High Speed Rail and Territorial Cohesion along the design process

From requirements to assessment framework and digital tools

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Index

01. Research question

The Sustainability Report

Assessment of the socio-economic impacts of the infrastructures, with specific reference to

- the promotion of **social inclusion**,
- the **reduction of inequalities** and territorial differences
- Improving the **quality of life** of citizens

Assessment of any significant contributions to at least one or more of the following environmental objectives, as defined in the context of the same regulations, taking into account the life cycle of the work to

- climate change mitigation;
- adaptation to climate change;
- sustainable use and protection of water and marine resources;
- transition to a circular economy
- prevention and reduction of pollution;
- protection and restoration of biodiversity and ecosystems;

Contribution to territorial cohesion

References

PNRR Guidelines
for the elaboration of the technical and economic feasibility project to be considered at the base of public work tenders of the National Recovery and Resilience Plan and Complementary National Plan

New Italian Procurement Code
With the publication in the Official Journal of Legislative Decree No. 36 of March 31, 2023, the new Public Procurement Code is applied to public tenders for works, services, and supplies launched from July 1, 2023.

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02. Goals, methodology and phases

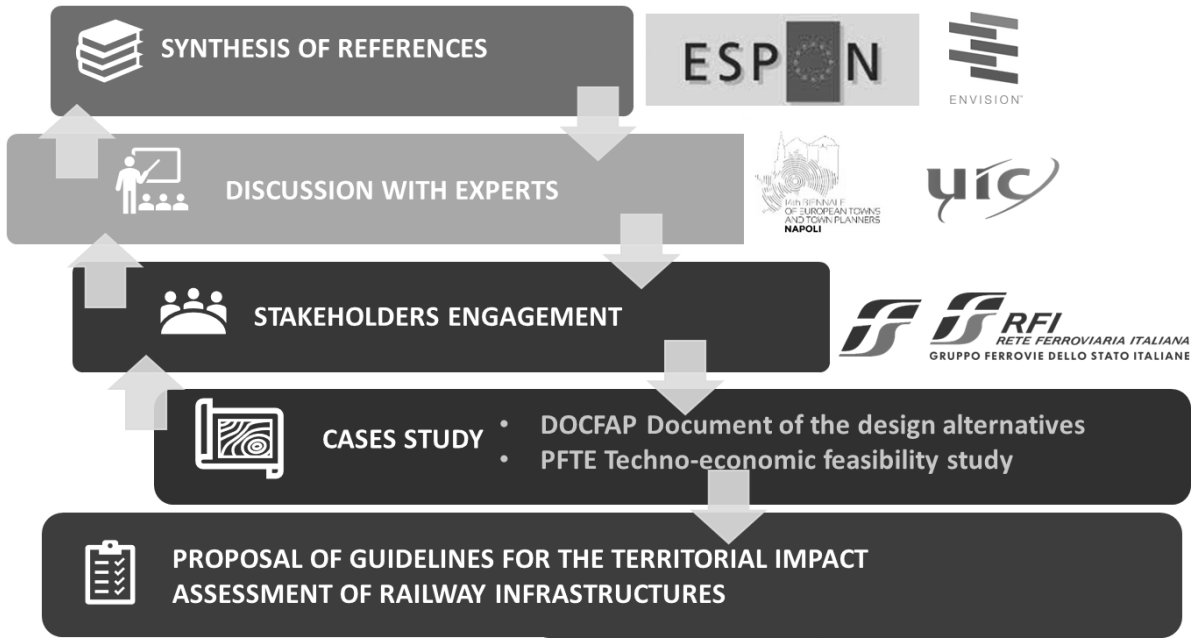
Goals

The Guidelines for the Territorial Impacts Assessment of Railways are aimed at ***guiding designer, clients and policy makers in the evaluation of railway project contribution to territorial cohesion***, building a bridge with key sustainability performance indicators.

Methodology

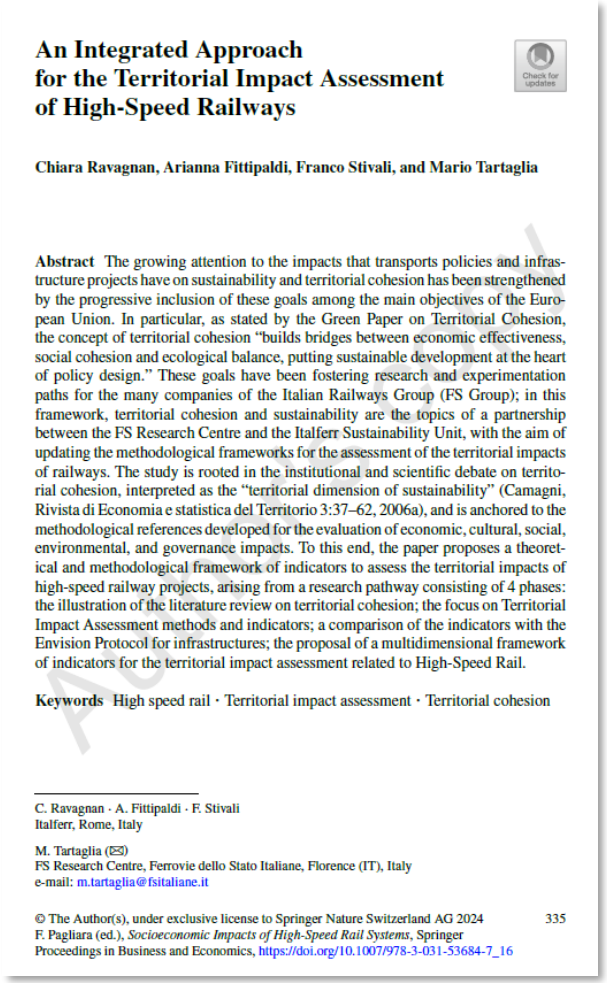
The study considers the ***concept of territorial cohesion, interpreted as "the territorial dimension of sustainability"*** (Camagni, 2006a), focusing on the Territorial Impact Assessment method (Medeiros, Camagni, Prezioso) and, in particular, on the pioneering Tequila methodology developed by Camagni (Camagni, 2006a).

Phases



03. Synthesis of references and framework proposal

State of the art



An Integrated Approach for the Territorial Impact Assessment of High-Speed Railways

Chiara Ravagnan, Arianna Fittipaldi, Franco Stivali, and Mario Tartaglia

Abstract The growing attention to the impacts that transports policies and infrastructure projects have on sustainability and territorial cohesion has been strengthened by the progressive inclusion of these goals among the main objectives of the European Union. In particular, as stated by the Green Paper on Territorial Cohesion, the concept of territorial cohesion "builds bridges between economic effectiveness, social cohesion and ecological balance, putting sustainable development at the heart of policy design." These goals have been fostering research and experimentation paths for the many companies of the Italian Railways Group (FS Group); in this framework, territorial cohesion and sustainability are the topics of a partnership between the FS Research Centre and the Italferr Sustainability Unit, with the aim of updating the methodological frameworks for the assessment of the territorial impacts of railways. The study is rooted in the institutional and scientific debate on territorial cohesion, interpreted as the "territorial dimension of sustainability" (Camagni, Rivista di Economia e statistica del Territorio 3:37–62, 2006a), and is anchored to the methodological references developed for the evaluation of economic, cultural, social, environmental, and governance impacts. To this end, the paper proposes a theoretical and methodological framework of indicators to assess the territorial impacts of high-speed railway projects, arising from a research pathway consisting of 4 phases: the illustration of the literature review on territorial cohesion; the focus on Territorial Impact Assessment methods and indicators; a comparison of the indicators with the Envision Protocol for infrastructures; the proposal of a multidimensional framework of indicators for the territorial impact assessment related to High-Speed Rail.

Keywords High speed rail · Territorial impact assessment · Territorial cohesion

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03. Synthesis of references and framework proposal

A proposal

SUSTAINABILITY REPORT (MIMS, 2021)	PILLARS	INDICATORS	METRIC	TERRITORIAL BENCHMARKS/SENSITIVITY PARAMETERS (regional value)	Sources
REDUCTION OF TERRITORIAL IMBALANCES	Territorial Efficiency	**Railway infrastructure safety (reduction of interference)**	Pedestrian crossings addition (no.) Rail crossing reduction (n.)	**Deaths in railroad crossings (number)**	RFI - Rete Ferroviaria Italiana
		External accessibility (to national and international infrastructure nodes)	Reduction of access times to HS stations, Ports and Airports (minutes)	**Number of inhabitants in peripheral municipalities according to National Strategy for Inner Areas (n. of inhabitants per Region)**	Agenzia Nazionale per la Coesione
		Density of Infrastructural equipment	Increase of railway equipment per area (km of railways per km^2)	**Regional railways density per area (km/km^2)**	RFI - Rete Ferroviaria Italiana Eurostat
		Safety of people (reduction of accidents)	Modal shift (Additional % of railway modal share in relation to car share)	**Regional motorization rate (cars/inhabitants)**	Eurostat
		Expense for work purposes	Value of the increase in traffic for work reasons due to the additional business expense (euro/year)	**GDP per capita (euros/inhabitant)**	ISTAT - Istituto Nazionale di Statistica
		Expense for tourism purposes	Value of the increase in tourist traffic due to the additional tourist expense (euro/year)	**Tourism expense per year (euros/year)**	CNR - Consiglio Nazionale delle Ricerche
PROMOTION OF SOCIAL INCLUSION AND IMPROVEMENT OF THE QUALITY OF LIFE	Territorial Identity	**Accessibility an enhancement of historical-cultural and naturalistic heritage**	Reduction of distances from HS stations to regional and national parks or Natura 2000 network (km)	**Number of natural parks, cultural sites and itineraries reachable by train stations (number)**	RFI - Rete Ferroviaria Italiana
			Reduction of distances from AV stations from archaeological areas (km)		
			Reduction of distances from high-speed stations, cycle paths and cultural and tourist itineraries (km)		
		Development of sustainable and resilient territorial visions	Compliance with the objectives shared by the Regional Planning in sustainable infrastructure (n. doc or goals)	**Mobility demand in Sustainable Strategies (level of demand)**	Regional Strategies for Sustainable Development
REDUCTION OF POLLUTION, MITIGATION AND ADAPTATION TO CLIMATE CHANGE AND TRANSITION TOWARDS A CIRCULAR ECONOMY	Territorial Quality	**Increase in spaces for collective use**	New spaces for social uses (n. or sqm)	**Access to services (BES range)**	ISTAT - Istituto Nazionale di Statistica
			Regeneration of abandoned or degraded spaces to communities (n. or sqm)		
		Accessibility to urban and metropolitan services	Reduction of access times at urban and metropolitan levels (minutes)		
		Mitigation of the effects on climate change	Climate-changing gas emissions avoided (tCO2e)		
		Air quality	Reduced polluting emissions (t)		
		Energy saving and renewable energy	Percentage of energy used from renewable sources (%)		
			Energy savings resulting from the modal shift (%)		
		Soil	Volumes of excavated land reused (mc)		
			Renaturalisation and/or reclamation of soil and vegetation (sqm)		

$$TI = \Sigma c_i = (\Delta c_1 \bullet \theta c_1 \bullet Src_1) + (\Delta c_2 \bullet \theta c_2 \bullet Src_2) + \ldots + (\Delta c_n \bullet \theta c_n \bullet Src_n)$$

$c_{(i=1,2,..n)}$ = All the Criteria/Indicators of the Framework

Δc_i = Indicator value Score

θc_i = Criteria/indicators weight ($0 \leq \theta c \leq 1$)

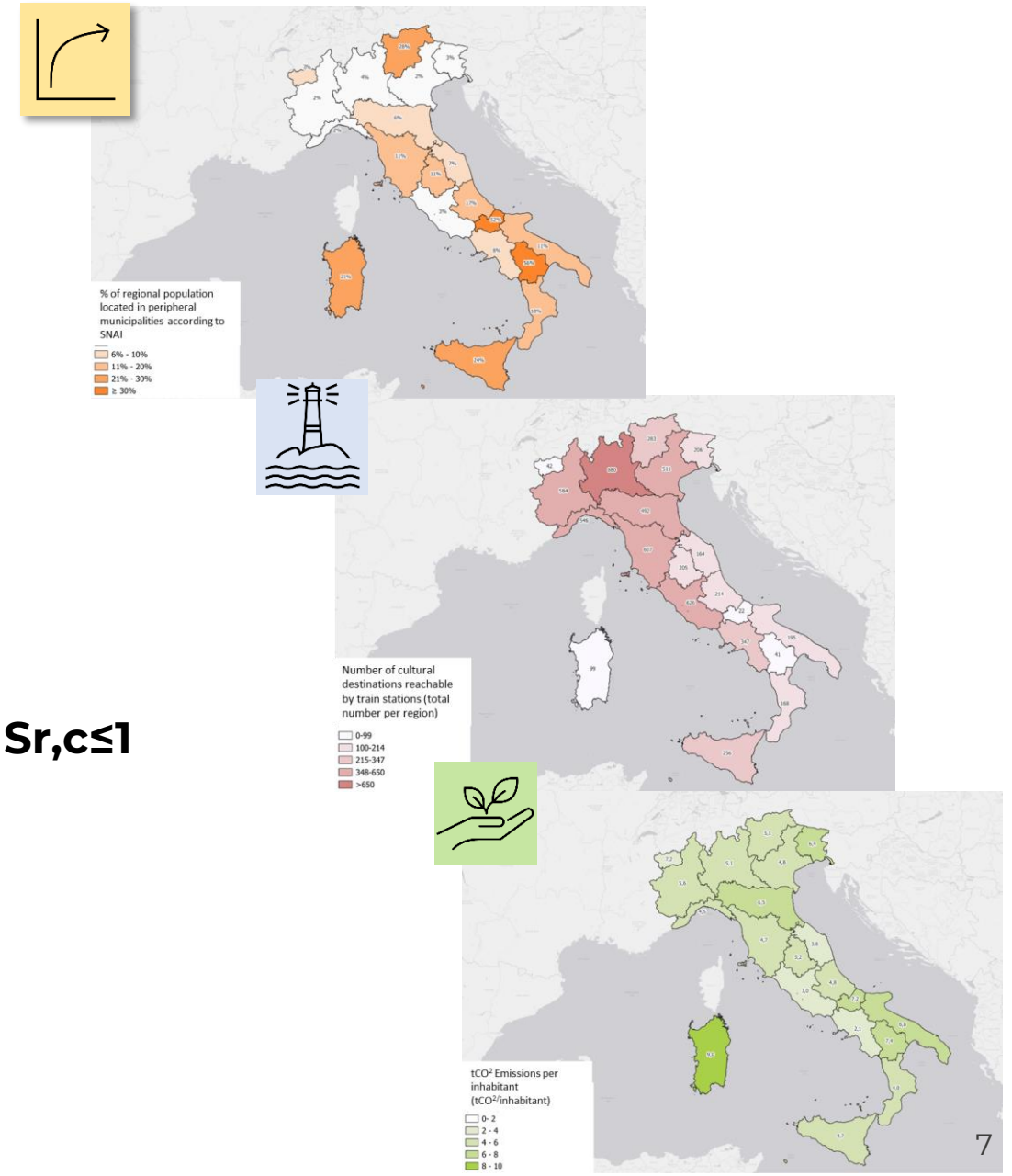
Src_i = Sensitivity of Regions ($0 \leq Sr,c \leq 1$)

03. Synthesis of references and framework proposal

Territorial sensitivity

Territorial (regional) sensitivity

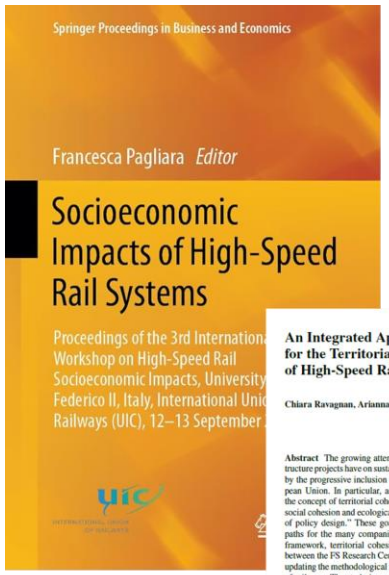
can be described as the degree to which a territory (region) is directly and indirectly affected, either adversely or beneficially by change, in relation to "***how single territories/regions are subject to specific fields, due to their socio-economic and geographical characteristics and to the social values and territorial stakeholders they are likely to show***", taking into account possible benefits of infrastructure on functional organization, environment and communities (ESPON, 2012).

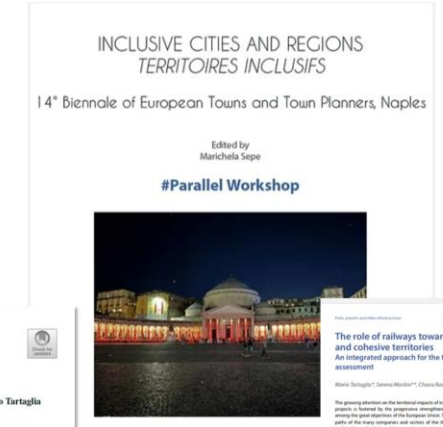


Sr,c = *regional sensitivity to the criteria/indicator* c 0≤ Sr,c≤1

>>> Articulation in 5 ranges

04. Discussion with experts





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05. Stakeholder engagement

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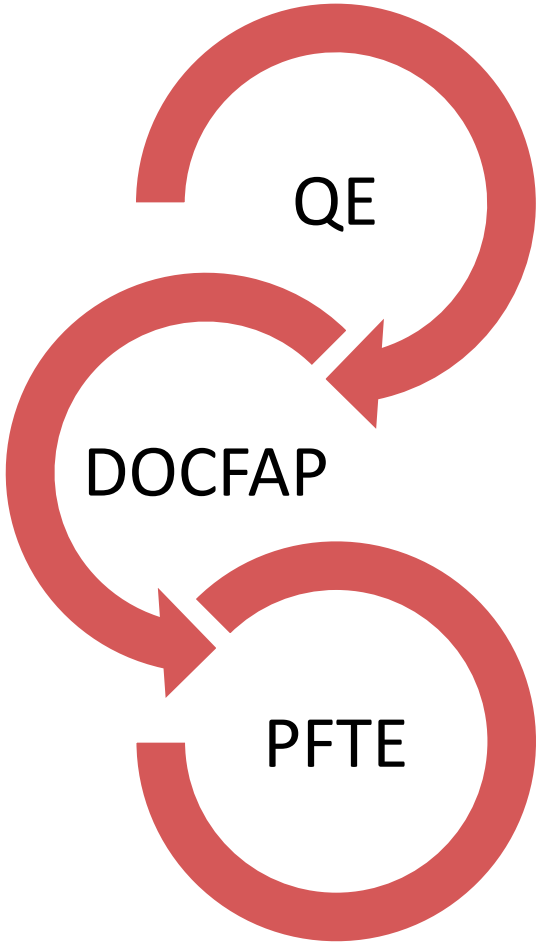
- TIA evaluation in the *Project Requirement Framework*
- Alignment with SDGS
- Alignment with CBA and MCA
- Alignment with Wider Economic Impacts
- Organization of the data flow
- Digitalization processes across companies in SIMS platform

05. Stakeholder engagement

The updated framework



RFI

- Benchmark Analysis of the area
- Guidelines for TEA in relation to the project classification (type), potential, funding source, Ten-T

ITF/RFI

- Update and align MCA indicators

ITF

- Update framework for the development of TI Assessment

05. Stakeholder engagement

The Quadro Esigenziale – *Requirements framework*

The **QE** specifies the needs of the community and the client in relation to the project to be carried out and identifies the objectives to be pursued in a strategic vision of sustainable development.

Key drivers of sustainability

- TEN-T connectivity
- improved accessibility to rail transport;
- reduction of territorial inequalities;
- modal shift, reduction of climate-changing emissions.

The added value of TIA

The QE includes a knowledge layer for the socioeconomic characterization of the area affected by the intervention, which includes governance, demographic, economic, environmental, and other indicators. At this stage, territorial sensitivity analysis can provide a **useful contribution** to the **representation** of benchmarks for identifying indicators that **lag behind national levels**, highlighting any critical issues and determining the relevance of the intervention to reduce territorial disparities.

Possible integration into QE

Sensitivity analysis of TIA
provides a benchmark in the areas of :

- Consistency of the project initiative with territorial governance
- Socio-economic analysis of the intervention area
- Analysis of the environmental and landscape system

Determine whether the reference territory shows a gap compared to the country

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05. Stakeholder engagement

DocFAP – *Document of feasibility of design alternatives*

DOCFAP develops a comparative analysis of design alternatives based on the requirements and objectives outlined in the QE to identify the best alternative.

Key drivers of sustainability

- Conservation of natural resources and biodiversity;
- Reduction in environmental costs;
- Active and integrated governance;
- Enhancement of the landscape and fabric of society;
- Connectivity, access to services and opportunities.

Current situation has been analyzed, in terms of which TIA's indicators are currently used in:

- Transportation studies
- Costs Benefits Analysis
- Multi-Criteria Analysis.

For the same studies, integration proposals have been developed, where it was felt that added value could be brought.

Multi-criteria analysis would be the analysis tool with the greatest integration of some TIA indicators

Key considerations for the category indicators: Territorial Efficiency and Territorial Identity

SUSTAINABILITY REPORT (MIMS, 2021)	STEMA DETERMINANTS AND INDICATORS (Prezioso, 2018)		TEQUILA COHESION PILLARS AND INDICATORS (Camagni, 2006)		INDICATORS	State				Possible additions			
	PILLARS	INDICATORS	PILLARS	INDICATORS		SdT	AMC	ACB	Note	SdT	AMC	ACB	Note
REDUCTION OF TERRITORIAL IMBALANCES	SUSTAINABLE GROWTH	Risk	Territorial Efficiency	Risk Reduction	Railway infrastructure safety (reduction of interference)	x		x	The costs of carrying out the repair works and the benefits related to the reduction of deaths/injuries and the time saved on the road and rail for users are being evaluated.		x		if attribute not invariant among design alternatives
		Multimodal accessibility		External accessibility and interregional integration	External accessibility (to national and international infrastructure nodes)	x			We typically estimate accessibility through transportation analyses, based on project characteristics. Rarely do we specifically assess international accessibility.	x	x	x	Depending on the project: through the SdT, we estimate the reduction in access/egress time and the impact on the number of people benefiting from this reduction. Through the CBA, we monetize this benefit, evaluating its economic feasibility. In terms of territorial cohesion, this indicator could be included if the quantification of the attribute itself differs among the project alternatives.
				General accessibility	Infrastructural equipment						x		if the quantization of the attribute itself turns out to be different
				Internal Connectivity	Regional internal connectivity								
	INCLUSIVE GROWTH	Life expectancy		Relative share of public transport and absence of congestion	Safety of people (reduction of accidents)	x		x	We usually estimate modal shifts in the SdT and the related accident savings in the ACB, monetizing the benefit.				For TIA: the number of accidents could be used as a metric instead of the modal shift
		Unequal distribution of regional income		Development of regional GDP and reduction of income inequalities	Expense for work purposes						x		if attribute not invariant among design alternatives
					Expense for tourism purposes						x		if attribute not invariant among design alternatives
PROMOTION OF SOCIAL INCLUSION AND IMPROVEMENT OF THE QUALITY OF LIFE		Cultural opportunities	Territorial Identity	Visibility and enhancement of cultural heritage and landscape resources	Accessibility an enhancement of historical-cultural and naturalistic heritage					x	x		In terms of territorial cohesion, this indicator could be included if the quantification of the attribute itself is different between the project alternatives.
										x	x		In terms of territorial cohesion, this indicator could be included if the quantification of the attribute itself is different between the project alternatives.
										x	x		In terms of territorial cohesion, this indicator could be included if the quantification of the attribute itself is different between the project alternatives.
				Development of territorial "vocations" and "visions"	Development of sustainable and resilient territorial visions	x			We routinely check that the estimated performances are in line with the targets of the current programming.		x		In terms of territorial cohesion, this indicator could be included if the quantification of the attribute itself is different between the project alternatives.
					Territorial leadership and stakeholder engagement								
		Cultural opportunities	Territorial Quality	Quality of life and access to public facilities	Increase in spaces for collective use						x		In terms of territorial cohesion, this indicator could be included if the quantification of the attribute itself is different between the project alternatives.
											x		In terms of territorial cohesion, this indicator could be included if the quantification of the attribute itself is different between the project alternatives
					Accessibility to urban and metropolitan services	x		x	We usually estimate modal shifts in the SdT and the related time savings between o/d, monetizing the benefit.	x	x		In terms of territorial cohesion, this indicator could be included if the quantification of the attribute itself is different between the project alternatives.
REDUCTION OF POLLUTION, MITIGATION AND ADAPTATION TO CLIMATE AND TRANSITION TOWARDS A CIRCULAR ECONOMY	SUSTAINABLE GROWTH	CO2 emissions		Protection, saving and regeneration of environmental resources	Mitigation of the effects on climate change	x		x	We usually estimate the savings in vehicle kilometres and CO2 emissions in the CBA, monetising the benefit.	x	x		We usually estimate the savings in vehicle kilometres and CO2 emissions in the CBA, monetising the benefit.
		Air			Air quality	x		x	We usually estimate the savings in vehicle kilometers and polluting emissions in the ACB, monetizing the benefit.	x	x		We usually estimate the savings in vehicle kilometers and pollutant emissions in the CBA, monetizing the benefit.
		Self Sufficiency Energy			Use of renewable energies			x	We usually evaluate climate change and polluting emissions in the CBA by considering various energy supplies from increasingly renewable sources over the years (ES source), monetizing the benefit.		x		This indicator could be inserted if the quantization of the attribute itself is different between the design alternatives.
		Waste			Saving and reusing resources				We are used to using indicators in AMC for earth movement, specifically to date not on the reuse of excavated earth.		x		This indicator could be inserted if the quantization of the attribute itself is different between the design alternatives
							x		We are used to using this indicator in the AMC.				
									We are used to using indicators in AMC relating to land use, but not specifically on renaturalization.		x		This indicator could be included in the development of AMC, if the quantization of the attribute itself is different between the design alternatives.

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05. Stakeholder engagement

The **PFTE -** *Technical and Economic Feasibility Project*

The **PFTE** is a design document that assesses the technical and economic feasibility in the context of public works. It includes studies, analyses, and evaluations to define the project's characteristics, costs, and benefits, and to ensure its sustainability and compliance with regulations.

SUSTAINABILITY REPORT (MIMS, 2021)	STEMA DETERMINANTS AND INDICATORS (Prezioso, 2018)		TEQUILA COHESION PILLARS AND INDICATORS (Camagni, 2006)		INDICATORS	METRIC	TERRITORIAL BENCHMARKS
	PILLARS	INDICATORS	PILLARS	INDICATORS			
REDUCTION OF TERRITORIAL IMBALANCES	SUSTAINABLE GROWTH	Multimodal accessibility	Territorial Efficiency	External accessibility and interregional integration	External accessibility (to national and international infrastructure nodes)	Variation of access times to HSR stations (active mobility)	SNAI Peripheriсity
				Internal Connectivity	Regional internal connectivity	Reducing the distance of territories from HSR stations or new HSR stations	Existing and projected Ten-T network
				General accessibility	Infrastructural equipment	Increase of railway equipment per 10.000 inhabitants (km of railways per inhabitant)	Regional railways density per capita compared to national and european average
				Traffic Reduction	Traffic congestion reduction	Modal shift (Additional % of railway modal share in relation to car share)	National and regional motorization rate compared to the European average
		Life expectancy		Safety	Interference Minimisation	Rail crossing reduction (n.) Pedestrian crossings addition (no.)	Accident rate compared to the European average
		Unequal distribution of regional income		Development of regional GDP and reduction of income inequalities	Expense for work purposes	Value of the increase in traffic for work reasons due to the additional business expense (euro/year)	Regional GDP per capita compared to the national and European average
					Expense for tourism purposes	Value of the increase in tourist traffic due to the additional tourist expenditure (euro/year)	Added valute of tourism per capita compared to the national and European average
PROMOTION OF SOCIAL INCLUSION AND IMPROVEMENT OF THE QUALITY OF LIFE		Cultural opportunities	Territorial Identity	Enhancement of cultural heritage and landscape resources	Accessibility an enhancement of historical-cultural and naturalistic heritage	Reduction of distances from HS stations to regional and national parks or Natura 2000 network (km)	National accessibility of the Parks
						Reduction of distances from AV stations from archaeological areas (km)	National accessibility of archaeological areas
						Reduction of distances from high-speed stations, cycle paths and cultural and tourist itineraries (km)	National accessibility of the Cycleways
					Regeneration of landscape	Regeneration of degradated landscape (n. of actions)	BES Landscape satisfaction index
				Development of territorial "vocations" and "visions".	Development of sustainable territorial visions	Compliance with the objectives shared by the Regional Planning/Programming in terms of sustainable infrastructure (n. doc or goals)	Presence of programming and planning documents based on sustainable mobility
		Cultural opportunities	Territorial Quality	Quality of life and access to public facilities	Increase in spaces for collective use	New spaces for social uses (n. or sqm)	Provision of public spaces at the local level
					Accessibility to urban and metropolitan services	Reduction of access times at urban and metropolitan levels (minutes)	Provision of services at municipal and provincial level
REDUCTION OF POLLUTION, MITIGATION AND ADAPTATION TO CLIMATE CHANGE AND TRANSNITION TOWARDS A CIRCULAR ECONOMY	SUSTAINABLE GROWTH	CO2 emissions		Protection, saving and regeneration of environmental resources	Mitigation of the effects on climate change	Climate-changing gas emissions avoided (tCO2e)	Regional emissions in relation to european average
		Air			Air quality	Reduced polluting emissions (t)	Regional emissions in relation to european average
		Self Sufficiency Energy			Use of renewable energies	Percentage of energy used from renewable sources (%)	Use of renewable energies at national and regional level
		Waste			Saving and reusing resources	Volumes of excavated land reused (mc)	Regulation threshold
						Energy savings resulting from the modal shift (%)	Regulation threshold
						Renaturalisation and/or reclamation of soil and vegetation (sqm)	Regulation threshold

Alignment with other methodologies

- SDGs
- WEI -Wider Economic Impacts
- BES - Sustainable and equal wellbeing KPI
- EIA - Economic Impact Assessment

06. Guidelines

1. Objectives and scope of application of the Guidelines

- 1.1 Objectives of the guidelines. The contribution of infrastructure projects to territorial cohesion
- 1.2 Scope of application. Sustainability assessments

2. Technical-scientific and regulatory references and setting of the methodological structure

- 2.1 Territorial Impact Assessment TIA
- 2.2 The SDGs
- 2.3 The 2021-2027 Cohesion objectives
- 2.4 The Envision Protocol
- 2.5 Setting of the methodological structure

3. Methodological references for the assessment of the territorial impacts of railway infrastructures

- 3.2 The pillars of territorial cohesion
- 3.3 The indicators of territorial impacts
- 3.4 The sensitivity of the Regions
- 3.5 The methodology for the project TIA

4. Attachments

- The reference documents
- The case study application

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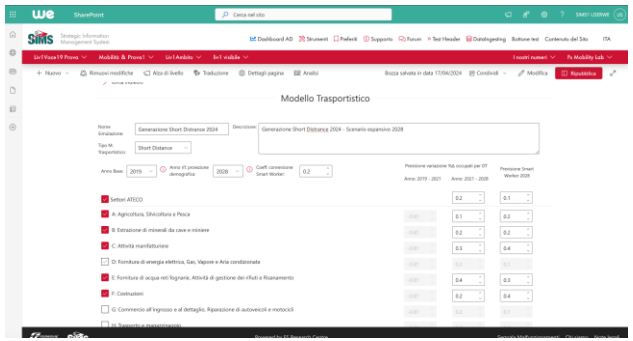
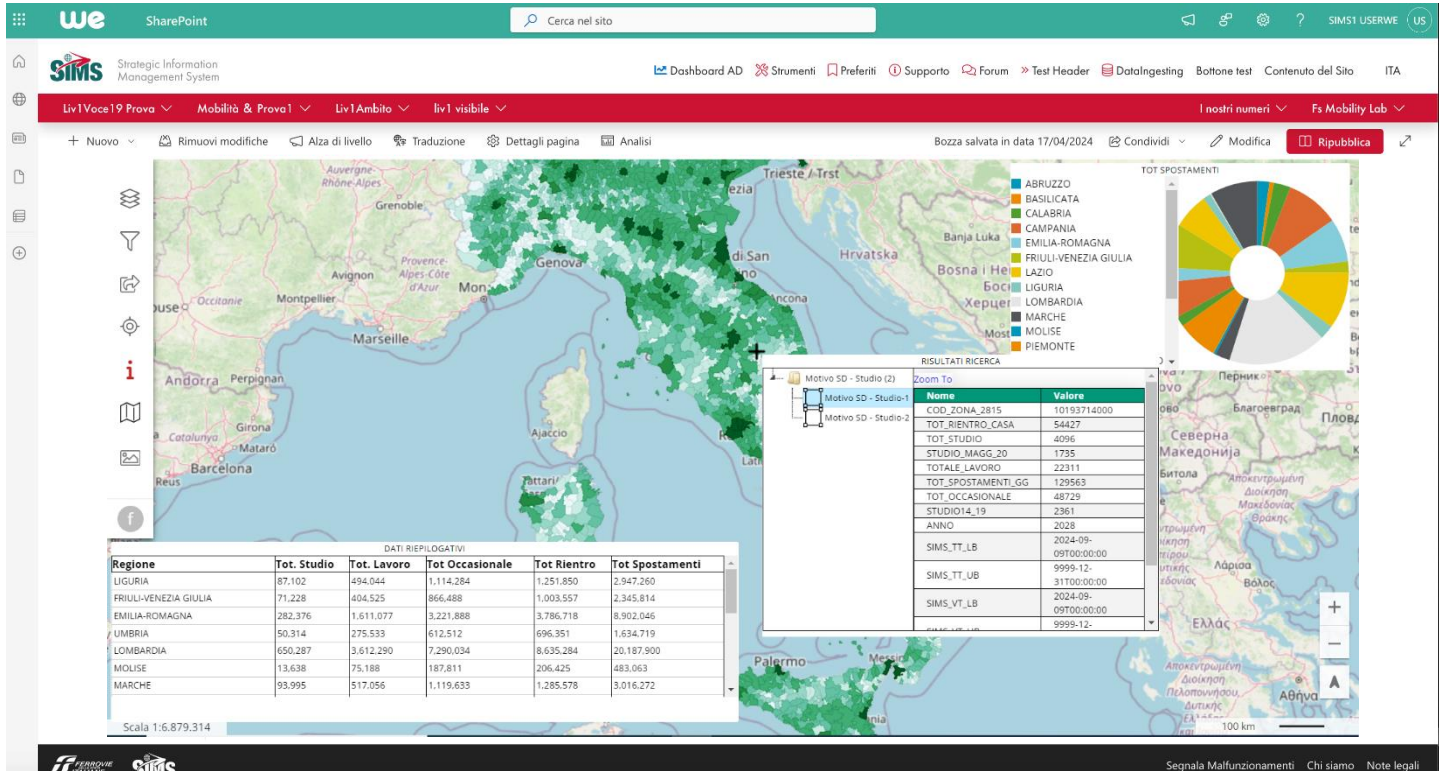
07. TIA & SIMS

The Ferrovie dello Stato Italiane Group has adopted and continues its roadmap for the implementation of a **Strategic Information Management System (SIMS)** aimed at supporting the strategic decision-making processes of the Holding Company FS Italiane and the other FS Group companies and at the collection, storing and processing of official Group data according to the "Process of Supply and Management of Official Data of the FS Italiane Group".
The purpose of the SIMS is to support the collection and supply of data, information, and information tools through appropriate analysis tools and through the creation of a Data Warehouse.



The Data Warehouse of SIMS and its application and presentation layers based on the Geo-Business Intelligence paradigm guarantees the segregation of data and representations (WebGIS and Geo-BI apps) by profiling of users.
SIMS is, therefore, the perfect container for enterprise-level distribution of TIA framework in a groupware and collaborative environment.



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08. Conclusions and future developments

- Development of **new KPIs**: Urban planning compliance
- Development of **dynamic benchmark maps**: TEN-T network map
- Possible **integration with EIA** framework developed by FS Research Centre
- Involvement of **external stakeholders** in the discussion, including UIC, ISTAT (National Statistic Institute), INU (National Urban Planning Institute), ISPRA (Environmental Protection and Research Institute).
- Release of the **Guidelines** for Railway Projects
- Development of the **TIA digital tool** in FS «Strategic Information Management System»

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https://www.italferr.it/en/sustainability-.html

#RFI
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