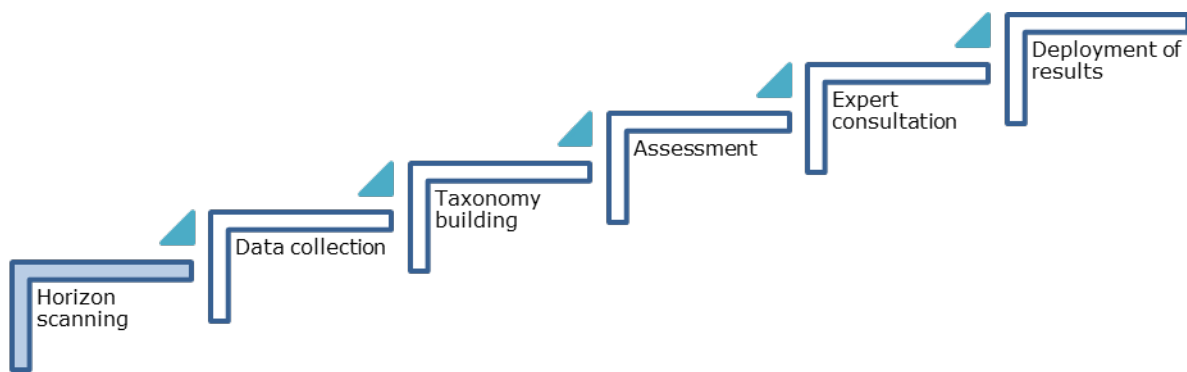
The framework enables analysts to readily observe where most developments are concentrated and where their attention is needed. When a number of items are mentioned in the same cell, it may give rise to further analysis on potential interaction effects.

As stated before, the horizon scanning exercise provides input to several other activities. Firstly, the horizon scanning insights will support the analysis on NETT in transport. The

NETT analysis aims to identify those technologies that are promising for advancing the EU policy goals. The analysis is mainly based on technology oriented desk research and patent statistics. The NETT inventory will not include technologies in the strict sense but also innovation in the transport sector in general, including innovative transport trends and initiatives.

The entire process is based principally on the activities shown in Figure 5 and described below:

Figure 5. Activities for creating a NETT in transport inventory.



Source: Gkoumas et al., 2018.

Focusing on the different activities, the horizon scanning exercise complements these analyses by describing the broader push and pull factors that impact the relevance of a specific technology. Horizon scanning provides essential input for the creation of an ontology of technologies and trends that are candidate for further analyses.

The starting point for the creation of the NETT inventory is the TRIMIS database. The “technologies” and “technology themes” that constitute a basic NETT taxonomy are identified using as a basis the TRIMIS database. Horizon scanning complements and enriches the NETT database with elements that may not be part of the existing NETT inventory. In this sense, it complements the NETT inventory with forward oriented elements, therefore covering the entire spectrum of technologies with a future potential.

The principal activities are summarised as follows:

- This data collection process includes several steps that secure the as-complete-as possible collection of data for the taxonomy, using structured and unstructured data sources.
- The taxonomic modelling is developed in three sequential steps, comprising: the identification of domain elements, the definition of the taxonomy dimensions and the definition of the taxonomy attributes.
- The NETT assessment focuses on their maturity level and their readiness for implementation, using a broad range of KPIs (e.g. TRL levels).
- The last step for developing the inventory of NETT is the consultation with experts in different sectors of transport and other horizontal or transversal sectors.
- Finally, outcomes of the NETT in transport assessment are disseminated both statically and dynamically (in the form of infographics) using different numerical and graphical representations, including evolutionary tree diagrams.

The presented horizon scanning framework is aligned with the variables as used in the NETT analyses, so that linkages between both studies are facilitated.

A second link is established with the capacity mapping exercises, which aim to understand the current resources available for transport R&I and future requirements. For instance, in a recent report on R&I capacity in connected and automated transport (van Balen *et al.*, 2018), a fit-gap analyses could be presented by linking the current with the required research needs as determined by the horizon scanning exercise. By comparing current and future needs in terms of skills and resources, horizon scanning helps to better understand where opportunities lay for Europe in connected and automated mobility.

3.4 TRIMIS horizon scanning implementation

In order to understand how the horizon scanning exercise can be organised efficiently, four implementation scenarios have been evaluated within the TRIMIS context. Implementation scenario A includes the development and use of an in-house TRIMIS horizon scanning Team. Implementation scenario B includes the use of a JRC-wide horizon scanning scheme. This will require the introduction and addition of the transport theme to the themes covered by the pilot activities (e.g. Energy and climate change and Migration and security) and provision of the relevant guidelines and keywords according to the STRIA roadmaps and the existing EU political framework on transport. Implementation scenario C includes the outsourcing of the horizon scanning activity of the TRIMIS to an external organisation specialised in horizon scanning having an already set-up network of scanners and scanning procedures. Finally, implementation scenario D includes the use of a JRC-wide horizon scanning scheme combined with support from dedicated external sources that will use an already set-up network of scanners and scanning procedures. The inputs provided by the external sources will be forwarded to the existing horizon scanning scheme. Out of the examined scenarios, scenario D was the selected solution.

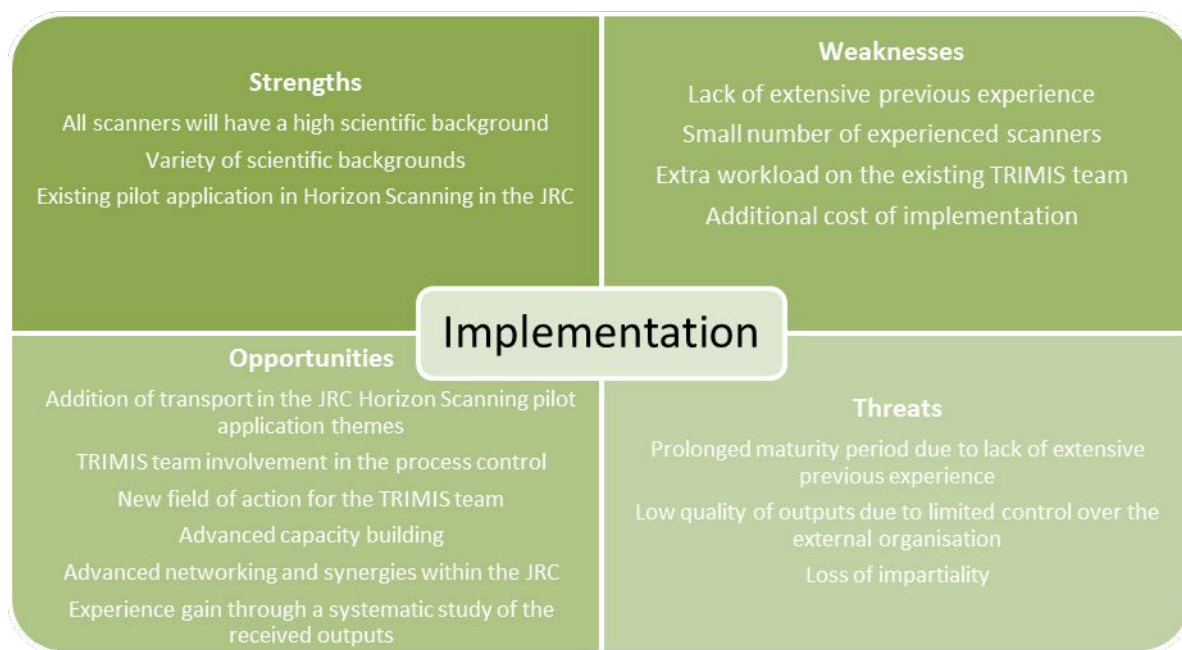
The use of a JRC-wide horizon scanning scheme instead of a fully outsourced scheme will also contribute towards the independency of the JRC policy advice, from an independent and multidisciplinary research service of the EC that is secure against biased scanning inputs and horizon scanning outputs.

The TRIMIS team will review inputs provided by the external sources and forwarded to the existing horizon scanning scheme. This will lead to opportunities for advanced networking and synergies within the JRC, to advanced capacity building, and to additional insight through a systematic study of the received outputs.

Moreover, and in order to enable a broad scanning, a challenge will be to succeed in creating a nucleus of motivated scanners, something that will also help avoiding the need of an extensive dependency on external scanners. Extending the scanner-base with scanners covering a broader scientific spectrum will likely require a thorough review process for the items flagged to ensure consistency. In this context, the review process will take into account specific relevant borderline items that are present in other domains and have an impact on the transport field, even if not directly linked to transport.

A final challenge will be to cover the developments and ongoing analysis outside the transport field, yet affecting it. In this sense, societal challenges and changes in the working patterns (e.g. by introducing teleworking) have an impact that needs to be assessed since they could reduce the need for daily commute. The same applies for other sectors undertaking radical transformations (e.g. additive manufacturing in the construction sector) that could have an impact in transport logistics and freight transportation. This practice will allow for a wider and more complete identification and assessment of signals with a potential impact on the transport sector. Figure 6 provides an overview of the strengths, weaknesses, opportunities and threats of the TRIMIS selected implementation scenario.

Figure 6. SWOT analysis of implementation scenario.



Source: Own elaboration

It should be noted that there is a minimum required time before a scanner begins giving satisfactory scanning items and before the horizon scanning process reaches the minimum required standards. Therefore, time savings of at least six months could be achieved by using an existing horizon scanning scheme.

See Annex III for a detailed analysis of the four potential scenarios that have been examined.

3.5 Communication

Another main element of the horizon scanning exercise is the efficient communication of its outcomes to the TRIMIS target audience through the appropriate channels using the appropriate format.

In line with its development goals, TRIMIS aims to provide insights for transport R&I related audiences, including:

- STRIA Working Groups and relevant policy-makers
- TRIMIS users and transport stakeholders in general
- The JRC horizon scanning community

The outputs need to be formatted in a way tailored to the needs of the audience and thus the format can be varying, including:

- STRIA Technology assessment reports
- Policy briefs
- NETT and horizon scanning focused reports

These outputs will present the extensive and complex analysis in a format that is intuitive and comprehensible, so to facilitate the dissemination of knowledge amongst stakeholders and decision-makers.

4 Conclusions

The JRC undertakes the monitoring and assessment on specific themes and scientific areas. The horizon scanning process will take advantage of the potential benefit of developing a cross-thematic and cross-disciplinary common space. Continuous monitoring of current advances could lead to the identification of emerging issues with possible future impacts and clustering of diverse items from the whole scientific and technological spectrum. It will ensure better visibility from a higher level of observation and monitoring, avoiding limitations caused by monothematic approaches.

The JRC possesses a wide professional and scientific human capital. In order to achieve maximum engagement of scanners, the horizon scanning process should be beneficial to their work. Apart from scanning patterns, appropriate workshop times and locations should be selected in order to assist JRC personnel involved in the horizon scanning process to regularly participate and to increase the efficiency.

From the analysis of the four implementation scenarios, the selected scenario has the most benefits but also an additional cost due to the necessary support of external contractors.

Horizon scanning within the TRIMIS context will focus on the following:

- TRIMIS will invest in and utilise the current Horizon Scanning @ JRC scheme.
- Transport will be added to the current horizon scanning themes.
- The TRIMIS team will join the Horizon Scanning @ JRC scheme.
- Work towards the development of a Commission-wide network of scanners through the appropriate information and dissemination activities.
- Use of horizon scanning findings for the Future and Emerging Technologies inventory building process.
- Use of horizon scanning findings to support TRIMIS policy recommendations.
- Work towards a clear positioning and promotion of Transport R&I-related issues within the Megatrends context.

TRIMIS is a collaborative project since the users can benefit and contribute to an institution-wide horizon scanning scheme. By implementing horizon scanning it will establish a continuous two-way data feed with Horizon Scanning @ JRC and Megatrends Hub providing resources (e.g. reports, KPIs) with relevance to emerging trends and existing megatrends, thus contributing to the production of the desired policy insights in line with the emerging anticipatory culture within the EU. The proposed approach will lead to opportunities for advanced networking and synergies within the JRC, to the development of advanced capacity building, and to gained experience through a systematic study of the received outputs.

Finally, the value of horizon scanning in the context of TRIMIS is dependent on interpreting signals of change in areas with a potential relation and impact on transport. This can then be linked to a broader context and provide valuable insights for the JRC and for EU policymakers. Horizon scanning will act a supplementary science-for-policy interface, gathering, analysing and providing collective intelligence on potential future challenges interconnected with a wide spectrum of transport elements.

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List of abbreviations and definitions

DG MOVE	Directorate-General for Mobility and Transport
DG RTD	Directorate-General for Research and Innovation
EASAC	European Academies Science Advisory Board
EC	European Commission
EMM	Europe Media Monitor
EPSC	European Political Strategy Centre
ERA	European Research Area
ESPAS	European Strategy and Policy Analysis System
EU	European Union
ICT	Information and Communications Technology
JRC	Joint Research Centre
KO	Key Orientations
KPI	Key Performance Indicator
NETT	New and Emerging Technologies and Trends
ORBIS	Open Repository Base on International Strategic Studies
PSF	Policy Support Facility
R&I	Research and Innovation
RIO	Research and Innovation Observatory
SET-Plan	Strategic Energy Technology Plan
SETIS	Strategic Energy Technologies Information System
SO	Specific Objectives
STRIA	Strategic Transport Research and Innovation Agenda
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TIM	Tools for Innovation Monitoring
TRIMIS	Transport Research and Innovation Monitoring and Information System
TRL	Technology Readiness Level

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Annexes

Annex I. Institutional backdrop

Beginning from 2011 the concept of horizon scanning has constantly been incorporated in the JRC annual management planning. In the JRC Management Plan of 2011 it is included under the Specific Objectives (SO) for operational activities i.e. activities aiming at putting into place all the necessary tools and mechanisms/processes to make the JRC Strategy a success. Specifically it is included under the SO 2 entitled "Specify and detail the JRC's role in support of the European Research Area (ERA) and the Innovation Union", for which the JRC will increase its policy support capacity, with horizon scanning being one of the capacities that will allow the support of the Innovation Union and the ERA. It will also support the development of Joint Undertakings and other bodies, offering skills in developing underlying information systems such as the Strategic Energy Plan (SET-Plan) and Information System (SETIS) and contributing to the development of the governing framework for these bodies (European Commission, 2015, 2017b).

In the JRC Management Plan 2012 annual challenges, the development of capabilities in horizon scanning & foresight and anticipation of new policy needs and the dissemination of scientific information will have a central role in delivering on the new orientations, also aspiring on the enhancement of the support its support to the implementation of the Innovation Union flagship initiative and the European Research Area that began in 2011. Also, the Specific Objectives (SO) for operational activities and specifically SO5 "Strengthen the integration of scientific advice into policy-making by providing additional inputs to the policy cycle, including: Analysis of the economic dimension and policy options, Anticipation of new policy needs, Related modelling, Analytic Facts & Figures" calls for an integrated approach for the preparation and implementation of EU legislation and reinforcement of the JRC competences including horizon scanning in a series of relevant fields. In this context, the implementation of horizon scanning and foresight analysis in areas that require horizontal approaches and crosscutting disciplines is of high importance since foresight, anticipatory and horizon scanning analyses will allow the JRC to identify and communicate areas where new scientific developments and socio-economic trends could require new JRC research activities.

Dominique Ristori, former Director-General of the JRC, in his speech at the European Commission-EASAC High-level Event on Independent Scientific Advice for EU Policies entitled "Strategic Foresight for Future EC Policy initiatives" held in Brussels on 16 October 2012 highlighted the importance of strategic Foresight and its potential contribution to the development of EU policy initiatives, presented the involvement of JRC in Foresight and proposed the reinforcement strategic Foresight activities for policy-making. JRC had recently developed a new capacity for foresight and horizon scanning, while being one of the few Commission services with relevant experience and capacity. On horizon scanning, the JRC provided an early identification of emerging scientific and technological developments, assessing their potential socio-political implications and the need for relevant research activities. The main product of this activity was a Horizon Scanning Bulletin planned to be issued four times a year and distributed to all DGs plus a special issue on the future of the car. Four relevant studies were active at the JRC, namely:

1. Eco-innovation and eco-industries
2. Tomorrow's healthy society – research priorities for foods and diets
3. Food security
4. Future needs for standardisation in the context of innovation and competitiveness in 2025.

In the JRC Management Plan 2013 annual challenges, foresight studies and horizon scanning are highlighted as critical for "the continued development of key horizontal competences and capacities needed for the repositioning of the JRC as the in-house science service providing pro-active policy advice at the heart of the Commission's policy process". Foresight and horizon scanning was added to the JRC core indicators table, with

Reports and identification of new research areas being the indicator and the number of Foresight Studies and Horizon Scanning Bulletins being annually measured since 2012. Horizon scanning can be found also under SO 6 “Strengthen the integration of scientific advice into policy-making by providing additional inputs to the policy cycle” retaining the requirements stated in 2012 under SO 5.

In the JRC Management Plan 2014 the JRC General objective 1 calls for the provision of an integrated and pro-active scientific and technical support to the European policy making process. The SO 1b aims “To provide customer-driven scientific and technical support to Union policies, while flexibly responding to new policy demands in the area of the ‘Single market, growth, jobs and innovation’ that calls for use of foresight for the identification of research and innovation priorities and the application of horizon scanning techniques and dissemination of results. Foresight and horizon scanning remained on the JRC core indicators table, with reports and identification of new research areas being the indicator and the number of Foresight Studies and Horizon Scanning Bulletins being annually measured. The JRC set of core indicators is based on the balanced scorecard concept and includes a series of indicators on impact, productivity and efficiency.

In the Joint Research Centre (JRC) Management Plan 2015, foresight and horizon scanning remained on the JRC core indicators table, with reports and identification of new research areas being the indicator and the number of Foresight Studies and Horizon Scanning Bulletins being annually measured. In the Key Orientations (KO) of the JRC Work Programme for Research, Science and Innovation, foresight and horizon scanning are included in the framework conditions for research and innovation, including national policies. Additionally, horizon scanning and foresight processes are included in the cross-cutting activities intended to be used in order to continue developing the monitoring capacity of significant trends, anticipating societal challenges, tackling complex problems and identifying forward-looking solutions.

In the JRC Management Plan 2016, horizon scanning is included in the KOs for the JRC multi-annual work programme 2016-2017, specifically under KO 1 “A new boost for jobs, growth and investment”. For research, science and innovation, modelling, monitoring and analysis of the R&I main drivers and socioeconomic barriers is required, along with an analysis and ex-ante assessment of the socioeconomic impact and effectiveness of R&I policy instruments at European Union (EU), Member State and regional level, as well as at the sectoral and cross-sectoral level. In this framework the use of Research and Innovation Observatory (RIO) is highlighted for the processes of collection, production and dissemination of data and analysis related to national R&I policies to be used in country monitoring in the European Semester. The development and use of indicators, scoreboards, information systems and web platforms for monitoring and analysing progress in the implementation of the Innovation Union and the European Research Area for Member States and key strategic partners is also highlighted.

The Directorate of Tuesday 26 July 2016 decided to implement horizon scanning in the JRC as a pilot activity. The horizon scanning pilot activity focus was planned to be twofold, on:

- Energy and climate change (particularly the short-term impacts of climate change)
- Migration and security

The first outcomes of the pilot were expected by the end of December 2016. In this framework, a call for interest for people that are interested in horizon scanning and would like to become scanners and contribute to this pilot activity was launched in search for people willing to invest time in at least one of the focus areas exploring for weak signals that could be defined as:

- Emerging issues
- Outlier behaviour
- Discontinuities

- Unconventional wisdom
- Disruptive technologies

These signals would be indicators of potential future changes with significant socio-political impact, possibly not yet on the policy radar. The deadline for the manifestation of interest was 20 September 2016, with JRC I.2 being responsible for receiving possible manifestation of interest. Each applicant should indicate their area/areas of interest and their view on contributing to the pilot activity.

On 20 October 2016 the first meeting of the network of horizon scanning correspondents in the Knowledge Management Units who will play a crucial role in the Pilot Project to be launched later this year took place. The next step planned was the recruitment of a group of scanners throughout all JRC thematic Directorates to collect and share items that would be potential weak signals.

On 4 August 2016 DG JRC Director General Vladimir Sucha posted on Connected Commission web platform an invitation for contribution to the horizon scanning pilot project "Horizon Scanning @ JRC" that has been launched within the JRC with the aim to test the process and the possibility make use of the existing human resources and collective intelligence in view of the need for strengthening the anticipatory capacity of the Commission in order to enable it to identify knowledge needs at an early stage. The JRC could potentially play a key role towards this goal since it already incorporates a high level of necessary expertise and tools, as highlighted in the 2030 Strategy.

In the JRC Management Plan 2017 the focus is on the implementation of change and fine-tuning within the context of the new JRC 15-year development strategy launched in 2016, having a proactive and long-term perspective up to 2030. Flexibility, responsivity and cross-thematic work and collaboration are the main new characteristics that need to be promoted. Thus, JRC activities will be related to ten inter-linked groups of policies called priority nexus with the aim of promoting cross-sectoral connections and collaboration and the establishment of a multidisciplinary approach towards the accomplishment of higher competitiveness, fairness and resilience. Horizon scanning, foresight or technology watch are some of the tools that need to be further used for this goals. Horizon scanning is continually included in the JRC KOs in the area of "Research, Science and Innovation" and in the required outputs related to knowledge management under "Knowledge Management Methodology and Knowledge Sharing". Horizon scanning performance is one of the indicators used for which a Follow-up on definition of methodology, processes and strategic business intelligence courses is required and having March 2017 as the target date for the set-up of a relevant process in collaboration with JRC I.2. Dedicated training courses with experts on horizon scanning have been organised to help the 'scanners' familiarise with weak signals of change, search, presentation, storage, tagging and tracking methods.

On March 8 2017 a dedicated horizon scanning training took place at the JRC Ispra premises.

On Jul 5, 2017 JRC Director General Vladimir Sucha announced on Connected Commission the launch of the Megatrends Hub pilot in line with the JRC strategy, highlighting the importance of the development of anticipatory culture and the significance of foresight and the need for a systemic and systematic cross-disciplinary assessment of developments with potential future implications.

The Megatrends Hub is expected to contribute to increased foresight capacity, creating a framework for thinking about the future and linking most foresight activities on one platform and therefore requires the contribution of all compatible work in order to complete the system and to make it relevant for policymaking and users in general.

Scanning the Horizon Bulletin

In 2011, the JRC initiated a series of activities to improve its capacity to identify science and technology developments that could potentially be useful in future EU policy making.

The edition of the Scanning the Horizon bulletin was the first product of the Science Advice to Policy, Innovation and Horizon Scanning unit. Six issues were published between November 2011 and November 2014 plus a special issue on the future of cars. It was based on a review of literature and specialised news sources using a series of categories most relevant to the spectrum of EU policies, a process that could eventually allow policy makers to use the latest scientific information and innovations as a supporting factor in the policy making process. Horizon scanning activity presented through the bulletin aimed at using the JRC capacities to offer a regular (bimonthly at the time) overview of emerging topics which might influence future European policies. Each issue covers a varying series of themes related to European policy. For each one of the themes included in the bulletins, horizon scanning items were presented including a title, the person and/or unit submitting the item, a brief description, sources and implication for policy and society.

Guidelines to horizon scanning contribution were prepared and published by JRC Science Advice to Policy Unit including a definition of horizon scanning, the reasons for developing a horizon scanning process within the JRC, the definition of horizon scanning items, namely:

1. Trends
2. (New) Drivers of Change
3. Weak Signals
4. Discontinuities
5. Shocks/"wild cards"/sudden unexpected events/"black swans"

It is highlighted that the JRC can add value to horizon scanning by summarising disperse information, identifying and clarifying issues, putting these issues into perspective and analysing implications to policy and society, both in general and at EU level. All members of JRC staff are considered potential horizon scanners and could contribute to the Horizon Scanning Bulletin through the submission of small half page items from any reliable and traceable source without any domain limitations.

The preparation of the contributions that could potentially be published in the Horizon Scanning Bulletin could have the form of one of the following:

1. A short text
2. A bullet point list
3. An original source highlighted accordingly

A short text of 300-500 words summarising the selected issue and providing an analysis of possible socio-political implications for the EU. Horizon scanning items should be sent to the respective JRC horizon scanning functional mailbox to the attention of the editor accompanied by the primary sources and complete references and contact information of the author for further correspondence. A bullet point list of the highlights of a specific issue, accompanied by the original source or an original source highlighting accordingly the key messages could be sent to an editor that would eventually convert them to the desirable format for publication. Information concerning the horizon scanning process could be found on the Foresight & Horizon Scanning page on the JRC Intranet.

The first Scanning the Horizon Bulletin, published in November 2011, drew information from specialised literature and news sources relevant to the fields of technology, energy, environment, science & society, agriculture & food and geopolitics. The analysis provided on the first issue was not exhaustive and was intended to serve as a pilot in order to measure the impact and readership on such information.

The second Scanning the Horizon Bulletin, published in April 2012, included a notification that it is not a news service but a process intended to support policy making within the Commission and that it is intended for internal distribution within the European

institutions only. It covered the fields of Energy, Transport & ICT, Agriculture & Food Security, Innovation, Environment & Climate Change, Health & Consumer Protection, Safety & Security.

The third Scanning the Horizon Bulletin, published in August 2013, covered issues concerning Innovation, Energy, Transport & ICT, Agriculture & Food Security, Environment & Climate Change, Stability & Growth, Health & Consumer Protection.

The fourth Scanning the Horizon Bulletin, published in March 2013, covered issues concerning Agriculture & Food, Energy, Environment & Global Change, Robotics & ICT, Biology & Health, Society, Economy, Technological Innovation, Security. Apart from the features included in the previous issues, Keywords were added for each of the horizon scanning items.

The fifth Scanning the Horizon Bulletin, published in November 2013, covered issues concerning Energy, Biology & Health, Agriculture & Food, Economy & Industry, Technological Innovation.

A Scanning the Horizon Bulletin Special Issue was published in February 2014, entitled What Cars in what Future. This issue covered the topics of Propulsion of the Future, Vehicle Innovation, Towards Self-driving, maybe even Self-flying Cars, Changing Mobility.

The sixth Scanning the Horizon Bulletin , published in November 2014, covered issues concerning Agriculture & Food, Biology & Health, Energy, Environment, Space, Technological Innovation, Science & Society.

Annex II. Tools potentially supporting horizon scanning

Research and Innovation Observatory (RIO)

The Research and Innovation Observatory (RIO) is a European Commission initiative within the Innovation and Growth science areas developed by the JRC in collaboration with DG Research and Innovation for the monitoring and analysis of research and innovation developments at EU and national level in order to support better policy making in Europe. The RIO-PSF website is a source of information for European and national policy makers as well as other stakeholders in the field of R&I policy; users have access to Country Analysis, Policy Support Facility, Statistical Data and a Library (European Commission, 2017a).

This Country Analysis section provides information on R&I policies and performance of Member States and selected countries associated to Horizon 2020 framework programme. More specifically, for each country the data available cover the following:

- RIO Country report
- European Semester
- Key indicators
- ERA Progress
- Library
- Organisations

The Policy Support Facility (PSF) is designed to provide practical support to Member States and associated countries in for the design, implementation and evaluation of reforms that enhance the country's R&I framework. More specifically it provides:

- Peer reviews
- Mutual learning exercises
- Specific support to countries

The statistics section provides data, key indicators and interactive visual tools covering the field of innovation.

- Inputs – Investments & Human Resources
- Framework conditions
- Innovation outputs
- Impact

Finally, the library section provides a series of national and EU R&I policy documents

Europe Media Monitor (EMM)

The European Commission's Joint Research Centre Competence Centre on Text Mining and Analysis has developed Europe Media Monitor (EMM), a family of applications monitoring and analysing a large number of news reports from thousands of news sources in more than sixty languages daily, 24 hours a day 7 days a week (European Commission, 2018). Through the use of advanced information extraction techniques is able to identify information in the news, categorise it, locate it, and determine who is involved and what is reported, aggregate the information, issue alerts and produce intuitive visual presentations of the information found. The process involves recognising names mentioned in the news either creating automatically a new entity for cases of new occurrences or adding them to previously known entities. EMM allows users to track what is being said by people and organisations, follow news on a given topic and see what the biggest stories are currently in a given language. Users have the option to customise the received output in order to see news falling into specific subjects or concerning specific

countries or by specific news sources. Registered organisations can further filter the news and produce their own newsletters and email or PDF versions can be sent to defined user groups. EMM features newsfeeds organised by:

- EU Focus
- EU Policy areas
- Themes
- Geographical Division
- Offices & Agencies

Under Current EU policy areas exist among others:

- Research, Science and Innovation
- Transport

Tools for Innovation Monitoring (TIM)

Tools for Innovation Monitoring allow users to extract knowledge and intelligence from datasets containing textual information (European Commission, 2016). Currently there are four active online tools, namely:

- Tim Technology
- TIM Edge
- TIM Energy
- TIM Cyber Security

TIM Technology includes specific technology watch systems to map areas of science and innovation. Specifically, TIM Edge is a monitoring system intended to track emerging technologies listed in thematic fields as they progress towards market applications, display relevant and provide data visualisation using networks graphs, word clouds, maps and histograms, while TIM Energy is used for mapping technologies and innovations in the field of Energy as identified in the Strategic Energy Technologies Plan (SET-Plan). Finally, TIM Cyber Security is used for the mapping of cyber-security through domains of specialisations, sectorial dimensions and technological applications.

TIM Technology Editor, an additional development tool restricted to EU institutions' staff, is used for the exploration of science and innovation through gathering scientific literature, patent data, news articles and data from R&D projects funded by the EU. Additional TIM tools are either being developed or in the pipeline.

Datasets used in the context of TIM tools are acquired from four data providers according to the specific type:

- Scientific publication data (currently retrieved from Elsevier)
- Patents data (currently from retrieved from the European Patents Office)
- EU funding data (currently retrieved from CORDIS database)
- R&D project data (currently retrieved from EUREKA)

ESPAS

Finally, it should be mentioned that the European Strategy and Policy Analysis System (ESPAS), is an inter-institutional project of the European Parliament, the European Commission, the Secretariat General of the Council of the European Union and the European External Action Service aiming at strengthening the EU forward planning capacities. ESPAS provides a framework for cooperation and consultation at administrative level, on a voluntary basis, that will allow the involved parties to work

together on medium and long-term trends facing or relating to the European Union (European Union, 2016a).

In this context the Open Repository Base on International Strategic Studies (ORBIS), an on-line open library on long-term trends publications, has been developed, intended to be the first global foresight hub including the largest library of prospective studies (European Union, 2016b).

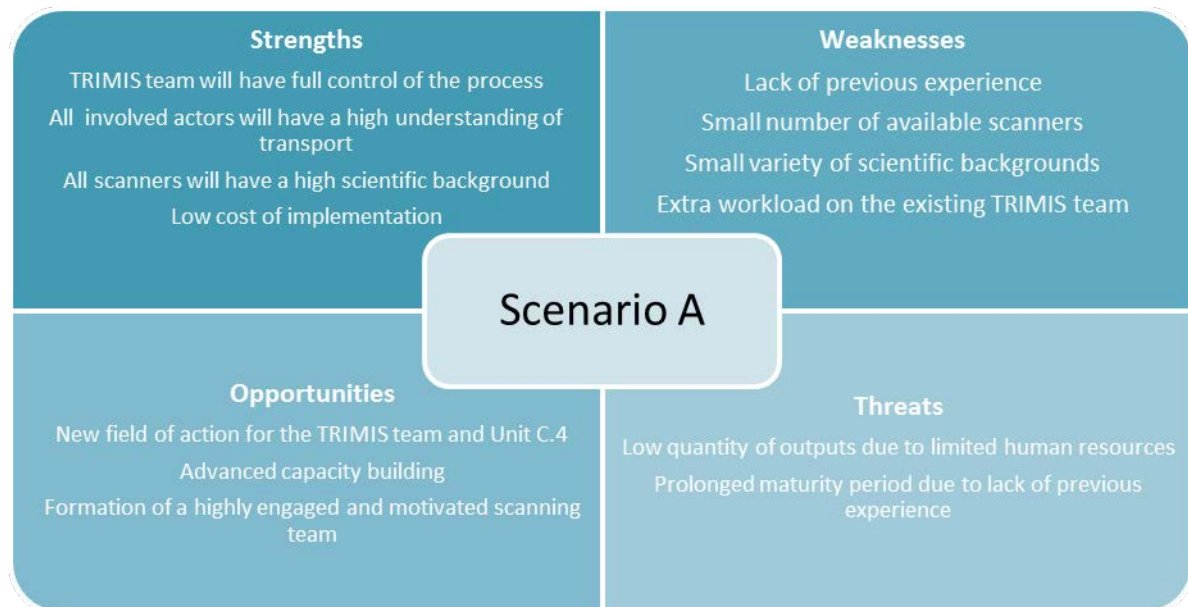
The ESPAS process is coordinated by a steering group, encompassing senior officials from the participating EU institutions or bodies and it is chaired by the Head of the European Political Strategy Centre (EPSC) in the European Commission. The secretariat of the network is provided by the European Parliament and the ESPAS project team implements the guidelines decided by the steering group. Under the guidance of the inter-institutional ESPAS steering group, the ESPAS network will continuously update the ESPAS knowledge base on key long-term trends and additionally an ESPAS Conference will be held annually.

Annex III. TRIMIS horizon scanning implementation scenarios

Implementation scenario A – In-house TRIMIS horizon scanning

Implementation scenario A includes the development and use of an in-house TRIMIS horizon scanning team. The team will be responsible for the successful completion of all stages of the horizon scanning process.

Figure A1. SWOT analysis of implementation scenario A.

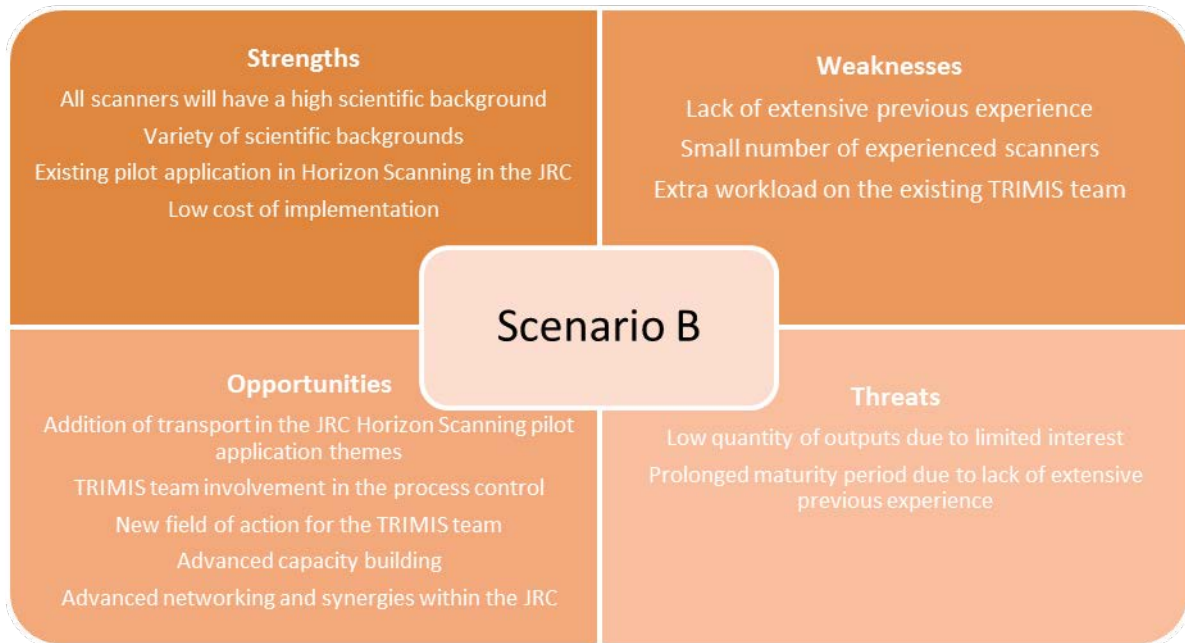


Source: Own elaboration

Implementation scenario B – In-house JRC horizon scanning

Implementation scenario B includes the use of a JRC-wide horizon scanning scheme. This will require the introduction and addition of the transport theme to the themes already covered by the pilot activities (e.g. Energy & climate change and Migration and security) and provision of the relevant guidelines and keywords according to the STRIA roadmaps and the existing EU political framework on transport.

Figure A2. SWOT analysis of implementation scenario B.

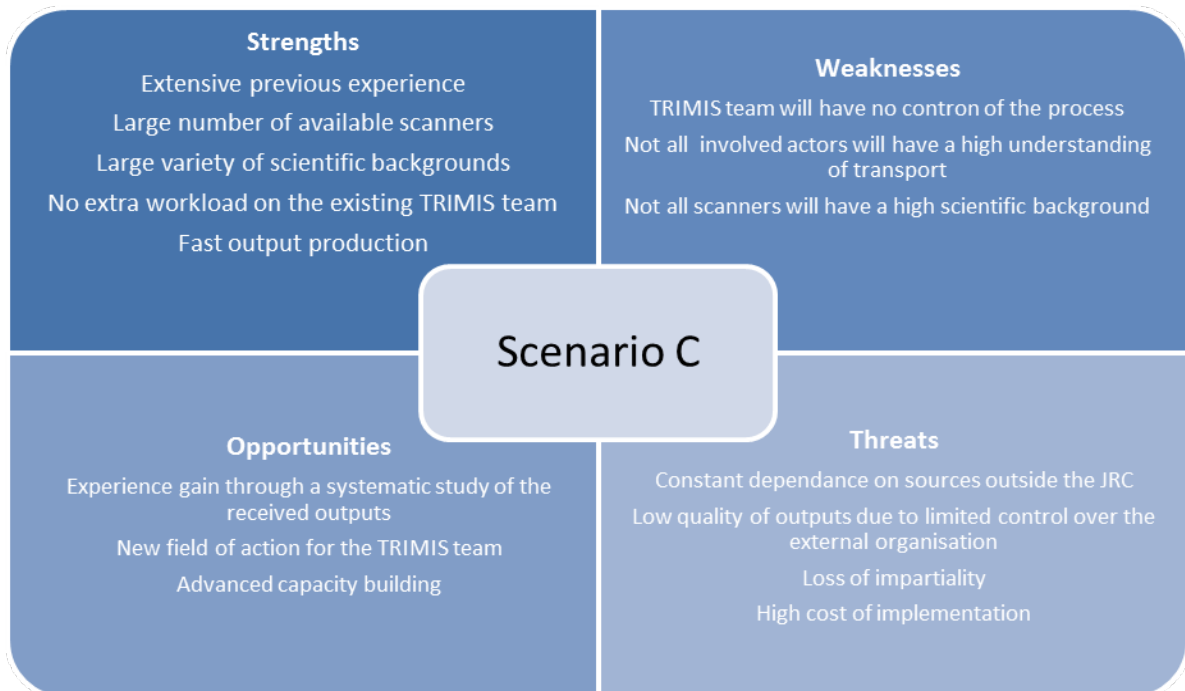


Source: Own elaboration

Implementation scenario C – External horizon scanning

Implementation scenario C includes the outsourcing of the horizon scanning activity of the TRIMIS to an external organisation specialised in horizon scanning having an already set-up network of scanners and scanning procedures.

Figure A3. SWOT analysis of implementation scenario C.

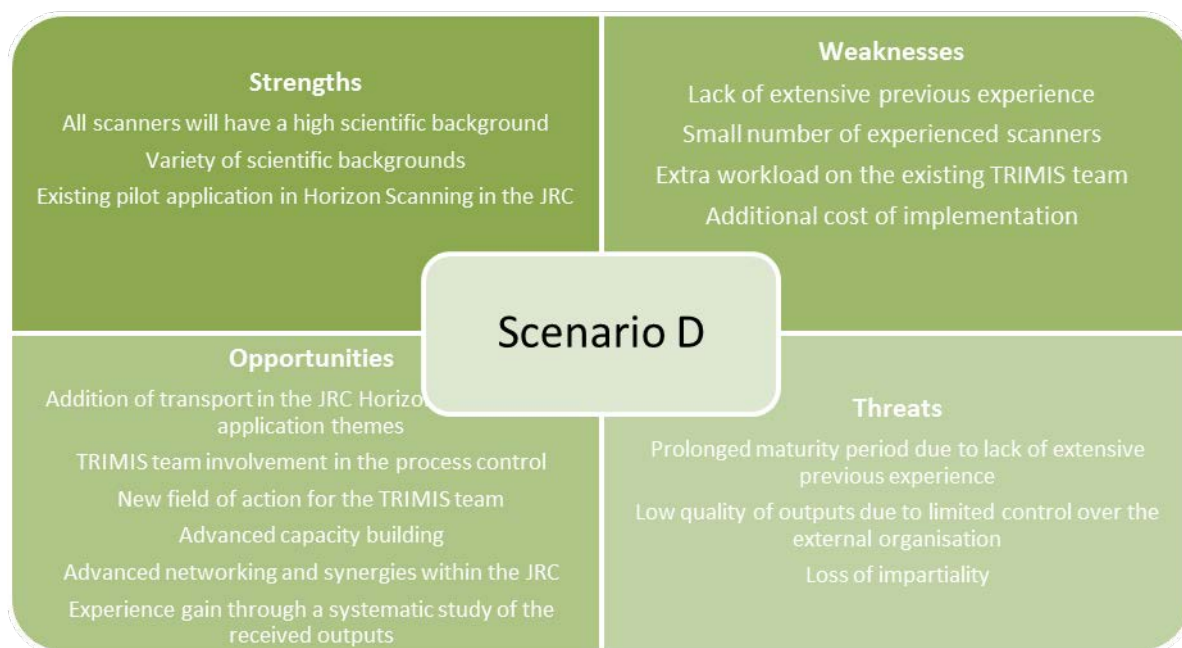


Source: Own elaboration

Implementation scenario D - Hybrid approach for horizon scanning

Implementation scenario D includes the use of a JRC-wide horizon scanning scheme combined with support from dedicated external sources that will use an already set-up network of scanners and scanning procedures. The inputs provided by the external sources will be reviewed by the TRIMIS team and forwarded to the existing horizon scanning scheme.

Figure A4. SWOT analysis of implementation scenario D.



Source: Own elaboration

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